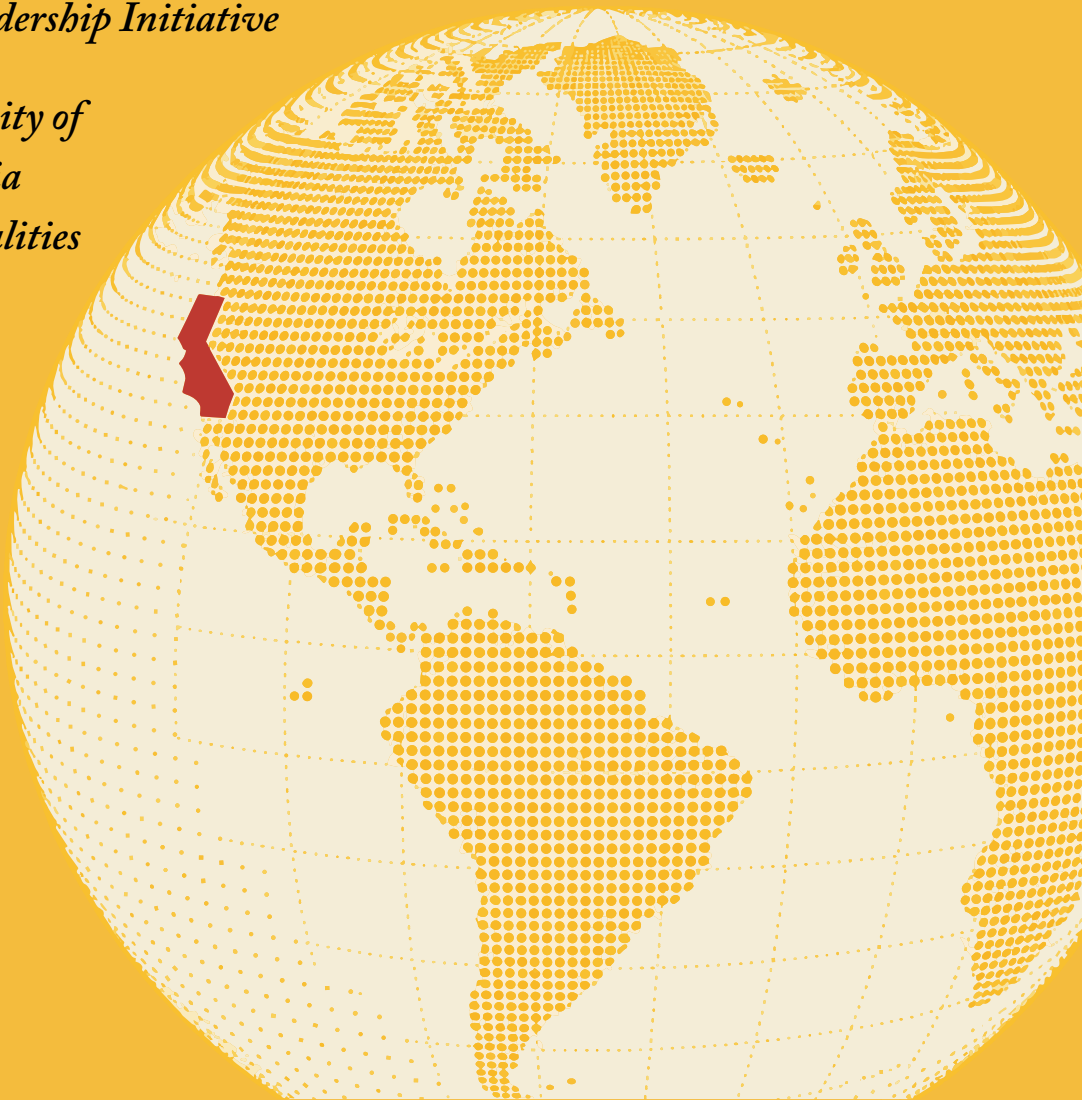
CALIFORNIA'S GLOBAL HEALTH DIVIDEND

The Case for State Leadership

A multi-institutional research project of the California Global Health Leadership Initiative

Led by the University of Southern California Institute on Inequalities in Global Health



NOVEMBER
2026

USC Institute on Inequalities in Global Health

FRIENDS OF THE GLOBAL FIGHT | AGAINST AIDS, TUBERCULOSIS AND MALARIA

ALLIANCE FOR INNOVATION IN Global Health

CDU

UNIVERSITY OF CALIFORNIA Global Health Institute

UCLA Center for Global Health Security

UCSF Institute for Global Health Sciences

STANFORD CENTER FOR INNOVATION IN GLOBAL HEALTH

CALIFORNIA'S GLOBAL HEALTH DIVIDEND: THE CASE FOR STATE LEADERSHIP

A multi-institutional research project of the California Global Health Leadership Initiative

Led by the University of Southern California Institute on Inequalities in Global Health

IN PARTNERSHIP WITH

Alliance for Innovation in Global Health

Charles R. Drew University of Medicine and Science Office of International Affairs

Friends of the Global Fight Against AIDS, Tuberculosis and Malaria

Stanford Center for Innovation in Global Health

University of California, San Francisco Institute for Global Health Sciences

University of California Global Health Institute

University of California, Los Angeles Center for Global Health Security

WITH SUPPORT FROM

Coefficient Giving

NOVEMBER 2026

USC Institute on Inequalities in Global Health

The University of Southern California (USC) Institute on Inequalities in Global Health (IIGH) seeks to address the systemic inequalities that prevent millions of people from leading healthy, fulfilling lives. IIGH works with partners across USC and around the world to drive change through a powerful combination of impact-oriented research, next-generation education, and cutting-edge policy interventions, embedding a human rights lens to create solutions that are equitable and sustainable.

IIGH's vision is a just and healthy world: one in which health is understood as a human right, not a privilege.

EDITOR
Jonathan E. Cohen, *J.D., M.Phil.*

SECRETARIAT
Jonathan E. Cohen, *J.D., M.Phil.*
Chris Collins, *M.P.P.*
Laura Ferguson, *Ph.D., S.M.*
Sofia Gruskin, *J.D., M.I.A.*

CHAPTER CONTRIBUTORS
Yugen Chen, *M.S.*
Chris Collins, *M.P.P.*
Sarah Emoto, *M.P.H.*
Laura Ferguson, *Ph.D., S.M.*
Paul Ngangula, *M.S.-G.H., B.Eng.*
Saskia Popescu, *Ph.D., M.P.H., M.A., CIC, FAPIC*
Amber Reza, *M.B.B.S., M.P.H.*

PROJECT PARTNERS AND PEER REVIEWERS
Sara Anderson, *Alliance for Innovation in Global Health*
Michele Barry, *Stanford Center for Innovation in Global Health*
Madhavi Dandu, *University of California Global Health Institute*
Cynthia Davis, *Charles R. Drew University of Medicine and Science*
Andrea DeLuca, *University of California, San Francisco*
Lejeune Lockett, *Charles R. Drew University of Medicine and Science*
Amanda Marr Chung, *Stanford Center for Innovation in Global Health*
Payam Nahid, *University of California, San Francisco*
Anne Rimoin, *University of California, Los Angeles Center for Global Health Security*
Lara Stemple, *University of California Global Health Institute*
Allison Tatarsky Berman, *University of California, San Francisco*

RESEARCH ASSISTANTS
Vanessa Andrick
Luke Frikert
Abigail Moreno
Liam Rafaty
Sophia Samson
Maya Ueoku

COPYEDITORS
Kristin Kelly Jangraw
Samantha Majerus
Stephanie Oppenheimer
Summer Peet

DESIGNER
Albert Berces

ABOUT THE CHAPTER CONTRIBUTORS

Yugen Chen, *M.S.,* is a Ph.D. candidate in economics at the University of Southern California and conducts research at the USC Schaeffer Center for Health Policy & Economics.

Jonathan E. Cohen, *J.D., M.Phil.,* is a professor of clinical population and public health sciences at the University of Southern California, where he also serves as director of policy engagement for the USC Institute on Inequalities in Global Health.

Chris Collins, *M.P.P.,* is president and CEO of Friends of the Global Fight Against AIDS, Tuberculosis and Malaria.

Sarah Emoto, *M.P.H.,* carried out this work while working as a research program specialist at the USC Institute on Inequalities in Global Health. She is currently studying for an M.A. in the History of Science, Technology and Medicine at the University of Manchester.

Laura Ferguson, *Ph.D., S.M.,* is an associate professor of population and public health sciences at the University of Southern California, where she also serves as the director of research for the USC Institute on Inequalities in Global Health.

Paul Ngangula, *M.S.-G.H., B.Eng.,* is a D.Phil. (Ph.D.) candidate in social intervention and policy evaluation at the University of Oxford and a consultant to Friends of the Global Fight Against AIDS, Tuberculosis and Malaria.

Saskia V. Popescu, *Ph.D., M.P.H., M.A., CIC, FAPIC,* is an assistant professor of epidemiology and public health within the University of Maryland School of Medicine and the CEO of the Global Health Security Network.

Amber Reza, *M.B.B.S., M.P.H.,* is a physician and a special research adviser at Friends of the Global Fight Against AIDS, Tuberculosis and Malaria. She holds an M.P.H. from the Keck School of Medicine of USC.

Table of Contents



4
Table of Abbreviations

6
Executive Summary

9
Introduction

19
Chapter 1: Influence as Partnership: The Reciprocal Benefits of California's Global Health Engagement

39
Chapter 2: The Impact of Federal Global Health Spending on California's Economy

63
Chapter 3: The Impact of Global Health Partnerships on Biomedical and Technological Innovation in California

89
Chapter 4: Global Biosurveillance and Infectious Disease Detection in California

117
Conclusion

Table of Abbreviations

AFRIMS	Armed Forces Research Institute of Medical Sciences
AI	Artificial intelligence
AIDS	Acquired immunodeficiency syndrome
AMC	Advance market commitment
AMR	Antimicrobial resistance
APHIS	Animal and Plant Health Inspection Service, U.S. Department of Agriculture
ARPA-H	Advanced Research Projects Agency for Health
ASPR	Administration for Strategic Preparedness and Response
AVAC	AVAC *(formerly AIDS Vaccine Advocacy Coalition)*
BARDA	Biomedical Advanced Research and Development Authority
BEA	Bureau of Economic Analysis
BMC	BMC *(formerly BioMed Central)*
CAHFS	California Animal Health and Food Safety Laboratory System
Cal OES	California Governor's Office of Emergency Services
CalREDIE	California Reportable Disease Information Exchange
CARB-X	Combating Antibiotic-Resistant Bacteria Biopharmaceutical Accelerator
CDC	Centers for Disease Control and Prevention
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health
CEDAW	Convention on the Elimination of All Forms of Discrimination Against Women
CE-IVD	Conformité Européenne marking for in vitro diagnostic medical devices
CEO	Chief executive officer
CHANGE	City Hub and Network for Gender Equity
CHMP	Committee for Medicinal Products for Human Use *(European Medicines Agency)*
COP	Conference of the Parties
COREQ	Consolidated Criteria for Reporting Qualitative Research
COVID-19	Coronavirus disease 2019
COVIDNet	California COVIDNet, the state genomic sequencing network
CPC	Cooperative Patent Classification
CpG	Cytosine-phosphate-guanine (in CpG 1018 adjuvant)
DARPA	Defense Advanced Research Projects Agency
DHS	U.S. Department of Homeland Security
DNA	Deoxyribonucleic acid
DoD	U.S. Department of Defense
DRC	Democratic Republic of the Congo
DRIVe	Division of Research, Innovation, and Ventures
EBS	Event-based surveillance
EIOS	Epidemic Intelligence from Open Sources, WHO
FAIN	Federal Award Identification Number
FCTC	Framework Convention on Tobacco Control
FDA	Food and Drug Administration
FIND	Foundation for Innovative New Diagnostics *(now FIND, the global alliance for diagnostics)*
FTE	Full-time equivalent
FY	Fiscal year
Gavi	Gavi, the Vaccine Alliance
GDD	Global Disease Detection, a CDC program
GDP	Gross domestic product
GDPDEF	GDP implicit price deflator
GEIS	Global Emerging Infections Surveillance, U.S. Department of Defense
G-FINDER	Global Funding of Innovation for Neglected Diseases
GHSA	Global Health Security Agenda
GISAID	Global Initiative on Sharing All Influenza Data
GISRS	Global Influenza Surveillance and Response System
GLASS	Global Antimicrobial Resistance and Use Surveillance System
GOARN	Global Outbreak Alert and Response Network
H1N1	Influenza A virus subtype H1N1
H5N1	Influenza A virus subtype H5N1
HealthMap	HealthMap digital disease biosurveillance platform
HHS	U.S. Department of Health and Human Services
HIV	Human immunodeficiency virus
HIV-1	Human immunodeficiency virus type 1
HIV/AIDS	Human immunodeficiency virus / acquired immunodeficiency syndrome
HPAI	Highly pathogenic avian influenza
HRSA	Health Resources and Services Administration
ICLEI	Local Governments for Sustainability *(formerly International Council for Local Environmental Initiatives)*
ICT	Information and communication technology
IDVs	Indefinite-delivery vehicles

IHR	International Health Regulations *(2005)*
IMGs	International medical graduates
IMPLAN	Impact Analysis for Planning
INSIGHT	International Network for Strategic Initiatives in Global HIV Trials
KFF	Kaiser Family Foundation
KI	Key informant
KPSS	Kogan-Papanikolaou-Seru-Stoffman
LMICs	Low- and middle-income countries
MMR	Measles, mumps, and rubella
MOU	Memorandum of understanding
MTB/RIF	Mycobacterium tuberculosis and rifampicin resistance *(GeneXpert assay)*
MTB/XDR	Mycobacterium tuberculosis and extensively drug-resistant tuberculosis *(GeneXpert assay)*
NAICS	North American Industry Classification System
NAMRU	Naval Medical Research Unit
NARMS	National Antimicrobial Resistance Monitoring System
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NBIC	National Biosurveillance Integration Center
NCT	ClinicalTrials.gov registration number prefix
NGO	Nongovernmental organization
NHRC	Naval Health Research Center
NIAID	National Institute of Allergy and Infectious Diseases
NIH	National Institutes of Health
NSF	National Science Foundation
NVSL	National Veterinary Services Laboratories
OECD	Organisation for Economic Co-operation and Development
OID	Operational Infectious Diseases
PARRQA	Planning for and Assessing Rigor in Rapid Qualitative Analysis
PATH	PATH *(formerly Program for Appropriate Technology in Health)*
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PHSSEF	Public Health and Social Services Emergency Fund
PIID	Procurement Instrument Identifier
PIPP	Predictive Intelligence for Pandemic Prevention
PLOS	Public Library of Science
PMID	PubMed identifier
PREDICT	USAID PREDICT, a zoonotic pathogen biosurveillance program
PREZODE	Preventing Zoonotic Disease Emergence
ProMED	Program for Monitoring Emerging Diseases
RCR	Relative citation ratio
R&D	Research and development
REMI	Regional Economic Models, Inc.
RIMS II	Regional Input-Output Modeling System II
RQA	Rapid qualitative analysis
rRT-PCR	Real-time reverse transcription polymerase chain reaction
SAM	Social accounting matrix
SARS	Severe acute respiratory syndrome
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SBIR	Small Business Innovation Research
SDGs	Sustainable Development Goals
SNAP-Ed	Supplemental Nutrition Assistance Program Education
SRQR	Standards for Reporting Qualitative Research
TAS	Treasury Account Symbol
TB	Tuberculosis
UC	University of California
UC Berkeley	University of California, Berkeley
UCLA	University of California, Los Angeles
UCSF	University of California, San Francisco
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
U.S.	United States
USAID	United States Agency for International Development
USC	University of Southern California
USDA	U.S. Department of Agriculture
USPTO	United States Patent and Trademark Office
VLR	Voluntary local review
VNR	Voluntary national review
WastewaterSCAN	WastewaterSCAN, a national wastewater monitoring network
WHO	World Health Organization
Wits RHI	Wits Reproductive Health and HIV Institute, University of the Witwatersrand
WOAH	World Organisation for Animal Health
WRAIR	Walter Reed Army Institute of Research



EXECUTIVE SUMMARY

Engagement in global health brings relational, economic, industrial, epidemiological and other health-related benefits to the state of California. We call these benefits *California's global health dividend.*

Global health is at an inflection point, marked by a retreat in U.S. federal leadership and a fundamental rethinking of multilateral health cooperation. This study offers new evidence of the benefits of global health engagement for the nation's most populous state. Drawing on California's deep expertise in global health research, practice and policy, the study brings together eight organizations to make the case for a new era of state leadership in global health.

California has helped define global health — just as global health has helped define California. From San Francisco's grassroots response to HIV and AIDS to pioneering applications of artificial intelligence (AI) to predict disease outbreaks, California has become synonymous with health innovation that benefits the state and the world at large. These reciprocal benefits offer a model of global health leadership rooted in partnership and shared prosperity.

Yet despite California's defining contributions to global health, there is surprisingly little research on how this contribution benefits Californians themselves. This study aims to fill that gap.

Drawing on disciplines from economics to epidemiology to political science, the study finds that California's global health dividend reaches communities across the state and generates benefits spanning multiple sectors. Global health grants bolster California's economy. Global health partnerships generate demand for California products. Global health surveillance helps California authorities detect and respond to biological threats. Global health partnerships influence California's own health programs.

These benefits are mutually reinforcing. The federal dollars that enhance California's biosurveillance systems also bring jobs to the state. The ecosystem of scientists, inventors and technicians who propel biomedical products to market also attracts top international talent to California's universities. The international partnerships that spur biomedical innovation also generate critical information during disease outbreaks.

Many of these benefits accrue to Californians who need them most. Cross-border partnerships have advanced progress toward eliminating tuberculosis (TB), a disease that occurs mostly among Californians who are Asian or Hispanic. Global biosurveillance has helped to detect illnesses such as dengue and mpox that hit Black, Hispanic and Latino communities the hardest. International research partnerships have improved telehealth delivery of reproductive health care, benefiting Californians without access to facility-based care. U.S. bilateral HIV/AIDS assistance in countries such as Ethiopia, Kenya and Nigeria may ease financial and caregiving burdens for California's African diaspora communities.

For Californians, cooperating with other countries to address shared health challenges transcends motivations of charity and self-interest. Global health is a natural expression of the state's diversity, connectedness and innovative spirit.

STUDY FINDINGS

1.
GLOBAL HEALTH INFLUENCE AS PARTNERSHIP

A primary domain of California's global health dividend consists of the diplomatic and public health benefits that the state and its international collaborators accrue from trust-based partnerships.

FINDING 1A

Global health engagement gives California international influence beyond its formal authority.
Through multilateral initiatives, paradiplomacy, knowledge production, workforce development and participation in epistemic communities, California helps shape global policies, standards and responses. This influence extends to diverse health-related fields that matter to Californians, such as border health, climate and the environment, pandemic preparedness, sustainability, tobacco control, urban health and women's health.

FINDING 1B

California's influence is built on trusted relationships, scientific credibility and reliability.
Sustained partnerships, consistent behavior and exceptional knowledge production establish California as a credible and reliable partner. The scale of California's scientific contribution is

substantial: 55,826 publications linked to relevant National Institutes of Health (NIH) grants dated 2016-2025 involving California institutions were cited more than 2.19 million times by June 2026, with average influence well above that of comparable NIH-funded research. Its diverse ecosystem creates a multiplier effect across research, diplomacy, preparedness and policy.

FINDING 1C

The benefits are reciprocal and directly advance California's interests.

Engagement generates goodwill and diplomatic access while improving outbreak intelligence, institutional capacity, emergency preparedness and health within California. This is all particularly important in the current moment of U.S. federal retreat from multilateral cooperation for health. Better coordinating these strengths and fostering critical international relationships could strengthen global health leadership as a strategic public asset.

2.

GLOBAL HEALTH AS ECONOMIC INVESTMENT

A second domain of California's global health dividend consists of the economic activity generated by federal global health dollars spent in the state.

FINDING 2A

Every federal global health dollar spent in California generates an estimated $1.40 to $2.15 in economic activity, totaling more than $46 billion in the study period.

Federal global health-related funding of $21.5 billion from 2016 to 2025 generated about $30.2 billion in economic output and about 157,000 job-years in California, 40% more than the funding investment. When spending from wages is included, the estimates rise to $46.3 billion in output, $28.6 billion in value added and approximately 239,000 job-years, more than double the investment.

FINDING 2B

Patents arising from global health funding generate substantial estimated private value.

The study provides the first estimate of the private value of patents emerging from federal global health-related awards, weighted by California inventors' share. These patents generated an estimated $1.9 billion (median-based estimate) to $5.7 billion (mean-based estimate) in private value, expressed in 2024 dollars.

FINDING 2C

Federal cuts threaten the co-location of the people and institutions that make California a hub of global health investment.

California attracts global health research and innovation because research institutions, specialized personnel, clinical infrastructure and private-sector partners are located in close proximity. Because each part of this ecosystem strengthens the others, federal cuts threaten this competitive advantage and could dismantle long-standing partnerships that would take years to reassemble.

3.

DELIVERING GLOBAL HEALTH INNOVATION

A third domain of California's global health dividend consists of the benefit to biomedical innovators of entering into global health partnerships that increase demand for their products.

FINDING 3A

California invents, and global health partnerships deliver.

A twice-yearly HIV prevention medicine developed in Foster City, California, reached nine African countries within a year of U.S. Food and Drug Administration (FDA) approval with purchasing support from the Global Fund to Fight AIDS, Tuberculosis and Malaria and the U.S. State Department. Separate agreements established a price of approximately $40 per person per year for future generic supply. A donor-financed price reduction and subsequent agreement with the Global Fund cut the cost of a TB diagnostic cartridge developed in Sunnyvale, California, by more than half, from $16.86 to $9.98 and then $7.97, on a platform now installed on nearly 50,000 instruments worldwide.

FINDING 3B

International purchasing commitments give California companies predictable demand at scale, allowing greater development, investment, manufacture and reach.

While profits come from markets in wealthy countries, international purchasing commitments from global health institutions let California innovators raise investment capital, reserve manufacturing capacity even before product approval and bring benefit across the world. International purchasing also holds input prices down and returns evidence from products in use, including drug resistance data, to companies' discovery work.

FINDING 3C

California funding could further increase the global health dividend for state residents and increase transparency and tracking.

The California Science and Health Research Bond Act (Senate Bill 895), signed into law in September 2026, could lead to a $7.5 billion state research fund contingent on voter approval, giving the state a share of successful discoveries. Funded companies could be required to report on volumes supplied through donor channels as well as prices and time from approval to delivery in low- and middle-income markets, making California the first jurisdiction to systematically quantify what global health spending returns both at home and abroad.

4.

GLOBAL BIOSURVEILLANCE AND LOCAL DETECTION

A fourth domain of California's global health dividend consists of the increased disease detection and response capacity stemming from California's role in a global ecosystem of biosurveillance.

FINDING 4A

Global biosurveillance and California detection and response capacity are mutually reinforcing.

Federal and state investments in global biosurveillance systems have strengthened California's capacity to detect and respond to life-threatening infectious threats by (a) providing early warning from outside that enables preparedness and public health response and (b) enhancing state biosurveillance activities, including changes to laboratory testing, reporting and case identification. California is a national leader in outbreak detection, identifying the first U.S. cases of pandemic H1N1 influenza in 2009 and of clade I mpox in 2024.

FINDING 4B

Outbreak timelines show that when international warnings reach California before confirmed local cases, the state has time to prepare.

Reconstruction of selected outbreak timelines documents intervals between upstream warning and the first confirmed California case (27 days in the case of COVID-19) during which the state can alert clinicians, prepare laboratories and initiate response. The course of different recent Ebola outbreaks in Africa demonstrates the critical importance of time, laboratory capacity, screening and response in potentially making the difference between catastrophe and containment.

FINDING 4B

California relies on global field programs and monitoring capacity for its outbreak response.

Recent disruptions to federal global health funding endanger the international partnerships, laboratory networks, trained personnel and relationships needed in an outbreak emergency. Sustaining the field programs of California universities and other institutions, as well as the capacity of California public health laboratories, genomic and wastewater monitoring, and public health workforce, is a critical complement to California's participation in the World Health Organization's (WHO) Global Outbreak Alert and Response Network (GOARN) and is essential to state health security.

THE OPPORTUNITY: EXPANDED GLOBAL HEALTH LEADERSHIP

Animating this study is the question of how California will sustain its legacy of global health leadership in a shifting global context. Since January 2025, the U.S. government's dramatic retreat from decades of bipartisan commitment to global health has coincided with a broader transformation of the global health architecture seeking greater focus on partnerships to advance country-led priorities. No state can make up for the U.S. government's role in global health. But California's scientific capacity, economic power, political leadership and international standing make it a natural leader in this moment of change.

California has asserted global health leadership through participating in international biosurveillance networks and interstate public health alliances. Looking ahead, phenomena such as AI, healthy aging and One Health will present new opportunities in which California has an outsized role. The California global health dividend will grow or shrink depending on how the state's city, county, state and congressional officials exercise leadership in response to these opportunities. The question is whether this dividend can be increased and sustained — with benefits reaching all Californians, including those most exposed to health risks that cross borders.

ABOUT THIS STUDY

Each chapter of this study investigates a dimension of how California has helped invent and sustain the field of global health, and how Californians have benefited in return. Prepared by separate author teams under the guidance of a Secretariat and project partners, the chapters reflect methodological lenses of epidemiology, economics, political science and case-study research.

- The **Introduction** situates the study within California's legacy of global health leadership and current trends in global health, drawing out key themes from the individual chapters and the interplay between them.
- **Chapter 1** combines literature review, interviews and citation analysis to examine how California exercises global health influence through trust-based partnerships that generate mutual benefit inside and outside the state.
- **Chapter 2** uses quantitative analysis of federal transactions and input-output modeling to estimate the economic activity associated with federal global health spending in California over a 10-year period.
- **Chapter 3** synthesizes interviews and documentary evidence into case studies that demonstrate the reciprocal benefits of global health partnerships with California-based biomedical innovators.
- **Chapter 4** reconstructs detection timelines for select pathogens and interprets them with documentary evidence and expert interviews to describe how global biosurveillance systems strengthen California's detection and response capacity.
- The **Conclusion** calls for a new era of California global health leadership from the city, county, state and congressional levels, drawing on lessons from the study to inform California's leadership role.

The chapters were overseen and edited by faculty at the University of Southern California Institute on Inequalities in Global Health, with Secretariat support from Friends of the Global Fight Against AIDS, Tuberculosis and Malaria. Project partners representing six California institutions guided the definition of research questions, advised the chapter researchers and peer-reviewed chapters. The study marks the launch of the California Global Health Leadership Initiative, which brings the study partners and other stakeholders together to define a shared vision and mobilize collective action toward a new era of global health leadership in California.

INTRODUCTION

California's Global Health Dividend



JONATHAN E. COHEN

In February 2026, researchers monitoring elephant seals at California's Año Nuevo State Park observed young seals displaying unusual neurological symptoms. Within days, laboratory testing confirmed the state's first outbreak of highly pathogenic avian influenza A (H5N1) virus in marine mammals. California researchers had already intensified their surveillance at Año Nuevo, in part because a team of wildlife researchers and virologists from California and Argentina had seen evidence of the virus spreading between marine mammals in Patagonia.

• KEY TAKEAWAYS •

- **A new interdisciplinary initiative.** The newly formed California Global Health Leadership Initiative combines interdisciplinary expertise in political science, economics, public health and other fields to estimate the diverse benefits of global health engagement for the state of California, with implications for other subnational actors.
- **The benefits of global health to California.** This study provides evidence of four types of benefit that flow back to California from its global health engagement — trust-based partnerships that generate reciprocal health-related benefits; economic activity associated with federal global health grants; increased access to and demand for California biomedical innovations from global health partnerships; and strengthened disease detection and response capacity from global biosurveillance systems.
- **An opportunity to lead.** In the wake of dramatic cuts to U.S. global health programs, California's political leaders at all levels of government — city, county, state and congressional — have an opportunity to continue the state's legacy of global health leadership by safeguarding the global health partnerships, systems and institutions on which the state relies and bringing the benefits of global health engagement home to their constituents.

Meanwhile, the National Science Foundation's $18 million Center for Pandemic Insights, established at the University of California, Davis in 2024, was advancing the use of drones and novel sensors to improve disease detection in wildlife populations. Public officials responded to the H5N1 outbreak by immediately closing public viewing areas, issuing advisories to protect residents and pets, monitoring potentially exposed workers and expanding disease surveillance along the California coast. The outbreak's last reported cases occurred in March, and it was officially declared over in May 2026.

This study introduces the concept of the California global health dividend: the constellation of relational, economic, industrial, epidemiological and other benefits that the state of California accrues from cooperating across borders to address shared health-related threats and opportunities. Recent precipitous declines in development assistance have focused attention on the motivations of high-income economies, such as the United States, for investing in global health research and programs, including whether these motivations stem primarily from moral obligation or self-interest (Bharali et al., 2026). This study examines the benefits of global health engagement for the U.S. state of California — the most populous in the nation, the fourth-largest economy in the world and a historic engine of U.S. global health leadership.

For California — a state defined by its demographic diversity, active land borders and ports and globally connected communities — global health engagement is nothing short of an expression of the state's core identity. San Francisco's grassroots response to HIV and AIDS, among the deadliest pandemics in modern history, became a model of local action with global reach (Kevany, 2015). In southern California, Latino immigrants and their children have helped build statewide networks of health promoters ("promotores de salud") that bring a model of community health work to the state (Assembly Floor, 2009; Bracho & Lee, 2020). For the state's current leadership, recent changes to the global health architecture are now forcing the question of how a new generation of political leadership can build on this historic track record of global health engagement to mitigate the risks posed by national disinvestment.

This study is the first to reckon with the California global health dividend across multiple domains of reciprocal benefit. In the chapters that follow, we explore the impact of California's global health engagement on the state's diplomatic influence, economic activity, industrial and scientific innovation, and health security. Earlier research established that global health is a substantial sector of the California economy (Nandi, 2009) and quantified the jobs in the state supported by global health financing (Global Health Technologies Coalition, 2017). Those accounts described the size of a sector or a particular impact of global health funding. Building on this evidence, this study explores a set of questions that capture the impacts of global health engagement across multiple domains. What is the return on investment to the state from a dollar in federal global health funding? What is the financial value to California researchers or institutions from global health-related patents? How have California leadership and scientific credibility drawn international talent to the state? How have California experts exercised influence on committees that determine international guidelines to the reciprocal benefit of the state and its development partners? How have purchasing agreements from multilateral health agencies shaped production and deployment of transformative life science innovations by California companies? How have federal grants built California's capacity to detect and contain disease outbreaks? How have lessons learned by researchers working on health issues impacting low- and middle-income countries returned benefit to California towns and cities and vice versa?

The questions addressed in this study are selective rather than exhaustive of the range of benefits that California accrues from its global health engagement. Study partners,[1] members of the newly formed California Global Health Leadership Initiative, began with a long list of research questions spanning domains of international diplomacy, the economy, innovation and health security. Partners selected what they considered to be the key question per domain in order to experiment with various approaches to describing California's global health dividend and to catalyze additional research, both in California and other jurisdictions. The study's purpose is thus to open a research agenda and a political conversation that furthers understanding of the role of subnational actors in the international health ecosystem and the benefits to these actors of global health investment.

LEADERSHIP AT A CROSSROADS

In 1999, a newly elected U.S. Congresswoman from Oakland introduced legislation calling for an "AIDS Marshall Plan for Africa," helping to set in motion a bipartisan consensus that would transform global health. Four years later, Congress took up Rep. Barbara Lee's and the Congressional Black Caucus's call to create the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) and authorized U.S. support for the Global Fund to Fight AIDS, Tuberculosis and Malaria (Rourke, 2023). Representative Nancy Pelosi of San Francisco led the bipartisan effort to secure the first U.S. contribution to the Global Fund and worked with Presidents George W. Bush and Barack Obama to more than double bilateral funding for global AIDS programs (Office of Speaker Emerita Nancy Pelosi, n.d.). California members of Congress from both parties would continue to play leading roles in sustaining PEPFAR. In 2008, Democrat Howard Berman from Los Angeles led the program's $48 billion reauthorization, and in 2018, Republican and House Foreign Affairs Committee Chairman Ed Royce from Orange County advanced the reauthorization bill sponsored by Republican Chris Smith of New Jersey and co-sponsored by Barbara Lee. During the 2013 debate on PEPFAR reauthorization, Barbara Lee publicly thanked Chairman Royce for keeping PEPFAR bipartisan (House Committee on Foreign Affairs, 2008; U.S. Congress, 2013).

For California, global health engagement is nothing short of an expression of the state's core identity.

The question of how California continues that legacy of leadership animates this study. In January 2025, the U.S. government initiated a dramatic retreat from the bipartisan global health consensus that leaders from California and other states had long maintained. This began with a 90-day foreign aid freeze and the dismantling of the U.S. Agency for International Development (USAID), which would see over 80% of its programs close and the remainder absorbed into the U.S. Department of State (Tanis & Fadel, 2025; Sulgodu Ramachandra & Webster, 2025). Shortly thereafter, the U.S. initiated its exit from the World Health Organization, ending roughly $111 million a year in assessed dues and $570 million in voluntary contributions (U.S. Department of Health and Human Services, 2026). Federal global health-related obligations for work performed in California fell by nearly a third between 2024 and 2025, a reduction of about $483 million in a single year (Chen, 2026).

In response to this retreat, California has asserted scientific and public health leadership — as was done in 2004 when the state established a $3 billion initiative to sustain biomedical research in the wake of federal restrictions on embryonic stem cell research (Adelson & Weinberg, 2010). In 2026, Governor Gavin Newsom authorized the California Department of Public Health to become the first state agency to join the World Health Organization's (WHO) Global Outbreak Alert and Response Network (GOARN) (Office of Governor Gavin Newsom, 2026), a move followed by other states (Ferguson & Emoto, 2026). California also helped to drive new regional U.S. efforts, joining Washington and Oregon to launch a West Coast Health Alliance that now includes Hawaii (Washington State Department of Health, n.d.) and helping launch the 15-member Governors Public Health Alliance to share data and coordinate on health threats (Office of Governor Ned Lamont, 2025).

Even before the dismantling of USAID, and partially in response to shrinking budgets for development assistance worldwide, a new paradigm of global health had begun to take shape. Wealthier nations began more explicitly linking aid to their own

[1] In alphabetical order: Alliance for Innovation in Global Health; Charles R. Drew University of Medicine and Science Office of International Affairs; Friends of the Global Fight Against AIDS, Tuberculosis and Malaria; Stanford Center for Innovation in Global Health; University of California Global Health Institute; University of California Los Angeles Center for Global Health Security; University of California San Francisco Institute for Global Health Sciences; University of Southern California Institute on Inequalities in Global Health (study lead).

California stands to benefit from a future of global health defined by the exchange of knowledge and the pursuit of shared solutions.

economic, security and migration objectives, raising questions about whose interests global health programs were meant to serve (Christensen & Simon, 2024). For their part, low- and middle-income countries were simultaneously asserting agency over their own health affairs. In 2023, the Future of Global Health Initiatives launched the Lusaka Agenda, which called for global health initiatives to reorient around primary health care, domestically financed health systems, health equity, strategic and operational coherence, and addressing market failure in health products research and development (Future of Global Health Initiatives, 2023). This was followed in 2025 by a range of initiatives, most prominently the Accra Reset High-Level Panel on Reform of the Global Health Architecture and Governance, a head-of-state initiative calling for "deep reform" to the global health architecture with an emphasis on country-driven, equitable and complementary-financed health priorities alongside international funding for global public goods (Pate et al., 2026).

California stands to benefit from a future of global health defined by the exchange of knowledge and the pursuit of shared solutions. The state is home to a thriving and globally connected ecosystem of universities, life sciences companies, local governments and community organizations that derive reciprocal benefit from global health partnerships rooted in trust (Ferguson & Emoto, 2026). The state's life sciences industry employs about 406,000 people, supports about 1.08 million jobs and generates an estimated $394 billion in economic output. California institutions received $6.26 billion through 9,486 awards from the National Institutes of Health (NIH) and the National Science Foundation in 2025, more than any other state (Biocom California, 2026). California laboratories, surveillance systems and research institutions are national leaders in pandemic detection and response and have longstanding partnerships and networks across the globe.

Economic and educational exchange further tie California to health concerns beyond state borders. California is a key player in the Pacific Rim economy, with more than 5 million California jobs, about one in five, depending on international trade (U.S. Global Leadership Coalition, n.d.). The state's largest immigrant groups — from Mexico, the Philippines, China, India and Vietnam — mirror its trade and health ties across the Pacific and the border (Cuellar Mejia & Johnson, 2026). California enrolled 139,351 international students in 2024-25, more than any other state, and hosts more international scholars than any other state (Institute of International Education, 2025, 2026). The connections that make California a hub of trade, migration and scholarship also make engagement in health beyond its borders a matter of state self-interest and identity.

STUDY FOCUS AND METHODS

The study includes four distinct chapters, each examining a dimension of the impact of global health engagement on the state of California. The chapters are rooted in a broad understanding of global health engagement as research, programs, partnerships and diplomacy concerned with health across national borders, including the health of populations in California to the extent it shapes and is shaped by events and populations elsewhere. Each chapter makes this definition operational in its own way. For example, Chapter 1, concerned with the reciprocal benefits of how California exercises influence through partnership, treats an engagement as relevant to global health if it involves collaboration on health with an entity outside the United States or a multilateral health initiative (Ferguson & Emoto, 2026). Chapter 2, which estimates the economic output of U.S. global health spending in California, identifies global health-related spending through federal accounts, including those that are explicitly global, such as the NIH Fogarty International Center and the global health account of the Centers for Disease Control and Prevention (CDC), as well as those that include global health within a broader set of grants, such as the Public Health and Social Services Emergency Fund, screened for global health relevance using keyword and project-description rules (Chen, 2026).

Throughout the study, "California" refers to the state government, local governments, universities, nonprofit organizations, companies and communities based in the state. The study distinguishes throughout between U.S. federal investment that flows to or through California and activity that is resourced by the state's government and institutions, with an emphasis on the former given that global health has to date been principally and historically a federal mandate. Chapter 2 assigns federal spending to California by reported place of performance and includes subawards to California recipients only where their parent awards were not already counted, so as to avoid double counting (Chen, 2026). Its analysis of patent values to California, for example, weights each patent by the share of its inventors located in the state.

While suggestive for future direction of policy, this study is retrospective, covering different time periods corresponding to the objectives of each research chapter. Chapter 2 estimates economic activity associated with U.S. global health spending in California from 2016 to 2025, in order to capture trends over the decade preceding the recent contraction in federal spending. Chapter 1 follows this time frame in linking federal awards to published research by California experts. Chapter 3 follows biomedical technologies produced in California dating back to 2004, with the longer timeframe reflecting the lengthy process of biomedical innovation. Chapter 4 reconstructs disease outbreaks from 2009 to 2026 to document the effects of recent funding cuts on biosurveillance.

The chapters were prepared by separate author teams and deploy different methodologies pertaining to their research topic. Chapter 1 combines a literature review, a citation analysis of publications linked to NIH global health grants and interviews with leaders in academia, government and industry to describe the mutual benefits accrued from trust-based global health partnerships (Ferguson & Emoto, 2026). Chapter 2 analyzes 28,375 federal transactions, estimates associated economic activity with the Bureau of Economic Analysis's Regional Input-Output Modeling System (RIMS II) and links federal awards to patent grants to California inventors (Chen, 2026). Chapter 3 analyzes the interplay between California life science products and global health delivery systems, using interviews with informants and

documentary evidence to trace the development and deployment of innovations in HIV, tuberculosis and malaria control (Ngangula & Collins, 2026). Chapter 4 describes the relationship between biosurveillance investments and California's detection capacity, reconstructs detection timelines for select pathogens and interprets them with documentary evidence and expert interviews (Reza & Popescu, 2026). All of the chapters use qualitative interviews and anonymize their key informants, and Chapter 3 names specific companies with their consent. Each chapter received collaborative peer review from project partners, with at least one reviewer focused on scholarly substance and another on synthesis and communication. The value of this study lies in part in its chapters' methodological and disciplinary diversity, which allows California's global health dividend to be examined through lenses of political science, economics, epidemiology and case-study research.

KEY FINDINGS

Global Health Influence As Partnership

Chapter 1 examines how California exercises global health influence through trust-based partnerships that generate reciprocal benefits within and beyond the state. Through a novel systematic analysis of global health influence exercised by a single subnational jurisdiction, Laura Ferguson and Sarah Emoto posit that California exercises influence through four distinct pathways: engagement with multilateral initiatives, paradiplomacy with other governments, knowledge production and workforce development, and participation in the expert communities that set global health guidelines and norms. Identifying trust, credibility and reliability as foundations on which global health influence rests, the authors anchor the overall study within a framework of reciprocal rather than unidirectional benefit.

Measures of California's global health knowledge production and participation in norm-setting underscore this conclusion. Between 2016 and 2025, more than 55,000 publications were linked to NIH global health grants involving California institutions — an achievement built on longstanding partnerships with scholars and institutions in low- and middle-income countries. These publications had been cited more than 2.19 million times by mid-2026, at an average rate between the 80th and 95th percentiles of comparable NIH-funded work. Nearly a third had been cited in clinical trials or clinical guidelines that set the standards for disease detection, prevention and care — standards that benefit Californians and non-Californians alike. The influence wielded by California experts was also evident in international advisory and norm-setting groups: of the 120 WHO committees, advisory groups and task forces that publish their membership, 20 include at least one member from a California institution, working in collaboration with experts from jurisdictions around the world.

Global Health As Economic Investment

Chapter 2 provides new evidence of the economic benefits to the state of U.S. global health spending, providing the first transaction-level estimate of federal global health-related spending in California along with multiple measures of economic output associated with that spending. Yugen Chen finds that between 2016 and 2025, federal agencies committed $19.0 billion ($21.5 billion in 2024 dollars) in global health-related funding for work performed in California. This funding was associated with $30.2 billion in economic output, $19.2 billion in value added and about 157,000 job-years of employment in California. When spending by the households of global health-related workers is included, the estimates rise to $46.3 billion in output, $28.6 billion in value added and about 239,000 job-years.

Importantly, Chen provides the first estimate of the economic output associated with each federal dollar coming into California: every federal dollar is associated with between $1.40 and $2.15 in state economic output (Chen, 2026). Chen also offers the first analysis of California economic benefit linking federal awards and intellectual property. Federal awards were linked to 104 patents granted from 2016 to 2025, the equivalent of 49 patents after weighting by the share of the inventors located in California. Using established benchmarks, the study offers the first estimate of private value of these patents for California, estimated at between $1.9 billion and $5.7 billion in 2024 dollars, depending on whether median or mean values are applied. These findings help to bridge the significant benefit that federal global health spending delivers to low- and middle-income countries with its benefit to U.S. state-based universities, laboratories, firms, contractors, trainees and specialized workers.

Delivering Global Health Innovation

Chapter 3 documents how California-based life-sciences innovators benefit from global health partnerships and where in the value chain that support is most effective. Through case studies of three health innovations developed in the Bay Area and delivered to global markets, Paul Ngangula and Chris Collins find that companies located the contribution of global health partnerships at the point of access rather than at discovery. Gilead Sciences of Foster City licensed lenacapavir, a twice-yearly injectable HIV prevention drug, royalty-free to six generic manufacturers eight months before U.S. approval. Within ten months, initial shipments had been delivered to nine African countries under a purchase agreement supported by the Global Fund to Fight AIDS, Tuberculosis and Malaria and the U.S. Department of State, while separate agreements established a price of approximately $40 per person per year for future generic supply (Ngangula & Collins, 2026; The Global Fund, 2026). A 2012 buy-down by Unitaid, USAID, PEPFAR and the Gates Foundation, followed by a 2023 agreement negotiated by the Global Fund, the Stop TB Partnership and USAID, reduced the cost of Cepheid's Xpert cartridge from $16.86 to $8.98 to $7.97, with the Sunnyvale-made tuberculosis diagnostic tool now deployed on a platform of as many as 50,000 instruments worldwide (Ngangula & Collins, 2026).

What companies interviewed for this study reported valuing from global health partnerships was not profit from sales in low- and middle-income countries, but rather predictable demand at scale. Advance purchase commitments were key to allowing late-stage investment to be underwritten, manufacturing capacity to be reserved and prices to be lowered. The absence of committed de-

The absence of committed demand, by contrast, can stop a technically successful technology.

Detection capacity is slow to build and easy to lose if not maintained.

mand, by contrast, can stop a technically successful technology. Semisynthetic artemisinin, invented at the University of California, Berkeley, cleared every technical and regulatory hurdle, and Sanofi and PATH delivered 51 million malaria treatments made with it by 2015. Production ended, however, because cheaper plant-derived supply existed and no purchaser had committed to buy.

Global Biosurveillance and Local Detection

Chapter 4 offers an original description of California's role in a global biosurveillance ecosystem designed to prepare for emerging and endemic disease threats, together with estimates of the detection lead time that role affords. Amber Reza and Saskia Popescu document, for example, that the first international signal of COVID-19 preceded California's first confirmed cases by 27 days, providing a potential window for state and local authorities to alert clinicians, prepare laboratories and screen travelers.

Importantly, California is both a producer and a recipient of early signals. In addition to identifying the first U.S. cases of pandemic H1N1 influenza and clade I mpox, California laboratories have led in tracking viruses that pass from animals to people. PREDICT, a program led by the University of California, Davis (UC Davis) One Health Institute from 2009 to 2020, tracked zoonotic infections in more than 30 countries across Africa, Asia and Latin America, training nearly 7,000 professionals and identifying hundreds of previously unknown viruses (Reza & Popescu, 2026). After H5N1 was detected in dairy cattle in Texas and Kansas in March 2024, California intensified surveillance of its own herds, detecting the virus in August and subsequently identifying infections among dairy workers. This illustrates how signals shared across jurisdictions can trigger coordinated animal and human disease surveillance within an interconnected One Health system (Reza & Popescu, 2026).

Detection capacity is slow to build and easy to lose if not maintained. In 2014, Ebola circulated for about three months before it was recognized in Guinea, in an epidemic that killed more than 11,000 people. When it returned in 2021, after years of investment in laboratories and trained personnel, it was recognized within about a month and contained at 23 cases. In 2026, amid contractions in that investment, an outbreak of Bundibugyo virus in the Democratic Republic of the Congo again went undetected for about three months and has become the second-largest Ebola epidemic on record (Reza & Popescu, 2026). California's own health security depends on the sustained capacity of these systems to detect and report outbreaks, particularly in the context of international travel and trade (Wolicki et al., 2016; California Department of Public Health, n.d.a).

CALCULATING THE GLOBAL HEALTH DIVIDEND: THE MAGNIFIER EFFECT

In addition to providing evidence of benefit within specific domains, when read together, the four study chapters illustrate how diplomatic, economic, industrial and health benefits magnify each other.

A clear thread, for example, runs from California's receipt of federal dollars documented in the economic impact analysis in Chapter 2 to the enhanced state biosurveillance capacity described in Chapter 4. Two of the four largest accounts analyzed in Chapter 2 — the U.S. Department of Health and Human Services (HHS) Public Health and Social Services Emergency Fund and the CDC's global health account — awarded California funds to strengthen epidemiology and laboratory capacity, immunization, emergency response and public health infrastructure, with funding peaking in 2021 during COVID-19. These are the same laboratories, epidemiologists and reporting systems that Chapter 4 identifies as the determinants of how quickly a biological threat is recognized in California, and that have acted swiftly to collect and analyze samples and to identify new pathogens (Reza & Popescu, 2026). The dollars counted in one chapter as economic output form the infrastructure of early warning in another.

With response time critical to outbreak control, the biosurveillance ecosystem described in Chapter 4 also relies on the networks of trust-based influence described in the analysis of trust-based partnerships in Chapter 1. Beyond laboratory capacity, trust is a condition that allows a partner to report an outbreak before its scale is known. When COVID-19 emerged, the network of more than a hundred universities around the world built through the UC Davis-led PREDICT program was already in place, and network members met weekly to share lessons through the early months of the pandemic. Similarly, California's membership in GOARN can simultaneously be viewed as an act of diplomacy that strengthens the state's international standing and relationships, as well as a practical channel to provide outbreak intelligence that buys lead time for effective state response.

An additional thread connects the economic activity spurred by research spending with the state's global influence gained through top-tier knowledge production. The two NIH accounts that anchor research funding counted in the analysis of economic activity in Chapter 2 funded many of the more than 55,000 publications Chapter 1 traces as the basis for California's scientific standing and participation in international health policy and norm-setting (Chen, 2026; Ferguson & Emoto, 2026). A federal grant therefore returns a twofold dividend to California. It supports jobs and purchases while the work is under way, and it produces knowledge that extends the state's authority and influence long after the money has been spent.

This thread is reinforced in part by what economists call agglomeration, the gains achieved through sharing resources and infrastructure, matching workers with employers and creating and spreading knowledge when key resources are co-located or close by (Duranton & Puga, 2004). California's agglomeration advantage is explicitly highlighted by a key informant for the economic analysis in Chapter 2, who notes that the concentration of specialized scientists, physicians, laboratories and technical teams makes global health work in the state productive and desirable despite the state's relatively higher costs (Chen, 2026). Interviewees for Chapter 1 on trust-based partnerships similarly describe California's top-tier research institutions and scientific reputation as factors moving foreign ministries of health, WHO committees and international partners to include state experts. California's international standing in turn attracts students, scholars and collaborators to the state (Ferguson & Emoto, 2026). Together, the chapters portray a reinforcing cycle of Cali-

fornia's concentrated global health expertise, global relationships and the benefits that flow back to the state.

DISTRIBUTING THE GLOBAL HEALTH DIVIDEND: THE EQUITY EFFECT

A dividend implies shareholders, and so raises the question of how benefits are distributed. While not specifically documented in the chapters in this volume, the Californians with the most at stake in global health are often those whose families and communities span borders, and may be the first to feel the effects of new threats. For the 28% of Californians who are foreign born, or the nearly half of California children with an immigrant parent (Cuellar Mejia & Johnson, 2026), the fault lines between personal, community and global health are faint.

Tuberculosis offers an illustration. California recorded 2,150 cases of tuberculosis in 2025, the most in the state since 2013 (Colorado Boulevard, 2026). Nearly 40% of these occurred among people aged 65 and older, and that year tuberculosis cost the state an estimated $303 million in medical and societal costs (California Department of Public Health, 2026). Nearly nine in 10 of these cases occurred among Asian or Hispanic residents, while the disease incidence rate among people born outside the United States was 12 times that of U.S.-born residents (California Department of Public Health, n.d.b). Even more to the point, in a report to the California legislature, the California Department of Public Health identifies the state's border communities as representing a substantial share of the state's tuberculosis (TB) burden and stresses that "Progress toward TB elimination in California is likely to be hastened by strong collaborations with national and international health partners" (California Department of Public Health, n.d.c). This is supported by evidence that coordination between the U.S. and Mexico supports the identification and treatment of tuberculosis patients whose cases traverse the border (Woodruff et al., 2018).

The disease protection that is enabled by California's biosurveillance cooperation with low- and middle-income countries also benefits California's vulnerable communities. In 2024, Los Angeles County recorded an unprecedented cluster of 14 locally acquired dengue cases (Vaughan et al., 2026). Baldwin Park, in the San Gabriel Valley, accounted for five of the first eight cases (Hernández, 2024). About 73% of its residents are Hispanic or Latino, 44% were born abroad and 11% of those under 65 lack health insurance (U.S. Census Bureau, n.d.). Similarly, in a 2023 Los Angeles County mpox outbreak, Black residents accounted for 23% of cases, and the Black patients were more vulnerable as a result of not having been fully vaccinated (Leonard et al., 2024). As Chapter 4 of this study illustrates, the protection of these vulnerable communities relies on surveillance information and early warning systems that can inform public health preparedness and response.

The benefits of California's global health dividend to historically marginalized communities extend beyond infectious diseases to broader drivers of health and well-being. Ambulatory health care, which Chapter 2 finds to have accounted for 37.5% of federal global health-related funding in California, generates more jobs per dollar than research services (Chen, 2026). Those jobs and the household spending they support help pay for groceries, gas and school expenses. Chapter 1 documents ways in which lessons from global health return to benefit everyday Californians. These reciprocal innovations include practices of community health workers around the world that have informed the state doula workforce, as well as new approaches to the telehealth delivery of reproductive health care to populations who may not have access to facility-based care (Ferguson & Emoto, 2026).

Global health programs matter to California's diaspora communities, which maintain deep cultural, economic and familial ties to countries that benefit.

It is equally clear that global health programs matter to California's diaspora communities, which maintain deep cultural, economic and familial ties to countries that benefit from U.S. global health assistance. For example, Nigeria, Ethiopia and Kenya are among the leading African countries of origin for Black immigrants in California, with approximately 35,000, 23,000 and 10,000 residents, respectively (USC Equity Research Institute, 2025). These same countries are major recipients of U.S. support through PEPFAR, with planned allocations totaling approximately $854 million in fiscal year 2024 and more than 3.3 million people receiving PEPFAR-supported HIV treatment that year (Center for Global Development, 2025). For Californians supporting relatives abroad, these investments may offer benefits closer to home. Research documents the substantial financial and emotional responsibilities that African migrants shoulder in caring for family members in their countries of origin, while studies of expanded HIV treatment in Africa demonstrate reductions in household medical spending and financial hardship (Afulani et al., 2016; Ajefu & Ogebe, 2021). Although the effects on California's diaspora communities have not been directly measured, access to effective, publicly supported HIV care abroad could reduce the financial and caregiving burdens borne by families in California. California institutions also contribute directly to these international health systems: for example, the University of California, San Francisco participates in the federally supported STRIPE HIV initiative, which strengthens HIV workforce education and clinical care across African countries including Nigeria, Ethiopia and Kenya (UCSF Institute for Global Health Sciences, n.d.).

LOOKING AHEAD

While the focus of this study is retrospective, its implications are future facing. The California global health dividend will grow or shrink depending on how the state's city, county, state and congressional officials exercise leadership to protect the state's role and investment. This will, in turn, be shaped by a new generation of global health-related challenges and opportunities in which California already has an outsized stake. Drawing on the chapters' findings while also going beyond their retrospective analysis, three of these challenges and opportunities are:

Artificial Intelligence. California is home to 32 of the world's top 50 artificial intelligence companies and to about a quarter of the field's patents and papers presented at major scientif-

In today's globalized world, a virus that emerges anywhere can reach a California airport within a single incubation period.

ic conferences (Office of Governor Gavin Newsom, 2025). In contrast to the three health products examined in Chapter 3 of this study, the next generation of biomedical innovation will increasingly involve machine learning for diagnostics, outbreak prediction, drug discovery and health system management. As documented here, UC Davis is already developing tools that use artificial intelligence (AI) to assess the risk of viral spillover (Reza & Popescu, 2026), and Stanford researchers are studying the use of generative AI in health care in low- and middle-income countries (Ferguson & Emoto, 2026). Major philanthropic efforts and partnerships, such as those launched by the Gates Foundation with Anthropic and OpenAI, and by the philanthropy Coefficient Giving, have prioritized joining California's AI expertise to new approaches to global health programming (Beasley, 2026; Coefficient Giving, 2026; Stevenson & Rigby, 2026; Tolomia, 2026). Whether the efforts to deploy powerful new AI tools in health close or widen gaps in access between the rich and poor, and how California innovators can be supported, incentivized and held accountable for bringing their pioneering research to bear on yet unsolved health problems for the underserved at home and abroad, may become one of the defining tests of the state's global leadership this century.

Healthy aging. California is an aging society in an aging world, with longer life expectancy and declining birth rates producing unprecedented demographic shifts that demand new approaches to health care and the social drivers of health. California's Master Plan for Aging projects that by 2030, 10.8 million Californians — about a quarter of the population — will be age 60 or older (California Department of Aging, 2021). The realities of multiple chronic diseases, cognitive decline, caregiving, elder abuse and social isolation — to name a few — are shared across high-, middle- and low-income countries and demand knowledge exchange and shared solutions. California's care workforce relies disproportionately on immigrant workers from countries that are themselves aging societies, suggesting a need and opportunity for international cooperation to create pathways for dignified care work in all countries regardless of income level (McConville et al., 2024). The state's growing population of older persons requires integrated and person-centered health care in addition to treatment for specific diseases, which echoes the abovementioned call from U.S. development partners for a global health architecture rooted in primary health care and local realities.

One Health. The principle that human, animal and environmental health are interdependent and should be studied and managed together rather than in separate silos (One Health High-Level Expert Panel [OHHLEP] et al., 2022) is increasingly a principle of global health governance and a specialized domain of scientific expertise. This principle runs through the chapters of this study, from UC Davis's leadership of PREDICT and identification of new viruses, to the detection of H5N1 avian influenza in California's dairy herds, marine mammals and wastewater (Ferguson & Emoto, 2026; Reza & Popescu, 2026). Recent pandemic pathogens, including HIV, H5N1, Ebola and likely SARS-CoV-2, crossed over to humans from animals, and new pathogens will likely do so in the future. As the nation's largest agricultural producer, a state with long coastlines, ample wildlife, growing exposure to climate-related diseases and top-tier animal health and environmental scientists, California is a natural leader in making One Health an organizing principle of global health.

CONCLUSION: CALIFORNIA AND GLOBAL HEALTH LEADERSHIP

In today's globalized world, a virus that emerges anywhere can reach a California airport within a single incubation period. A drug invented in a Foster City laboratory and purchased by a global health institution can reach a clinic anywhere within a year. A disease outbreak among seals in Argentina can trigger enhanced biosurveillance at a state park outside Santa Cruz. A community health education model developed in Mexico can help improve reproductive health care in Los Angeles. A nurse trained in the Philippines can join the workforce caring for a growing population of older Californians.

Each chapter of this study shows how California has helped invent and sustain the field of global health, and how Californians have benefited. The state is a detector, with its laboratories, sequencing networks and field programs picking up threats that matter to the country and the world. It is an inventor, producing medicines and diagnostics at companies and universities that reach people on five continents. It is a diplomatic force, with experts shaping guidelines and global response, and stepping in to fill gaps left by federal withdrawal. And it is an economic engine, generating billions of dollars in economic activity as it engages in the research on and delivery of health protection measures here at home and abroad.

No state can make up for the U.S. government's role in global health, and continued federal investment in global health research, purchasing and programming is critical to the state's robust engagement in the field. Alongside this, California's scientific capacity, economic power, political leadership and international standing make it a natural leader in this moment of change in the global health architecture. The diversity of state residents, the importance to the state of international trade and intellectual exchange, and state commitment to health protection of the most vulnerable make investment in global health a matter of both self-interest and global benefit. It is no surprise that half of Californians believe that diplomacy, humanitarian aid and development are essential to American security and prosperity (Klaus et al., 2025). The chapters of this study underscore the importance of taking up that call.

The challenge to state political leaders is how the California global health dividend can be recognized, increased and sustained. The dividend's impact will be judged by how it benefits the Californians most exposed to health risks that cross borders, by the benefits flowing from California innovation to the rest of the world and by how California leadership sets a model for other states or subnational actors in a time of major contraction of federal funding for global health. For Californians, the motivation for global health leadership transcends the binary of moral obligation and self-interest. Global health is who we are.

REFERENCES

Adelson, J. W., & Weinberg, J. K. (2010). The California stem cell initiative: persuasion, politics, and public science. *American journal of public health, 100*(3), 446–451. *https://doi.org/10.2105/AJPH.2009.168120*

Afulani, P. A., Torres, J. M., Sudhinaraset, M., & Asunka, J. (2016). Transnational ties and the health of sub-Saharan African migrants: The moderating role of gender and family separation. Social Science & Medicine, 168, 63–71. *https://doi.org/10.1016/j.socscimed.2016.09.009*

Ajefu, J. B., & Ogebe, J. O. (2021). The effects of international remittances on expenditure patterns of the left-behind households in sub-Saharan Africa. Review of Development Economics, 25(1), 405–429. *https://doi.org/10.1111/rode.12721*

Assembly Floor. (2009, August 24). *ACR 75 (V. Manuel Pérez): California Promotores Month* [Bill analysis]. California State Assembly. *https://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_0051-0100/acr_75_cfa_20090824_190237_asm_floor.html*

Beasley, S. (2026, September 1). Coefficient Giving boosts pledge to $1 billion, banking on an AI windfall. *The Chronicle of Philanthropy*. *https://www.philanthropy.com/news/coefficient-giving-boosts-pledge-to-1-billion-banking-on-an-ai-windfall/*

Bharali, I., Yamey, G. b. d.-e. d.-s., & Ogbuoji, O. (2026). T*he Overlooked Benefits of Health Aid to Donor Countries*. Think Global Health. *https://www.thinkglobalhealth.org/article/the-overlooked-benefits-of-health-aid-to-donor-countries*

Biocom California. (2026, June 22). *Biocom's 2026 economic impact report highlights the strength, resilience and future of the life science industry in California* [Press release]. Business Wire. *https://www.businesswire.com/news/home/20260622721738/en*

Bonnifield, R., & Madan Keller, J. (2025, November 14). Tough times, tough choices: Charting PEPFAR's next chapter while safeguarding its legacy. Center for Global Development. *https://www.cgdev.org/publication/tough-times-tough-choices-charting-pepfars-next-chapter-while-safeguarding-its-legacy*

Bracho, A., & Lee, G. (2020, January). *A global health model for inclusion: From Venezuela to California and back again*. National Association of County and City Health Officials. *https://mail.naccho.org/uploads/downloadable-resources/From-Venezuela-to-California.pdf*

California Department of Aging. (2021). *Master plan for aging*. State of California. *https://eastonad.ucla.edu/sites/g/files/oketem336/files/media/documents/California_Governors_Master_Plan_for_Aging-CA_Dept_of_Aging-2021.pdf*

California Department of Public Health. (2026). *TB in California: 2025 snapshot*. *https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/TB-in-California-2025-Snapshot.aspx*

California Department of Public Health. (n.d.a). B*inational Case Reporting*. *https://www.cdph.ca.gov/Programs/CID/OBBH/Pages/Binational-Case-Reporting.aspx*

California Department of Public Health. (n.d.b). *Tuberculosis in California: 2025 Snapshot*. *https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/TB-in-California-2025-Snapshot.aspx*

California Department of Public Health. (n.d.c). *Tuberculosis*. *https://www.cdph.ca.gov/Programs/CID/OBBH/Pages/Border-Tuberculosis.aspx*

Centers for Disease Control and Prevention. (2009). Swine influenza A (H1N1) infection in two children—Southern California, March–April 2009. *Morbidity and Mortality Weekly Report, 58*(15), 400–402.

Chen, Y. (2026). *The impact of federal global health spending on California's economy* [Unpublished report]. California Global Health Leadership Initiative.

Christensen, J., & Simon, M. (2024). Using aid to control migration. *Political Studies, 72*(3), 883–902. *https://doi.org/10.1177/00323217231162254*

Coefficient Giving. (2026). *Request for proposals: Global health and wellbeing in an era of transformative AI*. Retrieved October 14, 2026, from *https://coefficientgiving.org/funds/global-health-wellbeing-opportunities/request-for-proposals-global-health-and-wellbeing-in-an-era-of-transformative-ai/*

Colorado Boulevard. (2026, March 25). *TB cases rise in L.A. County to highest level since 2016*. *https://www.coloradoboulevard.net/tb-cases-rise-in-l-a-county-to-highest-level-since-2016/*

Cuellar Mejia, M., & Johnson, H. (2026). *Immigrants in California*. *Public Policy Institute of California*. *https://www.ppic.org/publication/immigrants-in-california/*

Duranton, G., & Puga, D. (2004). Micro-foundations of urban agglomeration economies. In J. V. Henderson & J.-F. Thisse (Eds.), *Handbook of regional and urban economics* (Vol. 4, pp. 2063–2117). Elsevier.

Ferguson, L., & Emoto, S. (2026). *Impact of global health initiatives on California's international influence* [Unpublished report]. California Global Health Leadership Initiative.

Future of Global Health Initiatives. (2023). The Lusaka Agenda: Conclusions of the Future of Global Health Initiatives process. *https://d2nhv1us8wflpq.cloudfront.net/prod/uploads/2023/12/Lusaka-Agenda.pdf*

Global Health Technologies Coalition. (2017). *Return on innovation: Global health R&D delivers for California*. *https://ghtcoalition.treepl.co/documents/pdf/Return-on-Innovation-Global-health-R-D-delivers-for-California.pdf*

Hernández, C. (2024, October 17). More local dengue is popping up in LA County. Here's a look at the treatments being done to curb it. *LAist*. *https://laist.com/news/health/los-angeles-dengue-san-gabriel-valley-baldwin-park-outbreak-aedes-mosquito*

House Committee on Foreign Affairs. (2008, July 30). *U.S. global HIV/AIDS legislation becomes law* [Press release]. *https://democrats-foreignaffairs.house.gov/2008/7/us-global-hivaids-legislation-becomes-law*

Institute of International Education. (2025). *Open Doors 2025 fact sheet: California*. *https://opendoorsdata.org/wp-content/uploads/2025/11/OpenDoors_FactSheet_California_-2025.pdf*

Institute of International Education. (2026). *Open Doors 2025: International scholars*. *https://opendoorsdata.org/wp-content/uploads/2026/02/Open-Doors25_Scholars_PresentationPDF.pdf*

Kevany, S. (2015). Global health diplomacy, "San Francisco values," and HIV/AIDS: From the local to the global. *Annals of Global Health, 81*(5), 611–617. *https://doi.org/10.1016/j.aogh.2015.12.004*

Klaus, I., Baldassare, M., Jordan, M., & Manalese, A. (2025). 2025 Carnegie California global affairs survey. *Carnegie Endowment for International Peace*. *https://carnegieendowment.org/research/2025/12/2025-carnegie-california-global-affairs-survey*

Leonard, C. M., Poortinga, K., Nguyen, E., Karan, A., Kulkarni, S., Cohen, R., Garrigues, J. M., Marutani, A. N., Green, N. M., Kim, A. A., Sey, K., & Pérez, M. J. (2024). Mpox outbreak—Los Angeles County, California, May 4–August 17, 2023. *Morbidity and Mortality Weekly Report, 73*(2), 44–48. *https://doi.org/10.15585/mmwr.mm7302a4*

McConville, S., Payares-Montoya, D., & Bohn, S. (2024). *California's Care Workforce: An Overview of Needs, Opportunities, and Challenges.* Public Policy Institute of California. *https://www.ppic.org/publication/californias-care-workforce/*

Nandi, A. (2009). *The importance of the global health sector in California: An evaluation of the economic impact.* University of California Global Health Institute. *https://escholarship.org/uc/item/69v7f2jz*

Ngangula, P., & Collins, C. (2026). *Impact of global health partnerships on biomedical and technological innovation in California* [Unpublished report]. California Global Health Leadership Initiative.

Office of Governor Gavin Newsom. (2025, March 12). ICYMI: *California is home to 32 of the top 50 AI companies. https://www.gov.ca.gov/2025/03/12/icymi-california-is-home-to-32-of-the-top-50-ai-companies/*

Office of Governor Gavin Newsom. (2026, January 23). *Governor Newsom meets with World Health Organization Director-General, announces California becomes first state to join WHO-coordinated international network. https://www.gov.ca.gov/2026/01/23/governor-newsom-meets-with-world-health-organization-director-general-announces-california-becomes-first-state-to-join-who-coordinated-international-network/*

Office of Governor Ned Lamont. (2025, October 15). *Governor Lamont and 14 other governors launch Governors Public Health Alliance* [Press release]. *https://portal.ct.gov/governor/news/press-releases/2025/10-2025/governor-lamont-and-14-other-governors-launch-governors-public-health-alliance*

Office of Speaker Emerita Nancy Pelosi. (n.d.). *Leadership on HIV/AIDS.* Retrieved October 13, 2026, from *https://pelosi.house.gov/issues/leadership-hivaids*

One Health High-Level Expert Panel (OHHLEP), Adisasmito, W. B., Almuhairi, S., Barton Behravesh, C., Bilivogui, P., Bukachi, S. A., Casas, N., Cediel Becerra, N., Charron, D. F., Chaudhary, A., Ciacci Zanella, J. R., Cunningham, A. A., Dar, O., Debnath, N., Dungu, B., Farag, E., Gao, G. F., Hayman, D. T. S., Khaitsa, M., . . . Zhou, L. (2022). One Health: A new definition for a sustainable and healthy future. *PLOS Pathogens, 18*(6), Article e1010537. *https://doi.org/10.1371/journal.ppat.1010537*

Pate, M. A., Kaberuka, D., & Piot, P. (2026). Transforming the global health ecosystem: Lessons learned and a vision for the future. Accra Reset. *https://www.accrareset.org/publications/Transforming-the-Global-Health-Ecosystem/*

Reza, A., & Popescu, S. (2026). *Impact of global biosurveillance on California's health security* [Unpublished report]. California Global Health Leadership Initiative.

Rourke, C. (2023, February 22). *Rep. Barbara Lee on PEPFAR.* ONE Campaign. *https://www.one.org/us/stories/rep-lee-pepfar/*

Stevenson, C., & Rigby, J. (2026, January 22). Gates and OpenAI in $50m deal that will help fight global aid cuts. *The Independent. https://www.aol.com/articles/gates-openai-50m-deal-help-171815734.html*

Sulgodu Ramachandra, S., & Webster, P. (2025). USA's exit from the WHO and freeze on USAID funds globally: its perils and possible opportunities. *Journal of public health* (Oxford, England), 47(Supplement_1), i16–i20. *https://doi.org/10.1093/pubmed/fdaf122*

Tanis, F., & Fadel, L. (2025, July 1). USAID officially shuts down and merges remaining operations with State Department. *NPR. https://www.wwno.org/npr-news/2025-07-01/usaid-officially-shuts-down-and-merges-remaining-operations-with-state-department*

The Global Fund. (2026, April 14). *Global Fund and U.S. expand commitment to long-acting HIV prevention as country rollout of lenacapavir accelerates* [Press release]. *https://www.theglobalfund.org/en/updates/2026/2026-04-14-us-global-fund-expand-commitment-long-acting-hiv-prevention-country-rollout-lenacapavir-accelerates*

Tolomia, C. (2026, May 14). Anthropic and the Gates Foundation launch a $200 million AI partnership. Quartz. *https://qz.com/anthropic-gates-foundation-ai-health-education-partnership-051426*

UCSF Institute for Global Health Sciences. (n.d.). Workforce development. University of California, San Francisco. *https://globalhealthsciences.ucsf.edu/our-work/areas-of-expertise/workforce-development/*

U.S. Census Bureau. (n.d.). *QuickFacts: Baldwin Park city, California.* Retrieved October 13, 2026, from *https://www.census.gov/quickfacts/fact/table/baldwinparkcitycalifornia/PST045224*

U.S. Congress. (2013, November 19). *Congressional Record, 159*(165), H7232–H7235. *https://www.congress.gov/113/crec/2013/11/19/159/165/CREC-2013-11-19-pt1-PgH7232-3.pdf*

U.S. Department of Health and Human Services. (2026, February 23). *HHS fact sheet: U.S. withdrawal from the World Health Organization.* Centers for Disease Control and Prevention. *https://www.cdc.gov/global-health/resources/us-withdrawal-who.html*

U.S. Global Leadership Coalition. (n.d.). *California: Facts and Figures. https://www.usglc.org/state-facts/california/*

USC Equity Research Institute. (2025, May). Black immigrants in California. California Immigrant Data Portal. *https://www.immigrantdataca.org/data-hub/special-projects/black-immigrants-in-ca*

Vaughan, A. M., Park, C., Ngo, V. P., Contreras, Z. A., Lee, J. J., Danza, P., Haddix, M., Moir, O., Green, N., Brown, M., Burleson, T., Marutani, A., Nicholas, A., Hallum, T., Vetrone, S., Ortiz, L., Fernandez, G., El-Tobgy, E., Escobar, J., . . . Halai, U.-A. (2026). Investigation of and response to autochthonous dengue, Los Angeles County, California, USA, August–November 2024. *Emerging Infectious Diseases, 32*(5), 720–727. *https://doi.org/10.3201/eid3205.251812*

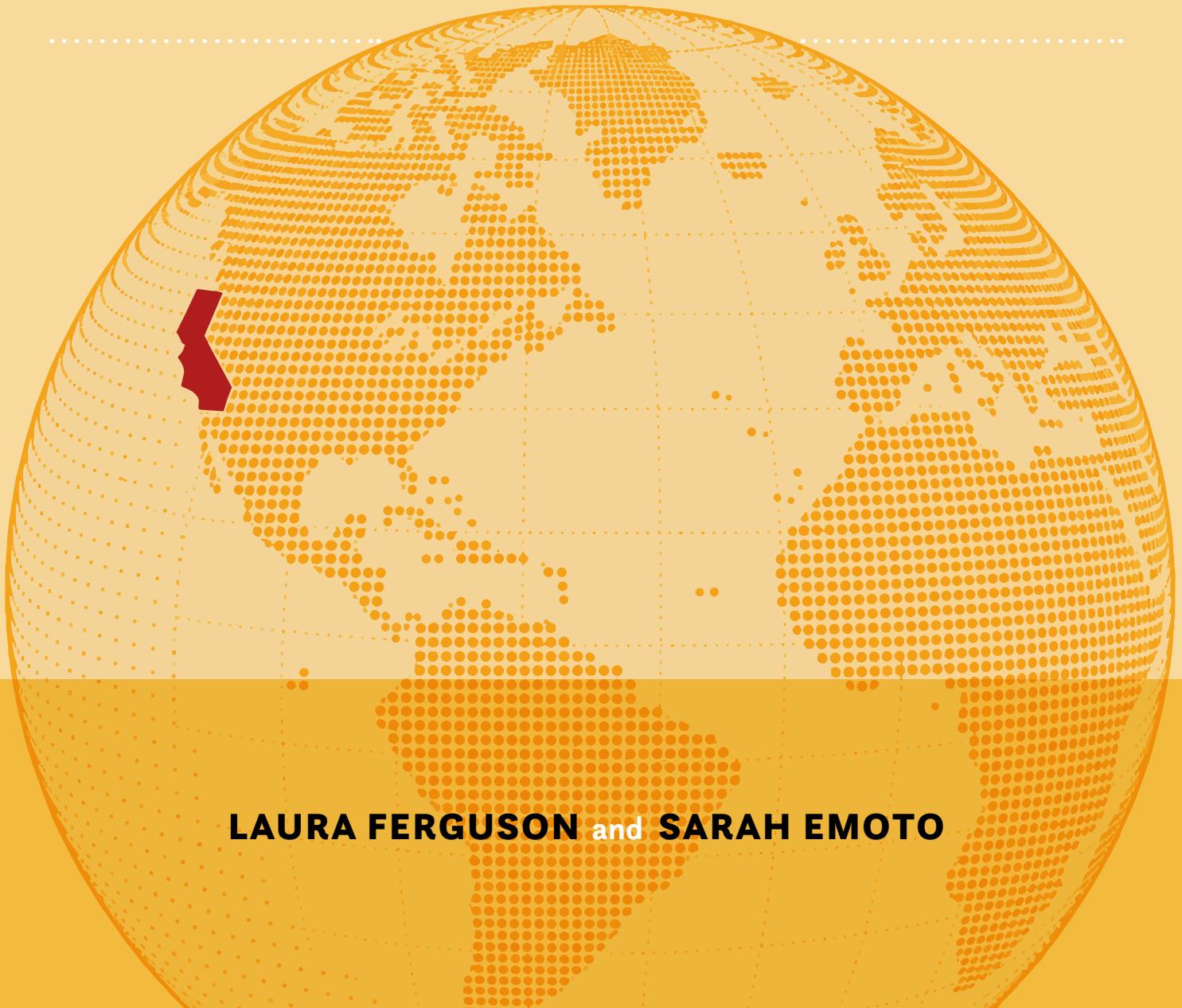
Washington State Department of Health. (n.d.). *West Coast Health Alliance.* Retrieved October 11, 2026, from *https://doh.wa.gov/about-us/west-coast-health-alliance*

Wolicki, S. B., Nuzzo, J. B., Blazes, D. L., Pitts, D. L., Iskander, J. K., & Tappero, J. W. (2016). Public health surveillance: At the core of the Global Health Security Agenda. *Health Security, 14*(3), 185–188. *https://doi.org/10.1089/hs.2016.0002*

Woodruff, R. S. Y., Miner, M. C., & Miramontes, R. (2018). Development of a Surveillance Definition for United States-Mexico Binational Cases of Tuberculosis. *Public health reports* (Washington, D.C. : 1974), 133(2), 155–162. *https://doi.org/10.1177/0033354918760575*

CHAPTER 1

Influence as Partnership: The Reciprocal Benefits of California's Global Health Engagement



LAURA FERGUSON and SARAH EMOTO

EXECUTIVE SUMMARY

California's engagement in global health amplifies its influence in international policy forums, standards-setting bodies and multilateral initiatives while also strengthening the state's security, institutions and health. Although California lacks the formal authority or jurisdiction of a nation-state, its state and local governments, universities, nonprofit organizations and private-sector actors shape global priorities and responses through sustained relationships, policy leadership, scientific expertise and knowledge exchange in global spaces. This role is especially important during the current federal retreat from global health and multilateral cooperation.

Drawing on a literature review, publication analysis and key informant interviews, this chapter identifies four principal pathways by which California's engagement in global health amplifies its international influence, yields reciprocal benefits and shapes global health responses. Engagement with multilateral initiatives, including the World Health Organization's (WHO) Global Outbreak Alert and Response Network (GOARN), the Paris Agreement, the Sustainable Development Goals (SDGs), the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) and the Framework Convention on Tobacco Control (FCTC), provides access to global discussions and promotes policy diffusion. The practice of paradiplomacy, including cooperation with Mexico on health in border areas and bilateral climate agreements, enables California to exchange expertise and build coalitions. Investment in knowledge production and workforce development contributes to building California's scientific authority, professional relationships and reciprocal learning with other jurisdictions. Finally, participation in epistemic communities and technical networks allows California experts to shape and learn from global guidelines, standards and agendas.

Across these pathways, trust, credibility and reliability are the foundations of successful engagement and influence. California's reputation for scientific excellence, innovation and a willingness to act creates access and credibility; this is then strengthened by consistent behaviors and long-term partnerships. Relationships established before a crisis enable faster information sharing and

• KEY TAKEAWAYS •

- **Global health engagement gives California international influence beyond its formal authority.** Through multilateral initiatives, paradiplomacy, knowledge production, workforce development and participation in epistemic communities, California helps shape global policies, standards and responses. This influence extends to diverse health-related fields that matter to Californians, such as border health, climate and the environment, pandemic preparedness, sustainability, tobacco control, urban health and women's health.
- **California's influence is built on trusted relationships, scientific credibility and reliability.** Sustained partnerships, consistent behavior and exceptional knowledge production establish California as a credible and reliable partner. The scale of California's scientific contribution is substantial: 55,826 publications linked to relevant National Institutes of Health (NIH) grants dated 2016-2025 involving California institutions were cited more than 2.19 million times by June 2026, with average influence well above that of comparable NIH-funded research. Its diverse ecosystem creates a multiplier effect across research, diplomacy, preparedness and policy.
- **The benefits are reciprocal and directly advance California's interests.** Engagement generates goodwill and diplomatic access while improving outbreak intelligence, institutional capacity, emergency preparedness and health within California. This is all particularly important in the current moment of U.S. federal retreat from multilateral cooperation for health. Better coordinating these strengths and fostering critical international relationships could strengthen global health leadership as a strategic public asset.

collective action during disease outbreaks and climate-related emergencies. California's diverse institutional ecosystem also creates a multiplier effect: Scientific authority reinforces diplomatic credibility, partnerships improve preparedness and lessons developed overseas inform policy and practice within California. The scale of this contribution is substantial: 55,826 publications linked to relevant NIH grants dated 2016-2025 involving California institutions were cited more than 2.19 million times by June 2026, with average influence well above that of comparable NIH-funded research.

The benefits of this engagement to California are diplomatic, security-related and humanitarian. Global health engagement raises the state's profile, creates trusted channels during political tension, improves access to outbreak information and generates goodwill and wider opportunities for collaboration. Reciprocity, including "capacity bridging" and adapting global lessons to California, strengthens the value and legitimacy of these partnerships. California cannot replace federal funding or diplomatic authority in the field of global health, but it can preserve relationships and better leverage existing assets. This chapter therefore recommends selectively filling critical gaps left by federal withdrawal, coordinating the collective value of work continuing across California institutions and communicating its benefits more clearly. Sustained and coordinated global health leadership is a strategic public asset that can increase California's influence while protecting Californians.

1.
INTRODUCTION AND PROBLEM DEFINITION

This chapter examines how California's engagement in global health amplifies the state's influence in international policy forums, standards-setting bodies and multilateral initiatives; shapes global and local responses to issues such as pandemics and climate-related health risks; and yields reciprocal benefits within and outside the state. Through engagements in global health, Californian institutions can help shape global health priorities and actions that go on to benefit people in the state and around the world. These types of interactions can take many different forms, including engagement in multilateral spaces, paradiplomacy, knowledge production and workforce development, and participation in epistemic communities. However, participation alone in global health spaces does not guarantee meaningful collaborations or influence; it is how institutions operate in these spaces that determines how successful this might be.

Global health relies on cooperation, which itself is founded on trust. Successful soft power or influence depends on the ability to earn trust, credibility and legitimacy through competent, reliable behavior, thereby building a favorable reputation and relationships that make others more willing to cooperate or be persuaded in areas that often go beyond the initial scope of collaboration. These types of influence operate in both directions through diverse pathways and can be achieved by the many different types of stakeholders in California operating in the global health space, including state and local government, the private sector, nonprofit organizations and academic institutions. The collective influence of California's institutions on global health at home and overseas is demonstrable and multifaceted.

California not only interfaces substantially with other parts of the world, but it also runs the biggest set of health departments, agencies and related bodies in the U.S., second only to the federal government, meaning that its strong operational base can be leveraged to both support and influence others. While other U.S. states may not have the same economic power or, in most cases, broad engagement in global health spaces, California can provide a model for how states, particularly in the absence of federal leadership, can continue to protect their people through global health engagement while also helping position the U.S. as a significant actor in global health. Through its broad and diverse engagement in global health, California is sending a strong signal to the world that it continues to play a leadership role that is based on respect, trust and mutual benefit.

2.
METHODOLOGY

We used three different methods to gather a variety of data to help understand how California engages in global health spaces and how the state exercises influence. First, to try to better delineate the scope of this work and provide an organizational framework for the different types of global health engagement and influence, we carried out a literature review of both peer-reviewed and grey literature. We then did an analysis of publications derived from NIH-funded global health grants to institutions in California to provide insight into the scale of new knowledge being produced and its reach. Finally, we conducted key informant interviews with academics and representatives of government and private-sector institutions to better understand the mechanisms revealed by the literature review and publication analysis.

2.1 Literature Review

We reviewed relevant literature to identify the different mechanisms through which influence is gained and exercised in global health broadly. We used an iterative search strategy that involved a snowballing approach and targeted searches. As a starting point, we reviewed the article, "The Overlooked Benefits of Health Aid to Donor Countries" (Bharali et al., 2026), from which we identified several sources relevant to national-level influence and engagement in global health generally. From these initial sources, we identified concepts and terms that informed targeted searches using Google Scholar. Key search terms included global health diplomacy, international health diplomacy, paradiplomacy, policy diffusion, policy influence, soft power, subnational and California. We reviewed sources relevant to global health, as well as some broader international relations sources, with attention to donor-state, subnational and California-specific influence. While most sources were peer-reviewed articles, we also reviewed some grey literature such as policy reports and non-governmental organization (NGO) documents. We systematically extracted information from each source on the types of actors involved; the global health topic(s) addressed;

Trust, credibility and reliability are the foundations of successful engagement and influence.

State and local governments in California and other California-based actors are engaged in and influencing the field of global health.

the types of engagement or activities described; the mechanisms of influence; and the types of benefits, beyond influence, to actors as a result of global health engagement.

Alongside the literature review, we manually searched various government, multilateral, and network and coalition websites to identify examples of how the state and local governments in California and other California-based actors are engaged in and influencing the field of global health. Some targeted searches on Google were also conducted based on topics or initiatives that the literature identified as areas with which California-based actors have demonstrated engagement, such as the SDGs, climate change and the Paris Agreement, and CEDAW. Network and coalition websites were identified either from being referenced in the literature or on government websites, and then they were manually searched for California-based entities involved. Examples of the types of websites searched are included in Appendix A.

Identified examples were determined relevant if the engagement or initiative specifically mentioned global or international health; involved collaboration with an entity outside the U.S. (including engagement in transnational networks, coalitions or other countries' governments) on an issue relevant to health; or involved engagement with multilateral initiatives relevant to health. Information was systematically extracted from websites and any identified relevant documents on the California-based and external actor(s) involved, the global health topic(s) addressed and the nature of the engagement or activity. These California-based global health engagements and initiatives were then categorized by the mechanisms of influence based on concepts identified in the literature and analyzed to understand the outcomes of that specific mechanism of influence, including any benefits either to the California-based actor or to California broadly.

2.2 Publication Analysis

The list of global health-related NIH grants that involved a California-based institution as a recipient (prime or sub-awardee) was obtained from USAspending.gov files downloaded on June 9, 2026. The main reporting window covers complete calendar years 2016-2025, corresponding to the time period used in other sections of the overall study. We identified global health transactions using Treasury Account Symbol and federal-account information. We included only NIH accounts: the Fogarty International Center (global health, international, low- and middle-income country (LMIC) or infectious-disease research/training), the National Institute of Allergy and Infectious Diseases (HIV, tuberculosis, malaria, emerging infectious disease, surveillance, international cohort or LMIC research) and the Office of the Director (Common Fund, trans-NIH global health, international infectious disease or global health security).

Looking beyond prime-award data that, alone, may miss global health transactions that reach California through downstream agreements, we integrated subaward transactions with a reported California subaward place of performance. At the same time, prime award and subaward amounts cannot simply be added together. A subaward represents the downstream allocation of funds originating from a prime award, not an additional federal obligation. Counting a California prime award and its California subaward as separate federal spending would therefore risk double counting the same underlying federal funding. We addressed this problem by linking each subaward to its associated prime award through prime_award_unique_key. First, we constructed the set of prime-award keys already represented in the California prime pool. A California subaward was then added to the augmented analysis pool only when its associated prime award was absent from that California prime pool.

From this set of NIH grants, the NIH project ID numbers were matched to PubMed identifiers (PMIDs) using the NIH ExPORTER link tables (https://reporter.nih.gov/exporter/linktables), which link publications with NIH-funded grants that publications cite as providing support. The data in the link tables were compiled by fiscal year based on the NIH projects active during that year. After removing duplicates (due to some publications being associated with multiple grants and, because the link tables are based on projects active in a fiscal year, not publication year, some publications appear in multiple fiscal years), there were a total of 55,930 unique PMIDs from fiscal years 2016-2025 that were at least in part funded by global health-related NIH grants that involved a California-based recipient institution. These PMIDs were put into the NIH citation analysis database, iCite (https://icite.od.nih.gov/analysis). There were 104 PMIDs not found in the database, so the total number included in the citation analysis was 55,826. NIH ExPORTER and iCite data were retrieved on June 22, 2026.

2.3 Key Informant Interviews

Through the combined network of the partners involved in this project, supplemented by internet searches, we identified experts in California whose work brings them into global policy spaces and/or exposes them to opportunities to influence global health policy and practice. We reached out to 12 potential interview participants across academia, government and the private sector, of whom eight agreed to participate (four people working within academia, two representatives of government and two of the private sector).

Semi-structured key informant interviews of 30-60 minutes were carried out over Zoom or Teams with each of these individuals to gather information on their experiences engaging in this type of work, including examples of how they engage in global health spaces and whether, and to what extent, they think this is important both for California and for the state's influence in global health more broadly. Interviews were recorded and transcribed for thematic analysis in NVivo. Thematic analysis was iterative, combining deductive themes derived from the literature review and inductive themes generated from participants' narratives.

2.4 Triangulation

Findings from the interviews were then analyzed alongside the literature review and publications analysis to identify points of convergence and divergence, and to create a more comprehensive synthesis of these different types of data.

2.5 Limitations

The qualitative aspect of this research is limited by the small sample size of interview participants. Furthermore, we only interviewed people known to be based in California and engaged in global health work. Although it might exclude the perspectives of people who are not involved in global health and are therefore less likely to see the value of this to California, this approach to sampling was chosen to try to maximize learning from real-world experiences of engaging in global health work from California so as to help build the evidence base of how this might matter.

While it would have been ideal to have two researchers code and analyze the qualitative data, this was not feasible within the study period, so a single researcher (LF) carried out qualitative data analysis.

3.
KEY FINDINGS

The overall benefits of California's global health engagements have been simultaneously diplomatic, security-related and humanitarian. Work that strengthens health systems and saves lives has also built goodwill, improved surveillance and preparedness, expanded professional and commercial relationships and maintained trusted channels during periods of political tension. These should not be treated as competing rationales. Nor should global health be understood as a one-way transfer of Californian expertise. Some of the most useful examples in this chapter involve capacity bridging, in which partners bring different forms of knowledge and experience to a shared problem. This reciprocity has been central to equitable partnership and to the legitimacy on which lasting influence depends. These foundations frame this study's key findings and the resulting conclusions.

3.1 Section Overview

In this section, findings from the different types of data and analyses are presented. First, we explore three elements that emerged in the interviews as key foundations for global health influence: trust, credibility and reliability. This is followed by subsections on each of four mechanisms of influence identified: engagement with multilateral global health initiatives, paradiplomacy, knowledge production and workforce development, and epistemic authority. Within each subsection, the mechanism of influence is described with attention to how it operates broadly in the context of California, and then specific California-focused examples of the mechanism are provided. The examples include engagements involving the California state government, local county and city governments, and non-governmental actors based in California, though not all subsections include examples from each type of actor. Additionally, while some examples may fit into more than one mechanism of influence, they are organized by a primary mechanism of influence based on descriptions identified in the literature; if additional mechanisms are relevant to the example, these are noted. These subsections include data from the peer-reviewed and grey literature as well as the key informant interviews.

3.2 Foundational Elements of Global Health Influence

All key informants underscored the notion that trust begets trust.

3.2.1 Trust All key informants underscored the notion that trust begets trust. Within the context of engagement in global health, trust can be understood as a relational concept: an actor's willingness to accept vulnerability by relying on another actor, based on the expectation that the latter will take its interests into account and refrain from exploiting the discretion afforded to it (Hoffman, 2002). Examples of vulnerability in this context might include disclosing a disease outbreak before its scale is fully understood, depending on another country for vaccines or entering into a pooled procurement arrangement. Importantly, trust is dynamic, taking time to develop and with the potential to deteriorate rapidly. Attention to who bears vulnerabilities; how benefits, burdens and recognitions are distributed; and how less powerful actors can contest decisions can help foster trust through transparent and equitable partnerships.

Each of the different mechanisms of influence described below relies on trust for meaningful change to be achieved. Many participants provided examples where collaboration on foreign partners' local priorities created opportunities to also work on issues that were of more concern to the U.S. as a donor. For example, one person talked about working first on issues around child health, which was prioritized by local partners, before being able to introduce work on emerging infectious diseases, which were the primary concern for the U.S. due to the potential threat they pose to the U.S. Another interview participant described the value of the trusting relationships developed through engagement in global health spaces as "the hill I will die on."

The recent dismantling of the U.S. Agency for International Development (USAID) and withdrawal of a large proportion of U.S. government global health funding has created challenges to the trust held by others toward the U.S. A researcher who participated in an interview described significant economic and cultural impacts from the current Ebola outbreak in the Democratic Republic of the Congo that would have been preventable had the U.S. still held the trusting relationships that it used to have there. In an article describing how the dismantling of USAID has cost lives and threatens global stability, Kayser and colleagues also decry the loss of soft power, noting that humanitarian interventions are "fundamental to human life [so] an ideal avenue for soft power" (Kayser et al., 2026). This is not to suggest a fully transactional nature of humanitarian intervention but to acknowledge that alongside the humanitarian benefits, broader trust can be generated through these interventions.

While some informants described having lost partners' trust which ended previously longstanding partnerships as a result of abrupt funding cuts in 2025, others talked about how the strength of their long-term partnerships has withstood this test, with partners understanding that a specific institution is different from the federal government responsible for the cuts. Participants noted that it is through working together on hard problems to generate trust that they then have the capacity to

work on new areas and deal with new crises when they arise. This is particularly important in the context of crises where time is of the essence, as if there is no pre-existing trust it is very difficult to rapidly mobilize an appropriate response.

One interview participant succinctly highlighted the importance of California's global health engagement in the current moment: "Our global relationships, as the U.S., are being threatened, and there's a real reckoning about how trusted a partner the U.S. is on anything — NATO [North Atlantic Treaty Organization], the UN [United Nations], GOARN [Global Outbreak Alert and Response Network] — so it's really important for California to step in as one of the world's largest economies, with a strong government, academia and private sector, as we weather the federal storm."

3.2.2 Credibility Credibility is the perceived likelihood that an institution's information is accurate, its commitments are sincere and it has both the capacity and willingness to act as stated. Repeated credibility can become part of an institution's reputation, which ultimately contributes to trust. To yield influence, institutions must be seen to know what they are doing and to go about this in ways that incorporate transparency and correspond to evidence and good practice.

All academic participants spoke about this in different terms in relation to California's global health engagement, such as "People watch what happens here," "Reputation helps us … We're seen as an innovation hub" and "California's 'can do' attitude gives us outsized influence, as policymakers want to hear from us." They noted that California is seen as a leader in innovation, that it is known to have some of the best universities in the world and it has a booming private sector relevant to global health. One private sector participant noted that "California is known for innovation. Having the reputation of things starting in the state that have global impact … that helps all of us."

In addition to California's credibility enhancing its reputation, it also serves to attract new talent, which further strengthens what California can offer to global health and what that new talent can in turn offer to California. California's credibility draws more undergraduate and graduate students than any other state in the U.S.

3.2.3 Reliability Reliability can be understood as a basis for trust and credibility. It refers to a demonstrated tendency of fulfilling commitments, following agreed procedures and sustaining engagement over time and evolving circumstances (Crescenzi et al., 2012). Key elements of reliability include honest communication, justification for changes in behavior and attention to the effects of any changes on partners.

"California's 'can do' attitude gives us outsized influence, as policymakers want to hear from us."

Reliability in relationships was highlighted as key for successful engagement in any global health spaces. While this can be difficult to achieve amidst strong political winds, state and local governments, NGOs, including academic institutions, and the private sector can create critical long-term stability to counter changes in federal-level political priorities and the ruptures that can result therefrom. Interview participants from academia spoke about long-standing partnerships, some going back decades, in which their reliable actions have helped foster continued engagement.

3.3 Influence Through Engagement with Multilateral Global Health Initiatives

3.3.1 Mechanism of influence Through engagement with and local adoption of multilateral global health initiatives, the California state government, as well as county and city governments within California, have become known and respected, have demonstrated recognizable leadership and have gained expanded influence in international policymaking spaces and multilateral fora. As a subnational actor, California does not have the formal authority to engage in "core global health diplomacy," defined as "negotiations between or among nations to dissolve disputes and enact formal agreements" (Katz et al., 2011). In practice, this means that, unlike nation-states that are members of global governance bodies such as the UN and WHO, it cannot negotiate or sign onto binding international treaties. However, in the identified examples below, California state and local governments have engaged in multilateral initiatives and exercised influence through alternative pathways.

In some cases, the engagement itself has provided opportunities for influence in shaping global dialogue and policy, as California-based individuals and entities can gain access to multilateral spaces and interact with those involved in negotiations even though the state representatives cannot negotiate directly. Influence has also occurred indirectly through policy diffusion, as effective and innovative solutions to shared global challenges serve as examples to be replicated and scaled up in other cities or countries (Fulgenzi, 2024). Localized adoption of global initiatives has also contributed to influence through contributions to global indicator reporting, which informs future frameworks, indicators and standards. Through participating in these global initiatives and processes, subnational governments participate in broader epistemic communities (discussed in more detail in a later subsection), through which they also gain legitimacy. This legitimacy may have particular implications in the U.S. context, as the U.S. federal government is often more immune to international or top-down pressure; thus, engagement with global initiatives in the U.S. is often accomplished through local government adoption and norm diffusion, rather than through action at the federal level (Och, 2018).

3.3.2 Examples of California's engagement with multilateral global health initiatives Examples of California's engagements with global initiatives include the state's commitment to and adoption of global goals and frameworks such as the Paris Agreement, the FCTC, the SDGs and CEDAW and, more recently, its membership in the WHO GOARN.

Commitment to and adoption of global goals and frameworks California and many local governments within the state have engaged directly with a variety of multilateral initiatives such as CEDAW, the FCTC, the SDGs and the Paris Agreement. Through engaging with these global goals and frameworks, California and local governments have gained opportunities for participation and recognition in global fora and contributed to global indicator reporting, knowledge production and data sharing.

This, in turn, enhances global influence through policy diffusion and pressure on counterpart jurisdictions to adhere to shared goals, all of which ultimately shapes global policy and agendas to the benefit of Californians and others (Fulgenzi, 2024).

Adoption of CEDAW

CEDAW is a legally binding human rights treaty adopted by the UN in 1979 to eliminate discrimination against women and promote gender equality. CEDAW obligates states parties to take all appropriate measures, including legislation, to address discrimination against women and ensure their full and equal realization of rights (UN General Assembly, 1979). The U.S. is one of only a few countries that has not ratified CEDAW.

San Francisco was the first U.S. city to formally adopt a CEDAW ordinance in 1998, and its Department on the Status of Women was one of a few organizations that spearheaded the "Cities for CEDAW" campaign in the U.S. (Lee, 2019). Since then, multiple local governments within California and across the U.S. have locally adopted CEDAW either through binding ordinances or resolutions. Ordinances have generally committed local governments to conducting a gender analysis of the jurisdiction's services, workforce and budget to institutionalize a gender lens within local operations; establishing an oversight body responsible for monitoring implementation of the ordinance; and providing resources to support implementation (The Leadership Conference Education Fund & Women's Intercultural Network, 2018). According to the Cities for CEDAW campaign website (updated as of 2023), three California counties and four cities have ordinances and an additional three counties, 13 cities, plus the California State Senate have adopted CEDAW resolutions (Cities for CEDAW, 2023). Increasing local adoption illustrates the normative power of local governments to gain influence through widespread diffusion, even when higher levels of government are not engaged (Och, 2018).

The UN Framework Convention on Tobacco Control

Even though the U.S. is not a formal party to the 2005 UN FCTC, California has engaged with it through academic and civil society institutions. The University of California, San Francisco (UCSF) Center for Tobacco Control Research and Education is an official WHO Collaborating Centre on Tobacco Control, and researchers there provide technical assistance and global analysis on implementing specific treaty components. Civil society organizations in California collaborate with global networks such as the Global Alliance for Tobacco Control to promote FCTC objectives internationally, often drawing on tobacco control lessons from California to help inform actions elsewhere. For example, California's statewide "quitline," a smokers' hotline, provided early evidence that centralized telephone counseling could deliver effective, culturally and linguistically appropriate smoking cessation support at population level. The model was disseminated through international training and contributed to the wider evidence base underpinning part of the FCTC guidelines. National "quitlines" have subsequently been implemented by numerous FCTC parties (Zhu et al., 2000). The use of Californian policy responses as exemplars for other countries builds the state's credibility and garners interest from other countries working toward the same goals. This support to the WHO and to civil society globally in the fight against tobacco has provided reputational gains for the institutions involved as well as the successful state actions they have shared with others.

The Paris Agreement and engagement with UN Climate Conferences

California has remained committed to its targets in mitigating and responding to climate change.

The Paris Agreement is a legally binding international treaty addressing climate change, adopted in 2015 under its parent treaty, the UN Framework Convention on Climate Change (UNFCCC) (United Nations Climate Change, n.d.). The primary aim of the Paris Agreement is to keep the global average temperature rise as close as possible to 1.5 degrees Celsius above pre-industrial levels (United Nations, 2015). Countries party to the agreement commit to reducing greenhouse gas emissions and collectively working to mitigate and adapt to climate change impacts. Countries must report their progress in implementing their commitments every five years with an updated national climate action plan. Countries meet annually at the Conference of the Parties (COP), the primary multilateral decision-making body for international climate change negotiations. While only countries party to the UNFCCC may negotiate, COP sessions bring together many actors across sectors, including subnational governments (such as California), the private sector and civil society.

Even as the U.S. has repeatedly withdrawn from the Paris Agreement, California has remained committed to its targets in mitigating and responding to climate change. California governors have attended the UN Climate Conferences since COP15 in 2009, when Arnold Schwarzenegger attended; Jerry Brown attended in 2015 when the Paris Agreement was signed and in the same year co-founded, with the German state Baden-Württemberg, the Under2 Coalition, a coalition of subnational governments committed to achieving the targets of the Paris Agreement (Holmes, 2020; Reyes-Velarde & Lazo, 2025; The Climate Group). Gavin Newsom attended COP26 and, most recently, COP30; delegates from the Governor's Office also attended COP29. In 2025, the California State Senate formally adopted a resolution to affirm the state's continued commitment to the Paris Agreement (LegiScan, 2025).

Although California is a non-state actor that cannot formally participate in COP negotiations, its commitment to global climate targets and its presence at these conferences provides opportunities for influence in global spaces. At COP30, Governor Newsom co-chaired the Local Leaders Forum where subnational leaders engage in mutual learning around implementation of climate goals. California delegates' participation in presentations and international panels at side events also provided an opportunity to feed into contemporary debates and engage with other climate leaders (State of California Governor's Office of Land Use and Climate Innovation, 2024). COP30 was centered around the leadership of Indigenous peoples as the guardians of biodiversity, and the California delegation shared the state's approach to advancing Indigenous climate solutions, supporting tribal-state climate partnerships and dismantling harmful historical legacies that interfere with Indigenous land management practices (Governor of California, 2025a). Lessons shared by other countries can also help further strengthen California's work in this area, benefiting often-neglected Indigenous peoples.

California is a reliable institutional partner committed to multilateral cooperation, supportive of WHO and science-based health, and capable of acting at a scale normally associated with nation states.

Outcomes of engagement in these conferences have also included new bilateral climate agreements between California and other governments. At COP30, California signed new memoranda of understanding (MOUs) with the state of Pará, Brazil, and with federal agencies of Chile, Colombia, Denmark, Kenya and Nigeria (Governor of California, 2025a, 2025b). These MOUs seek to deepen collaboration on issues as diverse as biodiversity, clean energy, clean transportation, methane reduction, and wildfire prevention and response. The MOU with Denmark focuses on jointly tackling data center decarbonization — and creating faster and cleaner grid connections — with California's new CalFUSE framework that is designed to help customers use clean power when it is most available, drawing lessons from Denmark's experience with grid flexibility. Following the meetings, Governor Newsom said, "We formed new international partnerships that will make California stronger economically, environmentally and as a global climate leader." This illustrates the overlapping mechanisms of influence, as engagement in global climate policy spaces fosters opportunity for paradiplomacy, which in turn increases influence within global spaces while also yielding domestic benefits. Given the disproportionate burden of disease among disadvantaged communities due to fossil fuel extraction, any shift toward greener energy can also help reduce health inequities locally.

Local adoption of the SDGs

The UN 2030 Agenda for Sustainable Development includes 17 global goals, collectively known as the SDGs. The SDGs address interconnected issues such as ending poverty and hunger, improving good health and well-being, achieving gender equality, reducing inequalities and climate action, among others (United Nations Department of Economic and Social Affairs Sustainable Development, n.d.). While non-binding, the 17 SDGs were universally adopted by all UN member states in 2015. Countries are encouraged to submit voluntary national reviews (VNRs) of progress toward the SDGs, both to exchange useful practices and lessons learned and to contribute to global monitoring and progress (United Nations High-Level Political Forum on Sustainable Development, n.d.). An interview participant familiar with the engagement of Los Angeles with the SDGs described these reviews as a "horse race process": "once you're in this community of practice and other people are doing it, there's a certain amount of pressure to also do it."

While the U.S. has not yet submitted a VNR, the cities of Los Angeles and Sacramento have formally engaged with the UN SDGs and have participated in the voluntary local review (VLR) process (Los Angeles in 2019 and 2021, Sacramento in 2024). Influence through policy diffusion within global spaces has been demonstrated, for example, by the Los Angeles SDG data platform referenced as a model for indicator tracking within the UN Economic Commission for Europe guidelines for developing VLRs (United Nations Economic Commission for Europe (UNECE), 2025). Adoption of SDGs and reporting progress through the VLR process has amplified local government influence in global decision-making and agenda setting processes, as VLRs feed into the High-Level Political Forum on the SDGs (United Cities and Local Governments, 2021). Engagement in SDG indicator reporting has also been a tangible way to account for local government contributions to the SDG agenda, allowing for recognition in multilateral spaces, where local governments have historically been overlooked as actors (Ortiz-Moya & Reggiani, 2023).

WHO Global Outbreak Alert and Response Network (GOARN)

The WHO GOARN is a network of over 360 member institutions engaged in providing international response and support for disease outbreaks and public health emergencies (World Health Organization, 2023). In 2026, the California Department of Public Health (CDPH) became the first U.S. state government agency to join GOARN; since then, six additional states have joined, amplifying the positive impact of California's joining. In addition to CDPH, other California-based institutions that are members of GOARN include the Chan Zuckerberg Biohub (headquartered in San Francisco) and the University of California (UC) Davis One Health Institute. As members of GOARN, these California-based institutions have directly engaged in global collaborations related to disease outbreak surveillance, monitoring and response, influencing broader global guidelines, and agenda setting. Members also provide technical knowledge and expertise, exercising influence through credibility and scientific authority. The exact scope of work has expanded relative to needs, which keep changing, but the strong network of trusted partners has been able to adapt to this, growing their sphere of influence to address evolving needs.

Californians have benefited from engagement with this WHO initiative, as member institutions receive alerts and information related to global outbreaks, which contributes to California being better prepared for disease prevention and responses. At a time when the U.S. has withdrawn from the WHO and is therefore removed from key global health security discussions, including disease surveillance and outbreak monitoring, data sharing and response, membership of GOARN brings critical access to information and partnerships to protect the health and wellbeing of Californians. Member institutions also receive capacity building through training and education opportunities, which translate to a stronger public health workforce. Beyond this, one interview participant highlighted the importance of signaling to global bodies that even if the federal government is retreating, there are still state actors who are interested in engaging and cooperating.

In these examples of commitment to and localization of the global frameworks and engagement in a global network, Californians have benefited from government action toward controlling tobacco, mitigating climate change, promoting sustainable development and furthering gender equality. Formal engagement with these initiatives can improve policy within California jurisdictions, aligning it more closely with international human rights law as well as with globally agreed-upon development goals. Improved data collection for indicator tracking also allows for measuring progress, identifying gaps and improving implementation. Importantly, California gains credibility from

its adoption of these frameworks and, even if it may not have full voting rights, it has a seat at the table in relevant discussions about shaping these and future frameworks. Finally, these initiatives, including most recently becoming part of GOARN, show the world that California is a reliable institutional partner committed to multilateral cooperation, supportive of WHO and science-based health, and capable of acting at a scale normally associated with nation states.

3.4 Influence Through Paradiplomacy

3.4.1 Mechanism of influence As described above, California lacks the authority to engage in the "core global health diplomacy" conducted through formal treaty negotiations. However, the state government of California engages in global health paradiplomacy, through agreements with other entities. Paradiplomacy, or informal diplomacy, is described as an emerging aspect of international relations in which local or regional authorities or governments engage in interactional activity with counterpart local governments, nation-states and/or international organizations (Fulgenzi, 2024). These activities may complement, duplicate, challenge, correct or compensate for formal diplomatic activities at the centralized nation-state level (Fulgenzi, 2024). California paradiplomacy contributes to its broader influence in global health through policy diffusion and increased credibility. Direct agreements with other cities, states or provinces, and national governments provide opportunities for the exchange of information, expertise and practices, which contributes to shaping norms, practices, policies and priorities of the entities with which it has agreements (Fulgenzi, 2024). These engagements in turn increase California's credibility and demonstrate California's active leadership and willingness to cooperate on shared global goals and initiatives. They also go on to benefit the people of California who are ultimately governed by California-influenced global health-related norms and standards, just as they are when formal diplomacy is carried out by their federal government.

3.4.2 Examples of California's paradiplomacy Examples of California's paradiplomacy relevant to global health include its partnership with health officials in Mexico in the CDPH Office of Binational Border Health, and several MOUs related to climate change.

CDPH Office of Binational Border Health

California formally engages with federal Mexican and Baja state government health officials on health issues affecting both sides of the border region. The mission of the CDPH Office of Binational Border Health is to facilitate communication, coordination and collaboration among health officials in both California and Mexico, health professionals, and communities to optimize border health (California Department of Public Health & Office of Binational Border Health, 2022). This partnership not only illustrates California's direct engagement in health diplomacy with other governments, but it also is beneficial to Californians, as enhanced collaboration allows both governments to respond more effectively to health issues impacting communities within both jurisdictions, including cross-border health threats. This also creates a foundation for collaboration on a broader range of issues relevant to these cross-border areas.

Climate change agreements

California has signed 91 bilateral climate change MOUs with entities in 28 countries plus the World Bank and an additional 19 multilateral agreements with various international alliances and coalitions (California Energy Commission, n.d.). Multiple state agencies are involved in these partnerships through California's Intergovernmental Climate Action Team. Through these climate change agreements, California state leadership aims "to strengthen the global response to the threat of climate change and to promote a healthy and prosperous future for all citizens" (California Energy Commission, n.d.).

These engagements amplify California's influence in broader global climate change spaces, as they act as mechanisms of policy diffusion not only through exchanging information and influencing practices and policies horizontally in other subnational jurisdictions, but also through a bottom-up vertical mechanism with federal governments in other countries. As California gains credibility and support from government entities in other countries, its informal influence is extended as the national governments of those countries engage in global policy spaces with the formal treaty-negotiating power that California, as a subnational entity, lacks (Ruckert et al., 2016).

A notable climate agreement that California has entered into is its linked cap-and-trade program with the Canadian province of Québec (California Environmental Protection Agency Air Resources Board, 2013). Originally envisioned as the Western Climate Initiative, a partnership between multiple U.S. states and Canadian provinces, this collaboration was reduced to a bilateral arrangement following the financial crisis, changes in state governments and political opposition to carbon pricing in some places. However, California and Québec remained committed to compatible economy-wide carbon pricing, and the agreement produced valuable regulatory integration. This initiative limits the amount of greenhouse gas emissions corporations may produce and requires emissions to be offset through purchasing auctioned allowances; the proceeds from the allowances are reinvested into state environmental health initiatives (Leffel, 2018). While the initiative inherently brings economic returns to California from the proceeds of allowances, the partnership with Québec is significant as linked systems enable carbon allowances to be purchased at lower costs, which makes compliance with emissions caps more feasible for corporations, thus increasing the efficiency of emissions reductions at lower costs (International Emissions Trading Association & Environmental Defense Fund, 2022). California's influence through these types of agreements comes from perceived effectiveness of its policies, the size of its market, and the availability and willingness to engage officials who can explain implementation.

California's climate MOUs have strengthened its soft power by making the state a recognized source of policy expertise, a trusted convening partner and an influential node in transnational climate governance.

California's climate MOUs have strengthened its soft power by making the state a recognized source of policy expertise, a trusted convening partner and an influential node in transnational climate governance.

Given the diversity of California, the increasing resource constraints and the growing appreciation of the need to bridge population and individual health domestically, there is a lot to be learned from locally produced global health knowledge.

Their clearest returns are access, credibility, policy diffusion and coalition leadership, all of which accrue downstream benefits to Californians.

Academic paradiplomacy
Many Californian universities are also seen as trusted brokers who are able to create long-term relationships with partners around the world including other universities, governments, nonprofits and the private sector. They are often seen to have the legitimacy to bring together these different groups of actors in different countries, which can create new, evidence-based national-level structures to improve health. Building capacity and creating safe spaces for collaboration opens up a wide range of opportunities to influence health actions, including through collaborative knowledge production and epistemic communities as discussed below.

3.5 Influence Through Knowledge Production and Workforce Development

3.5.1 Mechanism of influence California-based institutions amplify California's influence in global health spaces through knowledge production and workforce development, which in turn both contribute to credibility and epistemic authority mechanisms described in the section below.

Knowledge production within global health comprises the practices and institutions through which understandings of and appropriate responses to health problems are created, interpreted, validated and shared. Individuals and institutions engaged in knowledge production gain credibility and epistemic authority, and knowledge production directly contributes to the evidence base that informs global policy, guidelines, and agenda and priority setting. Workforce development builds and sustains the people and institutions required to generate global health knowledge and translate it into effective action globally and locally.

These are not apolitical processes: political, societal and institutional arrangements shape whose questions, methods, evidence and interpretations are recognized, and whose capacities are developed. This is critical in shaping which issues become visible, which populations are prioritized (or not), and where resources are directed (Abimbola et al., 2024).

3.5.2 Examples of California's knowledge production

The value of the global health paradigm
Interview participants drew attention to how they have been able to leverage the strengths of the global health paradigm and apply it to domestic public health efforts. Several advantages of the global health paradigm were highlighted, including its focus on both population and individual health; its inherent interdisciplinarity; the diversity of populations it reaches; and its comparative resource constraints, which have required a high degree of creativity to find low-cost solutions — often with hard-to-reach populations. Given the diversity of California, the increasing resource constraints and the growing appreciation of the need to bridge population and individual health domestically, there is a lot to be learned from locally produced global health knowledge. This is particularly true for reaching historically marginalized or disadvantaged populations for whom lessons from resource-constrained settings might provide new insights into affordable access to health information and services.

Creation of new knowledge that immediately benefits California
For health issues that transcend national borders, such as climate change and the spread of infectious diseases, global health research anywhere in the world can yield positive benefits for the whole world, including California. An example of this is work led by Stanford University to reduce the air pollution associated with brick kilns in Bangladesh. Through changes in the brick-making process, costs and carbon dioxide emissions were reduced and, as a result, national policy in Bangladesh changed. Not only did this development create goodwill from Bangladesh, which was grateful for cheaper and cleaner brick production, but it also provides a model for brick production elsewhere and the potential for substantial reduction in emissions that affect everyone. Referring to "the physical commons of the earth that we share," one interview participant noted that "everywhere needs a healthier, cleaner [energy] transition to improve health everywhere."

Creation of new knowledge that can be used to inform actions in California
In addition to contributing to enhancing California's influence, global health research output can benefit California, as it contributes to the evidence base that informs health policy, practice and services in California. For example, an interview participant highlighted that work on health worker burnout and respectful maternity care that started in low- and middle-income countries is now being implemented in California. The doula system in California is a version of "community health worker" that is very prominent in many low- and middle-income countries. While many factors contributed to development of the doula system, UC researchers who had previously done work with community health workers in other countries have also been actively engaged in research and implementation relating to doulas in California. Although a direct link is not documented, it is likely that this institutional overlap facilitated lessons around trusted community workforces, accompaniment, task sharing and health system integration. California-based global health researchers have worked with community health workers for years and thus have the credibility to adapt lessons to the local context.

Faculty at UC institutions noted how useful it was to work on access to reproductive health care including abortion both globally and within the U.S. Their ability to show the high quality of telehealth care and at least equivalent health outcomes to in-person care has informed telemedicine abortion care policies domestically and overseas. Studies by UC researchers on the safety of telehealth abortion are cited in the 2025 WHO Safe Abortion Guideline (World Health Organization, 2025), which in turn is cited alongside a very wide range of other evidence, much of it generated locally, in a comment submitted by the University of California, Los Angeles (UCLA) and UCSF on behalf of more than 260 reproductive health researchers to the Food and Drug

Administration (FDA) urging it to ground any national policy decisions relating to medication abortion in transparent and rigorous science (UCLA School of Law Center on Reproductive Health & UCSF Advancing New Standards in Reproductive Health, 2025). UCSF is also studying a cutting-edge strategy, which is already used widely in Bangladesh, Cuba and elsewhere, for possible use in the U.S. It involves providing "period pills" (comprising mifepristone and misoprostol) that can be taken to bring back a late period, without a pregnancy test, potentially providing a useful framing that reduces stigma.

Lessons on the value of a One Health approach have also been locally applied. Based on previous research that found avian influenza among sea mammals in parts of South America and on noticing an increase in avian influenza among sea birds in California, UC Davis researchers tested local marine mammals and discovered avian influenza in seven seals in Año Nuevo State Park. Their fast response, which drew on lessons learned from their global work, precipitated a rapid response to increase monitoring and minimize risk of transmission to humans.

Similarly, California-based disease ecologists have been studying diseases such as Chagas disease and dengue for years; now that these diseases are spreading into California, there is a home-grown knowledge base to inform local and state responses. The constant evolution of disease underscores the importance of belonging to an international scientific community committed to producing evidence that can inform policy and practice wherever the need arises. That California already has legitimacy in these areas of health science can not only inform policies locally, but also across other states in the U.S. where the disease burden is changing.

Creation of knowledge that informs global health policies and strategies

The creation of knowledge by California researchers relating to global health interventions or implementation science, once published, has been used to inform policies and strategies among funders, governments and non-governmental organizations. For example, reflecting a strong global reputation, individual research studies carried out at the University of Southern California (USC) have been used to inform national One Health policy in Uganda, as well as the funding priorities of the Swedish government for addressing HIV and sexual and reproductive health and rights in sub-Saharan Africa and the World Bank for health systems strengthening in The Gambia.

Publication of new knowledge

One example of California's engagement in global health knowledge production is research output linked to California-based institutions. We captured research output through the volume and citations of publications linked to global health-related NIH grants that involve a California-based recipient institution using the NIH ExPORTER publication link tables and the iCite database (iCite et al., 2026; National Institutes of Health, n.d.). Publication volume and citation-related metrics are presented by fiscal year in Table 1 below.

TABLE 1 : Research output and influence generated by global health-related NIH grants to California institutions by fiscal year for 2016-2025.

Fiscal Year	Publication count	Maximum relative citation ratio (RCR)[2]	Mean RCR	Median RCR	Weighted RCR[3]	Total citations	Mean citations per publication	Maximum citations per publication	Median citations per publication	Number of publications cited by clinical documents (clinical trials or clinical guidelines)
2016	4174	276.54	2.89	1.23	12040.95	309797	74.22	7958	29	1985
2017	4506	294.02	2.7	1.23	12169.25	299912	66.56	6413	27	2083
2018	4710	406.13	2.83	1.25	13315.06	305628	64.89	8874	26	2052
2019	4583	501.44	2.81	1.26	12882.08	268187	58.52	11116	23	1967
2020	5927	368.37	3.02	1.27	17920.90	327335	55.23	6502	20	2326
2021	6325	564.88	2.84	1.29	17984.97	262178	41.45	8263	17	2250
2022	6264	168.99	2.61	1.26	16319.58	180624	28.84	2139	12	1889
2023	6641	414.09	2.65	1.21	17564.21	132037	19.88	2970	8	1531
2024	6403	669.43	2.74	1.19	16973.10	79988	12.49	3419	5	1032
2025	6293	501.78	4.98	3.18	7094.31	25699	4.08	1317	2	384
TOTAL	**55826**	—	—	—	—	**2191385**	—	—	—	**17499**

[2] Relative citation ratio (RCR) is a measure of scientific influence calculated as the citations per year of each paper in analysis, normalized to the citations per year of NIH-funded papers in the same field and year. An RCR of 1.0 has the same cites per year as the average NIH-funded paper in the same field and year (iCite Support, 2024).

[3] Weighted RCR is the sum of the RCRs of the publications in the analyzed set, which weights the publication count by their influence relative to NIH-funded papers. A more influential set of publications will have a weighted RCR that is higher than the total number of publications in the set, while a set of articles with below average influence will have a weighted RCR that is lower than the number of publications.

TABLE 2 : Percentiles associated with publication RCRs based on NIH-funded publications (iCite, 2026)

PERCENTILE	99.9%	99%	95%	90%	80%	70%	60%	50%
RCR[3]	38	13.11	5.72	3.81	2.39	1.72	1.3	1.0

[3] Relative citation ratio (RCR) is a measure of scientific influence calculated as the citations per year of each paper in analysis, normalized to the citations per year of NIH-funded papers in the same field and year.

In the dataset used for this analysis, from fiscal years 2016-2025, there were a total of 55,826 unique papers published that are linked to NIH-funded global health grants involving a California institution. By June 2026, this set of publications has been cited 2,191,385 times. In addition to general scientific influence, clinical influence is illustrated by the number of publications cited by clinical documents. Across all fiscal years, 17,499 (31.3%) publications have been cited by clinical documents. Table 2 below shows the percentiles associated with relative citation ratios (RCRs) of NIH-funded publications.

Based on these percentiles, the mean RCR for all fiscal years falls between the 80th and 95th percentiles, indicating that for the publications analyzed, the average number of citations of this set of publications linked to California institutions is well above that of the average NIH-funded paper in the same fields and years.

While this analysis does not take into account institutional affiliations of the authors of the publications, it usefully captures one aspect of California's knowledge production and illustrates how research output translates to broader scientific influence, epistemic authority and California's reputation for academic excellence.

Workforce development

Global health workforce development initiatives can create long-lasting relationships, capabilities and professional influences, all of which enhance the ability to influence global health. The reputation of California's academic institutions has helped to create opportunities for engagement in this type of workforce development. For example, the Mastercard Foundation selected UC as a partner where they could fully fund top high school students from Africa to do their bachelor's degree; the president of Rwanda has established an agreement with UC Berkeley specific to global health training; and UC Davis recently hosted faculty from six countries in Southeast Asia for veterinary training. These initiatives signal opportunities for long-standing collaborations between Californian universities and their alumni worldwide. USC's Senior Fellowship in Global Health Communication Leadership, with a focus on sub-Saharan Africa, offers leaders, journalists, writers, authors, researchers, academics and creators the opportunity to collaborate with USC on projects that advance shared goals at the intersection of communications and global health, and it has been the foundation for strengthening intercontinental relationships. Likewise, UCLA Law provides full-tuition fellowships to emerging leaders under its Health and Human Rights Fellowship Program, bringing lawyers from India, Kenya, Malawi, Nigeria, South Africa and elsewhere to earn a Master of Laws (LLM) and to forge connections with transnational lawyers working at the intersection of law and health.

Global health workforce development initiatives can create long-lasting relationships, capabilities and professional influences.

An innovative example of maximizing the use of available human resources is the virtual training academy that UCSF ran for librarians on contact tracing during COVID-19. Librarians were, at the time, unable to work due to physical distancing but they were still a resource that could be tapped. Building on models used for training in low- and middle-income countries and the centrality of community leadership in global health, UCSF worked with community-based organizations and included cultural humility in their training and, in this way, trained librarians who managed to reach some traditionally "hard-to-reach" populations with COVID outreach efforts.

One reciprocal model can be seen at UCLA, which recently hosted a group of pediatricians from Mozambique for training with the idea that some UCLA faculty will now go to Mozambique for training. This notion of "capacity bridging," with reciprocal knowledge exchange being central, where the strengths of California-based institutions as well as those of their global health partners around the world can be brought together, exemplifies the mutual respect of equitable partnerships that strengthens trust in influence.

Similarly, the University of California Global Health Institute's (UCGHI) Center for Health Workforce, or HEAL initiative, trains, mentors and builds community among frontline health professionals dedicated to working in resource-denied settings. Embodying California's interconnectedness with global health approaches, HEAL supports projects in Malawi, Mexico, Navajo Nation, California and elsewhere, employing a unified strategy of supporting health workers already rooted in the communities they serve.

Over the long term, these relationships can foster mobility of people and products, with some participants suggesting that any strengthening of the health workforce and health system will generate demand for medical products and equipment that California will be well-placed to provide. Workforce development can also serve to create epistemic communities of professionals who share terminology, evidence standards and ways of defining problems, thus expanding the influence of California's approach to tackling health challenges.

3.6 Influence Through Epistemic Authority and Communities

3.6.1 Mechanism of influence California and entities and individuals within California have gained influence in international policy spaces through epistemic authority and communities. Epistemic communities are networks of experts who share a common understanding of the political and scientific nature of an issue and gain and exert influence through their collective authoritative claims to knowledge and the ability for consensus on issues (Betsill & Bulkeley, 2006). The authority of epistemic communities stems from credibility and demonstrated scientific competence and contributions, and this authority in turn generates increased credibility and trust, which contributes to the ability to exert influence in global spaces (Pratiwi, 2024). Transnational advocacy networks are examples of epistemic communities, and they gain influence and authority through the ability both to collect, produce and share out information, knowledge and values, not only through the network members but more broadly globally (Betsill & Bulkeley, 2006). Influence from transnational networks occurs through enhanced recognition and credibility as part of a network with epistemic authority, and increasingly networks and coalitions participate in international fora, advocating for the interests of their members and shaping global policy (Betsill & Bulkeley, 2006). These networks often have greater influence than an individual actor because of their pooled member influence; networks also provide a mechanism for subnational authorities to engage directly and independently in global spaces, independent from engagement that occurs from the federal government (Betsill & Bulkeley, 2006).

3.6.2 Examples of California's engagement in epistemic communities California has demonstrated epistemic authority through various California-based entities participating in global health-related networks and coalitions, and through representation of individuals affiliated with California-based institutions on global scientific and technical committees and advisory groups. These epistemic communities can also provide opportunities for engagement in the types of multilateral spaces described above.

Not only has participation in these networks and coalitions enhanced influence globally, but where California local governments have been involved, they have brought effective policy solutions and lessons learned from peers back to the state, as the examples below illustrate. These communities have provided a "safe space" in which peers can discuss failures as much as successes without public scrutiny, which allows for more honest sharing of lessons, which in turn further strengthens trust among members. In some cases, networks can also bring a range of benefits, including resources, to members for initiatives in those cities.

Participation in transnational networks and coalitions
Several California entities have been engaged in transnational networks. Select examples are described below.

ICLEI - Local Governments for Sustainability
There are 37 California cities that have been members of ICLEI — Local Governments for Sustainability (formerly International Council for Local Environmental Initiatives), a global network of over 2,500 local and regional governments across 125 countries committed to sustainable and equitable urban development and climate action (ICLEI - Local Governments for Sustainability, n.d.). ICLEI has provided a peer network for sharing local policies and initiatives, including data measurement tools to report on progress. ICLEI has also represented its members in multilateral spaces, bridging members with multilateral agencies and enabling its members to collectively influence global policy through its advocacy efforts. For example, it has been an accredited observer of the UN Framework Convention on Climate Change, maintained partnerships with various UN agencies and participated in the UN High-level Political Forum on Sustainable Development.

The CHANGE network supported research in Los Angeles on caregiver experiences to support the development of guidance for cities in disaster response and recovery.

One of ICLEI's initiatives has been the California Statewide Energy Efficiency Collaborative, in which ICLEI provides support to California members in reducing emissions through technical support and trainings, peer-exchange events and no-cost access to ICLEI's emissions management software tool to conduct emissions inventories and support development of climate action plans (ICLEI - Local Governments for Sustainability, 2011).

City Hub and Network for Gender Equity
Los Angeles was one of the six founding cities of the City Hub and Network for Gender Equity (CHANGE), a transnational network of 16 cities with a shared goal of advancing gender equity through local governments. CHANGE developed the first Voluntary Gender Review in alignment with SDG 5 on gender equality, and members directly contribute to global indicator development, measurement and monitoring. The CHANGE policy library, a repository of relevant subnational laws and policies that members can learn from, includes example laws and policies from both California and Los Angeles, such as the Healthy Youth Act and the Menstrual Equity Act, illustrating policy diffusion.

Following the 2025 wildfires in Los Angeles, the CHANGE network supported research in Los Angeles on caregiver experiences to support the development of guidance for cities in disaster response and recovery (Cities Change, 2026).

C40
Los Angeles and San Francisco have been member cities of C40, a global network of 97 mayors committed to showing measurable progress on cutting greenhouse gas emissions, since shortly after its founding in 2005 (C40 Cities, n.d.). The network has not only provided a space for exchange of ideas and effective policies in a context of polarized climate debates, but it has also given a voice to members in representing cities at UN climate conferences, G20 summits and other global fora to influence the global climate agenda.

As part of the C40 network, Los Angeles and San Francisco have made various commitments to actions aimed at reducing emissions that, in addition to improving air quality and minimizing health impacts from pollution, bring additional benefits to their

"We contribute to changes in [WHO] guidelines that are like a bible for the rest of the world even if the U.S. doesn't follow them."

residents. For example, one commitment relates to reducing emissions while ensuring a just transition for communities and workers reliant on high pollution industries through the creation of good, green jobs (C40 Cities, n.d.). Another commitment is to accelerate renewable energy systems, which also creates more good, green jobs and, within this, to prioritize accessible and affordable renewable energy programs for underserved communities (C40 Cities, n.d.). Given the difficulty in enforcing the reduction of greenhouse gas emissions, these voluntary commitments provide a meaningful way to promote positive change and share lessons learned.

An interview participant described one clear example of engagement in a global epistemic community creating a relationship that yielded direct domestic benefits. Through his involvement with the C40 as well as other international groups, then-Los Angeles Mayor Eric Garcetti developed a close relationship with Giuseppe Sala, the mayor of Milan. During the very early days of the COVID-19 pandemic, when Milan was particularly hard hit, Garcetti called Sala to learn from the Italians' experiences. The advice that he received allowed Garcetti to engage with local health authorities in Los Angeles to jump-start a lot of the work to protect the city.

Alliance for Innovation in Global Health (formerly Bay Area Global Health Alliance)

Beyond local governments, other California-based institutions have also exercised influence through transnational networks. The Alliance for Innovation in Global Health (formerly Bay Area Global Health Alliance) is a California-based alliance with a mission to advance global health innovation and impact. The Alliance acts as a convener and catalyst among its members. While the Alliance is based in California and includes many California institutions, its multi-sector network of over 100 members includes organizations from around the world, represented by academic institutions, coalitions, governments, nonprofit organizations and the private sector.

The Alliance for Innovation in Global Health illustrates the strengths of a multi-sector network, as it has supported partnerships among its members, such as the Advancing Health Online initiative, which brought together Merck and Meta in investing in social media and digital platforms to improve health communication and systems. Funding from the initiative has supported Stanford's Center for Digital Health and Center for Advanced Study in Behavioral Sciences to study the use of generative artificial intelligence in health care contexts in low- and middle-income countries (Advancing Health Online Initiative; Bay Area Global Health Alliance, 2024). The Alliance has served as the dissemination partner for this initiative at Stanford as well as other initiatives, providing opportunities to amplify the findings and bringing attention and potentially further investment.

Participation in national alliances

The California Governor's Office has been part of a range of governors' alliances, including two that are particularly relevant to health: the Public Health Alliance and the Reproductive Freedom Alliance. These bipartisan alliances include governors from states across the U.S. who come together to develop tactical strategies to improve health across the country. This can be particularly important if leadership at the federal level is lacking and global commitment to protecting health and rights is waning. As one example, when over-the-counter contraception was first introduced, it was not covered by federal Medicaid; the alliance of governors convened their leads on Health and Human Services as well as state Medicaid directors to find a way to include this medication under state Medicaids and thus ensure its accessibility to the population. As with other alliances, the pre-existing trust among members of the alliance enabled this to happen much faster than otherwise. These alliances have developed far beyond their original scope to incorporate other "quiet work" within governor powers because the relationships exist to make this possible. While not transnational networks, these alliances help bridge local and global health, with valuable lessons and influence being shared in these spaces that governors may later take to the global spaces in which they engage.

Representation on global scientific and technical committees, advisory groups and networks

Individuals and entities representing California-based institutions have engaged in influencing global health policy spaces through participation in WHO scientific and technical committees, advisory groups and networks. Individuals on these committees and groups, with their credibility and scientific authority, directly influence global health policy guidelines, standard setting, and agenda and priority setting.

WHO convenes public health experts on committees, advisory groups, working groups and task forces to provide recommendations on various global health topics. Out of 155 WHO committees, groups and task forces currently listed on the WHO website, 120 publicly list members and their affiliations. Of those, 20 have at least one member affiliated with a California-based institution, with a total of 30 individuals representing 20 different California-based institutions. An academic key informant noted that "we contribute to changes in [WHO] guidelines that are like a bible for the rest of the world even if the U.S. doesn't follow them." This illustrates not only that Californian researchers have helped to inform guidelines that shape national health actions around the world, but also that, even if the U.S. does not generally take heed of these guidelines, it can still benefit from them if other countries' responses to infectious diseases, pandemic preparedness or reduction of climate emissions are improved. The same informant also explained that academics have produced research from their participation in such an epistemic community, which helps further their careers, consolidate institutional reputations and attract students to work with them, thus strengthening academia within the state.

On the same website, WHO lists 31 networks of institutions and organizations (as opposed to the committees above where membership is based on individual expertise) that it coordinates. Of the 31 networks listed, 19 provide a list of members. Three of these groups have at least one member that is a California-based institution, representing four different California institutions.

Participation in communities of practice of professionals can also provide opportunities for learning applicable to local work. For example, through engagement with the Global Action on

Nursing group, UCSF researchers found useful examples of how some low-tech simulation training developed for use in low- and middle-income countries might be equally valuable in very rural or under-resourced areas of California.

Surveillance for pandemic threats
With funding from USAID for 10 years, UC Davis led the PREDICT project to strengthen global capacity for detection of viruses with pandemic potential that can move between animals and people. During this period, over 6,800 people were trained for the One Health workforce in over 30 countries, more than 60 laboratory systems were enhanced, 217 known viruses were detected and 949 novel viruses were detected. Thanks to PREDICT, when the COVID-19 pandemic hit, there was a ready-made global network of over 100 universities working together on One Health to address issues including global health security. Weekly meetings during the early months of the pandemic provided opportunities for cross-learning, which informed early responses around the world and prevented additional disease and death. As noted by a participant, "You can't do that if you don't have trust … It would have taken months to activate if we hadn't already had the network in place." PREDICT created its own epistemic community by bringing together existing regional networks with new partners, and it produced important scientific discoveries throughout its 10-year existence, immediate positive impacts on responses to COVID-19 around the world and a legacy of strengthened disease surveillance globally that also yields benefits globally, including in the U.S.

Informal epistemic communities
Interview participants stressed that soft power and policy influence do not operate solely at the global level of New York, Washington, D.C., or Geneva, but also at regional, national and subnational levels. One researcher described work that they had done to address the adulteration of turmeric in Bangladesh, which led to new national regulations that were later adopted in India, Nepal and Pakistan where this was also a challenge. Solutions "grow legs as others see what we've done." Even without formal epistemic communities in place, informal networks of global health professionals have disseminated solutions on a more ad hoc basis, which stretches the impact, including the positive influence, of the original work.

While some of these engagements might have less direct benefit to California, influence is gained by the institutions represented and feeds into other mechanisms of influence related to epistemic authority and credibility.

4. DISCUSSION

4.1 Overview

This research identified multiple pathways through which California's engagement in global health yields benefits for the state, including through the influence and soft power that such engagement generates. The research suggests that different types of institutions are more suited to some of these pathways than others, which allows the diversity of California-based global health actors to leverage their respective strengths, creating synergies that amplify the state's overall influence. In addition, the access generated by all these different mechanisms can potentially be used for wider economic, scientific and diplomatic relationships.

"You can't do that if you don't have trust … It would have taken months to activate if we hadn't already had the network in place."

Particularly in times of crisis, trusted relationships have proven key to effective action. Under the earlier paradigm of "international health," these relationships were primarily between nation-states, usually between high-income and low- or middle-income countries. The evolution into global health encompassed a diversification of key actors within the field, and, as the field continues to develop, the opportunities for engagement continue to expand and yield reciprocal benefit. California has been a leader in demonstrating the importance of subnational actors participating in global health spaces, as well as in challenging the binary between global health "donors" and "beneficiaries." The political value of its participation, as well as that of other states, is particularly high in the current moment of federal retreat from many of these spaces: maintaining the trust, reputation and reliability that underpin effective collaborations is sustaining a wide range of benefits for health and far beyond.

Below, we explore the different types of benefits accrued to California from the types of engagement in global health spaces described above. We then highlight that these engagements also respond to what Californians want.

4.2 Types of Benefits to California of Engagement in Global Health Spaces

The influential benefits accrued to California from its engagement in global health spaces might be grouped into three categories: diplomatic, security and humanitarian. These are explored in turn below alongside examples of how some of the initiatives described above create these types of benefits.

4.2.1 Diplomatic benefits Constructive engagement in global health spaces demonstrates a commitment to collaboration and a shared concern for humanity that others in the spaces (whether themselves national or subnational actors) share and value. It thereby raises the state's profile and credibility as a serious global health player. These benefits are accrued through all four of the pathways of influence explored in the "Findings" section above. Engagement with multilateral initiatives such as the Paris Agreement and the UN Climate Conferences, the FCTC and localization of the SDGs and CEDAW all yield these diplomatic benefits. In terms of paradiplomacy, the bilateral MOUs on climate change constitute a good example where we see diplomatic benefits. These benefits also arise from knowledge creation, and dissemination also contributes to diplomatic benefits as advances in science are shared with the world. And, finally, participation in epistemic communities such as ICLEI, CHANGE and the C40 as well as engagement by people from California in WHO Technical Advisory Groups augment learning, sharing and diplomatic networks.

"Eventually companies here will sell medical equipment to the health systems we're building."

Investment in health overseas brings reputational and diplomatic benefits as can be seen in how favorable attitudes toward the U.S. and U.S. health aid have been more prevalent when U.S. donations were in the top decile of health aid compared to when they were in the lowest decile of aid, and when the U.S. President's Emergency Plan for AIDS Relief and the President's Malaria Initiative were implemented (Dietrich et al., 2016; Goldsmith et al., 2014; Jakubowski et al., 2016). While the attitudes of the general public might not be affected as much by non-financial contributions, diffusion of knowledge and policy across states and internationally has boosted California's credibility and generated goodwill toward the state.

The strong alliances that can be created through predictable, long-term engagements that promote reciprocal learning and benefits have constituted lasting political partnerships that enable action far beyond any original scope of work, including in times of crisis. These relationships have given California:

- Trusted professional channels during political tension;
- Early knowledge of policy and technological developments;
- Opportunities to place California's ideas on partner agendas;
- Potential allies in multilateral negotiations; and
- Professional networks that outlast individuals in any key positions.

4.2.2 Security benefits Strong health ties have encouraged the rapid and transparent sharing of medical information, which can be critical to understanding and responding to infectious diseases. Assisting other countries to control outbreaks has also protected the health of populations within California. Again, there are examples across all four pathways of global health engagement that contribute to security benefits within California. With regard to engagement with multilateral initiatives, California's groundbreaking move to join the GOARN has yielded security benefits far beyond the state as other U.S. states have also since joined the network. Similarly, the PREDICT epistemic community, created by UC Davis, has generated substantial health security benefits. The CDPH Office of Binational Border Health is an example of how paradiplomatic efforts can contribute to health security. And the vast amount of knowledge generation and publication relevant to health security that emanates from California has helped to inform health security actions around the world.

Further extending this, and as has been central to the notion of soft power since its inception, contributing to stability in other countries through healthy populations, preventing famine and responding to natural disasters can help prevent state collapse and reduce forced migration, including into California and other parts of the U.S.

4.2.3 Humanitarian benefits California has, without a doubt, contributed substantially to saving lives around the world, combating infectious disease, strengthening sustainable health systems and building local capacities to create long-term health improvements. All of this has created goodwill from recipient countries, institutions and communities, which helps foster the kinds of influence explored in this study.

All of the initiatives described in this chapter have been designed to improve health and save lives, meaning that they all yield humanitarian benefits that are visible globally and locally. Participation in WHO Technical Advisory Groups is a clear example of people from California influencing humanitarian actions globally. Further, knowledge creation and workforce development, both key roles of the wide network of academic institutions in the state, have been key contributors to humanitarian benefits.

Across these three different types of benefits — diplomatic, security and humanitarian — the synergies between these different pathways of influence, and the diversity of Californian institutions engaged in them, create a multiplier effect for California's influence in global health spaces.

While the economic benefits of U.S. global health spending in California are explored elsewhere in this study, it is worth noting that the state's engagement in global health spaces also contributes to these benefits in meaningful ways. The trust instilled by the relationships developed through long-term global health engagement has, for example, opened discussions for procurement of biotech and medical exports as well as for new trade agreements and partnerships. As one key informant stated: "Eventually companies here will sell medical equipment to the health systems we're building."

4.3 Responding to Californians' Values

Californians recognize their interconnection with the rest of the world and the value of global engagements to their own lives. A recent survey by the Carnegie Endowment for International Peace found that two-thirds of Californians report feeling "somewhat concerned over potential disconnects between U.S. foreign policy and the priorities of Californians." In addition, 42% of Californians agree that California officials should pursue global engagement with leaders from other nations, up from 34% in 2024, and half of Californians also reported considering diplomacy, humanitarian aid and development support essential to American security and prosperity (Klaus et al., 2025).

Institutional and official statements suggest that global health engagement is understood as an expression of the state's values, particularly social justice, health equity, solidarity, scientific responsibility and assistance to people in need. There is, therefore, alongside the diplomatic, security and humanitarian benefits, a moral benefit to engagement in global health as it allows institutions to enact their stated values. The moral value of global health engagement lies in translating commitments to equality, justice and solidarity into collective actions to reduce avoidable suffering, improve population health and promote human dignity (Benatar et al., 2003; Ruger, 2004, 2012). As always, the ethical legitimacy of any moral claim rests on respecting local agency, addressing power inequalities, and establishing reciprocal, locally directed and sustainable partnerships (Garba et al., 2020; Lasker et al., 2018).

If the aim is to promote global health alongside the health of Californians who also benefit from global engagement, it follows that a long-term approach and a willingness to engage with partners' priorities are key to advancing the interests of all parties. A reciprocal approach is also important as California's credibility is strengthened when it is willing to learn from the experiences of others, rather than presenting the relationship as a one-way export of "superior" California policy. Genuine partnership, and

particularly the notion of trust, which is generated over time, has been seen as a strength of Californian institutions in the global health space and key to successful influence and mutual benefit.

5.
LESSONS LEARNED AND CONCLUSION

California's engagement in global health has proven central to the state's interests; it has helped California protect its population, strengthen its institutions and exercise influence in the world. Through these efforts it situates itself as a credible, significant global player, with a reputation that yields benefits beyond health.

This analysis shows that California, as a collection of subnational actors, has outsized influence on global health. Across the examples in this chapter, influence is rarely the result of formal authority. Rather, it is built through sustained participation in multilateral initiatives, paradiplomatic relationships, the production and exchange of knowledge, and participation in epistemic communities. These pathways help shape international agendas, standards and practice, while bringing information, ideas and relationships back to the state.

The analysis also shows that trust, credibility and reliability are assets that accumulate over time and provide the foundation of influence. California's reputation for scientific excellence, policy innovation and a willingness to act has given its institutions access and credibility, but this has been sustained only through consistent behaviors and long-term partnership. Relationships developed before a crisis have made rapid cooperation possible when a disease outbreak, climate-related emergency or other urgent threat emerges. Conversely, abrupt withdrawal has weakened the channels through which information is shared and collective action is organized.

A further lesson is that influence is dispersed across the state. State and local governments, universities, nonprofit organizations and private-sector actors have each reached different partners and policy spaces. California's strength has not rested on any single institution or sector but on the diversity and synergy of this wider ecosystem. Engagement with GOARN, climate agreements, global goals and human rights frameworks has sat alongside participation in technical committees, transnational networks, research collaborations and workforce development. Together, these activities have created a multiplier effect: scientific authority strengthening diplomatic credibility, global relationships improving health security and reciprocal learning generating solutions for California and overseas.

There is a collaborative spirit among the California global health community that recognizes the complementary strengths that different institutions bring. While important networks of global health actors within California exist, they could be expanded and strengthened to best leverage the state's collective assets. Interview participants underscored California's size and economic power, which position it well to exert more influence globally, and they noted that the state has not fully utilized this market capacity for proactive global health leadership. Even as there will not always be full alignment among all the California-based organizations working on global health or with the state government, the breadth of organizations engaged presents opportunities for additional synergies where common interests can be identified. Each institution has different levels of access to different spaces, which, with coordination, could be leveraged to maximize collective influence and benefits.

Across the wide variety of institutions in California working on global health, many, particularly universities, have continued their work even in the absence of funding. The diplomatic benefits of this work are currently being felt by the individual institutions engaged in this work but, with some coordination, California could claim the work being done across these institutions, thus furthering the state's reputation.

As California is the fourth-largest economy in the world, and one that is made stronger by investments in global health, allocations to global health initiatives from within the state budget can help California maintain its engagement, sustain the long-standing partnerships that matter so much for effective action and continue to contribute toward healthier societies at home and overseas. Some of this is already happening, as the examples in this chapter illustrate, and it could be expanded. Fully acknowledging the challenges arising from the current capacity limitations of CDPH, there could be evident benefits if it were possible for it to become more globally focused.

While a relatively high proportion of Californians already support state engagement in global health, this might be increased if people had a better understanding of the benefits to California, and the U.S. as a whole, of this engagement. This might also serve to incentivize other states to engage more in these spaces, thus multiplying the potential benefits to the country. Documenting California's approach to global health engagement as well as the benefits that it has yielded will be key. Ultimately, these benefits might help expand support for global health within and beyond the state.

The current period of federal retreat makes these lessons particularly urgent. California cannot replace the resources or formal diplomatic authority of the federal government, but it can preserve relationships, demonstrate continuity and maintain a visible U.S. presence in important global health spaces. Doing so will require selective investment, greater coordination across the state's global health actors, and clearer communication and narrative change about the benefits of this work to Californians. By connecting its activities more deliberately, sustaining partnerships that have earned trust and telling a story about their collective value as a coherent state contribution, California will be better positioned to improve health globally and protect its own future. Investing in global health engagement is not an altruistic exercise; it is an acknowledgement of humanity's interconnectedness and the scale of threats we are currently facing that can only be tackled together. California's global health leadership is a strategic public asset that should be recognized, sustained, strategically deployed and emulated.

Investing in global health engagement is not an altruistic exercise; it is an acknowledgement of humanity's interconnectedness and the scale of threats we are currently facing that can only be tackled together.

Appendix A:
SAMPLE WEBSITES SEARCHED

Examples of websites searched to identify information about California's engagement in global health spaces.

Government websites:

- California state: *https://www.ca.gov/*
- California Governor's Office: *https://www.gov.ca.gov/*
- California Energy Commission: *https://www.energy.ca.gov/*
- California Department of Public Health: *https://www.cdph.ca.gov/*
- Los Angeles County: *https://lacounty.gov/*
- Los Angeles County Department of Public Health: *http://publichealth.lacounty.gov/*
- Los Angeles City: *https://lacity.gov/*
- Sacramento City: *https://www.cityofsacramento.gov/*

Multilateral organization websites:

- United Nations – SDG Localization and the Voluntary Local Reviews: *https://sdgs.un.org/topics/voluntary-local-reviews*
- World Health Organization – Networks, committees, advisory groups, working groups and task forces: *https://www.who.int/groups*

Network and coalition websites:

- Alliance for Innovation in Global Health (formerly Bay Area Global Health Alliance): *https://bayareaglobalhealth.org/*
- C40: *https://www.c40.org/*
- Cities for CEDAW: *http://citiesforcedaw.org/*
- City Hub and Network for Gender Equity: *https://www.citieschange.org/*
- ICLEI – Local Governments for Sustainability (formerly International Council for Local Environmental Initiatives): *https://iclei.org/*

REFERENCES

Abimbola, S., van de Kamp, J., Lariat, J., Rathod, L., Klipstein-Grobusch, K., van der Graaf, R., & Bhakuni, H. (2024). Unfair knowledge practices in global health: a realist synthesis. *Health Policy and Planning, 39*(6), 636-650. https://doi.org/10.1093/heapol/czae030

Advancing Health Online Initiative. *Advancing Health Online Initiative*. Global Impact. https://ahoinitiative.org/

Bay Area Global Health Alliance. (2024). *State of the Alliance 2024*. https://bayareaglobalhealth.org/alliance-news/state-of-the-alliance-2024/

Benatar, S. R., Daar, A. S., & Singer, P. A. (2003). Global health ethics: The rationale for mutual caring. *International Affairs, 79*(1), 107-138. https://doi.org/10.1111/1468-2346.00298

Betsill, M., & Bulkeley, H. (2006). Cities and the Multilevel Governance of Global Climate Change. *Global Governance,* 12, 141-159. https://doi.org/10.2307/27800607

Bharali, I., Yamey, G., & Ogbuoji, O. (2026). *The Overlooked Benefits of Health Aid to Donor Countries*. Think Global Health. https://www.thinkglobalhealth.org/article/the-overlooked-benefits-of-health-aid-to-donor-countries

C40 Cities. *C40 Renewable Energy Accelerator*. https://www.c40.org/accelerators/renewable-energy/

C40 Cities. *Cities and Unions Call-to-Action on Jobs*. https://www.c40.org/accelerators/cities-and-unions-call-to-action-on-jobs/

C40 Cities. *Our Cities*. https://www.c40.org/cities/

California Department of Public Health, & Office of Binational Border Health. (2022). *Border Health Status Report to the Legislature*. https://www.cdph.ca.gov/Programs/CID/OBBH/Pages/OBBHPubs.aspx

California Energy Commission. *Climate Change Partnerships*. https://www.energy.ca.gov/about/international-cooperation/climate-change-partnerships

California Environmental Protection Agency Air Resources Board. (2013). *Agreement Between the California Air Resources Board and the Gouvernement du Québec Concerning the Harmonization and Integration of Cap-and-Trade Programs for Reducing Greenhouse Gas Emissions*. Retrieved from https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/linkage/ca_quebec_linking_agreement_english.pdf

Cities Change. (2026). *Rebuilding LA With Care A Playbook to Prepare for the Next Disaster*. https://www.citieschange.org/resources/rebuildingla/

Cities For CEDAW. (2023). *U.S. Cities that have signed or have proposed CEDAW*. http://citiesforcedaw.org/cedaw-cities/

Crescenzi, M. J. C., Kathman, J. D., Kleinberg, K. B., & Wood, R. M. (2012). Reliability, Reputation, and Alliance Formation. *International Studies Quarterly, 56*(2), 259-274. https://doi.org/10.1111/j.1468-2478.2011.00711.x

Dietrich, S., Mahmud, M., & Winters, M. (2016). Foreign Aid, *Foreign Policy, and Domestic Government Legitimacy: Experimental Evidence from Bangladesh*.

Fulgenzi, M. (2024). Subnational Authorities as Key Global Actors: Glocal Diplomacy in Pursuit of World Peace and Security in the Prism of the Vision and Goals of the UN 2030 Agenda. *Athena – Critical Inquiries in Law, Philosophy and Globalization, 4*(2), 92-168. https://doi.org/10.6092/issn.2724-6299/20344

Garba, D. L., Stankey, M. C., Jayaram, A., & Hedt-Gauthier, B. L. (2020). How do we decolonize global health in medical education? *Annals of Global Health, 86*(1), 29. https://doi.org/10.5334/aogh.2920

Goldsmith, B. E., Horiuchi, Y., & Wood, T. (2014). Doing Well by Doing Good: The Impact of Foreign Aid on Foreign Public Opinion. *Quarterly Journal of Political Science, 9*(1), 87-114. https://doi.org/10.1561/100.00013036

Governor of California. (2025a). *California delegation wraps historic participation at COP30: new global partnerships, clean energy records, and climate leadership*. California State Portal. https://www.gov.ca.gov/2025/11/26/california-delegation-wraps-historic-participation-at-cop30-new-global-partnerships-clean-energy-records-and-climate-leadership/

Governor of California. (2025b). *Governor Newsom expands California's global climate leadership at COP30, creating new partnerships with Brazil, Colombia, and Chile*. https://www.gov.ca.gov/2025/11/12/governor-newsom-expands-californias-global-climate-leadership-at-cop30-creating-new-partnerships-with-brazil-colombia-and-chile/

Hoffman, A. M. (2002). A Conceptualization of Trust in International Relations. *European Journal of International Relations, 8*(3), 375-401. https://doi.org/10.1177/1354066102008003003

Holmes, A. (2020). Diplomacy and Paradiplomacy in California. In (pp. 95-114). https://doi.org/10.1007/978-3-030-54132-3_6

iCite. (2026). *Global RCR Statistics*

iCite, Hutchins, B. I., & Santangelo, G. (2026). *iCite Database Snapshots*

iCite Support. (2024). *Results/Analysis Table (InfluenceModule)*. https://support.icite.nih.gov/hc/en-us/articles/9342461117595-Results-Analysis-Table-Influence-Module

ICLEI - Local Governments for Sustainability. ICLEI – *Local Governments for Sustainability*. https://iclei.org/

ICLEI - Local Governments for Sustainability. (2011). *California Statewide Energy Efficiency Collaborative*. https://iclei.org/activity/california-statewide-energy-efficiency-collaborative/

International Emissions Trading Association, & Environmental Defense Fund. (2022). A *Roadmap For Linkage: Aligning California and Washington's Carbon Prices*. https://www.ieta.org/uploads/wp-content/Resources/Reports/IETA_Report_ARoadmapForLinkageAligningCaliforniaandWashingtonsCarbonPrices_2022.pdf

Jakubowski, A., Omanga, E., Agot, K., & Thirumurthy, H. (2016). Large Price Premiums for Unprotected Sex Among Female Sex Workers in Kenya: A Potential Challenge for Behavioral HIV Prevention Interventions. *Journal of Acquired Immune Deficiency Syndromes, 72*(1), e20-22. https://doi.org/10.1097/QAI.0000000000000929

Katz, R., Kornblet, S., Arnold, G., Lief, E., & Fischer, J. E. (2011). Defining Health Diplomacy: Changing Demands in the Era of Globalization. *Milbank Q, 89*(3), 503-523. https://doi.org/10.1111/j.1468-0009.2011.00637.x

Kayser, G. L., Barrett, C. B., Smith, W., Lantagne, D., Brown, J., Graham, J., Rogers, B. L., Nyarko, K. B., Meeyam, T., & Rees, H. (2026). Dismantling the United States Agency for International Development Costs Lives and Threatens Global Stability. *American Journal of Public Health, 116*(9), 1324-1327. *https://doi.org/10.2105/ajph.2026.308652*

Klaus, I., Baldassare, M., Jordan, M., & Manalese, A. (2025). 2025 *Carnegie California Global Affairs Survey*. *https://carnegieendowment.org/research/2025/12/2025-carnegie-california-global-affairs-survey*

Lasker, J. N., Aldrink, M., & Balasubramaniam, R. (2018). Guidelines for responsible short-term global health activities: Developing common principles. *Globalization and Health,* 14, 18. *https://doi.org/10.1186/s12992-018-0330-4*

Lee, S. H. (2019). Thinking Globally, Acting Locally: CEDAW and Women's Human Rights in San Francisco. 13(1).

Leffel, B. (2018). *Subnational Diplomacy, Climate Governance & Californian Global Leadership*. *https://uscpublicdiplomacy.org/sites/uscpublicdiplomacy.org/files/useruploads/u39301/Subnational%20Diplomacy%2C%20Climate%20Governance%20%26%20Californian%20Global%20Leadership%20-%20Benjamin%20Leffel_0.pdf*

LegiScan. (2025). *California Senate Resolution 36*. *https://legiscan.com/CA/text/SR36/id/3197949*

National Institutes on Health. *NIH ExPORTER Link Tables*

Och, M. (2018). The local diffusion of international human rights norms – understanding the cities for CEDAW campaign. *International Feminist Journal of Politics, 20*(3), 425-443. *https://doi.org/10.1080/14616742.2018.1447312*

Ortiz-Moya, F., & Reggiani, M. (2023). Contributions of the voluntary local review process to policy integration: evidence from frontrunner cities. *npj Urban Sustainability,* 3. *https://doi.org/10.1038/s42949-023-00101-4*

Pratiwi, P. (2024). Epistemic Communities, Between Science and Power in International Domains: A Systematic Literature Review. *Review of International Relations,* 6, 1-18. *https://doi.org/10.24252/rir.v6i1.45840*

Reyes-Velarde, A., & Lazo, A. (2025). *Newsom brings California to the heart of the Amazon — and the U.N. climate conference*. CalMatters. *https://calmatters.org/environment/climate-change/2025/11/california-newsom-belem-climate-conference/*

Ruckert, A., Labonté, R., Lencucha, R., Runnels, V., & Gagnon, M. (2016). Global health diplomacy: A critical review of the literature. *Soc Sci Med,* 155, 61-72. *https://doi.org/10.1016/j.socscimed.2016.03.004*

Ruger, J. P. (2004). Health and social justice. *The Lancet,* 364(9439), 1075-1080. *https://doi.org/10.1016/S0140-6736(04)17064-5*

Ruger, J. P. (2012). Global health justice and governance. *The American Journal of Bioethics, 12*(12), 35-54. *https://doi.org/10.1080/15265161.2012.733060*

State of California Governor's Office of Land Use and Climate Innovation. (2024). *Governor's Office of Land Use and Climate Innovation Joins Delegates from Across Globe for UN Climate Change Conference. State of California Governor's Office of Land Use and Climate Innovation. https://lci.ca.gov/newsroom/news/2024/11-18/*

The Climate Group. *History of the Under2 Coalition*. *https://www.theclimategroup.org/history-under2-coalition*

The Leadership Conference Education Fund, & Women's Intercultural Network. (2018). *The Convention on the Elimination of All Forms of Discrimination Against Women – CEDAW.*

UCLA School of Law Center on Reproductive Health, Law, and Policy, & UCSF Advancing New Standards in Reproductive Health. (2025). *Reproductive Health Researchers' Comment*. *https://law.ucla.edu/sites/default/files/PDFs/Center_on_Reproductive_Health/Reproductive%20Health%20Researchers%20Comment%20Letter%20to%20FDA%208.27.25.pdf*

UN General Assembly. (1979). Convention on the Elimination of All Forms of Discrimination Against Women. *http://www.refworld.org/docid/3ae6b3970.html*

United Cities and Local Governments. (2021). *Guidelines for Voluntary Subnational Reviews: SDG Reporting by Local and Regional Government Associations*. *https://gold.uclg.org/sites/default/files/guidelines_en.pdf*

United Nations. (2015). The Paris Agreement.

United Nations Climate Change. *About the secretariat*. United Nations Climate Change. *https://unfccc.int/about-us/about-the-secretariat*

United Nations Department of Economic and Social Affairs Sustainable Development. *The 17 Goals*. *https://sdgs.un.org/goals*

United Nations Economic Commission for Europe (UNECE). (2025). *Regional Guidelines for the Development of Voluntary Local Reviews*. *https://unece.org/sites/default/files/2025-02/VLR%20Guidelines_E_1.pdf*

United Nations High-Level Political Forum on Sustainable Development. *Voluntary National Reviews*. *https://hlpf.un.org/vnrs*

World Health Organization. *Networks, committees, advisory groups, working groups and task forces.*

World Health Organization. (2023). *Governance framework of the Global Outbreak Alert and Response Network*. *https://iris.who.int/items/2257925d-36a8-4921-b190-ec92a4d64915*

World Health Organization. (2025). *Abortion care guideline, 2nd ed. https://www.who.int/publications/i/item/9789240104204*

Zhu, S. H., Anderson, C. M., Johnson, C. E., Tedeschi, G., & Roeseler, A. (2000). A centralised telephone service for tobacco cessation: the California experience. *Tob Control, 9 Suppl 2*(Suppl 2), li48-55. *https://doi.org/10.1136/tc.9.suppl_2.ii48*

CHAPTER 2

The Impact of Federal Global Health Spending on California's Economy



YUGEN CHEN

EXECUTIVE SUMMARY

Federal global health-related funding supports a network of research institutions, public-health programs, firms and specialized workers in California. This chapter provides new estimates of the economic activity associated with that funding and the benchmark private value of linked patented inventions. It combines transaction-level federal spending records, regional input-output modeling, patent linkage and valuation, and two key-informant interviews.

• KEY TAKEAWAYS •

- **Every federal global health dollar spent in California generates an estimated $1.40 to $2.15 in economic activity, totaling more than $46 billion in the study period.** Federal global health-related funding of $21.5 billion from 2016 to 2025 generated about $30.2 billion in economic output and about 157,000 job-years in California, 40% more than the funding investment. When spending from wages is included, the estimates rise to $46.3 billion in output, $28.6 billion in value added and approximately 239,000 job-years, more than double the investment.
- **Patents arising from global health funding generate substantial estimated private value.** The study provides the first estimate of the private value of patents emerging from federal global health-related awards, weighted by California inventors' share. These patents generated an estimated $1.9 billion (median-based estimate) to $5.7 billion (mean-based estimate) in private value in 2024 dollars.
- **Federal cuts threaten the co-location of the people and institutions that make California a hub of global health investment.** California attracts global health research and innovation because research institutions, specialized personnel, clinical infrastructure and private-sector partners are located in close proximity. Because each part of this ecosystem strengthens the others, federal cuts threaten this competitive advantage and could dismantle long-standing partnerships that would take years to reassemble.

Using USAspending data, the analysis identifies $19.029 billion in net federal obligations across 28,375 transactions during calendar years 2016-2025. The dataset assigns transactions to California using reported places of performance, screens multiple federal accounts for global health relevance and incorporates subawards under an explicit rule to avoid double counting. Obligations measure federal commitments rather than cash payments. Annual obligations peaked at $6.474 billion in 2021, reflecting exceptional emergency and public-health funding, before declining to $1.034 billion in 2025. The portfolio combines a recurring research base with a smaller number of large, episodic awards.

From 2016 to 2025, the 10-year funding for California in net federal obligations totals $21.492 billion after conversion to 2024 dollars. This input translates to $30.161 billion in output, $19.167 billion in value added[4] and approximately 157,000 job-years, according to the Bureau of Economic Analysis's Regional Input-Output Modeling System II (RIMS II). These estimates include initial activity and California supplier purchases. By including modeled household spending, these estimates rise to $46.314 billion in output, $28.618 billion in value added and approximately 239,000 job-years.[5] Each dollar of obligations is therefore associated with $1.40 in output under the first scenario and $2.15 under the second.

The innovation analysis links federal awards to 104 patents, equivalent to 49.37 patents after weighting by California inventor shares, which produces a mean-based private-value calibration of $5.726 billion and a median-based calibration of $1.846 billion (both in 2024 dollars) when applying Kogan-Papanikolaou-Seru-Stoffman (KPSS) benchmarks by patent grant year and technology class.

The interviews illustrate how federal support may sustain specialized teams, shared research capacity and technically risky development. They also describe complementary public, philanthropic and private financing, while emphasizing that research, implementation and commercialization can occur in different locations.

[4] Gross output counts intermediate sales within the supply chain, whereas value added excludes purchased inputs and measures the income and other value created in the region.

[5] ob-years measure employment supported over time, rather than unique workers or new hires.

1.

INTRODUCTION AND PROBLEM DEFINITION

This chapter examines the economic value to California associated with global health-related U.S. federal obligations in the state. Although the principal beneficiaries of bilateral global health assistance are the low- and middle-income countries that receive it, implementation also supports U.S.-based universities, laboratories, firms, contractors, trainees and specialized workers. Using transaction-level USAspending data, the chapter identifies global health-related obligations, maps them to California places of performance and downstream recipients and applies the U.S. Bureau of Economic Analysis's RIMS II to estimate associated output, value added, labor income and job-years. It then links federal award identifiers to government-interest patents, calibrates the private economic value of those patent outputs and uses key-informant interviews to clarify mechanisms and interpretation.

California provides an ideal setting for this analysis. Its gross domestic product reached $4.3 trillion in 2025, about 14% of U.S. gross domestic product (GDP). As of 2024, if treated as a country, California would rank as the world's fourth-largest economy, behind only the United States, China and Germany; its GDP per person exceeds that of all three (Payares-Montoya & Bohn, 2026). The state also contains a dense network of universities, medical centers, laboratories, nonprofit organizations and life-science firms engaged in global health research, training, clinical exchange, product development and implementation. Federal global health obligations therefore enter an economy large enough to contain specialized labor and supplier networks, yet diverse enough for the spending to reach several institutional domains.

The chapter measures associated economic value through two distinct channels. The first captures shorter-run activity: Federal obligations support work by California recipients, purchases from suppliers and household spending financed by labor income. RIMS II translates those obligations into modeled accounting estimates. These estimates reflect economic activity associated with the observed obligations; they do not identify a causal effect. The second channel captures value over a longer horizon. Federal support may reduce uncertainty, relax financing constraints and sustain research collaborations that produce patentable knowledge and potentially generate future returns. The patent analysis therefore uses the KPSS patent-value benchmarks to estimate the expected present private value of matched patents by discounting and summing their possible future returns.

1.1 Situating the Study Within Existing Literature

This study builds on the existing literature in three ways. First, whereas previous research sought to reconstruct the entire global health sector in California, this study identifies an observable federal funding stream at the transaction level and estimates the economic output associated with it. This scope is more specific about the source and location of spending, which makes it natural to treat federal obligations as an external inflow in the RIMS II analysis. Additionally, compared with previous studies that examined National Institutes of Health (NIH) global health funding alone, this study is broader in its coverage of federal agencies and accounts.

Second, the study presents both short-run regional economic accounting and a longer-run innovation proxy, capturing economic benefits from different perspectives.

Third, the study uses interviews to interpret mechanisms that administrative spending and patent data cannot reveal directly, including supplier purchases, collaboration, financing constraints, project supervision and the location of implementation. The interviews provide evidence on the mechanisms underlying the quantitative estimates.

As of 2024, if treated as a country, California would rank as the world's fourth-largest economy, behind only the United States, China and Germany; its GDP per person exceeds that of all three.

1.2 California Studies of Global Health Economic Activity

Existing literature describes California's global health economy as a broad institutional sector. Nandi's *The Importance of the Global Health Sector in California* (2009) defines the sector from the ground up in a context where standard economic databases do not contain a distinct global health industry. It identifies global health activity in four settings — private for-profit firms, nonprofit organizations, higher education and government — and combines GuideStar, InfoUSA, CorpTech, University of California administrative records, University of California, San Francisco information, and state employment data to define this sector of the California economy. The chapter also distinguishes activity oriented toward world markets from activity serving California's international and immigrant populations. Using 2007 data, Nandi estimates $25.6 billion in primary global health business activity and $49.8 billion in total economic activity, supporting 192,162 primary jobs and 351,829 jobs in total.

Nandi's estimates are best interpreted as a statewide economic footprint. The analysis first reconstructs the set of global health activities in California and assumes that this set captures nearly all global health-related activity in the state. It then applies input-output accounting to the measured activity. Standard input-output analysis, however, requires that the measured activity represent final demand — an inflow from a source independent of the existing California economy — rather than activity already occurring within the state. For this reason, Nandi's design is well suited to showing the observed global health sector's size and the economic activity associated with it, but it does not measure the economic activity value associated with a particular funding stream, which would require isolating a named external funding source.

The present study differs from Nandi in both scope and measurement. It is narrower because it does not attempt to capture all global health activity in California. Instead, it isolates global health-related federal obligations as an observable external fund-

Other California-focused studies provide institutional detail on the channels through which global health programs may support local activity.

ing stream and uses those obligations as inputs to a regional input-output analysis. This design is particularly important in a context where this federal funding is being reduced at a historic scale. It is also better suited to estimating economic values associated with external federal funding, which naturally enters the California economy from outside the state, while Nandi's whole-sector footprint remains the better measure of the sector's overall scale. The award-level data also make it possible to identify innovation outcomes associated with federal support and then measure their values.

Other California-focused studies provide institutional detail on the channels through which global health programs may support local activity. A Fogarty International Center article, drawing on the University of California Global Health Institute's 2007 data, reports that California's global health sector supported about 350,000 jobs and generated $19.7 billion in wages in 2007, involving roughly 600 private for-profit companies as well as the state's academic institutions. It highlights AdaptAir, a Stanford-linked breathing-machine accessory for children who cannot use standard-size equipment (Fogarty International Center, 2012). The Global Health Technologies Coalition similarly presents global health research as a source of scientific innovation, employment and business activity, using California in a broader national argument about the economic value of global health research (Global Health Technologies Coalition, 2011). Related studies emphasize training, clinical exchange and workforce infrastructure (Akey et al., 2026; Ozgediz et al., 2008; Sumstine-Felice, 2025).

United for Medical Research's state profiles and national reports provide a closer methodological benchmark for this study. They use RIMS II parameters to estimate state-level jobs and economic activity associated with NIH research awards (United for Medical Research, 2025, 2026). For California, the profiles treat NIH awards as external research funding that supports work by recipients and purchases of research-related goods, services and materials. Unlike NIH-focused studies, this chapter examines global health-related obligations across multiple federal agencies and accounts.

Taken together, the California literature establishes the sector's institutional breadth and identifies plausible employment, supplier, training and innovation channels. This study adds a transaction-defined estimate tied to a specific federal funding stream, a linked patent-value calibration and interview evidence on mechanisms.

1.3 Regional Input-Output Studies of Public Spending

The regional input-output literature provides an established framework for translating an external funding stream into associated local production, income and employment. Meghea et al. (2021) use the Impact Analysis for Planning (IMPLAN) regional model, an input-output method similar to RIMS II, to estimate direct, indirect and induced activity associated with external funding support. They apply the model to funding from NIH and its National Institute on Minority Health and Health Disparities for the Flint Center for Health Equity Solutions in Genesee County, Michigan. Planning Decisions, Inc. (2016) applies both RIMS II and IMPLAN to NIH-funded medical research in Maine. The UMass Donahue Institute (2025) combines USAspending award data with IMPLAN to estimate the contribution of federal research and development (R&D) awards to Massachusetts. United for Medical Research's annual reports similarly use RIMS II parameters to translate state NIH awards into jobs and economic activity (United for Medical Research, 2025, 2026). These studies share a common approach: identifying an external funding source, assigning spending to regions and industries and applying regional input-output multipliers.

Comparable methods appear in studies of health programs and public spending outside biomedical research (Deck & Riiman, 2010; Evangelakis, 2025; Kerna et al., 2015; Ku et al., 2014; Ku et al., 2025; Manzo & Bruno, 2025; Richardson et al., 2018; Ward & Bridge, 2019). Studies of federal spending outside health use the same general logic (Harpel & Romitti, 2025; Lendel & Yun, 2021; Maryland Department of Business and Economic Development, 2012). Collectively, this work shows that regional modeling frameworks such as RIMS II, IMPLAN and Regional Economic Models, Inc. (REMI) are established tools for estimating regional activity associated with external funding. The present study applies RIMS II to a California-specific portfolio of global health-related federal obligations.

1.4 Public R&D and Demand-Side Innovation

A separate literature explains why public R&D funding and procurement may influence innovation as well as contemporaneous production. Edler and Georghiou (2007) argue that public procurement can operate as demand-side innovation policy by reducing market uncertainty and creating learning between public buyers and suppliers. Brown et al. (2009) show that high-technology R&D is sensitive to finance, which motivates a de-risking channel through which federal awards may relax cash-flow constraints and make research projects feasible. De Rassenfosse et al. (2019) link U.S. government R&D procurement to patenting and document lags and diminishing returns to contract size. Azoulay et al. (2019) find that NIH funding increases private-sector patenting in the same disease areas. Jaffe (1989), Fabrizio (2009), the Organisation for Economic Co-operation and Development (2019) and Tian et al. (2022) further emphasize university research, absorptive capacity and university-industry collaboration as channels for innovation.

Patent market-value methods provide a way to translate counts of observable patent outputs into an economic benchmark. Kogan et al. (2017) infer the private market value of patents from publicly traded firms' stock-market reactions around patent grants and use the resulting KPSS values to study innovation, resource allocation and firm dynamics. Their framework supplies patent-level private-value estimates; using those estimates together with the extended patent-CPC data, this study constructs patent-value benchmarks by grant year and Cooperative Patent Classification (CPC) technology class (Kogan et al., 2017;

KPSS2017, 2025). In this study, those benchmarks are applied as calibrated values per patent and weighted by California inventor shares and CPC class shares for PatentsView government-interest patents linked to federal global health awards.

1.5 Illustrative Expert and Mixed-Methods Evidence

Illustrative expert evidence is useful because spending and patent records reveal outcomes but not the organizational processes that connect funding to them. Key-informant interviews can clarify whether an award supported local hiring, supplier purchases, collaboration, financing, project governance or implementation outside California. Mixed-methods and case-study research use such accounts to interpret quantitative patterns through mechanism evidence and case comparison (Creswell & Plano Clark, 2018; Yin, 2018).

1.6 Summary

Existing California work shows that global health is institutionally significant, innovation-oriented and tied to training and workforce development. What remains less developed is a transparent California-specific estimate focused on federal global health obligations that jointly measures short-run regional economic activity and uses the economic value of associated patent outputs to capture a channel linked to long-run economic growth. By identifying those obligations, mapping them to California, applying RIMS II simulations, linking award IDs to patent data, applying KPSS patent-value benchmarks and using interviews to clarify mechanisms, this chapter provides a more comprehensive and replicable framework. The chapter proceeds in four parts: the construction and analysis of federal global health-related obligations, regional economic activity estimated using RIMS II, patent-value calibration and illustrative expert evidence on funding mechanisms. Each part presents its methods followed by its findings. An integrated discussion then brings these results together.

2.
PART ONE: USASPENDING GLOBAL HEALTH TRANSACTION DATA

To estimate the economic activity associated with federal global health-related spending in California, we first constructed a transaction-level dataset from USAspending.gov (Bureau of the Fiscal Service, n.d.). We downloaded award-summary files, prime-award transaction files and subaward transaction files on June 9, 2026, covering contracts, contract indefinite-delivery vehicles (IDVs), grants, direct payments, loans and other funding mechanisms. The reporting window covered the complete calendar years from 2016 through 2025.

2.1 Methodology: Global Health Spending Transactions and Analysis Variables

The analysis uses transaction-level data on federal obligations, which provide the most granular information on the calendar dates of actions rather than only the fiscal year. We identified global health transactions using Treasury Account Symbol (TAS) and federal-account information. A TAS is the federal accounting identifier that links an obligation to the Treasury account through which the funding was provided. We divided the accounts into two groups. Direct global health accounts are sufficiently dedicated to global health that all associated transactions were retained. Candidate accounts support global health alongside other activities and therefore require project-level evidence of a global health purpose.

Candidate accounts support global health alongside other activities and therefore require project-level evidence of a global health purpose.

This distinction also reflects differences in how clearly "global health" can be identified in federal account structures. For the direct accounts, we relied on accounts already treated as global health funding in prior work, which provided an external basis for inclusion. For the broader candidate accounts, however, there was no single established classification rule that separated global health-related activities from other domestic or sector-specific spending. We therefore use the term "global health-related." The keyword screen was designed to retain activities whose stated purpose is connected to international health, cross-border health threats, pandemic preparedness, infectious-disease control or other activities that may generate health benefits outside the United States even when the immediate federal recipient is a U.S.-based institution. For example, the Public Health and Social Services Emergency Fund (PHSSEF) was not treated as a global health account in its entirety. Instead, we retained records with project-level language indicating activities related to diseases such as COVID-19, Ebola, mpox and influenza. This rule intentionally allows some federally funded activity performed for U.S. institutions to enter the sample when the underlying capability or health threat is not inherently domestic. By contrast, federal spending devoted primarily to routine U.S. health-insurance financing or ordinary domestic health care delivery is outside the study's definition. Appendix A reports the account-specific keyword and context rules used for all candidate accounts.

The direct-account definition was anchored in the federal accounts used by Kates et al. (2025) in their analysis of U.S. global health awards. They identify five principal accounts: the Global HIV/AIDS Initiative (019-1030), Global Health Programs (019-1031), Child Survival and Health Programs Fund (072-1095), HIV/AIDS Working Capital Fund (072-1033), and Global Health, Centers for Disease Control and Prevention (CDC; 075-0955). We classified all transactions associated with these accounts as global health-related spending.

Candidate accounts are broader federal accounts whose full totals cannot be interpreted as global health-related spending. The Economic Support Fund, for example, may finance global health activities but also supports many other economic development activities. We retained a transaction from such an account only when its award-level information provided affirmative evidence of a global health purpose. Candidate accounts include the Economic Support Fund, International Disaster Assistance,

selected NIH and Department of Health and Human Services (HHS) accounts, the Defense Health Program, Animal and Plant Health Inspection Service (APHIS) accounts, Food and Drug Administration (FDA) Salaries and Expenses, National Science Foundation (NSF) Research and Related Activities, and Department of Homeland Security (DHS) Science and Technology R&D.

We selected transactions by reviewing the most aggregated descriptions available before moving to more detailed records. We first evaluated award-level descriptive information and, when it was insufficient, examined transaction- or subaward-level fields. The reviewed fields include award and transaction descriptions, project titles, program activities and objectives, assistance-listing information, product or service descriptions, North American Industry Classification System (NAICS) classifications, recipient information and available geographic fields. The keyword rules vary by account because the non-global health activities that must be excluded also vary by account. For the Economic Support Fund, for example, the record must connect the award to areas such as HIV/AIDS, tuberculosis, malaria, maternal and child health, reproductive health, immunization or global health security. Appendix A documents the account-specific rules.

The dataset retains the variables needed to construct annual federal net obligations for the input-output analysis and to link awards to the subsequent innovation analysis. We used net federal obligations assigned to California in a calendar year as the input for the input-output accounting. Net federal obligations equal the sum of positive obligations and negative adjustments recorded during that year. This measure captures changes in relevant federal commitments in every year. It is an obligation measure, not a measure of cash outlays or payments. Because an obligation records when the federal government commits funds rather than when the recipient spends them, the obligation year need not coincide with the year in which all associated economic activity occurs. An award obligated in one year may finance work over multiple subsequent years. Specifically, we used the following variables in the dataset to calculate net obligations for a given calendar year: For prime-award transactions, federal_action_obligation supplies the spending amount, and action_date determines the calendar year. The corresponding subaward fields are subaward_amount and subaward_action_date.

For the Economic Support Fund, the record must connect the award to areas such as HIV/AIDS, tuberculosis, malaria, maternal and child health, reproductive health, immunization or global health security.

Account identifiers and program-family labels support the mutually exclusive aggregation of federal obligations by account. We calculated annual net federal obligations for each award-account-industry combination using the award, account, industry and year identifiers. This structure allowed us to disaggregate annual net-obligation trends by account and identify the accounts that most closely reflect the aggregate trends.

We also preserved recipient information, project descriptions, program classifications and traceability fields at the transaction and retained-award levels. These fields document why a record entered the global health sample and provide the linkage information required for the subsequent KPSS patent-valuation analysis (Kogan et al., 2017) of innovation associated with the identified awards.

Several methodological issues warrant attention. First, some transaction records are associated with more than one relevant TAS account. To prevent obligations from being double-counted across account classifications, we applied the following rule: A direct-account match takes precedence over a candidate-account match. Thus, if a transaction was associated with both direct and candidate accounts, we classified it under the direct account. If a transaction was associated with several direct accounts or several candidate accounts, we assigned equal weight to each account. The transaction's total obligation was therefore divided evenly across those accounts. This approach prevented the same transaction from contributing its full obligation to multiple accounts while preserving the transaction's total obligation amount. The subsequent account-level pattern summary relies on this classification.

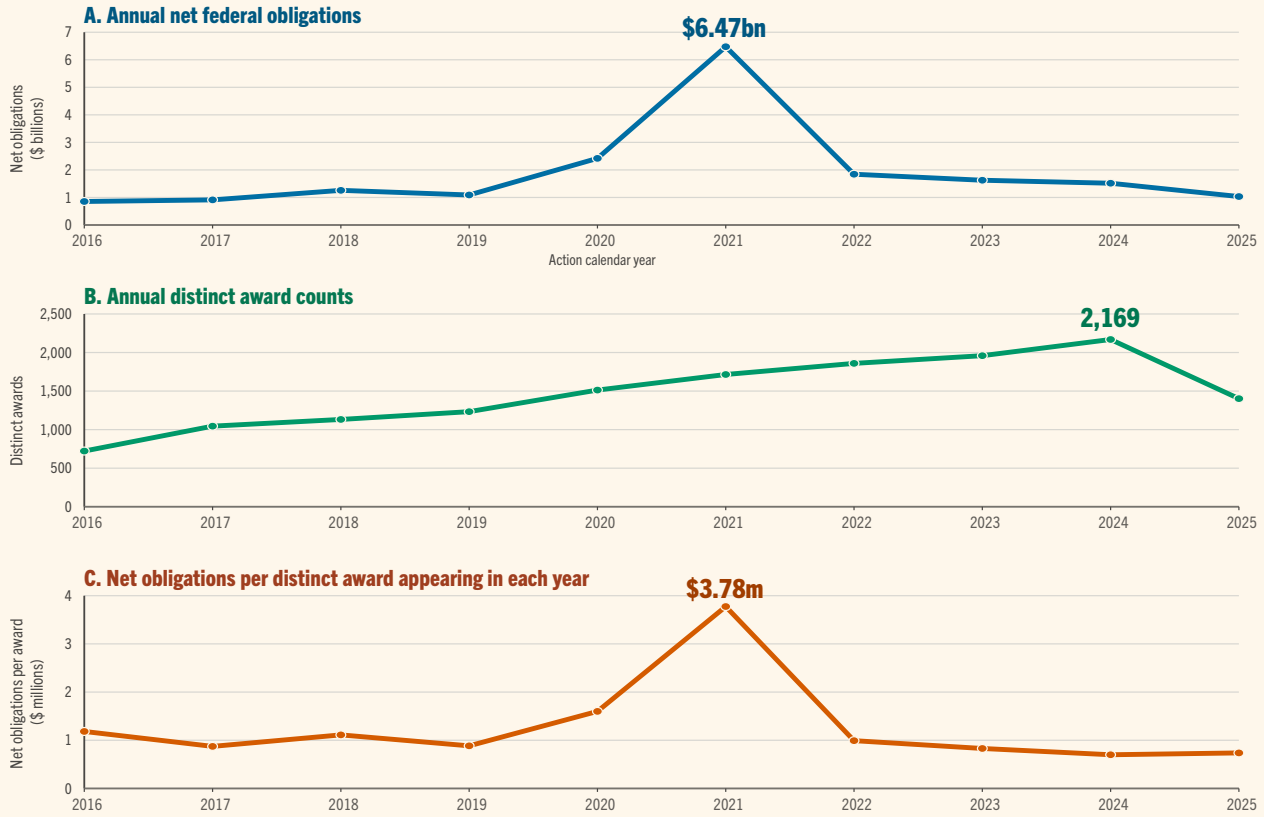
Second, prime-award records alone can miss California activity funded through downstream agreements. A federal prime recipient performing work outside California may subcontract or subgrant part of a project to a California organization. We therefore also retained subaward transactions with a reported California place of performance, recognizing that not all such transactions involving California organizations may have been recorded as such. Prime award and subaward amounts cannot simply be added, however, because a subaward reallocates funds originating from a prime award rather than creating an additional federal obligation. Adding a California prime award and its California subaward would count the same underlying federal funding twice.

We prevented this double counting by linking each subaward to its associated prime award using prime_award_unique_key. We first identified the prime-award keys already represented in the California prime pool. We then added a California subaward only when its associated prime award was absent from that pool. The initial screened files contained 25,345 California prime-award transactions and 5,274 California subaward transactions. After applying the linkage rule, 3,030 nonduplicative subaward transactions entered the analysis. The final dataset therefore contains 28,375 transaction rows — 25,345 prime-award transactions and 3,030 added subaward transactions — and $19.029 billion in net federal obligations from 2016 to 2025. Annual net obligations range from $0.854 billion in 2016 to $6.474 billion in 2021. The four largest accounts — the NIH Office of the Director, the Public Health and Social Services Emergency Fund, the National Institute of Allergy and Infectious Diseases, and Global Health, CDC — account for 86.7% of the 10-year total. Section 2.2 presents the annual and account-level disaggregation.

Third, we identified California activity using the reported place of performance rather than the recipient's headquarters. In USAspending, place of performance records the location where the award-funded work is reported to occur, whereas the recipient location identifies the organization's address. Place of perfor-

FIGURE 2.2.1

Federal Global Health-Related Spending Performed in California: Annual Net Obligations, Distinct Award Counts and Net Obligations per Distinct Award, 2016-2025



Note: Values are nominal dollars. Net obligations include positive obligations and negative deobligations. Net obligations per award equal each year's net obligations divided by distinct awards appearing in that year.
Source: Bureau of the Fiscal Service (n.d.).

mance is therefore the closer geographic concept for estimating activity occurring within California, especially when a recipient headquartered elsewhere performs work in the state. This choice nonetheless has a limitation. USAspending assigns geography from the location reported on the award or transaction record; it does not trace every vendor, worker or research collaborator involved in the project. A prime recipient or subrecipient outside California could hire a California-based researcher without separately reporting that portion of the work as a California place of performance. A manufacturer could send orders to California suppliers. Such derived activity would not enter our California dataset.

2.2 Key Findings: Annual Patterns in Net Federal Obligations and Award Counts

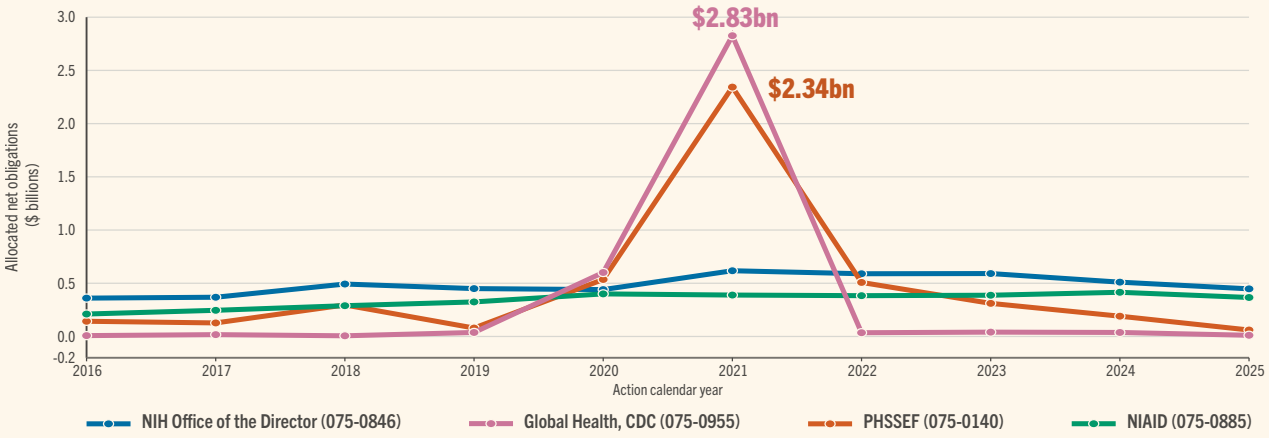
The California dataset reveals a combination of a recurring research base and episodic emergency and public-health-capacity support. The recurring component is spread across many NIH awards to California research institutions. The episodic component is delivered through a smaller number of high-dollar awards. The recurring research base drives the number of distinct awards represented in a year, whereas episodic funding can dominate the dollar amount of obligations recorded in a particular year.

The dataset records $19.029 billion in net federal obligations from 2016 to 2025. Kates et al. (2025) report approximately $37 million in FY2024 federal global health obligations to California-based prime recipients across five designated accounts. Our estimate covers a broader set of screened accounts, assigns activity by reported place of performance and incorporates California subawards under a rule to avoid double counting. These differences, together with our 10-calendar-year reporting period, mean that the two totals measure different funding scopes and are not directly comparable. Annual obligations increased from $0.854 billion in 2016 to $1.258 billion in 2018, slipped to $1.090 billion in 2019 and then rose to $2.420 billion in 2020. The series reached an exceptional $6.474 billion in 2021 before falling each year: to $1.844 billion in 2022, $1.625 billion in 2023, $1.517 billion in 2024 and $1.034 billion in 2025.

As shown in Figure 2.2.1, award counts followed a broader and more persistent expansion. The number of California-linked distinct awards appearing in the data rose from 722 in 2016 to 1,513 in 2020 and 1,715 in 2021. Counts continued to increase after the dollar peak, reaching 1,859 in 2022, 1,959 in 2023 and 2,169 in 2024 before falling to 1,402 in 2025. The aggregate series counts each award once in a calendar year, even if it has several transactions. An award active in several years appears once in each year.

FIGURE 2.2.2

Federal Global Health-Related Spending Performed in California: Annual Net Obligations for the Four Largest Accounts, 2016-2025



Note: Values are nominal dollars. Net obligations include positive obligations and negative deobligations. Net obligations per award equal each year's net obligations divided by distinct awards appearing in that year.
Source: Bureau of the Fiscal Service (n.d.).

Net obligations per annual distinct award show why the dollar and count series diverge. This measure rose from $1.18 million in 2016 to $1.60 million in 2020 and $3.78 million in 2021. It then fell below $1 million in 2022 and declined to $0.70 million in 2024 before edging up to $0.74 million in 2025. The 2021 peak therefore reflects an intensive-margin change — substantially more funding per award appearing in that year — rather than a comparable increase in the number of awards.

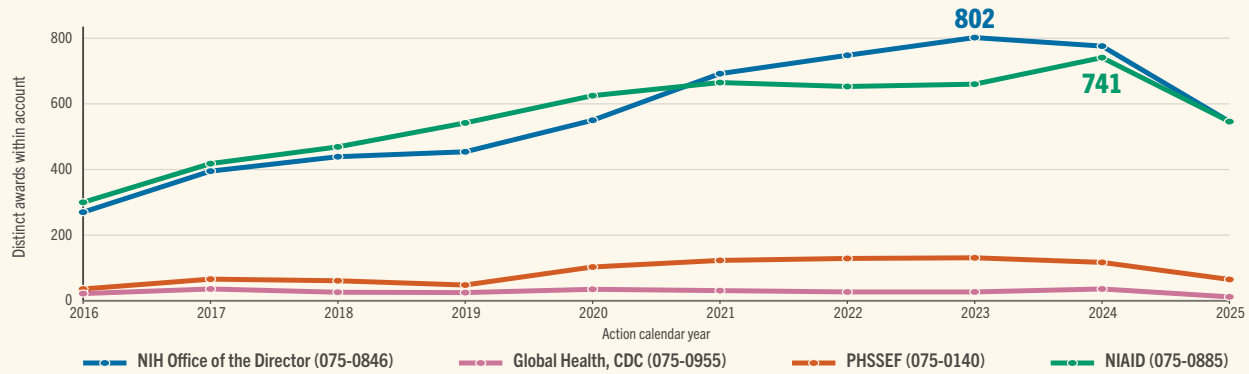
The 2021 peak was not a uniform expansion across accounts or awards. Aggregate net obligations per annual award more than doubled from $1.60 million in 2020 to $3.78 million in 2021, while award counts rose by only 13.4%. The increase was concentrated in the PHSSEF and Global Health, CDC. By contrast, the two NIH accounts added awards without a comparable increase in obligations per award. A rising award count can therefore coexist with falling dollars when the portfolio shifts away from exceptional high-value actions and toward a larger number of recurring research awards.

From 2021 through 2024, declining obligations per award explain the fall in total dollars even as the number of awards continued to expand. From 2024 to 2025, net obligations fell by 31.8%, and award counts fell by 35.4%, while net obligations per annual award increased slightly from $0.70 million to $0.74 million. The 2025 change therefore occurred on both margins — fewer awards and fewer total dollars — rather than solely through smaller obligations on a still-expanding award base.

Figures 2.2.2 and 2.2.3 show the account-level results. As described above, when a transaction was associated with multiple accounts, we divided its total obligation evenly among those

FIGURE 2.2.3

Federal Global Health-Related Spending Performed in California: Annual Distinct Award Counts for the Four Largest Accounts, 2016-2025



Source: Bureau of the Fiscal Service (n.d.).

accounts. Account-level aggregate obligations therefore rely on an equal-weight allocation. We treated distinct award counts differently. If an award is associated with multiple accounts, it contributes one active-award count to each associated account in that year. Distinct award counts are unique within each account-year but are not mutually exclusive across accounts, so account-level counts should not be added to recover the aggregate number of awards.

We selected four representative accounts that together account for 86.7% of net obligations coded to California over the 10-year window: the Office of the Director, NIH ($4.868 billion, or 25.6%); PHSSEF ($4.594 billion, or 24.1%); Global Health, CDC ($3.622 billion, or 19.0%); and the National Institute of Allergy and Infectious Diseases (NIAID; $3.412 billion, or 17.9%). Figures 2.2.2 and 2.2.3 compare their annual allocated obligations and within-account award counts. A brief description of each representative account follows the two figures depicting trends in net obligations and award counts.

Office of the Director, NIH (075-0846) This broad, distributed research portfolio includes Common Fund, trans-NIH global health, international infectious-disease and global health-security awards. Its obligations changed much less over the 10-year period than did its award counts. Annual allocated obligations rose from $360 million in 2016 to a high of $618 million in 2021, remained near $589-591 million in 2022-2023 and then declined to $510 million in 2024 and $448 million in 2025. Annual award counts increased from 270 in 2016 to 692 in 2021 and 802 in 2023 before easing to 776 in 2024 and 546 in 2025. Allocated net obligations per annual award consequently declined from $1.33 million in 2016 to $0.89 million in 2021 and $0.66 million in 2024, before increasing to $0.82 million in 2025.

Public Health and Social Services Emergency Fund (PHSSEF; 075-0140) This account has a more concentrated portfolio. It includes Biomedical Advanced Research and Development Authority (BARDA), pandemic-preparedness, pathogen-surveillance and international-outbreak-response records. Its two largest awards account for 52.1% of allocated obligations, and its two largest recipients — the California Department of Public Health and Los Angeles County — account for 74.3%. Retained descriptions emphasize epidemiology and laboratory capacity, immunization, emergency response, public-health infrastructure and medical countermeasures. Its time profile follows an emergency-funding cycle. Annual allocated obligations were $143 million in 2016, $296 million in 2018 and $79 million in 2019. They increased to $535 million in 2020 and $2.343 billion in 2021, then fell to $508 million in 2022, $311 million in 2023, $191 million in 2024 and $61 million in 2025. Award counts rose from 36 in 2016 to 103 in 2020 and 123 in 2021, remained between 117 and 131 from 2022 to 2024 and declined to 65 in 2025. The 2021 jump therefore came mainly from larger obligations per award: $19.05 million in 2021, compared with $5.20 million in 2020 and $3.94 million in 2022.

Global Health, CDC (075-0955) This is the most concentrated of the four accounts. Because it is a direct global health account, all associated transactions were retained without a project-level keyword screen. One Epidemiology and Laboratory Capacity assistance award, administered by Public Health Foundation Enterprises as the bona fide agent for the California Department of Public Health, contributes 93.7% of the account's 10-year allocated obligations. That concentration produces the account's episodic time series. The account records $8.1 million in 2016, $17.3 million in 2017, $6.3 million in 2018 and $37.7 million in 2019. Allocated obligations then rise to $601 million in 2020 and $2.826 billion in 2021 before returning to $35-41 million per year from 2022 to 2024 and $11.2 million in 2025. Only 31 distinct awards appear in 2021 and 27 in 2022, yet allocated net obligations fall from $2.826 billion to $35 million. The 2021 peak is therefore almost entirely an intensive-margin event, not an increase in award breadth.

Allocated obligations from the Public Health and Social Services Emergency Fund rose to $2.343 billion in 2021.

National Institute of Allergy and Infectious Diseases (NIAID; 075-0885) This account includes projects tied to HIV, tuberculosis, malaria, emerging infectious diseases, surveillance, international cohorts or research in low-resource settings. It has the most stable account-level dollar series, with growth occurring mainly through more awards rather than larger annual amounts per award. Annual allocated obligations rose from $211 million in 2016 to $400 million in 2020, remained between $383 million and $415 million from 2021 to 2024 and declined to $366 million in 2025. Counts increased from 300 in 2016 to 625 in 2020, 665 in 2021 and 741 in 2024 before falling to 546 in 2025. Allocated net obligations per annual award remained within a comparatively narrow range of $0.56-$0.70 million.

3.

PART TWO: TRANSLATING FUNDING OBLIGATIONS INTO REGIONAL ECONOMIC ACTIVITY

To translate the transaction-level spending data from USAspending.gov into an estimate of associated economic activity in California, we used RIMS II developed by the U.S. Bureau of Economic Analysis (BEA, 2013). RIMS II is an accounting model that estimates the economic activity, such as employment and economic output, associated with a change in input, also referred to as a change in final demand. It views the regional economy as a production network composed of existing industry producers connected through purchases. For example, when a medicine manufacturer receives an order from a federal agency, that order increases regional final demand in California. The manufacturer may contract with California research laboratories to support innovation, purchase raw materials from California biological-material suppliers and hire a logistics company to transport finished products to the federal agency. The effects of the initial federal order spread through California's production network, and all firms involved increase their output. At the same time, these firms hire additional labor to produce the added output. Increased employment raises average wage income among Cal-

A resulting multiplier is a ratio or coefficient that summarizes how one dollar of final demand in an industry is associated with economic activity throughout California.

ifornia households. Following a simple economic intuition, higher income induces households to spend more, creating derived demand in California's regional economy; the relevant firms then produce more and employ more labor. This process continues through successive modeled rounds of spending as expenditures circulate through and leak out of California's economy. We thus used RIMS II to translate federal global health-related net obligations assigned to California — interpreted as the change in final demand in the RIMS II model — into estimates of the production, value added and employment associated with that demand.

BEA then uses California data to estimate how much of that supply-network activity is likely to occur within the state and to construct industry-specific output estimates. A resulting multiplier is a ratio or coefficient that summarizes how one dollar of final demand in an industry is associated with economic activity throughout California. Multiplying the net obligation by the relevant multipliers yields estimates of the associated production output, value added and employment. The model requires each funding amount to be assigned to an industry because, for instance, an initial order placed with a drug manufacturer may have effects of a different magnitude than an order placed with a retailer.

3.1 Methodology: Benchmarks, Scenarios and Measures

Before applying the RIMS II multipliers, we assigned each retained funding observation to one RIMS II aggregate industry. The assignment used information available in the USAspending records, including NAICS classifications and award descriptions. For example, university and research-institute activity in the retained portfolio was assigned primarily to professional, scientific, and technical services; manufacturing-related awards were assigned to the corresponding manufacturing category. The resulting industry assignment determined which RIMS II output, value-added and employment multipliers were applied to each funding observation.

In our analysis, the California RIMS II multipliers combine national production relationships from BEA's 2017 Benchmark Input-Output tables with 2024 California regional data, so we used 2024 dollars as the common price basis for expressing net obligation amounts. Standardizing obligations to the same year makes them comparable across years. We chose 2024 as the benchmark because the multipliers are constructed using 2024 California data (BEA, 2026b).

RIMS II reports two nested scenarios. Type I includes the activity associated with the initial federal order and purchases from California suppliers. In the example above, the drug manufacturer purchases production materials from upstream suppliers and employs more labor. Type II adds the activity associated with household spending from the earnings supported: increased employment raises wage income, which induces additional household spending and creates derived demand for California industries. Type II therefore includes all Type I activity plus modeled household-spending effects.

The model reports three measures. Output is the total value of production, including intermediate sales among businesses in the supply chain. Value added is the portion of that production that becomes income and other value created in California: employee compensation, proprietors' income, other property income, and taxes on production and imports less subsidies. Because value added excludes the cost of intermediate inputs, it is the measure most closely comparable to a contribution to regional GDP. Employment coefficients translate each industry's modeled activity into job-years. One job supported for one year equals one job-year; the same position supported for two years equals two job-years. Job-years are not counts of unique workers, permanent positions or new hires.

These estimates depend on simplifying assumptions. The model assumes that businesses meet this demand using the same mix of workers, materials and local suppliers reflected in the BEA data, with available capacity, fixed prices and no displacement of other activity. The Type II scenario also assumes that workers spend part of the resulting income according to the household spending patterns in RIMS II.

A further limitation concerns the timing of the funding input. We assigned each obligation to the calendar year of its recorded federal action and applied the RIMS II multipliers to that obligation-year amount. This is a modeling convention rather than an assumption that every obligated dollar is actually spent in the same year. Federal obligations are commitments, and a multiyear grant or contract may support payroll, purchases and other activity over several subsequent years. The resulting annual estimates should therefore be interpreted as economic activity associated with obligations recorded in each year, rather than as measurements of economic activity that necessarily occurred within that same calendar year. This treatment is consistent with common practice in comparable regional economic-impact studies that use annual federal award or obligation data as inputs to input-output models, although the timing mismatch remains a source of measurement error when obligations and expenditures occur in different years (UMass Donahue Institute, 2025; United for Medical Research, 2025, 2026).

3.2 Key Findings: Aggregate and Industry Results

To compare obligations recorded in different years, we converted nominal obligations to 2024 dollars using BEA's GDP implicit price deflator (BEA, 2026a). This conversion places the funding on a common 2024-dollar price basis and matches the 2024 price year used for the RIMS II employment coefficients. After conversion, the cumulative 2016-2025 input is $21.492 billion. RIMS II associates this input with $30.161 billion in Type I output and $46.314 billion in Type II output, all in 2024 dollars. Put

differently, each $1 of federal global health-related obligations is associated with $1.40 in statewide production when the initial activity and California supplier purchases are included. When modeled household spending is also included, statewide production rises to $2.15 per dollar of obligations. This analysis isolates federal global health-related obligations rather than the broader sector-wide activity measured by Nandi (2009). It also extends beyond the NIH funding examined by United for Medical Research (2025, 2026), covering global health-related obligations across multiple federal agencies and accounts.

The corresponding value-added estimates are $19.167 billion under Type I and $28.618 billion under Type II — equivalent to $0.89 and $1.33, respectively, for each $1 of obligations. Value added is important because gross output counts intermediate sales within the supply chain, whereas value added excludes purchased inputs and measures the income and other value created in the region. RIMS II calculates it by applying industry-specific value-added coefficients to the modeled production associated with each funding observation.

The employment estimates sum to 156,919 Type I job-years and 238,604 Type II job-years. Across the full portfolio, these totals are equivalent to about 7.3 Type I job-years and 11.1 Type II job-years for each $1 million of obligations. A position supported in more than one year contributes one job-year in each year, and the model does not distinguish new hiring from retained positions or reassigned staff time.

The largest obligation-year modeled footprint occurs in 2021. The $7.372 billion input for that year is associated with $10.362 billion in production when the initial activity and California supplier purchases are included, and $15.949 billion when modeled household spending is also included. The corresponding value-added estimates are $6.622 billion and $9.891 billion, with 56,880 Type I and 85,135 Type II job-years. Lower obligation levels after 2021 produce correspondingly smaller annual simulations.

Professional, scientific, and technical services make the largest contribution to modeled activity.

Table 3.2.2 shows that two service industries account for nearly all of the statewide dollar estimates. Professional, scientific, and technical services receive $11.516 billion, or 53.6% of the input, and ambulatory health care services receive $8.065 billion, or 37.5%. Together they account for 91.1% of the input, 91.4% of Type I output, 91.7% of Type II output and about 92% of value added under both scenarios. The aggregate estimates therefore describe a research-and-public-health service portfolio rather than a broad cross-section of California production.

Professional, scientific, and technical services make the largest contribution to modeled activity. The $11.516 billion input assigned to this industry is associated with $16.235 billion in Type I output and $24.995 billion in Type II output, together with $10.314 billion and $15.439 billion in value added. It also accounts for 74,364 Type I and 118,665 Type II job-years. This concentration follows directly from the award portfolio: Uni-

TABLE 3.2.1 : Annual RIMS II Output and Value-Added Results in 2024 Dollars, 2016-2025

Year	Obligations (2024 $ billions)	Type I output ($ billions)	Type II output ($ billions)	Type I value added ($ billions)	Type II value added ($ billions)	Type I employment (job-years)	Type II employment (job-years)
2016	1.090	1.524	2.333	0.964	1.437	7,685	11,775
2017	1.144	1.610	2.474	1.019	1.525	8,102	12,468
2018	1.543	2.160	3.248	1.343	1.979	9,930	15,435
2019	1.315	1.845	2.840	1.173	1.755	9,353	14,380
2020	2.880	4.040	6.224	2.578	3.856	21,519	32,564
2021	7.372	10.362	15.949	6.622	9.891	56,880	85,135
2022	1.959	2.753	4.234	1.748	2.615	13,804	21,294
2023	1.666	2.338	3.593	1.485	2.219	11,615	17,964
2024	1.517	2.122	3.246	1.336	1.994	10,944	16,627
2025	1.005	1.407	2.173	0.898	1.346	7,088	10,961
TOTAL	**21.492**	**30.161**	**46.314**	**19.167**	**28.618**	**156,919**	**238,604**

NOTE: For each year, nominal obligations are converted before applying employment coefficients using the factor = 125.422 / GDPDEF$_y$, where 125.422 is the 2024 GDP implicit price deflator (GDPDEF; 2017=100). Annual GDPDEF values are 98.238 (2016), 99.995 (2017), 102.288 (2018), 103.975 (2019), 105.362 (2020), 110.157 (2021), 118.012 (2022), 122.382 (2023), 125.422 (2024) and 128.970 (2025). The RIMS II output and value-added multipliers are then applied to the adjusted industry inputs. Type I includes direct and indirect supplier-linked activity; Type II also includes modeled household-spending effects. Employment estimates in the annual rows and the total row are job-years, not unique workers or point-in-time jobs. **SOURCES:** Bureau of the Fiscal Service (n.d.); U.S. Bureau of Economic Analysis (2026a, 2026b). Annual estimates are indexed to the year in which obligations were recorded; obligations may support expenditures and economic activity over more than one year.

TABLE 3.2.2 : Annual RIMS II Output and Value-Added Results in 2024 Dollars, 2016-2025

RIMS code	Mapped aggregate industry	Input (2024 $million)	Input share	Type I output ($million)	Type II output ($million)
50	Professional, scientific, and technical services	11,516.0	53.6%	16,235.2	24,995.4
55	Ambulatory health care services	8,065.4	37.5%	11,340.0	17,455.2
02	Forestry, fishing, and related activities	698.3	3.2%	818.1	1,411.3
56	Hospitals	397.0	1.8%	595.3	873.5
63	Other services	313.5	1.5%	470.5	670.3
25	Chemical manufacturing	283.3	1.3%	385.0	479.5
01	Farms	141.2	0.7%	206.8	276.2
31	Other retail	40.6	0.2%	59.7	82.0
13	Computer and electronic product manufacturing	21.6	0.1%	27.2	39.2
40	Publishing industries (except Internet)	8.8	<0.1%	13.2	17.4
53	Waste management and remediation services	3.6	<0.1%	5.7	7.5
52	Administrative and support services	2.0	<0.1%	3.1	4.6
18	Miscellaneous manufacturing	0.4	<0.1%	0.6	0.8
19	Food and beverage and tobacco product manufacturing	0.2	<0.1%	0.3	0.4
27	Wholesale trade	0.1	<0.1%	0.2	0.3
49	Rental and leasing services and lessors of nonfinancial intangible assets	0.1	<0.1%	0.2	0.2
54	Educational services	0.1	<0.1%	0.1	0.1
07	Construction	<0.1	<0.1%	0.1	0.1
17	Furniture and related product manufacturing	<0.1	<0.1%	<0.1	0.1
21	Apparel, leather, and allied product manufacturing	<0.1	<0.1%	<0.1	<0.1
26	Plastics and rubber products manufacturing	<0.1	<0.1%	<0.1	<0.1
62	Food services and drinking places	<0.1	<0.1%	<0.1	<0.1
12	Machinery manufacturing	<0.1	<0.1%	<0.1	<0.1
TOTAL		**21,492.4**	**100.0%**	**30,161.3**	**46,314.3**

NOTE: Dollar columns are millions of 2024 dollars. Type I includes direct and indirect supplier-linked activity; Type II also includes modeled household-spending effects. Employment columns are cumulative job-years. Industries are ordered by 2024-dollar input.
SOURCES: Bureau of the Fiscal Service (n.d.); U.S. Bureau of Economic Analysis (2026a, 2026b).

The job-year distribution is slightly less concentrated than the output distribution.

versity and research-institute records alone contribute about $10.0 billion of the constant-dollar input assigned to this industry.

Ambulatory health care services receive fewer input dollars than professional, scientific, and technical services but are more employment-intensive. The $8.065 billion input assigned to this category is associated with 64,070 Type I and 94,994 Type II job-years. Its 37.5% share of the input becomes 40.8% of Type I job-years because its employment coefficient is 7.94 job-years per $1 million, compared with 6.46 for professional, scientific, and technical services.

The job-year distribution is slightly less concentrated than the output distribution. Forestry, fishing, and related activities receive 3.2% of the input but account for 6.8% of Type I job-years and 5.7% of Type II job-years. This pattern reflects relatively high RIMS II employment coefficients — 15.19 Type I and 19.48 Type II job-years per $1 million. Under the mapping, the category mostly represents APHIS and California food-and-agriculture public-agency activity. By contrast, chemical manufacturing receives 1.3% of the input but accounts for only 0.4% of Type I and 0.5% of Type II job-years because its employment coefficients are lower.

The remaining industries change the aggregate totals very little. The seven industries with at least 0.5% of the input account for 99.6% of input, output, value added and job-years. The other 16 mapped industries collectively receive $77.7 million and account for 523 Type I and 738 Type II job-years.

Type I value added ($million)	Type II value added ($million)	Type I employment (job-years)	Type II employment (job-years)
10,313.7	15,439.4	74,364	118,665
7,260.5	10,838.3	64,070	94,994
616.8	963.8	10,605	13,604
346.4	509.2	2,675	4,082
256.2	373.1	2,942	3,952
200.8	256.1	698	1,176
103.8	144.4	1,042	1,393
36.7	49.7	374	487
18.6	25.6	73	134
8.1	10.6	30	52
2.8	3.9	18	27
1.8	2.7	22	30
0.3	0.4	2	3
0.1	0.2	1	1
0.1	0.2	1	1
0.1	0.1	1	1
<0.1	0.1	1	1
<0.1	0.1	<1	<1
<0.1	<0.1	<1	<1
<0.1	<0.1	<1	<1
<0.1	<0.1	<1	<1
<0.1	<0.1	<1	<1
<0.1	<0.1	<1	<1
19,167.0	**28,618.0**	**156,919**	**238,604**

4.

PART THREE: PATENT-BASED INNOVATION VALUES AND KPSS CALIBRATION

Beyond supporting current economic activity, federal R&D funding and procurement can foster innovation by reducing financial constraints, stimulating demand for new technologies and supporting knowledge transfer between research institutions and firms (Edler & Georghiou, 2007; Brown et al., 2009; Azoulay et al., 2019). Such innovation can generate substantial long-term economic value, as reflected in the relationship between patented inventions and firms' market valuations (Hall et al., 2005; Kogan et al., 2017).

Patent data capture one observable and economically measurable dimension of innovation associated with federal global health-related spending. Patents are particularly useful because they identify discrete inventions, contain information on inventors and technological fields, and can be linked to federal awards and other administrative records. They have therefore long been used as indicators of inventive and technological output, although they do not capture all innovation and vary substantially in economic importance (Griliches, 1990). Patent characteristics also contain information about economic value: Hall et al. (2005), for example, show that citation-weighted patent portfolios are associated with firms' market valuation.

The use of patents is especially well established in studies of publicly funded biomedical research. Li et al. (2017) link NIH grants to subsequent patents and find that approximately 10% of grants are directly associated with a patent, while a substantially larger share produces publications that are later cited by patents. This distinction shows that public research can contribute to patentable innovation both directly and indirectly. Azoulay et al. (2019) similarly find that additional NIH funding increases subsequent private-sector patenting. These studies support the use of patents as an observable downstream outcome of publicly funded biomedical research, while also showing that innovation pathways extend beyond patents directly produced by grant recipients.

Relative to publications and many nonproprietary research outputs, patents can reasonably be interpreted as a more downstream and commercially oriented stage of innovation. Publications principally disseminate knowledge, whereas patents establish intellectual-property rights over inventions that may subsequently be licensed, transferred, financed or developed into commercial products. Jensen and Thursby (2001), for example, show that licensing of patented university inventions is an important mechanism through which federally supported research can enter industrial development. This relationship is particularly relevant in life sciences, where patenting is relatively common. Arundel and Kabla (1998) estimate that patent applications were filed for about 79% of pharmaceutical product innovations in their sample, compared with roughly 36% across industries overall. A patent is better understood as a relatively downstream intermediate outcome: It indicates that an invention has progressed far enough for intellectual-property protection to be sought.

4.1 Methodology: Calibration Method

We linked the California global health spending data to PatentsView (United States Patent and Trademark Office [USPTO], 2026) using federal award identifiers. We standardized the identifier text by converting each identifier to uppercase, removing punctuation and other nonalphanumeric characters, and screening out blank, invalid, very short or synthetic keys. The spending-side identifiers are prime-award Federal Award Identification Number (FAIN) and Procurement Instrument Identifier (PIID) values for prime awards and the corresponding prime identifiers reported on subawards.

We then exactly matched each cleaned spending identifier to a cleaned government-interest contract number in PatentsView.[6] The resulting match contains 104 distinct patents granted from 2016 to 2025.

[6] This exact-match approach is transparent and likely to have high precision, but it could miss patents whose government-interest statements contain incomplete, indirect, absent or materially different award numbers.

PatentsView supplies grant metadata, government-interest contract numbers, inventor and location records, assignee records, abstracts and CPC codes.

PatentsView supplies grant metadata, government-interest contract numbers, inventor and location records, assignee records, abstracts and CPC codes. We assigned each patent's California exposure using inventor locations recorded in PatentsView rather than the location of the patent assignee. For each patent, we calculated the California share as the number of California inventors divided by the number of inventors with usable locations. The KPSS data (Kogan et al., 2017; KPSS2017, 2025) estimate a patent's private market value from the stock-market response around its grant. Under the method's efficient-market assumption, the value is the owning firm's expected net present value from the patent; it is not realized revenue. Because KPSS values are available for patents linked to publicly traded firms, these values are best interpreted as external benchmarks rather than as observed values for every patent in this portfolio. Each included patent received the mean or median KPSS value for its grant year and CPC technology class and was then weighted by its California inventor share. We made two additional data-processing adjustments. First, for a patent with several unique CPC subclasses, each subclass received an equal share of the patent's technology weight. Second, the 13 patents granted in 2025 were assigned 2024 KPSS benchmarks because the extended KPSS files end in 2024 (KPSS2017, 2025).

4.2 Key Findings: Calibration Results

Table 4.2.1 reports the California-weighted valuation of the matched patent portfolio. The 104 distinct patents become 49.37 California-fractional patent equivalents after weighting each patent by its California inventor share. Applying the grant-year and CPC mean benchmarks gives an estimated private value of $5,726.18 million; applying the median benchmarks gives $1,845.94 million. Both totals are in constant 2024 U.S. dollars, after rebasing the original KPSS real values. The mean-based estimate is the headline portfolio benchmark, while the median-based estimate shows how the result changes when the high-value tail receives less weight. These totals are newly calculated benchmarks for the matched patent portfolio. The contribution lies in linking the chapter's selected federal awards to patents and combining established KPSS benchmarks with technology-class and California inventor weights.

The calibration is concentrated in the later grant cohorts. Patents granted from 2020 through 2025 account for about 79% of the mean-based real value. The 2022 cohort is the largest: 17 patents, a California-fractional count of 11.27 and $1,364.40 million under the real-mean calibration. It accounts for about 24% of the 10-year real-mean total. The next-largest annual values are $784.4 million in 2025 and $753.11 million in 2020.

The mean exceeds the median in every year. The real-mean total is about three times the real-median total, and annual mean-to-median ratios range from 2.35 in 2019 to 3.95 in 2022. This difference reflects the right-skewed KPSS patent-value distribution: Rare, high-value patents raise the mean much more than the median. The nominal columns report the corresponding KPSS nominal calibration only for reference and should not be combined with the real columns.

Annual values change with the number of patents, their California inventor shares, their CPC mix and the KPSS benchmark assigned to each year-technology cell. The large 2022 value coincides with both the largest patent cohort and the largest California-fractional count.

The choice between mean and median depends on the question. Mean benchmarks retain the expected contribution of rare, high-value patents and are appropriate for valuing a portfolio in expectation, but they are sensitive to the upper tail. Median benchmarks describe a more typical year-technology cell and produce a substantially lower, less tail-sensitive total. Reporting both makes that sensitivity visible.

TABLE 4.2.1 : California-Weighted Annual KPSS Patent-Value Calibration, 2016-2025

Grant year	Patents	CA frac.	Real mean (2024 $ million)	Real median (2024 $ million)	Nominal mean ($million)	Nominal median ($million)
2016	5	2.92	$248.58	$93.76	$191.32	$72.16
2017	2	1.68	$152.48	$49.41	$119.83	$38.83
2018	10	5.40	$497.10	$188.16	$398.12	$150.70
2019	10	3.07	$305.01	$129.60	$249.87	$106.17
2020	12	5.03	$753.11	$256.23	$625.35	$212.76
2021	10	3.63	$548.31	$211.83	$487.33	$188.27
2022	17	11.27	$1,364.08	$345.74	$1,290.63	$327.12
2023	9	3.75	$462.34	$119.56	$452.11	$116.92
2024	16	4.79	$610.76	$185.38	$614.50	$186.52
2025	13	7.83	$784.40	$266.28	$789.19	$267.90
TOTAL	**104**	**49.37**	**$5,726.18**	**$1,845.94**	**$5,218.25**	**$1,667.35**

NOTE: All value columns are annual calibration totals in millions. Real columns use KPSS xi_real rebased to constant 2024 U.S. dollars. Nominal columns use KPSS xi_nominal, measured in nominal/current-dollar KPSS units. "CA frac." is the sum of patent-level California inventor shares. Fractional CPC assigns equal technology weights across each patent's unique CPC subclasses.
SOURCES: Bureau of the Fiscal Service (n.d.); United States Patent and Trademark Office (2026); Kogan et al. (2017); KPSS2017 (2025).

5.

PART FOUR: ILLUSTRATIVE EXPERT INTERVIEWS

To better understand the pathways by which federal global health spending affects economic activity in California, we interviewed individuals with direct experience of the economic mechanisms examined in Parts One through Three.

5.1 Methodology

We conducted two semi-structured key-informant interviews and analyzed the transcripts using a rapid qualitative analysis (RQA) process informed by the Planning for and Assessing Rigor in Rapid Qualitative Analysis (PARRQA) framework (Kowalski et al., 2024). In this study's implementation, each interview was summarized against 15 pre-specified domains (D0-D14), and the case summaries were then entered into a cross-case matrix. Each statement was linked to a transcript timestamp so that quotations and interpretations can be checked against the source. For this study, coverage was coded "Direct" when a respondent addressed a domain, "Partial" when the response was relevant but incomplete and "Missing" when the question was not asked or was asked without a substantive answer. Evidence grades distinguished personal project knowledge (E1), specific direct observation (E2), broader ecosystem interpretation (E3) and conjecture or unsupported causal judgment (E4). These labels organize the strength and scope of statements.

Potential informants were identified to cover public-health and academic leadership, biotechnology and diagnostics, federal funding or procurement, and California-linked global health implementation. Selection emphasized experience with the mechanisms examined in the chapter, including federal awards, research and commercialization, workforce and supplier decisions, and the location of activity. Two expert interviews were completed on Aug. 11, 2026, and constitute the evidence used in this section.

The final sample contains two senior key informants (KIs). KI-001 primarily informs the discussion of basic science, clinical-research capacity, and complementarity among government, academic and private actors. KI-002 is a global health and diagnostics leader and a former health executive. His interview contributes experience from biotechnology, diagnostics, global health and federal R&D partnerships.

5.2 Key Findings: Cross-Case Findings and Evidence Gaps

The two interviews yield five mechanisms that help interpret relationships not directly observable in the administrative and patent data.

5.2.1 Federal funding supports innovation through direct project financing and broader research capacity Federal funding can support innovation through two complementary pathways. The first is direct project financing, which provides resources for research personnel, equipment, facilities and other activities needed to develop new technologies. KI-002 illustrates this pathway through direct participation in federally supported, high-risk diagnostic development. As the respondent explains, "Who is going to make that leapfrogging investment? That is where federal dollars come in." This account highlights the role of federal funding in supporting technically ambitious research that may be difficult to finance through commercial investment alone.

The second pathway operates through the broader research capacity created by earlier public investments. Federal support helps develop scientific knowledge, laboratories, clinical-trial networks, data systems and specialized personnel that private organizations can subsequently draw upon. KI-001 illustrates this pathway by describing how federally supported research and infrastructure contribute to private-sector innovation, even when a company's current development activities are not directly federally funded. Together, these accounts show how federal investments can support innovation both within funded projects and through research capabilities that extend beyond the original awards.

5.2.2 Agglomeration and specialized talent may help to explain California's advantage California's concentration of research institutions, specialized talent and private-sector partners can make it an attractive location for R&D despite its relatively high operating costs. KI-002 contrasts California with lower-cost regions, using North Dakota as an example, and explains that lower wages and facility costs may not compensate for the difficulty of assembling the specialized scientists, physicians and technical teams needed for complex research. As the respondent observes, "California provided the opportunity for this whole ecosystem to develop." KI-001 similarly emphasizes the connections among universities, publicly supported research, clinical infrastructure and private development. These accounts illustrate the benefits of agglomeration: Geographic proximity to specialized expertise, research facilities and potential collaborators can make complex R&D more feasible and efficient. Because much of the knowledge involved in such work is embedded in experienced research teams, retaining these teams can also help preserve research activity in California through acquisitions and organizational changes. This concentration of scientific and organizational capabilities provides one explanation for why California continues to attract research activity despite its higher costs.

5.2.3 Federal support is one component of mixed financing for R&D Federal funding often works alongside philanthropic, state and private investment to support research and technology development. KI-002 emphasizes the importance of combining these resources, stating, "You need philanthropy. You need state or federal support. They all have to come together." This complementarity is particularly relevant for technically ambitious projects that require substantial early investment but face uncertain commercial returns. Public funding can help support high-risk research and early technical development, while philanthropic and private resources may contribute to subsequent development and implementation. The interviews therefore highlight how federal support can contribute to innovation as part of a broader financing ecosystem, with different funding sources supporting different stages and needs of the research process.

"Who is going to make that leapfrogging investment? That is where federal dollars come in."

Federal programs can contribute to innovation through both financial support and the organizational structure used to manage uncertain research.

5.2.4 Program design and oversight shape how federal funding affects innovation The contribution of federal funding to innovation depends not only on the resources provided but also on how research programs are structured and managed. KI-002 describes federal programs that combine three- to five-year funding horizons with ambitious technical goals, quarterly reviews and close project supervision. Multiyear support gives research teams time to pursue difficult technical problems, while regular reviews provide opportunities to assess progress, incorporate feedback, revise milestones and redirect approaches when necessary. These features can be especially valuable for high-risk diagnostic development, where technical challenges and research priorities may evolve over the course of a project. The interview illustrates how federal programs can contribute to innovation through both financial support and the organizational structure used to manage uncertain research.

5.2.5 Funding received in California does not always generate economic activity in California Federal global health-related funding associated with California can support research and innovation whose economic benefits extend beyond the state. The interviews illustrate how research, procurement, testing, manufacturing and implementation may take place in different locations. California-based research institutions may purchase equipment or specialized components from suppliers elsewhere, while technologies developed in California may be tested or deployed in regions where the relevant health needs arise. Consequently, the location of a federal award or research activity does not necessarily coincide with the location of all subsequent economic activity. The RIMS II analysis incorporates regional purchasing patterns and spending that flows outside California, while the innovation analysis captures patented inventions linked to federal awards rather than the geographic distribution of subsequent production, commercialization or health benefits. Together, the interview evidence and quantitative analyses illustrate how California can serve as a center of global health innovation while participating in research and production networks that extend beyond its borders.

6.
INTEGRATED DISCUSSION

Federal global health-related funding is connected to California's economy through both short-run economic activity and long-run innovation values. The RIMS II analysis shows how federal obligations are associated with production, value added and employment within the state as recipients purchase goods and services, employ workers and generate household income in the short run. The patent analysis captures a different dimension: Federally supported projects are also linked to inventions with measurable private economic value in the long run. The interviews help connect these quantitative results by describing how funding supports the people, research infrastructure, technical capabilities and collaborations through which this activity occurs.

The scale of the regional economic activity closely follows changes in federal funding. From 2016 to 2025, $21.492 billion in federal obligations was associated with $30.161 billion in California output, $19.167 billion in value added and approximately 157,000 job-years when the initial activity and California supplier purchases are included. Including modeled household spending increases these estimates to $46.314 billion in output, $28.618 billion in value added and approximately 239,000 job-years. This corresponds to about $1.40 in output for every federal dollar under the first scenario and $2.15 when household spending is included.

The annual results also show that the composition of federal support changed substantially over the period. Funding reached its highest level in 2021, when large emergency and public-health awards were concentrated in the Public Health and Social Services Emergency Fund and Global Health, CDC. Obligations subsequently declined, while the number of awards continued to increase through 2024. This pattern suggests a transition from a smaller number of unusually large emergency awards toward a larger number of lower-dollar awards, including a more stable research portfolio. In 2025, both obligations and award counts declined, indicating a broader contraction in federally supported activity rather than simply a decline in average award size.

The innovation results show another way in which federal funding is connected to economic activity in California. The analysis identifies 104 patents linked to federal global health-related awards, equivalent to 49.37 patents after weighting by California inventor shares. Using KPSS benchmarks, these patents have an estimated mean-based private value of $5.726 billion and a median-based value of $1.846 billion, measured in inflation-adjusted 2024 dollars. These results are particularly relevant because research and development represents a large share of the federal awards identified in the study. Federal funding therefore supports not only current research activity but also projects that can contribute to later inventions and commercial development.

The interviews illustrate how the longer-term pathway can operate (Azoulay et al., 2019; Brown et al., 2009; Edler & Georghiou, 2007). One informant describes federal investment in basic science and clinical-research capacity that later private-sector projects can build upon. The other describes an example of direct federal support for technically ambitious diagnostic development. In both cases, funding supports more than an individual research expenditure. It helps sustain specialized personnel, laboratories, accumulated technical knowledge and collaborations that can be used across successive projects. These mechanisms are consistent with the literature on public research, R&D financing and demand-driven innovation.

Federal funding may also shape innovation through the way projects are organized. One informant describes multiyear programs that combine ambitious technical goals with regular federal review and project supervision. Longer funding horizons give technical teams time to pursue difficult problems, while recurring reviews provide opportunities to assess progress, revise milestones and redirect unsuccessful approaches. This suggests that the contribution of federal support can depend not only on the amount of funding available but also on the continuity and structure of that support.

California's research environment appears to strengthen these connections. Both informants emphasize the importance of specialized scientific workers, universities, clinical and laboratory infrastructure, complementary organizations and accumulated expertise. Because much of this knowledge is embedded in experienced individuals and teams, maintaining research capacity can matter beyond any single award.

Taken together, the findings point to effects operating over different time horizons. Changes in federal obligations are reflected immediately in the amount of regional economic activity associated with funded projects. Over longer periods, sustained support also contributes to the research capacity, technical knowledge and innovation pipeline from which later inventions and commercial applications can emerge. This distinction is important for evaluating funding changes: The consequences may extend beyond the immediate value of the awards affected.

This distinction is important for evaluating funding changes: The consequences may extend beyond the immediate value of the awards affected.

7. CONCLUSION

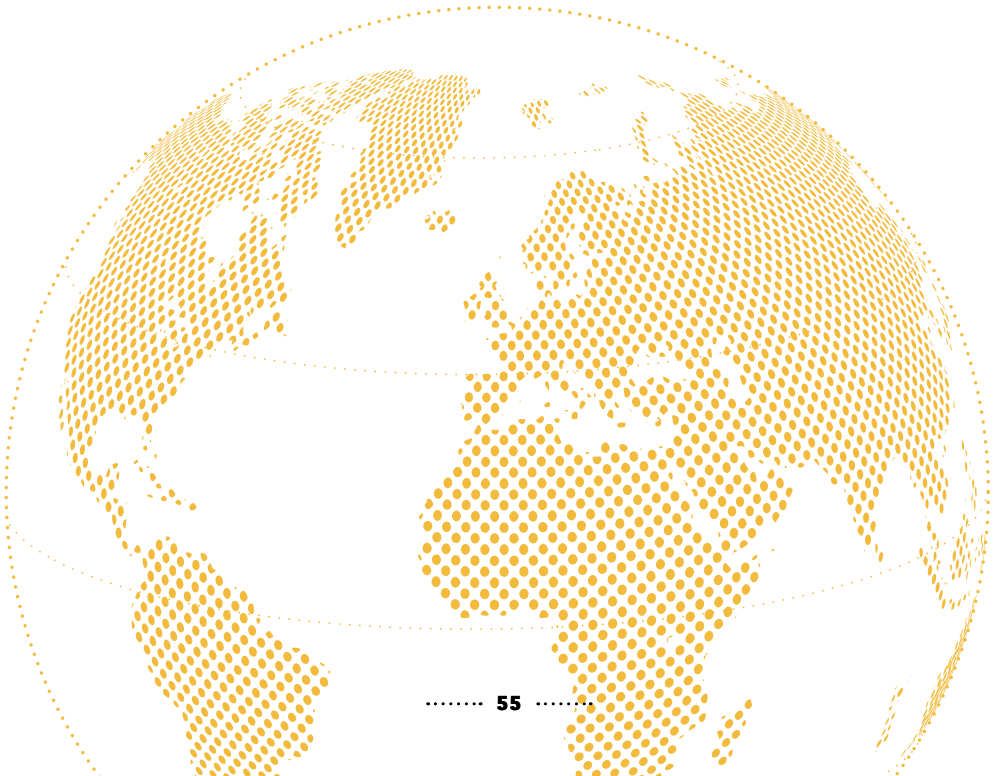
Federal global health-related funding plays a broader role in California than supporting individual research projects or public-health programs. It contributes to an interconnected system of scientific expertise, research institutions, specialized workers and private-sector innovation. The findings of this chapter offer three lessons for understanding the economic importance of that support and informing future funding decisions.

First, funding decisions should consider the continuity of research and public-health capacity, not just the amount of funding provided. Scientific expertise, laboratory infrastructure and institutional partnerships often take years to develop and depend on sustained support. Interruptions in funding may therefore affect ongoing projects as well as the teams and capabilities needed for future research. When reviewing funding priorities, policymakers and research institutions should distinguish the expiration of temporary emergency programs from changes in recurring research support and consider the longer-term implications for scientific capacity.

Second, effective coordination across funding sources can help bridge different stages of innovation. Federal, state, philanthropic and private financing often serve complementary roles, from basic scientific discovery to technical development and implementation. Identifying financing gaps and coordinating support around specific project needs can help promising research advance through these stages. Such coordination is particularly important when projects move from publicly supported research toward private development and commercialization.

Third, future funding decisions would benefit from stronger evidence on how public investment translates into economic and innovation outcomes. Better links between federal awards, employment, supplier spending, subsequent financing and commercialization would help policymakers understand where economic benefits occur and how they evolve over time. More systematic project-level evidence would also make it possible to assess which forms of support are most effective in sustaining research capacity and encouraging innovation.

Together, these lessons suggest that the economic importance of federal global health-related funding extends beyond the immediate activities it finances. The central policy consideration is how to sustain and strengthen the research capacity, institutional relationships and innovation pathways through which global health investment benefits both California and populations around the world.



Appendix A:

USASPENDING ACCOUNT MAP AND CONSTRUCTION RULES

The account map separates direct global health accounts from candidate accounts that require supporting text evidence. A direct-account match took priority when a row mapped to both direct and candidate accounts. When multiple direct accounts or multiple candidate accounts were present, the transaction's obligation was divided equally across the relevant accounts. This equal-weight allocation preserved the transaction's total obligation while preventing double counting across account classifications.

TABLE A1 : TAS/federal account map

Account	Account title	Agency	Rule	Program/family
019-1030	Global HIV/AIDS Initiative	State	direct	State - Global HIV/AIDS Initiative / PEPFAR
019-1031	Global Health Programs	State	direct	State - Global Health Programs
072-1095	Child Survival and Health Programs Fund	USAID	direct	USAID - Child Survival and Health Programs Fund
072-1033	HIV/AIDS Working Capital Fund	USAID	direct	USAID - HIV/AIDS Working Capital Fund
075-0955	Global Health, CDC	CDC / HHS	direct	CDC - Global Health
072-1037	Economic Support Fund	USAID / State	candidate	USAID/State - Economic Support Fund global health candidates
072-1035	International Disaster Assistance	USAID	candidate	USAID - International Disaster Assistance health/ outbreak response
075-0819	John E. Fogarty International Center	NIH	candidate	NIH - Fogarty global health research and training
075-0885	National Institute of Allergy and Infectious Diseases	NIH	candidate	NIH/NIAID - infectious disease and global health candidates
075-0846	Office of the Director, NIH	NIH	candidate	NIH Office of the Director - trans-NIH global health candidates
075-0140	Public Health and Social Services Emergency Fund	HHS / ASPR	candidate	ASPR/BARDA - pathogen, pandemic, and countermeasure candidates
075-0837	ARPA-H	HHS / NIH	candidate	ARPA-H - global health and pandemic candidates
097-0130	Defense Health Program	DoD	candidate	DoD - overseas infectious disease and global health engagement
012-1600	Salaries and Expenses, APHIS	USDA / APHIS	candidate	APHIS - zoonotic and agricultural pathogen surveillance
012-5161	Agricultural Quarantine Inspection User Fee Account	USDA / APHIS	candidate	APHIS - quarantine-linked pathogen surveillance candidates
075-0600	Salaries and Expenses, FDA	FDA / HHS	candidate	FDA - global regulatory science and AMR surveillance candidates
049-0100	Research and Related Activities	NSF	candidate	NSF - pandemic, One Health, and international infectious disease candidates
070-0803	Research and Development, Science and Technology Directorate	DHS	candidate	DHS - biosurveillance and biothreat detection candidates

TABLE A2 : Account-specific matching keyword and context rules for candidate accounts

Account	Account title	Keyword and context rule
072-1037	Economic Support Fund	Direct matches: PEPFAR; global health; HIV; AIDS; TB; tuberculosis; malaria; maternal; child survival; family planning; reproductive health; immunization; global health security; GHSA. Otherwise, require a global/international anchor together with either a disease anchor or a health-system anchor.
072-1035	International Disaster Assistance	Ebola; COVID; SARS-CoV-2; mpox; monkeypox; pandemic; epidemic; outbreak; health system; medical supply; disease outbreak response; public health emergency; cholera; measles; vaccine; diagnostic.
075-0819	John E. Fogarty International Center	Fogarty; global health; international; LMIC; low-resource; resource-constrained; HIV; AIDS; TB; malaria; infectious disease; training; research partnership; Zimbabwe. A global, disease, Fogarty, international, LMIC, or Zimbabwe context must also be present.
075-0885	National Institute of Allergy and Infectious Diseases	HIV; AIDS; TB; malaria; emerging infectious; infectious disease; pandemic; epidemic; outbreak; surveillance; international cohort; cohort; LMIC; low-resource; resource-constrained; global HIV; Zimbabwe; INSIGHT; dengue; Zika; Ebola; mpox; influenza. Exclude generic basic research described only as basic, molecular, cellular, mechanism, pathway, or structure when no global or disease anchor is present.
075-0846	Office of the Director, NIH	Common Fund; trans-NIH; global health; global health security; international infectious; infectious disease; pandemic; LMIC; low-resource; resource-constrained.
075-0140	Public Health and Social Services Emergency Fund	BARDA, DRIVe, or CARB-X must occur with diagnostic, detection, biosurveillance, sequencing, AMR, antimicrobial, pathogen, pandemic, outbreak, vaccine, therapeutic, countermeasure, COVID, Ebola, mpox, or influenza. The phrases pandemic preparedness, global pathogen surveillance, international outbreak, medical countermeasure, and public health emergency also qualify directly.
075-0837	ARPA-H	Global health; pandemic; international deployment; LMIC; low-resource; resource-constrained; global infectious; outbreak.
097-0130	Defense Health Program	GEIS; global emerging infection; WRAIR; Walter Reed Army Institute; NAMRU; Naval Medical Research Unit; AFRIMS; NHRC OID; overseas; force health protection; deployed force; military global health; tropical disease; malaria; dengue; leishmaniasis; infectious disease surveillance. PANACEA is excluded unless paired with an overseas, surveillance, GEIS, WRAIR, NAMRU, AFRIMS, force-health, deployed, or international anchor.
012-1600	Salaries and Expenses, APHIS	Zoonotic; zoonoses; animal disease; foreign animal disease; HPAI; avian influenza; H5N1; foot-and-mouth; African swine fever; classical swine fever; brucellosis; bovine tuberculosis; agricultural pathogen; plant pathogen; quarantine; disease surveillance; surveillance; survey; diagnostic; outbreak.
012-5161	Agricultural Quarantine Inspection User Fee Account	First require zoonotic, animal disease, foreign animal disease, HPAI, avian influenza, agricultural pathogen, plant pathogen, quarantine, import, cross-border, surveillance, diagnostic, or outbreak. Also require international, foreign, cross-border, quarantine, import, border, port of entry, overseas, or global.
075-0600	Salaries and Expenses, FDA	NARMS, antimicrobial resistance, or AMR must occur with surveillance, monitoring, global, international, foreign, food safety, or regulatory. The phrases global regulatory science, international drug safety, international food safety, foreign regulatory capacity, foreign regulator, regulatory capacity building, and global surveillance also qualify.
049-0100	Research and Related Activities	PIPP; predictive intelligence for pandemic prevention; pandemic; infectious disease ecology; disease modeling; global disease model; One Health; zoonotic spillover; spillover; international infectious disease; pathogen surveillance; early warning. Exclude device, manufacturing, materials, semiconductor, or sensor-fabrication work when no pandemic, infectious, zoonotic, surveillance, One Health, global, or international anchor is present.
070-0803	Research and Development, Science and Technology Directorate	Biosurveillance; bio-surveillance; NBIC; biothreat; bio-threat; pathogen detection; disease surveillance; public health surveillance; biological threat. A public/global health or pathogen/disease/biothreat/surveillance context is also required.

TABLE A3 : Net federal obligations by aggregate industry, 2016-2025

RIMS II code	Aggregate industry	Net obligations	Share
50	Professional, scientific, and technical services	$10,270,624,208.97	53.974%
55	Ambulatory health care services	$7,063,204,546.42	37.118%
2	Forestry, fishing, and related activities	$625,694,565.53	3.288%
56	Hospitals	$360,534,397.80	1.895%
63	Other services	$265,426,244.69	1.395%
25	Chemical manufacturing	$234,833,143.42	1.234%
1	Farms	$139,918,499.20	0.735%
31	Other retail	$34,401,425.89	0.181%
13	Computer and electronic product manufacturing	$20,759,674.79	0.109%
40	Publishing industries (except Internet)	$7,281,885.86	0.038%
53	Waste management and remediation services	$3,509,206.36	0.018%
52	Administrative and support services	$1,814,214.50	0.010%
18	Miscellaneous manufacturing	$376,583.06	0.002%
19	Food and beverage and tobacco product manufacturing	$194,000.00	0.001%
27	Wholesale trade	$107,342.28	0.001%
49	Rental and leasing services and lessors of nonfinancial intangible assets	$105,843.00	0.001%
7	Construction	$46,897.00	0.000%
54	Educational services	$40,515.00	0.000%
17	Furniture and related product manufacturing	$23,783.10	0.000%
21	Apparel, leather, and allied product manufacturing	$19,753.92	0.000%
26	Plastics and rubber products manufacturing	$13,123.35	0.000%
62	Food services and drinking places	$4,940.00	0.000%
12	Machinery manufacturing	$4,172.22	0.000%
TOTAL		**$19,028,938,966.36**	**100.000%**

TABLE A4 : Net federal obligations by TAS/federal account, 2016-2025

Account	Account title	Net obligations	Share
075-0846	Office of the Director, NIH	$4,868,202,237.66	25.58%
075-0140	Public Health and Social Services Emergency Fund	$4,594,334,660.82	24.14%
075-0955	Global Health, CDC	$3,621,895,495.54	19.03%
075-0885	National Institute of Allergy and Infectious Diseases	$3,411,889,122.52	17.93%
019-1031	Global Health Programs	$1,410,057,437.18	7.41%
012-1600	Salaries and Expenses, APHIS	$804,940,666.93	4.23%
075-0819	John E. Fogarty International Center	$126,204,259.16	0.66%
049-0100	Research and Related Activities	$124,512,083.00	0.65%
012-5161	Agricultural Quarantine Inspection User Fee Account	$29,412,863.16	0.16%
097-0130	Defense Health Program	$12,318,298.00	0.07%
072-1033	HIV/AIDS Working Capital Fund	$11,579,533.95	0.06%
019-1030	Global HIV/AIDS Initiative	$4,643,185.21	0.02%
075-0600	Salaries and Expenses, FDA	$3,903,743.53	0.02%
072-1037	Economic Support Fund	$3,746,647.00	0.02%
072-1035	International Disaster Assistance	$688,355.36	0.00%
070-0803	Research and Development, Science and Technology Directorate	$476,044.00	0.00%
TOTAL		**$19,028,938,966.36**	**100.000%**

Appendix B:
RIMS II INPUT-OUTPUT BACKGROUND

This appendix describes how an input-output model translates a change in final demand into total local economic activity. The model is useful for measuring the gross output, value added and employment associated with an external spending shock. Value added is the contribution to regional GDP: employee compensation, proprietors' income, other property income, and taxes on production and imports less subsidies. The model is not, by itself, a causal design (BEA, 2013).

B.1 Accounting Setup

Let x denote an n-by-1 vector of gross output by California industry. Let f denote final demand. Let A denote the matrix of technical coefficients, where a_ij is the dollar amount of input from industry i required to produce one dollar of output in industry j. The input-output accounting identity is

$$x = A x + f.$$

Solving for output gives

$$x = (I - A)^{(-1)} f.$$

For a change in final demand, the output response is

$$\text{Delta } x = (I - A)^{(-1)} \text{ Delta } f.$$

The matrix (I - A)^(-1) is the Leontief inverse. It captures the direct spending shock and the supplier purchases required to support that shock. The series expansion makes the logic clear:

$$(I - A)^{(-1)} = I + A + A^2 + A^3 + \dots .$$

The first term is the direct effect. The next terms are successive rounds of supplier demand. Employment and value added are calculated by applying industry-specific coefficients to the output response. If q is jobs per dollar of output and v is value added per dollar of output, then

$$\text{Delta Jobs} = q' \text{ Delta } x$$
$$\text{Delta Value Added} = v' \text{ Delta } x.$$

A Type I multiplier includes direct and indirect effects. Direct effects are the initial modeled activity. Indirect effects arise when the directly affected industry buys inputs from other industries. A Type II (social accounting matrix-based) multiplier also includes induced effects, which come from workers spending additional earnings in the local economy.

B.2 Illustrative Example

Consider a simple three-industry California economy with research services, professional suppliers and local services. Suppose the federal government obligates $100 million for global health-related research performed in California, and the obligation is assigned to the research-services industry. The final-demand shock is

$$\text{Delta } f = [100, 0, 0]'.$$

Assume the technical-coefficient matrix is

$$A = [[0.10, 0.05, 0.02], [0.20, 0.10, 0.08], [0.05, 0.15, 0.10]].$$

The corresponding Leontief inverse is

$$(I - A)^{(-1)} = [[1.128, 0.068, 0.031], [0.260, 1.143, 0.107], [0.106, 0.194, 1.131]].$$

Multiplying the inverse by the final-demand shock gives

$$\text{Delta } x = [112.8, 26.0, 10.6]'.$$

The $100 million research obligation therefore supports $149.4 million in total gross output in this example. The implied Type I output multiplier is 1.49. The direct shock is $100 million. The remaining $49.4 million reflects supplier-linked activity inside California.

If the employment coefficients are 6, 5 and 8 jobs per $1 million of output in the three industries, the same output vector implies about 892 jobs in the modeled period. If value-added shares are 0.55, 0.45 and 0.35, the output vector implies $77.4 million in value added. These coefficients are only illustrative; the main estimates should use the industry coefficients from the chosen input-output system. When annual employment estimates are summed across years, the chapter describes the total as job-years rather than unique people or permanent jobs.

B.3 Why the Input Must Be a Final-Demand Change

The calculation above is valid only when Delta f is a change in final demand. Final demand is spending from outside the interindustry production system: exports, federal purchases, investment, household consumption or other end-use demand. It is not the same as total sector revenue, total business activity or the sum of revenues across organizations connected by supplier relationships.

The distinction matters because gross output already includes intermediate sales. If a researcher enters a measure that already contains supplier activity as if it were new final demand, the multiplier counts the same output twice.

Return to the example above. A $100 million final-demand shock generates $149.4 million in total output after supplier effects. If an analyst observes the $149.4 million total and then enters that amount as a new final-demand shock, the model returns

$$1.494 \times 149.4 = 223.2.$$

The $223.2 million estimate is not a larger economic effect. It is a double count. The supplier rounds are included once in the observed $149.4 million total and a second time through the Leontief inverse.

A similar problem arises when the analyst sums revenues across linked organizations. Suppose a $100 million federal global health obligation to a California university includes a $20 million contract with a local data firm. The data firm's revenue is part of the supply chain required to carry out the university project. If the analyst enters $120 million as direct activity, the model treats the $20 million supplier contract as additional external demand. With the 1.49 multiplier, the estimated output becomes $179.3 million rather than $149.4 million. The extra $29.9 million comes from treating an intermediate transaction as a separate final-demand shock.

This is the key limitation of broad sector-footprint studies. If the input is a constructed measure of all global health-related activity in California, it may already include direct production, supplier revenue, payroll and other downstream activity. Applying a multiplier to that total can overstate the footprint unless the researcher first separates final demand from intermediate transactions.

B.4 California Global Health Interpretation

The California global health setting makes the final-demand requirement concrete. A federal obligation for global health research at a California university can be interpreted as external demand when the payer is the federal government and the activity is assigned to a California place of performance. The university then uses the funds to pay researchers, buy laboratory supplies, contract for data services, support clinical or field partnerships and operate facilities. The input-output model estimates the California output required to satisfy that external demand.

By contrast, a list of all global health organizations in California is not automatically a final-demand shock. Some organizations sell to one another. Some revenues reflect payments funded by the original federal award. Some payroll appears both as an expense of one organization and as income to workers. Entering the whole list as direct activity would blur final demand with the production chain. The result would be an economic footprint of an accounting aggregate, not the effect of a spending shock.

For this reason, this chapter starts from coded federal obligations rather than total global health-sector activity. The narrower input better matches the object required by the model: an externally financed change in demand assigned to a California industry and place. The approach does not measure every activity in California global health. It is designed to avoid counting the same activity once as an observed total and again through the multiplier.

B.5 Assumptions and Interpretation

Input-output estimates rely on fixed production relationships, fixed prices and no capacity constraints. They also assume that the industry and geography assigned to the spending shock are correct. These assumptions are useful for transparent accounting, but they limit causal interpretation (BEA, 2013). The estimates should be described as output, employment and value added associated with externally financed global health-related obligations, not as experimental estimates of all activity caused by global health spending.

Timing also matters. Federal obligations are commitments, not always same-year outlays. If a grant is obligated in one fiscal year and spent over several years, the input-output shock should be aligned with the spending period when possible. When obligations are observed, the estimates should be interpreted as activity associated with obligated funding under the assumed spending timing.

Appendix C:

PATENT LINKAGE DETAILS

TABLE C1 : Primary CPC class distribution of the 104 linked patents

Primary CPC class	Class title	Patent count
C07	Organic chemistry	35
A61	Medical or veterinary science; hygiene	34
C12	Biochemistry; microbiology; enzymology; genetic engineering	19
G01	Measuring; testing	6
B01	Physical or chemical processes or apparatus in general	2
C11	Animal or vegetable oils, fats, fatty substances, or waxes	2
G06	Computing; calculating or counting	2
G16	ICT specially adapted for specific fields	2
C09	Dyes, paints, polishes, adhesives, and related materials	1
G02	Optics	1
TOTAL LINKED PATENTS		**104**

REFERENCES

Akey, M., Groves, B., Hudspeth, J. C., Rabin, T. L., Cortez, S., Silvers, R., Novotny, J., Negussie, F., Orozco, P., Le, P., Sawhney, R., Raykar, N., Arteaga, M., Davis Rodriguez, J. A., Curran, M., Byekwaso, S., Saab, F., Bandolin, N. S., & Lipnick, M. S. (2026). Pathways to clinical training opportunities for international medical students and IMGs: The California experience. *Annals of Global Health, 92*(1), Article 3. *https://doi.org/10.5334/aogh.5020*

Arundel, A., & Kabla, I. (1998). What percentage of innovations are patented? Empirical estimates for European firms. *Research Policy, 27*(2), 127–141. *https://doi.org/10.1016/S0048-7333(98)00033-X*

Azoulay, P., Graff Zivin, J. S., Li, D., & Sampat, B. N. (2019). Public R&D investments and private-sector patenting: Evidence from NIH funding rules. *The Review of Economic Studies, 86*(1), 117–152. *https://doi.org/10.1093/restud/rdy034*

Brown, J. R., Fazzari, S. M., & Petersen, B. C. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *The Journal of Finance, 64*(1), 151–185. *https://doi.org/10.1111/j.1540-6261.2008.01431.x*

Bureau of the Fiscal Service. (n.d.). *USAspending.gov federal award, subaward, and account data* [Data set]. Data.gov. Retrieved June 9, 2026, from *https://catalog.data.gov/dataset/usaspending-gov-federal-award-subaward-and-account-data*

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Sage.

Deck, K., & Riiman, V. (2010). *The economic impact of Medicaid spending in Arkansas.* Center for Business and Economic Research, Sam M. Walton College of Business, University of Arkansas. *https://walton.uark.edu/initiatives/cber/_resources/files/2010/The_Economic_Impact_of_Medicaid_Spending_in_Arkansas.pdf*

de Rassenfosse, G., Jaffe, A., & Raiteri, E. (2019). The procurement of innovation by the U.S. government. *PLOS ONE, 14*(8), Article e0218927. *https://doi.org/10.1371/journal.pone.0218927*

Edler, J., & Georghiou, L. (2007). Public procurement and innovation — Resurrecting the demand side. *Research Policy, 36*(7), 949–963. *https://doi.org/10.1016/j.respol.2007.03.003*

Evangelakis, P. (2025, June 6). *Economic and fiscal impacts of Medicaid expansion reversal in Ohio.* Health Policy Institute of Ohio. *https://www.healthpolicyohio.org/files/publications/ohiomedicaidexpansionreversaleconomicimpactreportremi2025.pdf*

Fabrizio, K. R. (2009). Absorptive capacity and the search for innovation. *Research Policy, 38*(2), 255–267. *https://doi.org/10.1016/j.respol.2008.10.023*

Fogarty International Center. (2012, May/June). NIH funding helps drive innovation in California. *Global Health Matters, 11*(3). *https://www.fic.nih.gov/News/GlobalHealthMatters/may-june-2012/Pages/us-economic-impact-california.aspx*

Global Health Technologies Coalition. (2011). *The transformative power of global health research: Leadership in innovation saves lives and provides economic benefits to the US. https://www.ghtcoalition.org/documents/pdf/Transformative-Power-of-Global-Health-Research.pdf*

Griliches, Z. (1990). Patent statistics as economic indicators: *A survey. Journal of Economic Literature, 28*(4), 1661–1707.

Hall, B. H., Jaffe, A., & Trajtenberg, M. (2005). Market value and patent citations. *The RAND Journal of Economics, 36*(1), 16–38.

Harpel, E., & Romitti, M. (2025). *Military economic impact analysis for the State of Louisiana.* Business Development Advisors. *https://admin.opportunitylouisiana.gov/wp-content/uploads/2025/11/LED-Military-Impact-Analysis-2025.pdf*

Jaffe, A. B. (1989). Real effects of academic research. *The American Economic Review, 79*(5), 957–970.

Jensen, R., & Thursby, M. (2001). Proofs and prototypes for sale: The licensing of university inventions. *American Economic Review, 91*(1), 240–259. *https://doi.org/10.1257/aer.91.1.240*

Kates, J., Rouw, A., & Wexler, A. (2025, June 24). *Global health funding awards by state and congressional district.* KFF. *https://www.kff.org/global-health-policy/global-health-funding-awards-by-state-and-congressional-district/*

Kerna, A., Frisvold, G., Jacobs, L., Farrell, V. A., Houtkooper, L., & Misner, S. (2015). Application of IMPLAN to Extension programs: Economic impacts of the University of Arizona Cooperative Extension SNAP-Ed spending. *Journal of Extension, 53*(6), Article 21. *https://doi.org/10.34068/joe.53.06.21*

Kogan, L., Papanikolaou, D., Seru, A., & Stoffman, N. (2017). Technological innovation, resource allocation, and growth. *The Quarterly Journal of Economics, 132*(2), 665–712. *https://doi.org/10.1093/qje/qjw040*

Kowalski, C. P., Nevedal, A. L., Finley, E. P., Young, J. P., Lewinski, A. A., Midboe, A. M., & Hamilton, A. B. (2024). Planning for and assessing rigor in rapid qualitative analysis (PARRQA): A consensus-based framework for designing, conducting, and reporting. *Implementation Science, 19*(1), Article 71. *https://doi.org/10.1186/s13012-024-01397-1*

KPSS2017. (2025, December 7). *Technological innovation, resource allocation, and growth: Extended data* (December 7, 2025 version) [Data set]. GitHub. *https://github.com/KPSS2017/Technological-Innovation-Resource-Allocation-and-Growth-Extended-Data*

Ku, L., Bruen, B. K., Steinmetz, E., & Bysshe, T. (2014). *The economic and employment costs of not expanding Medicaid in North Carolina: A county-level analysis.* Center for Health Policy Research, George Washington University. *https://hsrc.himmelfarb.gwu.edu/sphhs_policy_facpubs/780/*

Ku, L., Gorak, T., Krips, M., Reid, A. M., & Levi, J. (2025). *Proposed budget cuts not only hurt CDC and public health, they also harm state and local economies and employment.* Center for Health Policy Research, George Washington University. *https://accountablehealth.gwu.edu/sites/g/files/zaxdzs6441/files/2025-09/cdc_economic_impact_report_0.pdf*

Lendel, I. V., & Yun, J. (2021). *The NASA John H. Glenn Research Center: An economic impact study, fiscal year 2020*. Center for Economic Development, Cleveland State University. *https://www.nasa.gov/wp-content/uploads/2015/06/csu_nasa_glenn_economic_impact_fy_2020_20210610_final-accessible.pdf*

Li, D., Azoulay, P., & Sampat, B. N. (2017). The applied value of public investments in biomedical research. *Science*, *356*(6333), 78–81. *https://doi.org/10.1126/science.aal0010*

Manzo, F., IV, & Bruno, R. (2025, December 1). *Federal funding cuts and freezes: Consequences for Illinois*. *Illinois Economic Policy Institute & Project for Middle Class Renewal*. *https://lep.illinois.edu/wp-content/uploads/2025/12/ilepi-pmcr-federal-cuts-consequences-for-illinois-final-1.pdf*

Maryland Department of Business and Economic Development. (2012). *The effect of federal spending and employment in Maryland, 2010*. *https://msa.maryland.gov/megafile/msa/speccol/sc5300/sc5339/000113/016000/016462/unrestricted/20130311e.pdf*

Meghea, C. I., Montgomery, B. W., Ellington, R., Wang, L., Barajas, C., Lewis, E. Y., Yeary, S. T., Van Egeren, L. A., & Furr-Holden, D. (2021). An NIH investment in health equity - The economic impact of the Flint Center for Health Equity Solutions. *BMC Public Health, 21*(1), Article 1774. *https://doi.org/10.1186/s12889-021-11795-5*

Nandi, A. (2009). *The importance of the global health sector in California: An evaluation of the economic impact*. University of California Global Health Institute. *https://escholarship.org/uc/item/69v7f2jz*

Organisation for Economic Co-operation and Development. (2019). *University–industry collaboration: New evidence and policy options*. *https://doi.org/10.1787/e9c1e648-en*

Ozgediz, D., Wang, J., Jayaraman, S., Ayzengart, A., Jamshidi, R., Lipnick, M., Mabweijano, J., Kaggwa, S., Knudson, M., Schecter, W., & Farmer, D. (2008). Surgical training and global health: Initial results of a 5-year partnership with a surgical training program in a low-income country. *Archives of Surgery, 143*(9), 860–865. *https://doi.org/10.1001/archsurg.143.9.860*

Payares-Montoya, D., & Bohn, S. (2026, May). *California's economy*. Public Policy Institute of California. *https://www.ppic.org/publication/californias-economy/*

Planning Decisions, Inc. (2016). *The economic & fiscal impact on Maine of NIH-funded medical research*. *United for Medical Research*. *https://unitedformedicalresearch.org/wp-content/uploads/2016/03/The-Economic-Impact-of-NIH-funded-Research-on-Maine-3.2.16-FINAL.pdf*

Richardson, J. A., Llorens, J. J., & Heidelberg, R. L. (2018). *Medicaid expansion and the Louisiana economy*. Louisiana Department of Health. *https://gov.louisiana.gov/assets/MedicaidExpansion/MedicaidExpansionStudy.pdf*

Sumstine-Felice, S. (2025, November 4). *Bridging local and global: How UCGHI is strengthening health workforce development across California*. University of California Global Health Institute. *https://ucghi.universityofcalifornia.edu/news/bridging-local-and-global-how-ucghi-is-strengthening-health-workforce-development-across-california/*

Tian, M., Su, Y., & Yang, Z. (2022). University–industry collaboration and firm innovation: An empirical study of the biopharmaceutical industry. *The Journal of Technology Transfer, 47*(5), 1488–1505. *https://doi.org/10.1007/s10961-021-09877-y*

UMass Donahue Institute. (2025). *Economic contributions of R&D funding in Massachusetts: Estimates of recent funding and economic multipliers*. *https://www.umass.edu/donahue/media/1715/download*

United for Medical Research. (2025). *NIH's role in sustaining the U.S. economy: 2025 update*. *https://www.unitedformedicalresearch.org/wp-content/uploads/2025/03/UMR_NIH-Role-in-Sustaining-US-Economy-FY2024-2025-Update.pdf*

United for Medical Research. (2026). *NIH's role in sustaining the U.S. economy: 2026 update*. *https://www.unitedformedicalresearch.org/annual-economic-report/*

United States Patent and Trademark Office. (2026, June 23). *PatentsView*. *https://www.uspto.gov/ip-policy/economic-research/patentsview*

U.S. Bureau of Economic Analysis. (2013). *Regional Input-Output Modeling System (RIMS II) user's guide*. *https://www.bea.gov/resources/methodologies/RIMSII-user-guide*

U.S. Bureau of Economic Analysis. (2026a, August 26). *GDP price deflator*. *https://www.bea.gov/data/prices-inflation/gdp-price-deflator*

U.S. Bureau of Economic Analysis. (2026b, May 5). *Regional Input-Output Modeling System (RIMS II) online order and delivery system*. *https://apps.bea.gov/regional/rims/rimsii/*

Ward, B., & Bridge, B. (2019). *The economic impact of Medicaid expansion in Montana: Updated findings*. Bureau of Business and Economic Research, University of Montana. *https://www.bber.umt.edu/pubs/BBER/Mediacaid_Expansion_2019.pdf*

Yin, R. K. (2018). Case study research and applications: *Design and methods* (6th ed.). Sage.

CHAPTER 3

The Impact of Global Health Partnerships on Biomedical and Technological Innovation in California



PAUL NGANGULA and CHRIS COLLINS

EXECUTIVE SUMMARY

On June 18, 2025, the United States Food and Drug Administration approved lenacapavir, a long-acting HIV prevention medicine developed at Gilead Sciences in Foster City, California. Within 12 months, it had been delivered to nine African countries, supplied by the company at no profit under a purchase arranged by the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) and the United States Department of State, and separate agreements had set an access price of about $40 per person per year for generic versions. No company, funder or procurement agency can measure what California industry gained from supplying it.

This chapter examines that gap. Global health funders have long asserted that the companies and universities supplying medicines, diagnostics and vaccines to low- and middle-income countries (LMICs) gain reduced development risk, guaranteed demand and faster regulatory approval in return. The America First Global Health Strategy makes the same assertion a matter of federal policy by naming "American health innovation" as one of its three pillars. To examine these assertions, we interviewed informants at 10 organizations and traced three California products through dated records: lenacapavir; the GeneXpert tuberculosis test developed by Cepheid in Sunnyvale; and semisynthetic artemisinin, a malaria drug ingredient invented at the University of California, Berkeley. While three cases cannot represent California's biomedical sector, the patterns reported here offer hypotheses to be tested across a wider set of products.

In all three cases, the evidence places the documented contribution of global health partnerships to California-based innovations at access rather than at discovery. In none of the three cases does a document show a partner shortening development or changing how clinical evidence was generated. The documented contribution is at the point of use: purchase, price reduction, royalty-free licensing and distribution in LMICs. Gilead licensed lenacapavir royalty free to six generic manufacturers eight

• KEY TAKEAWAYS •

- **California invents, and global health partnerships deliver.** A twice-yearly HIV prevention medicine developed in Foster City, California, reached nine African countries within a year of U.S. Food and Drug Administration (FDA) approval with purchasing support from the Global Fund to Fight AIDS, Tuberculosis and Malaria and the U.S. State Department. Separate agreements established a price of approximately $40 per person per year for future generic supply. A donor-financed price reduction and subsequent agreement with the Global Fund cut the cost of a tuberculosis diagnostic cartridge developed in Sunnyvale, California, by more than half, from $16.86 to $9.98 and then $7.97, on a platform now installed on nearly 50,000 instruments worldwide.
- **International purchasing commitments give California companies predictable demand at scale, allowing greater development, investment, manufacture and reach.** While profits come from markets in wealthy countries, international purchasing commitments from global health institutions let California innovators raise investment capital, reserve manufacturing capacity even before product approval and bring benefit across the world. International purchasing also holds input prices down and returns evidence from products in use, including drug resistance data, to companies' discovery work.
- **California funding could further increase the global health dividend for state residents and increase transparency and tracking.** The California Science and Health Research Bond Act (Senate Bill 895), signed into law in August 2026, could lead to a $7.5 billion state research fund contingent on voter approval that gives the state a share of successful discoveries. Funded companies could be required to report on volumes supplied through donor channels as well as prices and time from approval to delivery in low- and middle-income markets, making California the first jurisdiction to systematically quantify what global health spending returns both at home and abroad.

months before United States approval. A donor-financed buydown in 2012 cut the price of the GeneXpert tuberculosis cartridge from $16.86 to $9.98, and in 2023 the company agreed to supply the Ultra cartridge that replaced it at cost, for $7.97. The company reports an installed base of nearly 50,000 instruments.

What the organizations reported gaining was not profit but predictable demand at scale, which they described as creating a market that would not otherwise exist, allowing lower prices and making production planning and forecasting possible. Informants linked that demand to whether an investment was underwritten, manufacturing capacity was committed before approval and a candidate was taken forward, which suggests that institutional purchasing acts on these decisions rather than on how the science is done. One diagnostics company disagreed, describing the channel created by global health partnerships as receiving products it had already developed.

Informants described further benefits: continued purchasing sustains relationships with contract manufacturers that keep input prices down and funds the sales and support functions one company described as what allows its business to continue. Instruments placed through donor purchasing run any assay in the manufacturer's portfolio, and one informant said the installed base in the Democratic Republic of the Congo allows a faster Ebola response. Evidence from products in use, including drug resistance monitoring, returns into company discovery work and World Health Organization (WHO) prequalification opens national markets that would otherwise be entered one at a time. Reputation was the only benefit reported in all three cases. No informant described the donor channel as a source of profit; supply was described as at cost, in one case as a loss, or at a very thin margin, with profit located in high-income markets.

Artemisinin shows what happens when no institution commits to buying. A process invented at Berkeley was scaled in Emeryville and manufactured by Sanofi in Italy, and 51 million treatments reached African endemic countries by December 2015. Production then stopped and the plant was sold, because botanical artemisinin was cheaper and no purchaser had committed to buy it. The process succeeded technically and failed commercially. Royalty-free licensing and no-profit, no-loss manufacture meant that no margin was intended to reach California; what the Emeryville company retained was a validated fermentation platform, later redeployed into farnesene-derived products for cosmetics, flavors and fragrances.

Informants at all 10 organizations reported that no study, database or funder report measures what participation returns to a company, and our literature search found none. This study is the first systematic account, drawn from the organizations that supply these markets, of what they receive from global health partnerships and where in the product pathway each benefit acts. Measuring the size of those benefits requires three product-level figures: volume supplied through donor channels, the donor price alongside the high-income price and the interval from regulatory approval to first delivery in an LMIC. All three are already generated under existing supply contracts, and no one yet compiles them.

The institutional architecture of global health is now contracting faster than at any point since it was created. Development assistance for health fell to $39.1 billion in 2025, its lowest level in more than 15 years, with the United States responsible for more than $9 billion of the reduction. The Global Fund's eighth replenishment closed at $12.64 billion against an $18 billion target, a fifth below the seventh, and Gavi raised more than $9 billion against an $11.9 billion target. The Gates Foundation, the largest private funder in global health, pays out about $9 billion a year across all its programs and will close in 2045. Federal global health obligations for work performed in California fell 31.8% between 2024 and 2025, to $1.034 billion, but these fund research and public health capacity and exclude procurement by the Global Fund, Gavi and Unitaid. As purchasing falls, the first effect is an approved product that does not reach patients. Informants' accounts suggested that the effect on California companies would run through the demand signal itself, the predictable volume informants described as the condition for underwriting investment, planning production and holding input prices down.

No company, funder or procurement agency can measure what California industry gained from supplying it.

The cases yield six lessons, set out in Section 5.1. Aggregated demand, public reference pricing and quality assurance tied to WHO prequalification are the features of pooled procurement present where uptake was documented in these cases, and the cases suggest that their loss would reduce uptake under any mechanism that replaces or supplements the current ones. The artemisinin case shows that funding that solves a product's technical problems does not ensure that anyone will buy it: where a cheaper substitute already exists, that funding needs to be paired with a commitment to purchase. Companies could convert the sector's central claim from assertion into evidence by publishing the volume and price data they already report to procurers. California Senate Bill 895, passed on Aug. 31, 2026, and directed to the March 2028 ballot, would create a $7.5 billion state research fund with discount and recoupment provisions already attached; adding a requirement to report the three figures and to seek registration where disease burden is concentrated would make California the first jurisdiction to measure what its research investment returns rather than assert it.

Lenacapavir reached nine countries in 12 months through a purchase the Global Fund and the State Department had agreed to make. The next California product to reach that stage will meet a smaller Global Fund, a Gavi below its target and a United States procurement channel whose design has not yet been set out. Whether California's products continue to reach patients under those conditions, and whether the demand that underwrote their investment and production survives, can now be observed. The baseline needed to read it (volumes, prices and delivery intervals for 2023 through 2025) sits in procurement records and supply agreements that will not be retained indefinitely. Until those figures are collected, the benefit informants endorsed most often, predictable demand from donor purchasing, will remain unmeasured, and California is in a position to collect them.

1.
INTRODUCTION AND PROBLEM DEFINITION

With the country's largest population and the world's fourth-largest economy, California benefits significantly from American investments in research and programs designed to solve the world's most pressing and interconnected health challenges (Friends of the Global Fight Against AIDS, Tuberculosis and Malaria, 2025; Office of Governor Gavin Newsom, 2025; PPIC, 2026). California is home to wide-ranging expertise in program and product innovation, digital health, biomedical research, financing, policy and community responses, and has already played a significant role in improving the health of communities around the world (Kevany, 2015). In this context, this chapter examines how global health partnerships affect the speed, scale and/or rigor of biomedical and technological innovations developed in California.

For most medicines, diagnostics and vaccines used against HIV, tuberculosis and malaria in low- and middle-income countries, the purchaser is an institution that partners with the developer of the product, rather than a patient. The Global Fund, the United States President's Emergency Plan for AIDS Relief (PEPFAR), Gavi, the United Nations Children's Fund (UNICEF) supply division, the Stop TB Partnership's Global Drug Facility and Unitaid buy these products through pooled procurement, and the patient or the national health system rarely pays (KFF, 2025). Roughly half of Global Fund investments go to health products. In 2024 the Global Fund spent $2.5 billion on health products, $1.8 billion of it through its pooled procurement mechanism, the largest single channel for that spending. The value of orders placed through the mechanism fell by 43% in 2025, to $1.02 billion (The Global Fund, 2024a, 2024b). Global funding for research and development on neglected diseases was $4.17 billion in 2023, the most recent year for which the G-FINDER survey has published data, with HIV/AIDS, tuberculosis and malaria the three largest recipients, as they have been in every survey year since 2007 (The G-FINDER, 2024).

For most medicines, diagnostics and vaccines used against HIV, tuberculosis and malaria in low- and middle-income countries, the purchaser is an institution that partners with the developer of the product, rather than a patient.

Funders and product development partnerships attribute a return to the innovating firm that enters these arrangements. Four routes are asserted. Public financing absorbs the early and uncertain stages of development that private capital avoids, a pattern documented across technology sectors (Mazzucato, 2013). Advance purchase commitments convert an uncertain market into a defined one; the pneumococcal Advance Market Commitment pledged $1.5 billion so that manufacturers would enter a market its designers expected them to skip (Cernuschi et al., 2011). Partnerships transfer manufacturing capability, as when the Serum Institute of India described its meningococcal conjugate vaccine work with PATH as access to conjugation technology it had not previously held (Kulkarni et al., 2015). Public and multilateral partners provide regulatory and implementation support, including WHO prequalification and collaborative registration (WHO, n.d.). Each route is invoked to justify continued public financing (Yamey et al., 2017).

The problem this study addresses is that the return to the innovator has been asserted for two decades without being measured or traced. Evaluations describe the partnership as a delivery instrument: how many drug, vaccine and diagnostic candidates a product development partnership moved from preclinical research through clinical trials to regulatory approval, how market shaping lowers prices and how research financing reaches disease areas (The G-FINDER, 2024; Yamey et al., 2017). No peer-reviewed study measures the realized financial or commercial return to a named innovating firm attributable to partnership participation. The nearest work, published in February 2026, estimates the return on investment in the Medicines for Malaria Venture as a benefit-cost ratio of about 13, calculated from monetized deaths and disability-adjusted life years averted; its authors state that no earlier peer-reviewed publication had evaluated the return on investment generated by product development partnerships at all (Christen et al., 2026). That study measures the return to the public investor, not to the firm. The one empirical test of the innovation claim found against it: interviewing manufacturers with pneumococcal vaccines in development, the author found no evidence that the Advance Market Commitment had accelerated innovation, and emerging manufacturers described it as irrelevant to their decisions (Plahte, 2012). A 2024 report commissioned by the Medicines Patent Pool estimated that voluntary licensing could add between 2% and 17% to originator revenue in upper-middle-income countries, an illustrative range modeled from sector-wide sales data rather than a measured result for any firm (Medicines Patent Pool & Boston Consulting Group, 2024).

California concentrates the innovation that these partnerships draw on. Research organizations in the state received $6.26 billion across 9,486 awards from the National Institutes of Health and the National Science Foundation in 2025, more than any other state, according to the industry association Biocom California (Biocom California, 2026). Firms and universities in the state originated several of the products now moving through global health procurement. The United States dissolved the U.S. Agency for International Development (USAID) on July 1, 2025, and moved its remaining global health programs, including PEPFAR, into the Department of State (KFF, 2025). On Feb. 18, 2026, the Global Fund Board recorded a final eighth replenishment outcome of $12.64 billion against an $18 billion target, below the $15.7 billion raised at the seventh replenishment (The Global Fund, 2026b). Gavi secured more than $9 billion of an $11.9 billion target for 2026-2030 (International Finance Facility for Immunization, 2025). The United Kingdom is reducing official development assistance from 0.5% to 0.3% of gross national income by 2027 (Loft & Brien, 2026). Preliminary Organisation for Economic Co-operation and Development (OECD) data show that official development assistance from Development Assistance Committee members fell by 23.1% in 2025, the largest annual decline on record (OECD,

2026). As donor demand falls, the terms on which firms enter these partnerships, and what they receive for doing so, become a design question for funders and for the firms themselves.

This study aims to contextualize and understand how global health partnerships have accelerated the speed, scale, rigor and uptake of California-based biomedical and technological innovations. We treat a global health partnership as any funding, purchasing, licensing, regulatory, manufacturing or implementation relationship between a California-based innovator and a global health funder, procurer, product development partnership or technical agency. We assess speed as the timing of development, regulatory and market-entry milestones; scale as volume of production, supply and installed base; rigor as the design, conduct and quality of evidence generation; and uptake as adoption into guidelines, national registration, procurement and use. The analysis examines federal and donor purchasing power acting on California innovators. It does not evaluate returns to California state investment, does not estimate aggregate economic impact for the state and does not assume that acceleration occurred in any given case.

1.1 Literature Review

A structured literature search returned no evidence base for that description. A Web of Science search conducted on April 29, 2026, identified 179 records, none of which addressed the question. A supplementary Google Scholar search returned nine publications; none was California-specific, and none quantified benefit at the level of an individual company. We identified no database recording what a manufacturer receives from donor purchase of its product.

The reviewed publications yielded five findings: California has a large market for global health products, but global health institutions do not generate that market; the state has used policy instruments to incentivize innovation; life sciences were identified as an emerging industry cluster in California in 2007, with no more recent literature on those investments identified; a 1% increase in market size for a drug is associated with a 4% increase in the entry of nongeneric drugs, and reductions in revenue are associated with reductions in pharmaceutical research and development (Acemoglu & Linn, 2004); and advance market commitments can drive research and manufacturing (Cernuschi et al., 2011).

The largest body of evidence describes what partnerships deliver rather than what they return to the innovator. The G-FINDER survey has tracked neglected disease research funding annually since 2007 and reports funding flows by disease, product type and funder (The G-FINDER, 2024). A Duke University policy analysis catalogued U.S. government instruments for product development for global health and the mechanisms each is designed to activate (Yamey et al., 2017). Christen and colleagues estimated an internal rate of return of 52% and a benefit-cost ratio of 12.99 for $2.3 billion invested in the Medicines for Malaria Venture between 2000 and 2023, valuing 1.6 million deaths and 87 million disability-adjusted life years averted (Christen et al., 2026).

Galkina Cleary and colleagues found that National Institutes of Health (NIH) funding contributed to research associated with every one of the 210 new molecular entities approved by the United States Food and Drug Administration between 2010 and 2016, at more than $100 billion, over 90% of it basic research on drug targets (Galkina Cleary et al., 2018). The extension to 2019 found NIH contributions of more than $187 billion related to 354 of 356 approved drugs (Galkina Cleary et al., 2023).

California has a large market for global health products, but global health institutions do not generate that market.

Demand certainty through advance purchase has mixed evidence. Cernuschi and colleagues described the design of the pneumococcal Advance Market Commitment and the reasoning that guaranteed demand would draw manufacturers into the market (Cernuschi et al., 2011). Plahte's interviews with manufacturers found no evidence that the commitment motivated innovation (Plahte, 2012). A 2025 synthesis concluded that the commitment accelerated deployment of existing pneumococcal vaccines but had limited effect on research, and benefited firms that already held market-ready products and global manufacturing capacity (Nagar et al., 2025).

Transfer of manufacturing capability rests on case accounts. Kulkarni and colleagues at the Serum Institute of India described receiving the group A polysaccharide from SynCo Bio Partners and a conjugation method developed at the United States Food and Drug Administration, licensed to PATH and sublicensed to the Institute, and concluded that the project was a sound investment for the company (Kulkarni et al., 2015). Frasch and colleagues documented the same transfer from the technical side (Frasch et al., 2012).

Regulatory and implementation support is documented by case. WHO prequalification of semisynthetic artemisinin in May 2013 gave manufacturers a simplified route to regulatory acceptance in purchasing countries (PATH, 2013); WHO prequalified lenacapavir for HIV prevention in October 2025, three months after issuing a guideline recommending it, and Mozambique registered the product in January 2026 through the WHO collaborative registration procedure (Gilead Sciences, 2026; World Health Organization, 2025). The literature documents that prequalification and collaborative registration shorten the interval to national approval. It does not quantify the financial value of that interval to the firm.

We searched deliberately for any study measuring the realized financial or commercial return to a named innovating firm from global health partnership participation, using the terms product development partnership return on investment, firm-level returns, event studies of partnership announcements, voluntary licensing returns, advance market commitment innovation effects and analyses by the Access to Medicine Foundation. None was found. Event studies in pharmaceutical finance measure share-price reactions to public contract awards, trial results and news, and could in principle be applied to partnership entry, but have not been (Cho et al., 2024). The Access to Medicine Index ranks company access behavior and reports, for instance, that the number of companies with board-level accountability for access rose from 11 to 17 between 2018 and 2024; it does not measure re-

This study is the first scholarly examination of partnership-driven innovation for California, and we distinguish it from those economic impact estimates on that basis.

turns (Access to Medicine Foundation, 2024). The Medicines Patent Pool report projects an originator revenue range from voluntary licensing and calls for the benefit to be quantified (Medicines Patent Pool & Boston Consulting Group, 2024). The gap is therefore not one of missing methods. Standard firm-level methods exist and have not been applied to this question.

Evidence at the State Level. No peer-reviewed study has examined the effect of global health partnerships on innovation in any U.S. state. Four grey literature reports estimate economic activity associated with global health in California. The University of California Global Health Institute estimated in 2009 that the global health sector accounted for more than $75 billion in economic impact and about 350,000 jobs in the state (Nandi, 2009). The Global Health Technologies Coalition and Policy Cures Research published a state-by-state analysis of returns from United States global health research and development in 2024 (GHTC Impact Global Health, 2024). For California, the coalition estimates that U.S. government investment in global health research and development provided $3.9 billion to research institutions between 2007 and 2022 and generated more than 52,000 new jobs (Global Health Technologies Coalition, n.d.). Biocom California's annual economic impact reports aggregate federal award data for the state's life science sector (Biocom California, 2026). Each of these reports measures jobs, funding received or economic output. None examines the partnership as a mechanism acting on a product, and none asks what the firm received. This study is the first scholarly examination of partnership-driven innovation for California, and we distinguish it from those economic impact estimates on that basis.

2. METHODOLOGY

2.1 Study Design

In this multimethod qualitative study, we used a theory-informed explanatory multiple case study design. The study integrated semi-structured key informant interviews with systematic document analysis. Interview data were analyzed using a hybrid deductive-inductive approach. Selected innovation cases were examined using within-case process tracing to assess hypothesized mechanisms, timelines, alternative explanations and the strength of evidence for causal contribution. Cross-case analysis was used to compare mechanisms and outcomes across innovations. We report this study according to the Standards for Reporting Qualitative Research (SRQR) as the primary standard (O'Brien et al., 2014), and the interview component according to the 32-item Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong et al., 2007).

2.2 Conceptual Framework

We developed an analytical framework to examine the pathways through which global health partnerships may accelerate biomedical and technological innovation. The framework distinguishes five components: (1) partnership inputs, including research funding, technical assistance, clinical research collaboration, demand signals, procurement commitments, regulatory support, manufacturing support, licensing and implementation partnerships; (2) mechanisms, such as technical or financial de-risking, demand certainty, access to research populations and expertise, manufacturing learning and reduction of regulatory or implementation barriers; (3) intermediate changes in organizational, research, manufacturing or market decisions; (4) the four study outcomes (speed, scale, rigor and uptake); and (5) downstream benefits to California-based innovators or institutions, where supported by the evidence. The framework did not assume that acceleration occurred in every case. Contextual conditions, alternative explanations, unintended effects and evidence of no effect were examined alongside the hypothesized pathways. The framework was used to structure the codebook, document extraction, within-case analysis and cross-case comparison.

2.3 Study Scope and Definition of California-Based Innovation

The study focused on biomedical and technological innovations linked to global health partnerships and with a substantive connection to California. Eligible innovations included pharmaceuticals, vaccines, diagnostics, medical devices, platform technologies and other health technologies for which a material component of research, development, engineering, commercialization, manufacturing or organizational leadership occurred within California. For each innovation, the California connection was documented according to the relevant basis, including California-based discovery or academic research, company headquarters, research and development activities, manufacturing or product development leadership. A California connection based solely on product sales or use in the state was not considered sufficient for inclusion. The analysis examined the innovation pathway relevant to the global health partnership, from research and development through evidence generation, manufacturing, regulatory processes, procurement and implementation, as applicable to each case.

2.4 Case Definition and Unit of Analysis

The primary unit of analysis was the innovation-to-partnership pathway, defined as the development and adoption pathway of a California-based biomedical or technological innovation in relation to one or more global health partnerships. Cases were therefore defined by the innovation and the partnership activities relevant to its pathway, rather than by an individual informant, organization or funding mechanism. Within each case, analysis focused on stages of the innovation pathway relevant to the research question, including research and development, evidence generation, regulatory review, manufacturing and supply, licensing or technology transfer, procurement and implementation. Key informant interviews and documents were treated as

sources of evidence about these processes. Where a partnership affected only a specific stage of an innovation's pathway, causal contribution was assessed at that stage rather than attributed to the innovation as a whole.

2.5 Case Selection Criteria

Focal cases were selected purposively from candidate California-based innovations identified through interviews and document review. Before formal within-case analysis, candidate cases were assessed using prespecified criteria: a substantive California connection; an identifiable global health partnership; evidence relevant to at least two of the four study outcomes (speed, scale, rigor or uptake); sufficient timeline to reconstruct the innovation-to-partnership pathway; and availability of interview and document evidence to examine proposed mechanisms and alternative explanations. Final selection also sought variation in innovation type, stage of development, partnership mechanism and observed outcomes, including cases in which partnership effects were limited, mixed or absent. Evidence of direct commercial benefit to the California-based organization was not required for case inclusion.

2.6 Key Informant Sampling and Recruitment

Key informants were selected using purposive sampling based on their knowledge of California-based biomedical or technological innovation and global health partnerships. Eligible participants included senior leaders and individuals with direct or relevant organizational knowledge of product development, research financing, evidence generation, manufacturing, regulatory processes, procurement, market shaping, licensing or implementation. We sought perspectives from California-based companies and research institutions as well as global health funders, investors, nonprofit organizations and technical experts involved in enabling or evaluating these processes. Potential participants were identified through professional networks. Participants were contacted by email with information about the study and invited to participate voluntarily. Recruitment was guided by the relevance of participants' expertise to the research question and by the need to obtain evidence across different innovation stages, partnership mechanisms and stakeholder perspectives.

We completed 10 interviews, one per organization. Sample size was guided by information power rather than saturation. Information power emphasizes the depth and relevance of insights gathered over numerical thresholds (Malterud et al., 2016). Three features of the study favored a small sample: informants had direct knowledge of the decisions under study, the analysis was structured by an established framework (Section 2.2) and each focal case drew on documents as well as interviews (Section 2.8). The findings are reported as accounts from these 10 organizations rather than as representative of the sector. Eligibility was not limited to any region of California, and the geographic distribution of the products examined is reported in Section 3.3.1.

Before each interview, informed consent was obtained. Participants were informed that participation was voluntary, that they could decline to answer any question and that they could withdraw at any time before analysis. With permission, interviews were audio recorded and supplemented with notes. Identifying information was removed from transcripts and analytic files, and data were stored on password-protected devices.

2.7 Interview Guide and Data Collection

We used a semi-structured interview guide informed by the research question. The guide was adapted to each participant's expertise and organization while maintaining comparability across interviews. We conducted the interviews between July and August 2026. Following informed consent, we arranged the interview date and time with each key informant. Interviews were conducted in English by videoconference, and one respondent provided a written response when a synchronous interview was not feasible. Consent was confirmed again at the start of each interview. Interviews conducted via videoconference were audio recorded and transcribed.

2.8 Document Extraction and Analysis

We conducted a systematic document search for each focal case to reconstruct the innovation-to-partnership pathway and to triangulate key informant interview evidence. Documents included peer-reviewed articles, clinical trial records, company filings and investor materials, product development and licensing statements, procurement and allocation records, regulatory documents and relevant reports from global health organizations and implementing partners. Where available, quantitative indicators were extracted to support case timelines and assess changes in timing, scale, evidence generation, manufacturing and uptake. These indicators included dates of key milestones, trial activity, procurement volumes, manufacturing or supply commitments, installed base, country introductions and other case-specific measures. Documents were organized in a structured data extraction table and linked to the relevant case, partnership input, mechanism and outcome domain.

2.9 Data Preparation

Each interview transcript was assigned a study code (CAP-001 to CAP-010), and identifying information was removed before thematic coding. Where interviews involved more than one participant, the exchange was retained as a single record. Written responses were retained as a separate data source and analyzed alongside the interview transcripts. The document collection was organized by case and linked to the relevant partnership input, mechanism and outcome domain.

2.10 Thematic Analysis

Interview data were analyzed using a deductive-inductive codebook thematic analysis approach. An initial codebook was developed from the research question, the analytical framework, the interview guides and preliminary document review. Deductive codes captured partnership inputs, mechanisms,

Interview data were analyzed using a deductive–inductive codebook thematic analysis approach.

For each focal case, we constructed a timeline linking the innovation, relevant global health partnership activities, intermediate decisions or changes and observed outcomes.

contextual conditions, competing explanations and the four study outcomes: speed, scale, rigor and uptake. Inductive codes were added for concepts and case-specific issues not fully represented in the initial codebook.

Interviews were conducted by researcher (Chris Collins), who was part of the project team and familiar with the study objectives. Analysis was conducted independently by researcher (Paul Ngangula), also a member of the project team; Ngangula was part of the final two interviews. Both researchers read each transcript independently, recorded initial impressions and developed preliminary themes. The transcripts were coded using codebook thematic analysis, with key words and phrases drawn directly from the text. The two researchers then compared codes and themes, resolved differences and refined interpretation in team meetings before finalizing the analysis. An iterative process of deductive and inductive coding was used throughout. Analytic memos were used to summarize coded evidence, note contradictions and document links between interview statements and document sources. Case-level and cross-case interpretation were conducted only after the coding structure had been stabilized.

Intercoder agreement was not calculated. Codes were agreed by consensus, consistent with codebook approaches in which comparison between coders is used to refine code definitions rather than to produce an agreement coefficient (Braun & Clarke, 2021). Where the two researchers coded a passage differently, they returned to the transcript and agreed on a single code, revising the definition where the disagreement showed it to be unclear. Revisions were recorded in successive versions of the codebook, and coded excerpts for each theme are reported in Section 3.1.

2.11 Within-Case Process Tracing

For each focal case, we constructed a timeline linking the innovation, relevant global health partnership activities, intermediate decisions or changes and observed outcomes. Process tracing was used to assess whether proposed mechanisms, such as demand certainty, technical or financial de-risking, evidence generation, manufacturing learning, regulatory facilitation or implementation support, preceded and plausibly contributed to changes in speed, scale, rigor or uptake. The analysis compared interview accounts with document evidence, examined alternative explanations and assessed the plausibility of the counterfactual pathway without the partnership. Evidence was assembled at the level of specific case milestones, and causal claims were limited to pathways supported by convergent source evidence.

2.12 Cross-Case Synthesis

We compared cases using the analytic framework to identify recurring mechanisms, differences across innovation types and conditions under which global health partnerships were associated with acceleration in speed, scale, rigor or uptake. Cross-case synthesis drew on framework matrices, case timelines and interpretations recorded in analytic memos to compare evidence across innovations and stakeholder groups. We examined whether the same partnership input operated through similar or different mechanisms across cases, and whether case variation was explained by stage of development, product type, market context or the strength of the partnership signal.

2.13 Triangulation

We triangulated interview data with documents and, where available, quantitative indicators to compare accounts, verify timelines and assess the consistency of evidence across sources. Triangulation was used to determine whether a proposed mechanism was supported by multiple independent sources and whether interview claims were consistent with existing records. Interview, document and quantitative evidence were integrated at the case level before cross-case comparison. This approach supported credibility, dependability and confirmability of the analysis.

Throughout the chapter, "reported" and "described" denote informant accounts, and "documented" denotes claims corroborated by an independent source; an informant's account of why a decision was taken is reported as that informant's account, not as evidence that the decision would not otherwise have occurred.

2.14 Researcher Characteristics and Reflexivity

Both authors work with Friends of the Global Fight Against AIDS, Tuberculosis and Malaria (Friends U.S.), a nonprofit organization that advocates for U.S. support of the Global Fund. Friends U.S. is a partner in the California Global Health Leadership Initiative, which starts from the premise that investment in global health drives industrial innovation in California. We began the study with the view, informed by the policy and economic impact literature, that global health partnerships benefit California, and set out to identify those benefits and how they arise. To keep that view from shaping the analysis, the conceptual framework did not assume that acceleration occurred.

3. KEY FINDINGS

We conducted 10 key informant interviews, one per organization (CAP-001 to CAP-010). Five informants were employed by private sector companies, four by research or nonprofit organizations and one by an investment organization. The 10 interviews involved 13 participants; three interviews (CAP-003, CAP-006 and CAP-010) included two participants each. Five participants worked in research and development, four in company research functions and one as an academic researcher; three held commercial, market or global access roles in companies; two were investment staff; two led university or nonprofit innovation programs; and one held an organizational and policy role in a product development partnership.

Table 1 shows the characteristics of the participating organizations. Two were pharmaceutical manufacturers and two were molecular diagnostics manufacturers; the remaining six each represented a distinct organizational form, comprising a biotechnology company, a university research laboratory, a university health technology design program, a nonprofit medical technology innovation center, a product development partnership and a nonprofit health investment fund.

TABLE 1 : Characteristics of Participating Organizations (n = 10)

CHARACTERISTIC	n
SECTOR	
Private sector (company)	5
Research and nonprofit	4
Investment	1
ORGANIZATION TYPE	
Pharmaceutical manufacturer	2
Molecular diagnostics manufacturer	2
Biotechnology company	1
University research laboratory	1
University health technology design program	1
Nonprofit medical technology innovation center	1
Product development partnership	1
Nonprofit health investment fund	1

3.1 Phase I: Thematic Analysis

Ten themes were developed from the 10 interview records: (1) public research funding in product development; (2) the form of the demand signal and its effect on manufacturing; (3) predictable demand as the principal reported benefit; (4) whether the market shapes research decisions; (5) de-risking, and which risk is transferred at which stage; (6) the four study outcomes; (7) profit and margin in the global health channel; (8) benefits other than profit; (9) conditions under which expected benefits did not appear; and (10) California-located activity and expertise. Table 2 shows the summary of the thematic analysis.

3.1.1 Theme 1: Public research funding in product development Most company informants reported no public research funding for the products discussed. Two described products financed entirely by the company. One reported a single pandemic preparedness grant that had been terminated early, and one reported no funding from NIH in the past decade. A diagnostics informant recalled NIH and Small Business Innovation Research support in the company's earliest years. In the artemisinin case, all external funding was reported to have come from a private foundation rather than from a government funder.

"No. This was purely funded by [the company] privately"
(**CAP-009**, company)

"we did receive some NIH grants in the very earliest days"
(**CAP-007**, company)

Two informants described a different relationship to public money, in which publicly funded academic science is an input the organization draws on but does not receive.

"we rely on the fundamental science that comes out of NIH to reveal drug targets, underlying biological basis of disease, et cetera, from which we can launch credible drug discovery projects"
(**CAP-010**, company)

3.1.2 Theme 2: Form of the demand signal, and its effect on manufacturing No informant described an advance market commitment or a binding purchase agreement covering their own product at the time investment decisions were made. What informants described in place of such an instrument varied. One company proceeded on a verbal agreement with two donors and committed contract manufacturing capacity 18 months or more before regulatory approval.

"It was a verbal commitment... And based on that alone moved forward so that we would be in the position of having supply in 2026"
(**CAP-006**, company)

Another described receiving a three-year budget signal from a procurer and then working with individual countries on what they would buy.

"...The Global Fund ends up procuring or essentially allocating a budget. And then what we do is we work with all the individual countries who are getting a parcel out of that budget"
(**CAP-007**, company)

A nonprofit representative described continuous conversations with funders and procurers from the start of development, alongside consultation with ministries of health on country appetite.

"These are things that we're actively having conversations in from day one.... We've also been in places where we're developing something and there's not a market. And then, you know, I think there's a real question of it doesn't make sense to develop this or where a country might say this is not the thing that we need the most.... Having conversations with ministries of health and things like that to make sure that there's going to be a country appetite for the things that we're working on too."
(**CAP-005**, research/nonprofit organization)

A diagnostics informant described reading demand through closeness to clinicians, policymakers and guideline bodies. A company at research stage described proceeding on the basis of its own prior partnership experience in another disease, in the absence of any current commitment.

" ...Leveraging our malaria experience, which we've had now for over two decades, and we have been able to work with global partners to deliver almost a billion and a half doses ... of artemisinin-based combination therapy, sort of based on a lot of the structures that we've learned through the malaria experience... that has given us some level of confidence that if we're able to deliver a safe and effective medicine in another area of great unmet need, that we're going to be able to put together similar types of effective partnerships that'll help to ensure access. It is a little bit of a leap of faith because it's a little too early to be able to have real discussions with global partners"
(**CAP-010**, company)

3.1.3 Theme 3: Predictable demand as the principal reported benefit Predictable large-scale demand was the benefit informants endorsed most often. An investor said that without a donor advance purchase agreement, a late-stage investment would have been very difficult to underwrite.

"Without having the advanced purchase agreement from Gavi in place, it would have been very difficult for us to underwrite to this investment"
(**CAP-003**, investment organization)

A nonprofit representative said that without the promise of procurement there would be no market for the diseases the organization works on.

"Without the promise of Gavi procuring that vaccine, there would just be no market... And so, Global Funds and Gavis of the world are just critical. I think... without them, I think that the innovation space would be extremely limited for the diseases that we work on."
(**CAP-005**, research/nonprofit organization)

Two companies linked predictability directly to production planning and to the price they could offer. One company supplying on a no-profit, no-loss basis described forecasting as the protection against substantial loss, and recalled an early mismatch between production and need that required rapid scale-up and plant construction.

"We operate on a no profit, no loss basis. But the loss can be substantial if there is a huge mismatch between the demand and... the actual supply"
(CAP-010, company)

3.1.4 Theme 4: Whether the market shapes research decisions Informants differed on whether donor demand reaches research decisions, and the difference tracked position in the value chain. One diagnostics company described market existence and unmet clinical need as central to its go/no-go decision and as determining the level of research effort applied.

"First and foremost is that there is a market for such a product... that's very crucial to our decision making. And yeah, I think depending on all of those, really drives the effort that is required into the research"
(**CAP-009**, company)

A pharmaceutical research unit named scope of impact, meaning a plausible path to delivery, as one of three criteria guiding what it works on.

"It makes it very tricky for us to prioritize disease areas where we can't be assured that there's going to be a reasonable, a plausible path to a strong scope of impact"
(**CAP-010**, company)

A second diagnostics company took the contrary position, describing the channel as receiving products already developed.

"It's not really a driver of innovation because we're usually putting products out that we've either already manufactured or we've already developed"
(**CAP-007**, company)

3.1.5 Theme 5: De-risking: which risk, at which stage and for whom Accounts of de-risking varied by organization and by position in the value chain. A nonprofit developer described de-risking as the central function of procurement promises and named the risk as financial.

"Companies need an incentive to jump in on this. Otherwise, they're just losing money. And so the promise of procurement... the de-risking is everything"
(**CAP-005**, research/nonprofit organization)

In the artemisinin case, de-risking was reported as technical, and demand risk as explicitly not addressed (CAP-004, research/nonprofit organization). An investor described de-risking as stage-specific, with a product de-risked technically while still lacking a credible end market.

"De-risking one part doesn't necessarily mean de-risking across the value chain"
(**CAP-003**, investment organization)

Three accounts ran against the theme. One diagnostics company stated that its arrangement was not a de-risking arrangement. An adjuvant supplier said that involvement could add risk rather than remove it. A pharmaceutical informant described risk as shared between partners rather than reduced.

"It could introduce other risks, actually"
(**CAP-008**, company)

3.1.6 Theme 6: The four study outcomes Accounts of speed, scale, rigor and uptake were unevenly distributed across the 10 interviews and were informant-reported throughout. No account was accompanied by documentation, and no outcome account distinguished the portion attributable to activity located in California.

Speed: Speed appears in two interview records. One company reported executing technology transfer and voluntary licensing agreements, and accelerated regulatory filings, faster than it had done previously. Both were stated as internal comparisons without a named benchmark.

"Faster than we had done for any other product, and that had ever been done"
(**CAP-006**, company)

A second described a six-week outbreak assay against a two-year standard route, and attributed the difference to outbreak procedures and to the regulatory pathway rather than to a purchaser. One further company reported no link between procurement and registration, naming prequalification as the operative mechanism.

Scale: Scale appears in six interview records and carries the largest reported figures: cumulative patient reach for a combination therapy purchased almost entirely through donor channels, an installed base of more than 50,000 diagnostic instruments, production sized in metric tons to procurement forecasts, a volume purchase described as unprecedented for its kind and manufacturing capacity described as the binding constraint on a vaccine's reach.

"We have a very large installed base of over 50,000 [cartridge-based diagnostic] instruments"
(**CAP-007**, company)

Rigor: Rigor appears in four interview records. In each, informants described evidence generated alongside or after delivery rather than a partner altering trial design, sample size, endpoints or study population: post-approval implementation studies led by other organizations; studies arranged by the company itself in high-prevalence settings; real-world resistance data returning into discovery; and advisory involvement in research funded by partners.

"Most of our clinical studies and collaborations were done with country specific key opinion leaders and centers of excellence, wherever you have a high prevalence of that disease"
(**CAP-009**, company)

One interview record states that the outcome is inapplicable by design, because a chemically identical input entered approved products through an equivalence pathway requiring no new efficacy evidence.

Uptake: Uptake appears in five interview records and is nowhere quantified. Informants described donor channels as the route through which almost all volume reached patients, and budget allocation as being converted into country orders. They named guidelines and reimbursement as preconditions for adoption. One informant described adoption and price change across an entire product category, including competitors' products. Two interview records describe uptake that did not occur despite demand expressed at policy level.

"The cost, the pricing issue went down, the adoption went up, and they basically changed the way global health communities actually look at and implement phototherapy technologies"
(**CAP-001**, research/nonprofit organization)

3.1.7 Theme 7: Profit and margin in the global health channel No informant described the global health channel as a source of commercial profit. One company described supply to two donors as at cost and in practice a loss, with profit located in the domestic market.

"It's at cost. And to be honest, it's really a loss"
(**CAP-006**, company)

"The profit margin on those products is very, very thin. We don't sell at a loss"
(**CAP-007**, company)

In the artemisinin case, royalty-free licensing and a no-profit, no-loss manufacturing commitment removed margin before commercialization. One diagnostics informant described margin as present at launch and reduced over time through the company's own price reductions.

"Our profits have decreased over the years in areas where the U.S. government and other governments are funding"
(**CAP-009**, company)

One company described a no-profit, no-loss policy alongside a stated preference for a small margin to support reinvestment and to sustain the work internally.

"We're not seeking to maximize profit in that circumstance, but we would be seeking to have some element of profit"
(**CAP-010**, company)

3.1.8 Theme 8: Benefits other than profit Asked what the organization gains, informants named reputational benefit most consistently. One company described internal pride and external standing as a leader on access, and noted the difficulty of quantifying it. Another described donor purchasing as sustaining manufacturer relationships, input prices, sales and support functions and the business itself.

"Having that continued purchasing of those inventory instruments allows us to continue as an ongoing business"
(**CAP-007**, company)

The same informant described the company's installed instrument base in one country as enabling faster response to an unrelated outbreak.

"Because there's a very significant installed base in the Congo, that is going to allow... much faster response"
(**CAP-007**, company)

A pharmaceutical informant described real-world evidence from products in use, including resistance monitoring feeding back into discovery. A biotechnology informant named working relationships with federal agencies, and corporate social responsibility, as the value obtained.

"Developing working relationships with NIH and CDC... I think those can come along with all that as well"
(CAP-008, company)

3.1.9 Theme 9: Conditions under which expected benefits did not appear Informants described several arrangements that did not produce the anticipated benefit. In the artemisinin case, forecast demand did not materialize: botanical supply met global need at low prices and the semisynthetic product met market resistance. An academic informant described a low-cost ventilator for which no U.S. purchaser could be found, and a nonprofit device developer that subsequently closed.

"There was no market for that in the U.S. Nobody was willing to support it. They said, why do we need a lower cost?"
(**CAP-001**, research/nonprofit organization)

One company described the oversight burden of a public grant, terminated early, as the reason it does not expect to seek such funding again.

"It's very unlikely, unless we are called specifically to do that, that we would... seek such funding, because the complexity of managing those agreement... requires a lot of additional oversight"
(**CAP-010**, company)

An adjuvant supplier described a discussion with an international vaccine organization that did not proceed because the counterpart had no funds and was seeking investment from the company. A nonprofit center described a three-year foundation grant that ended, leaving the program suspended.

"Part of it was because they didn't have any money. And they were really looking for us to make an investment"
(**CAP-00**8, company)

3.1.10 Theme 10: California-located activity and expertise

Two companies located substantial activity in California. One reported that all research for five assays, and a current complete redesign of one assay, was conducted in the state, and that the redesigned product will enter U.S. government-funded programs.

"All of that has been done in California. And that new assay will go into U.S. government-funded programs for sure"
(**CAP-009**, company)

Another reported that most of its research effort is in California and that compounds now in late-stage development were discovered there.

"The seminal discovery of some of the compound that we're working on right now actually happened in California"
(**CAP-010**, company)

A nonprofit developer located its California connection in individual expertise rather than in facilities. An innovation center informant described the state's advantage as the presence of every component of the innovation system in one place, while questioning whether firms operating across several states can be attributed to a single state. Employment effects were asserted but not quantified by any informant.

"They're frequently missing some of the parts. We have all the parts here.... This is why this deserves extra resources, because there's already a well-established infrastructure of innovation and we just need to keep fueling this fire and making resources available... For global value"
(**CAP-002**, research/nonprofit organization)

"I think there are few companies which are really truly state, singular state"
(**CAP-002**, research/nonprofit organization)

3.2 Phase II: Document Search and Analysis

Documents were searched for each focal case on Sept. 5-6, 2026, in specified regulatory, trial registry, funder, procurement and financial repositories and in the peer-reviewed literature. Each document was classified as independent, semi-independent or company authored, and no company document was accepted as corroboration of a claim made by that company. All three cases met the minimum of three documents representing at least two types of documentary evidence (e.g. regulatory record, clinical trial registry, procurement report). Documents corroborated the licensing, regulatory, procurement and country introduction milestones in each case, and dated them independently of the interview record.

TABLE 2 : Summary of Thematic Analysis

THEME	SUBTHEMES
1. Public research funding in product development	No public funding for the product; historical or small-scale public support; philanthropic funding in its place; reliance on publicly funded academic science not received by the organization
2. Form of the demand signal, and its effect on manufacturing	Verbal commitment in place of a contract; donor budget allocated then converted country by country; forecasts and policy recommendations with no commitment to buy; continuous engagement from early development; demand read through clinicians and guideline bodies; prior experience as the basis for proceeding; forecasting for contract manufacturing; at-risk capacity decisions
3. Predictable demand as the principal reported benefit	Demand predictability enabling production planning; a market that would not otherwise exist; volume tied to price; forecasting as protection against loss under at-cost supply
4. Whether the market shapes research decisions	Market existence and unmet need as a go/no-go criterion; delivery path as a prioritization criterion; partnership acting after development; long development preceding any purchaser
5. De-risking: which risk, at which stage and for whom	Financial risk removed for private partners; technical de-risking without demand de-risking; de-risking confined to one stage; risk shared rather than removed; de-risking denied; risk added
6. The four study outcomes	Speed (2 of 10 interview records); scale (6 of 10); rigor (4 of 10); uptake (5 of 10); all informant-reported, none accompanied by documentation.
7. Profit and margin in the global health channel	Supply at cost or at a loss; thin margin; profit foreclosed by licensing or company policy; margin reduced over time; small margin sought for sustainability; profit located in the high-income market
8. Benefits other than profit	Reputation and staff pride; blame avoided; installed equipment available for outbreak response; continuity of supplier relationships and support functions; capability retained from working at speed and scale; evidence from use returning to research; relationships with federal agencies; reduced transaction costs
9. Conditions under which expected benefits did not appear	Demand undercut by competing supply; no high-income market for a lower cost design; grant terminated; administrative burden deterring future participation; partner without funds; organization closed
10. California-located activity and expertise	Research and development located in the state; current work destined for federally funded programs; expertise rather than facilities; regional ecosystem completeness; state-level attribution questioned; employment asserted but not counted

3.3 Phase III: Within-Case Analysis

3.3.1 Case selection Data from the 10 interview transcripts yielded 17 candidate innovation-to-partnership pathways. Eleven were excluded before criterion assessment: three had no California connection, one appeared only as a third-party comparison, three were pre-product or had no identifiable purchaser and four were leads or category-level accounts with evidence insufficient to assess. Six pathways were screened against five prespecified criteria: a substantive California connection, an identifiable partnership with a named counterparty and input type, evidence bearing on at least two of the four study outcomes, a milestone sequence sufficient to establish temporal ordering from partnership input through to outcome and evidence sufficient to examine the proposed mechanism together with at least one competing explanation. The three selected pathways vary by innovation type, by origin, by partnership mechanism and by outcome direction. Evidence of commercial benefit to the California organization was not required for selection.

All three focal products were developed in the San Francisco Bay Area: lenacapavir in Foster City, GeneXpert in Sunnyvale and semisynthetic artemisinin in Berkeley and Emeryville. Three accounts from San Diego were identified in the interviews but did not meet the study's definition of an innovation-to-partnership pathway (Appendix A). The findings therefore describe Bay Area products and may not reflect innovation elsewhere in the state.

3.3.2 Case 1: Lenacapavir (Gilead Sciences, Foster City)

Pathway

Lenacapavir is a long-acting HIV-1 capsid inhibitor developed at Gilead Sciences in Foster City, which is the California basis for the case. The pathway includes procurement of innovator-supplied lenacapavir by the Global Fund and the U.S. State Department through PEPFAR bridging access until generic supply through six royalty-free voluntary licensees is available at scale. Additional partnerships with two of Gilead's licensed generic manufacturers were supported by Unitaid, the Clinton Health Access Initiative and Wits RHI with Dr. Reddy's Laboratories, and the Gates Foundation and Hetero.

Partnership inputs

A demand signal was created in December 2024, when the U.S. State Department through PEPFAR and the Global Fund announced a plan to supply lenacapavir for two million people over three years. A procurement commitment with the Global Fund was announced on July 9, 2025, when a supply agreement for up to two million people at no profit was announced, and again in September 2025, when the U.S. State Department reaffirmed its commitment to joining the partnership. Voluntary licensing agreements were announced on Oct. 2, 2024, when royalty-free voluntary licenses covering 120 countries were executed with six generic manufacturers. The U.S. State Department and the Global Fund announced an expansion of their commitment to reach three million people with lenacapavir over three years on April 14, 2026.

Research funding as an input is absent. Informants reported nearly 20 years of work on the molecule within the company, an early university collaboration whose public funding they could not characterize and NIH-affiliated involvement beginning only after phase III and concerning community advisory boards rather than the therapy. No document establishing public research funding to the company for this compound was located. Technical assistance, manufacturing support and regulatory support are unevidenced in both the interview record and the documents.

Technical assistance, manufacturing support and regulatory support are unevidenced in both the interview record and the documents.

Mechanisms

Informants were read a list of possible benefits based on research evidence. They endorsed predictable large-scale demand as very important, endorsed evidence generation, endorsed lower unit cost on the basis that manufacturing price is tied to volume, qualified their endorsement of regulatory acceleration, and declined both profit and expanded commercial opportunities. De-risking was attributed to a verbal commitment from the purchasers.

Whether the purchaser committed before the company committed manufacturing capacity cannot be settled. The company reserved contract manufacturing capacity for primarily low and middle-income country supply at some point in 2024, with almost no indication of volume. The earliest independently dated purchaser commitment is December 2024. Because the manufacturing decision is dated only to a year, the two cannot be placed in order, and no document dating that decision was located. What is documented is that a purchaser commitment preceded both binding agreements by seven and nine months.

Intermediate changes

Four changes are reported, of which one is independently datable. The company reserved manufacturing capacity at risk in 2024 without a volume figure, and no document addressing this was located. Voluntary licenses were executed on Oct. 2, 2024, eight months before U.S. FDA approval on June 18, 2025. The company states that technology transfer to the six licensees was completed by December 2024, within three months of signing. Demand was consolidated into a single purchaser agreement in place of separate country contracts, and no document addressing this was located.

Outcomes

Speed. Informants reported that timelines were accelerated once demand from the two purchasers was anticipated, that technology transfers were signed faster than for any previous company product and that regulatory filings were pursued faster than previously. These are internal comparisons stated without a named benchmark. No document establishing the company's prior intervals was located, and the comparative claims are uncorroborated.

The regulatory sequence itself is dated: breakthrough therapy designation in October 2024, priority review acceptance on Feb. 18, 2025, U.S. approval on June 18, 2025, a positive European opinion on July 24, 2025, with a parallel opinion under the pathway for medicines intended for use outside the European Union, European Commission authorization on Aug. 26, 2025, and WHO prequalification in October 2025. The sequence documents the timing without attributing it to the partnership.

Scale. The purchase volume is documented at up to three million people over three years. An access price of approximately $40 per person per year for generic versions of lenacapavir is documented in agreements dated Sept. 24, 2025, involving Unitaid, the Clinton Health Access Initiative, Wits RHI and Dr. Reddy's Laboratories, and the Gates Foundation and Hetero. The corresponding high-income commercial price was not retrieved, so the ratio between the two prices cannot be stated. No procurement source recorded any volume supplied commercially in LMICs outside the donor channel.

Rigor. Informants agreed that the partnership contributed to evidence generation. The trial record documents where evidence was generated and not why. PURPOSE 1 ran at 28 sites in South Africa and Uganda, with 5,338 participants in the primary analysis, 84.3% of them in South Africa, and zero infections among 2,134 participants in the lenacapavir arm against background incidence of 2.41 per 100 person-years. PURPOSE 2 spanned Argentina, Brazil, Mexico, Peru, South Africa, Thailand and the United States. No document was located showing that a partner funded these sites, altered the trial design, changed the endpoints or influenced the populations enrolled.

Uptake. Country introduction is documented; however, informants did not speak to it. WHO guideline recommendation is dated July 14, 2025, South African approval October 2025 and approvals in Zambia, Zimbabwe, Malawi and Botswana in November and December 2025, with an import waiver recorded for Eswatini. Neither informant characterized country adoption.

Alternative explanations

The high-income commercial trajectory as the driver of development and timing: Informants reported that a strong paying domestic market exists and that developing the product made business sense on that basis alone. The company's existing prevention franchise recorded sales of $2.1 billion in 2024, up 6%. Breakthrough therapy designation and priority review account for U.S. approval timing without reference to any purchaser.

The partnerships bearing on the pathway are a development agreement with the Foundation for Innovative New Diagnostics, procurement through the Global Fund and two donor-financed price reductions.

Reputational exposure following an earlier long-acting product from another manufacturer: Informants described benefit from entering the market second, learning from the earlier product's difficulties and an expectation of blame had the company not proceeded. No document addressing this was located.

3.3.3 Case 2: GeneXpert and Xpert MTB/RIF Ultra (Cepheid, Sunnyvale)

Pathway

GeneXpert is a cartridge-based polymerase chain reaction platform developed by Cepheid in Sunnyvale. The Xpert MTB/RIF Ultra cartridge detects tuberculosis and rifampicin resistance. The partnerships bearing on the pathway are a development agreement with the Foundation for Innovative New Diagnostics, procurement through the Global Fund and a donor-financed price reduction involving Unitaid, USAID, PEPFAR, the Gates Foundation and the Stop TB Partnership.

Partnership inputs

This is the only case in the study where research funding is evidenced as a direct input. The informant reported a long history of partnering with federal agencies, NIH grants in the company's earliest days, and believed that the tuberculosis test was in part funded by government grants and awards. The development agreement with the Foundation for Innovative New Diagnostics, supported by the Gates Foundation and the National Institute of Allergy and Infectious Diseases, is dated 2006.

The informant described the Global Fund setting an overall budget on a three-year cycle and allocating to countries, after which the company works with individual countries on what they will buy. No binding purchase agreement and no advance market commitment covering this product was reported or located.

A donor-financed buy-down agreed in August 2012, under which Unitaid, USAID, PEPFAR and the Gates Foundation paid the company $11.1 million, set a ceiling cartridge price of $9.98, reduced from $16.86. On Sept. 19, 2023, the Global Fund, the Stop TB Partnership and USAID announced a further reduction negotiated with Cepheid and its parent company Danaher, taking the Ultra cartridge from $9.98 to $7.97 with pricing effective from Sept. 18, 2023.

Mechanisms

The informant highlighted the global health purchasing relationship from the buy-down, stating that "it's not really a driver of innovation" because the company is usually putting out products it has already developed, and that "it's not really de-risking future product innovation."

The retrieved document records show that public and philanthropic money reached the platform at the development stage from 1992 onward, and that the development agreement for the tuberculosis test preceded the first buy-down by six years. On the informant's account, the purchasing channel reaches an already developed product.

The informant mentioned that continued purchase provides scale economies, which was linked directly to holding prices down. The informant added that continued purchasing funds sales and customer support as well as sustaining an installed base of over 50,000 instruments, and described it as what allows the business to continue.

The informant described reputational benefit as something the company believes in strongly and commits time and resources to, and lower unit cost, conditionally, on the basis that large volumes can reduce unit costs in some cases.

Intermediate changes

The informant reported that manufacturing capacity is planned against aggregated demand signals and that this affects manufacturing planning. No document dating a manufacturing decision to a demand signal was located.

Outcomes

Scale. The installed base is the case's principal scale finding. The informant put it at over 50,000 instruments. The company disclosed a figure of nearly 50,000 systems, and no more recent figure was located. Donor-financed instrument placement leaves capacity in place for later outbreaks, because any assay in the company's portfolio runs on any instrument. The instance given was the Ebola response in the Democratic Republic of the Congo, where an existing installed base permits faster response than shipping instruments would.

Uptake. Uptake is documented and the informant did not characterize it. The WHO endorsed the tuberculosis test in December 2010, and it is now the recommended initial test for tuberculosis. Xpert Ultra was released and endorsed in 2017, and in 2024 became the first tuberculosis test to reach WHO prequalification.

Speed and rigor. Neither outcome is evidenced. The informant stated that the products supplied through this channel are already developed, and no document showing a partnership effect on development or regulatory timing was located.

Profit margin. The informant described the profit margin on these products as very thin, stated that the company does not sell at a loss and attributed participation to the company's public health mission. The 2023 price of $7.97 was announced as a no-profit price. The 2006 development agreement was reported on a cost of goods plus 20% basis.

Alternative explanations

Pandemic and biodefense procurement as the driver of manufacturing scale: In the first quarter of 2021 the company shipped 10 million cartridges, half of them for COVID-19 alone, with core revenue growth above 90% year on year. The parent company guided to shipping 45 million COVID-19 tests in 2021 and to approximately $2 billion in COVID-19 testing revenue, against total company revenue of $2.88 billion that year. Competitor entry as the explanation for the 2023 price reduction: Truenat, a competing molecular tuberculosis platform, was recommended by the WHO in 2020, three years before the reduction to $7.97.

3.3.4 Case 3: Semisynthetic artemisinin (UC Berkeley and Amyris, Emeryville)

Pathway

Artemisinin is the active component of the artemisinin-based combination therapies recommended by the WHO as first-line malaria treatment, and it is extracted from Artemisia annua. A synthetic biology route to artemisinic acid was developed in a University of California, Berkeley laboratory, the fermentation process was scaled by Amyris in Emeryville and industrial manufacture was carried out by Sanofi in Italy. Discovery and process development are the California basis for the case. The partnership consisted of philanthropic financing from the Gates Foundation, routed through the Institute for OneWorld Health and later PATH, with Sanofi as manufacturing partner.

Partnership inputs

Research and commercialization funding is the only input evidenced, and it is philanthropic rather than public. The interview records state that no NIH or other government research funder supported the project and that all external funding came from the Gates Foundation, approximately $53.3 million across two grants, $42.6 million in 2004 for the research and $10.7 million in 2009 for commercialization.

Research and commercialization funding is the only input evidenced, and it is philanthropic rather than public.

The record states that there was no binding purchase agreement and no advance market commitment for semisynthetic artemisinin. Informants instead described a WHO policy recommendation that created category demand, procurement forecasts used to size capacity and the philanthropic grant that supplied the capital an advance market commitment would otherwise have supplied.

Mechanisms

De-risking is described as primarily technical, and secondarily reputational, rather than demand, market entry or financing risk. Philanthropic capital and a committed manufacturing partner removed the uncertainty of moving from bench-scale titers to viable industrial production. On demand, the interview record states that "demand risk was explicitly not addressed," and that de-risking supply through philanthropy, "without a binding commitment on demand, leaves market entry risk fully in place."

Intermediate changes

Anticipated demand and a fixed price parity target drove process intensification toward botanical parity cost at industrial scale. Engineered yeast reached over 40 g/L amorphadiene and approximately 25 g/L artemisinic acid, a titer documented in the 2013 Nature process paper. Sanofi industrialized the process between 2008 and 2013 and adopted an optimized photochemical route because the original chemical route would not have been cost-effective at scale. Because the demand signal was a forecast rather than a committed purchase, capacity was built ahead of confirmed orders.

Outcomes

Speed and scale. Both were achieved at the manufacturing stage. Sanofi and PATH announced the launch of large-scale production at Garessio, Italy, on April 11, 2013, with 35 metric tons planned for that year and 50 to 60 metric tons annually from 2014. The informant puts realized production at approximately 25 metric tons in 2013, scaling toward 55 to 60 tons.

Uptake. Uptake occurred and then stopped. The first 1.7 million treatments were shipped to Africa in August 2014, and PATH reports 51 million artemisinin-based combination therapies containing semisynthetic artemisinin delivered to African endemic countries by December 2015. Beyond that point the product met market resistance, and the anticipated production ramp did not occur. Sanofi produced no semisynthetic artemisinin in 2015 and sold the Garessio plant. The WHO malaria reporting series was not retrieved with annual figures, so the 51 million treatments cannot be expressed as a share of total artemisinin-based combination therapy supply.

The partnership succeeded technically and in prequalification terms and did not produce a market.

Rigor. Semisynthetic artemisinin is chemically identical to botanical artemisinin and substituted directly into approved combination therapies. The regulatory route was the WHO prequalification of the active ingredient in May 2013, granted on quality and good manufacturing practice equivalence rather than on new efficacy evidence. Regulatory acceleration occurred through that substitution route and not through any donor mechanism.

Profit. The University of California, Berkeley required royalty-free licensing of the process to Sanofi, and Sanofi committed to no profit, no loss production to hold the price low for developing countries. No royalty stream or margin was intended to reach the university or Amyris from artemisinin sales. The value that did accrue to Amyris was indirect (validation of the isoprenoid platform, redeployed toward farnesene, cosmetics and flavors and fragrances).

Price series. Semisynthetic artemisinin was priced at approximately $350 to $400 per kilogram on a no profit, no loss basis.

Botanical artemisinin over the same period moved as follows. The informant puts it at roughly $1,200 per kilogram in 2004 and 2005, falling to about $170 per kilogram by 2007. Independent market reporting puts the peak above $1,100 per kilogram in 2006 and the trough at around $200 per kilogram in 2007, with spot prices below $200. The botanical price then recovered to approximately $550 per kilogram in 2011 and fell below $250 per kilogram by 2014 and 2015.

The informant states that price parity with botanical artemisinin was achieved. The retrospective account in Nature records instead that the semisynthetic material remained more expensive than the glutted botanical product through the period in which it needed to sell. On the market outcome, the botanical price sat below the semisynthetic price when purchasing decisions were being made.

Alternative explanations

The botanical price collapse as a sufficient explanation for commercial failure: Botanical supply met global need at prices below the semisynthetic price. The product met market resistance, Sanofi ceased production and the plant was sold. The partnership succeeded technically and in prequalification terms and did not produce a market.

3.3.5 Cross-case synthesis Comparison of the three cases across the five framework components shows that no partnership input is common to all of them. A binding procurement commitment exists in one case only, lenacapavir, where the July 2025 supply agreement with the Global Fund was announced after U.S. approval on June 18, 2025. Partnership money entered at different points in the pathway: in 2004 for artemisinin, before the product existed; between 1992 and 2020 for GeneXpert, before and alongside the 2006 development agreement and the 2012 and 2023 price reductions; and between October 2024 and September 2025 for lenacapavir, after nearly 20 years of internal development. No single input spans development and access in any case, and GeneXpert is the only case in which separate inputs reached both.

De-risking was denied in the GeneXpert case, attributed to a verbal purchaser commitment in the lenacapavir case and confined to technical risk in the artemisinin case, where demand risk was explicitly left in place. The strength of the demand signal does not order the outcomes: GeneXpert, with no binding demand instrument, has the widest and longest documented uptake (WHO endorsement December 2010 to prequalification Dec. 5, 2024), while artemisinin, supported only by a forecast, reached 51 million treatments and stopped. Reputation is the only mechanism reported in all three cases, and no source quantifies it.

Of the four study outcomes, only uptake is documented in every case, although interview evidence provided limited insight into the contribution of global health partnerships to that uptake. Speed and rigor are established in none. Scale carries the largest figures, but each case counts something different: a purchase commitment (lenacapavir), an uncorroborated installed base (GeneXpert) and delivered tonnage and treatments that then ceased (artemisinin). The one intermediate change traceable to a partnership-set parameter, Sanofi's process intensification to a price-parity target between 2008 and 2013, belongs to the case that failed commercially.

Case variation is explained by market context, not by stage of entry or signal strength. Artemisinin was a substitutable input facing an incumbent supply of the identical molecule priced below its $350-400 per kilogram no-profit price; lenacapavir and the Xpert cartridge had no equivalent alternative when adopted. Across all three cases, the partnership inputs closest to a documented outcome are price and purchase instruments acting at access, and even there the documents date uptake without attributing it. No case documents a financial return to a California organization, and an alternative explanation for the observed outcome remains unexcluded in each: the high-income market and FDA designations for lenacapavir, pandemic and biodefence procurement and Truenat entry for GeneXpert, and, for artemisinin, a botanical price collapse that is sufficient on its own.

4. DISCUSSION

4.1 Overall Impact of Partnership Input

The patterns in this section come from three cases selected for variation and are hypotheses for testing across a larger set of products, not established features of global health partnerships. Across three innovations differing in product type, origin, decade and commercial outcome, partnership inputs are documented closest to a single stage: moving an approved product into use. Speed is established in no case. Rigor is established in no case. Scale is reported in all three but counts a different object in each: a purchase commitment for lenacapavir, an uncorroborated installed base for GeneXpert and delivered tonnage that then ceased for artemisinin. Uptake, meaning adoption into WHO guidelines, national registration, procurement and use in low- and middle-income countries, is the only outcome documented

FIGURE 1

A summary of the findings that emerged from the analysis

Summary of key findings

Where partnership inputs and documented outcomes fall along each product's pathway

● Partnership input
○ Non-binding signal
— Context (not a partnership input)
■ Documented outcome
□ Documented, then ceased
◩ Company-reported outcome

PATHWAY	DISCOVERY	DEVELOPMENT	APPROVAL	USE documented contribution sits here
Semisynthetic artemisinin UC Berkeley · Amyris Berkeley and Emeryville Money in: **2004**, before the product existed	● **$42.6M Gates grant, 2004.** Philanthropic; no public funder.	● **$10.7M Gates commercialization grant, 2009.** Technical de-risking only.		○ **Forecasts only; no purchaser.** "Demand risk was explicitly not addressed."
		— Sanofi built capacity to a price-parity target, 2008–2013, ahead of any order.	■ **WHO prequalification, May 2013,** on equivalence; no donor mechanism.	□ **51M treatments delivered by Dec 2015, then production stopped.** Botanical supply was cheaper.
GeneXpert / Xpert Ultra Cepheid Sunnyvale Money in: **1992–2020**, from early development	● **Public laboratory work and early NIH and small-business grants, from 1992.** Only case with public research funding as a direct input.			● **Price reductions:** donor-financed buy-down, 2012, $16.86 → $9.98; Ultra supplied at cost from 2023, $7.97. No binding purchase agreement.
			■ **WHO endorsement, Dec 2010;** Ultra prequalified, Dec 2024.	◩ **~50,000 instruments installed** (company-reported). Widest and longest documented uptake of the three.
Lenacapavir Gilead Sciences Foster City Money in: **2024–25**, after nearly 20 years of development			● **Royalty-free licenses to 6 generic manufacturers, Oct 2024,** 8 months before FDA approval.	● **Supply agreement, Jul 2025.** Up to 2M people at no profit, expanded to 3M in Apr 2026; the study's only binding commitment, signed after approval.
	— **Nearly 20 years of company-funded development.** No public research funding located; informants described the high-income market as sufficient on its own ($2.1B prevention franchise, 2024).		— FDA approval, Jun 2025, timed by breakthrough designation and priority review, not by a purchaser.	■ **Rollout under way in 9 countries by mid-2026.**

All amounts in US dollars.

in every case, yet it is the outcome informants provided the least insight into. Country adoption was not characterized by informants in either the lenacapavir or the GeneXpert case, although WHO endorsement in December 2010 and prequalification on Dec. 5, 2024, date it independently.

In these cases, the documented contribution of global health partnerships sits at access rather than at discovery. The finding is consistent with the small empirical literature that exists. Plahte's interviews with pneumococcal vaccine manufacturers found no evidence that the Advance Market Commitment had motivated innovation, and emerging manufacturers described it as irrelevant to their decisions (Plahte, 2012). A 2025 synthesis of the same mechanism concluded that it accelerated deployment of existing vaccines, had limited effect on research and benefited firms already holding market-ready products and global manufacturing capacity (Nagar et al., 2025). Three separate bodies of evidence (an advance market commitment for vaccines, a supply agreement for an HIV medicine and a procurement relationship for a diagnostic platform) locate the effect at the same point.

Two claims commonly made for these partnerships therefore carry different evidentiary weight. The claim that donor purchasing moves products into use is supported by independent documents in two of three cases. The claim that donor purchasing causes California innovation to occur, or to occur faster, is supported in none.

Donor purchasing was described as the condition for a market existing at all. A nonprofit developer stated that without the promise of Gavi procurement there would be no market for the vaccine it was developing, and that without purchasers of that kind the innovation space for the diseases in its portfolio would be extremely limited. An investor stated that an advance purchase agreement from Gavi was what allowed a late-stage investment to be underwritten. A diagnostics company named market existence as central to its go/no-go decision and as setting the level of research effort applied, and two companies tied forecast volume to production planning and to the price they could offer. One company reported committing contract manufacturing capacity more than 18 months before approval on the strength of a verbal commitment from two purchasers. A second diagnostics company took the contrary position, describing the channel as receiving products it had already developed. They claim that without a purchaser, certain products would not be taken forward at all.

Lenacapavir: Informants reported approximately 20 years of internal work on the molecule and a paying domestic market sufficient to justify development on its own; the company's prevention franchise recorded $2.1 billion in sales in 2024. Breakthrough therapy designation in October 2024 and priority review acceptance on Feb. 18, 2025, account for the June 18, 2025, approval date without reference to any purchaser. The counterfactual for access differs and is now partly observable. By mid-June 2026 all nine Global Fund early adopter countries (Eswatini, Kenya, Lesotho, Mozambique, Nigeria, South Africa, Uganda, Zambia and Zimbabwe) had received first shipments and begun rollout, with approximately 135,000 doses delivered as of April 2026 and support extended to 12 further countries for delivery in the fourth quarter of 2026 (The Global Fund, 2026a; Unitaid, 2025). On April 14, 2026, the State Department and the Global Fund raised the commitment from two million to three million people (The Global Fund, 2026a). The relevant counterfactual is not the absence of lenacapavir; it is lenacapavir as a high-income product for a decade, which is the pattern the Unitaid partners described this rollout as departing from (Unitaid, 2025).

GeneXpert: The interview record for this case states without prompting that the purchasing relationship "is not really a driver of innovation" and "not really de-risking future product innovation," because the company supplies products it has already developed. The donor-financed price reductions — the August 2012 buy-down to a $9.98 ceiling and the Sept. 19, 2023, reduction of the Ultra cartridge to $7.97 — acted on price and volume rather than on development. Two competing explanations remain unexcluded: pandemic and biodefence procurement, under which the company shipped 10 million cartridges in the first quarter of 2021, and WHO recommendation of the competing Truenat platform in 2020, three years before the 2023 reduction.

Semisynthetic artemisinin: Botanical artemisinin was available at roughly $170 to $250 per kilogram against a semisynthetic no-profit price of $350 to $400 per kilogram. Sanofi and PATH delivered 51 million treatments by December 2015, after which production ceased, and the Garessio plant was sold. The account of the mechanism in the interview record is the analytically important element: philanthropic capital removed technical risk, and "demand risk was explicitly not addressed." A $53.3 million grant substituted for capital that an advance market commitment would have supplied and did not substitute for the commitment itself. The case also contains the only instance in this study of a global health project producing commercial value in an unrelated market. Royalty-free licensing by the University of California and no profit, no loss manufacture by Sanofi removed margin by design, and what the Emeryville company retained was a validated fermentation platform, subsequently redeployed into farnesene-derived products for cosmetics and for flavors and fragrances.

Philanthropy is smaller than the reduction it is being asked to offset and is concentrating.

Benefits other than profit were reported consistently across the interviews. Informants described continued purchasing as sustaining relationships with contract manufacturers, which the interview record for that case links directly to holding input prices down, and as funding sales and support functions and an installed base described as what allows the business to continue. That volume lowers unit cost was endorsed without qualification in the lenacapavir case and conditionally in the GeneXpert case on the basis that large volumes reduce unit cost in some circumstances. Instruments placed through donor purchasing run any assay in the manufacturer's portfolio, which converts procurement for one disease into standing capacity for others; the instance given was faster Ebola response in the Democratic Republic of the Congo. One informant described evidence from products in use, including drug resistance monitoring, as returning into the company's discovery work. Prequalification and guideline recommendation open national markets that would otherwise be entered one at a time, and one informant named prequalification rather than procurement as the mechanism that produces registration.

At the level of the state, this study cannot construct a counterfactual, and no existing source can. We identified no database recording what a manufacturer receives from donor purchase of its product, and no peer-reviewed study measuring the realized financial or commercial return to a named innovating firm from partnership participation. Informants at all 10 organizations reported that no such data exist; one investor located effects at the level of the innovation system rather than the firm.

Two companion analyses in this study reach a comparable boundary by different routes. The federal spending analysis identifies $19.029 billion in net federal global health-related obligations to California across 28,375 transactions between 2016 and 2025 and models 156,919 direct and supplier-linked job years, while stating that its input-output simulation is an accounting simulation rather than a causal estimate of jobs or output created by federal funding (Chen, 2026). The surveillance analysis documents a 27-day interval between international warning and California's first confirmed cases of COVID-19, and that Ebola detection in the same region improved from months in 2014 to 15 days in 2021, while stating that the published record "does not support a precise dollar per day of lead time valuation" (Institute for Health Metrics and Evaluation (IHME), 2025). The state of California can document the funding it receives and the health outcomes its systems support elsewhere and cannot yet state its own return.

Establishing that return would require product-level data on volumes supplied through donor channels, prices relative to high-income markets, and the interval between regulatory approval and first delivery in a low- or middle-income country. Neither the manufacturers, the procurement agencies nor the funders currently publish these figures, and we identified no research group compiling them.

Development assistance for health fell from $49.6 billion in 2024 to $39.1 billion in 2025, its lowest level in more than 15 years, with the United States accounting for a reduction exceeding $9 billion, and is forecast to reach $36.2 billion in 2030 under current policy (Institute for Health Metrics and Evaluation (IHME), 2025). Total official development assistance from Development Assistance Committee members fell 23.1% in real terms in 2025 to $174.3 billion, the largest annual contraction on record; U.S. assistance fell 56.9% and accounted for 75.1% of the total decline, and the OECD projects a further 5.8% reduction for 2026(OECD, 2026). Multilateral assistance fell 12.7%, with core contributions to the United Nations system down 27%, the

largest annual drop recorded for that component(OECD, 2026).

Both purchasers appearing in these cases raised less than their replenishment targets. The Global Fund Board recorded a final eighth replenishment outcome of $12.64 billion on Feb. 18, 2026, against an $18 billion target, below the $15.7 billion of the seventh replenishment, and approved $10.78 billion in country allocations on that basis (Collins & HIV i-Base, 2025). The U.S. pledge was reported at $4.6 billion, reduced from $6 billion(Kaiser Family Foundation, 2026). Gavi secured more than $9 billion against an $11.9 billion target for 2026-2030; the United States withheld its pledge, lost its board seat and released $600 million in appropriated funds on July 29, 2026 (Gates Foundation, 2025).

Philanthropy is smaller than the reduction it is being asked to offset and is concentrating. The Gates Foundation committed in May 2025 to spend more than $200 billion by Dec. 31, 2045, and set an annual payout of approximately $9 billion from 2026, after which it will close (Impact Global Health, 2026; Suzman, 2026). That payout, spanning all program areas including U.S. education and agriculture, is approximately the size of the single-year reduction in U.S. development assistance for health. Within research the concentration is already measurable. Impact Global Health reported funding for neglected disease research and development at $3.75 billion in 2024, more than $1 billion below its 2018 peak; funding to product development partnerships at $313 million, roughly $500 million below its 2008 peak and drawn from a small number of funders; NIH neglected disease funding falling for a fifth consecutive year; and growth in tuberculosis research attributable largely to one philanthropic funder and one late-stage vaccine candidate (U.S. Department of State, 2025).

Domestic resource mobilization is the substitution the America First Global Health Strategy names. The strategy records U.S. direct spending of approximately $1.3 billion per year on commodities for HIV, tuberculosis, malaria and polio, commits to covering 100% of those costs in fiscal year 2026 with declining support thereafter as recipient governments raise co-investment, and states that the United States will establish or contribute to one or more pooled procurement mechanisms (U.S. Department of State, 2025). The fiscal room for that transition is limited: health spending in high income countries was 299 times that in low-income countries in 2025, and per-person spending in low-income countries is forecast at $40 per year in 2030 (OECD, 2026).

4.2 What the Reductions Place at Risk for California

If the pattern in these cases holds more widely, the first consequence of withdrawing the purchaser would be an approved product that does not reach patients, not slower discovery in Foster City or Sunnyvale. A second consequence was predicted by informants: that without a purchaser, certain products are not taken forward at all. The artemisinin case is the nearest observable instance, and the low-cost ventilator an informant described, which found no U.S. purchaser before the nonprofit developing it closed, is a second. AVAC's assessment of June 2, 2026, states the point directly, noting that delivery and uptake of lenacapavir may be constrained by the loss of implementation infrastructure following U.S. aid reductions, at the moment the product becomes available (AVAC, 2026). The artemisinin case documents the endpoint of that sequence when the purchase does not materialize, and an informant described a second instance in which a low-cost ventilator found no U.S. purchaser and the nonprofit device developer subsequently closed. Cavalcanti and colleagues estimated that U.S. assistance prevented 91 million deaths between 2001 and 2021 and projected more than 14 million additional deaths by 2030 if the 2025 reductions are sustained, including more than 4.5 million children under five (Cavalcanti et al., 2025).

The first consequence of withdrawing the purchaser would be an approved product that does not reach patients, not slower discovery in Foster City or Sunnyvale.

The California research base is contracting in parallel, and that contraction is measurable. Research organizations in the state received $6.26 billion across 9,486 awards from NIH and the National Science Foundation in 2025, more than any other state (Biocom California, 2026). NIH suspended or canceled more than 1,000 University of California grants, including nearly 700 at the University of California, Los Angeles (UCLA), and the federal government froze $584 million of UCLA research funding in July 2025, most of it subsequently restored by court order (CalMatters, 2026; Daily Bruin, 2026). The companion federal spending analysis records annual net federal global health-related obligations to California falling from $6.474 billion in 2021 to $1.034 billion in 2025, with award counts falling from 2,169 in 2024 to 1,402 in 2025 (Chen, 2026). Impact Global Health identified at least $14 million in annualized NIH malaria grants terminated and not reinstated in 2025 (Impact Global Health, 2026).

These figures describe the funding entering California. This study did not find evidence connecting that funding to the outcomes it examined in two of its three cases. Public research funding is evidenced as a direct input for GeneXpert alone, and the documented investment, spanning 1992 to 2020, predates the reductions described above.

The America First Global Health Strategy, released in September 2025, directs U.S. global health purchasing toward American products, calling for U.S.-supported programs to use U.S.-manufactured diagnostics and medicines and for pooled procurement designed around medical innovations developed by U.S. companies (U.S. Department of State, 2025). It does not claim that supplying these programs is profitable, and informants in this study described such supply as at cost or at a thin margin. By making U.S. firms the intended suppliers, the strategy raises the question this study set out to trace, what that purchasing returns to the firms and to the states where their products are developed, and no source currently measures it. Four routes have been asserted for two decades: de-risking, demand certainty, manufacturing transfer and regulatory support. None has been quantified for a named firm, and they fare differently in these interviews. Demand certainty was endorsed most often, and was described as determining whether an investment could be underwritten, how production was planned and what price could be offered. De-risking was contested: one supplier described participation as

The return to California is measurable, and three figures carry most of it.

capable of adding risk, and in the artemisinin case it was confined to technical risk while demand risk was explicitly left in place.

Supply was described as at cost, as in practice a loss, as very thin margin or as foreclosed by licensing terms. Reputation was the only benefit reported in all three cases, and no source quantifies it. Across the 10 interviews the benefit endorsed most often was predictable demand at scale, and it is no better measured than reputation is. The difference between them is that one can be measured with data the parties already hold.

4.3 Limitations

This study examined 10 organizations and three innovations and cannot be generalized to California's biomedical sector. Outcome accounts for speed, scale, rigor and uptake are informant-reported throughout, and no outcome account was accompanied by documentation. No informant distinguished the portion of any outcome attributable to activity located in California, and employment effects were asserted but not counted. One competing explanation remains unexcluded in each case. The study examined federal and donor purchasing power acting on California innovators; it did not evaluate returns to California state investment and does not estimate aggregate economic impact for the state.

Three further sources of bias apply. The focal cases reached regulatory approval or WHO prequalification and entered donor procurement; products that failed earlier, or never entered a partnership, are less likely to be recalled by informants or recorded in documents, and so less likely to have reached the candidate pool. The artemisinin case offsets this only in part, because it failed commercially after clearing every technical and regulatory step. Informants were identified through the authors' professional networks, and the sample included no firm that chose not to supply donor channels and no organization critical of these arrangements. The artemisinin and GeneXpert pathways also rest partly on recollection of events between 2004 and 2015. Where recall and documents diverged, as on the botanical artemisinin price series and on whether price parity was reached, the documentary account is given precedence.

5. LESSONS LEARNED AND CONCLUSION

5.1 Lessons Learned

The six lessons below are the authors' interpretation of what these findings mean for policy. They extend beyond what three cases can establish and are offered for consideration:

1 Removing technical risk does not create a market, and a product can fail at the point where the two are confused. Semisynthetic artemisinin cleared every technical and regulatory hurdle set for it. Philanthropic capital of $53.3 million carried the process from bench titers to industrial manufacture, WHO prequalified the active ingredient in May 2013 and 51 million treatments reached African endemic countries by December 2015. In the interview record, demand risk "was explicitly not addressed." An identical molecule was available at $170 to $250 per kilogram against a no-profit semisynthetic price of $350 to $400, and production ceased. Where a California innovation enters a market in which a substitute already exists, capital that removes technical risk leaves the decisive risk in place unless it is paired with a volume guarantee, an advance purchase commitment or a documented price floor.

2 The return to California is measurable, and three figures carry most of it. Volume supplied through donor channels, the donor price alongside the corresponding high-income price and the interval between regulatory approval and first delivery in a low- or middle-income country are already generated under existing supply contracts. They measure the transaction rather than everything that follows from it, and they are the part that can be settled immediately. They have not been collected because no funder, procurement agency or research institution has been asked to collect them. Ways to collect these figures without creating new infrastructure should be explored.

3 The evidence on what companies gain from supplying donor channels sits inside the firms, and publishing it would let them substantiate what they describe. Every outcome account in this study is self-reported, and no informant could point to data quantifying benefit at company level. Companies supplying through donor channels already report volumes and prices to procurers under contract. Publishing them, through the Access to Medicine Index, existing procurement platforms or a common California reporting standard, would turn what informants described, predictable demand that underwrites investment and production, into evidence at low marginal cost to the firms. Collection is more credible held independently of both the companies and the funders: the University of California Global Health Institute, with the University of California, San Francisco, Institute for Global Health Sciences and partners at Stanford University and the University of California, Berkeley, could hold it annually, with the G-FINDER survey as the model for comparable year-on-year reporting.

4 Conditions can be attached to public research money, and the window in which they can be attached is narrow. Senate Bill 895, the California Science and Health Research Bond Act, passed into law on Aug. 31, 2026, places a $7.5 billion bond measure to support research funding before voters on the March 2028 primary ballot. It already requires that pharmaceuticals developed with bond funds be discounted for Californians and allows the state to recover a share of successful discoveries (California Science and Health Research Bond Act, 2026). Two additions would make the resulting portfolio measurable: a requirement that recipients developing products with global health applications report the three figures above, and a commitment to seek registration in LMICs where the relevant disease burden is concentrated. Either would make California the first jurisdiction to measure what its research investment returns rather than assert it.

5 Three features of pooled procurement were present where uptake was documented in these cases, and they are separable from the institutions that currently hold them. This study places the documented partnership contribution at uptake, which makes the purchasing mechanism the point of greatest consequence. Aggregation of demand across buyers, public reference pricing and quality assurance tied to WHO prequalification or a stringent regulatory authority accompanied the move from approval to delivery in the two cases where it occurred. In 2024 the Global

Fund spent $2.5 billion on health products, $1.8 billion of it through its pooled procurement mechanism(KFF, 2025). The America First Global Health Strategy commits the United States to establish or contribute to one or more pooled procurement mechanisms(U.S. Department of State, 2025). Whatever mechanism replaces or supplements the existing ones, these three features are the ones whose loss the cases here would predict.

6 A baseline can be built only while the records and the people who kept them are still in place. Volumes, prices and approval-to-delivery intervals for 2023 through 2025 are held in procurement records, company supply agreements and Global Fund reporting. Those records are retained for a limited period, and the staff able to locate and interpret them hold the positions now being eliminated. The three analyses in this commission measure different quantities and cannot be summed: federal obligations and modelled regional activity, surveillance detection intervals and innovation-to-partnership pathways. Maintained as a linked annual series, covering federal global health-related obligations by place of performance, registration and delivery of California-origin products in LMICs, and detection lead times for pathogens reaching the state, they would constitute that baseline.

5.2 Conclusion

This study asked how global health partnerships accelerated the speed, scale, rigor and uptake of California-based biomedical and technological innovations. Across 10 key informant interviews and three innovations traced through dated milestones, partnerships did not measurably accelerate development and did not change how evidence was generated. Informants described trial sites, endpoints and enrolled populations as set by the companies and their clinical collaborators, and no retrieved document shows a partner altering any of them. In these cases, what partnerships did was buy the product, lower its price, license it without royalty and distribute it across borders.

Gilead executed royalty-free licenses with six generic manufacturers on Oct. 2, 2024, eight months before U.S. approval; by mid-June 2026 Eswatini, Kenya, Lesotho, Mozambique, Nigeria, South Africa, Uganda, Zambia and Zimbabwe had all begun administering lenacapavir, supplied by the company at no profit; agreements signed in September 2025 set an access price of approximately $40 per person per year for generic versions. Two donor-financed reductions took the Xpert tuberculosis cartridge from $16.86 to $7.97 on a platform with an installed base of nearly 50,000 instruments, which also placed diagnostic capacity in the Democratic Republic of the Congo before the Ebola response required it. Sanofi and PATH delivered 51 million artemisinin-based treatments and then stopped, because botanical supply of the identical molecule was cheaper and no purchaser had committed to buy.

The artemisinin case is the most instructive of the three, because the science worked, the process worked, prequalification worked and the product failed. It failed for a reason unrelated to California's laboratories: no one had agreed to buy it. What survived was not the product but the platform. Royalty-free licensing by the University of California and no-profit, no-loss manufacture by Sanofi removed margin by design, and what the Emeryville company retained was a validated fermentation technology, subsequently redeployed into farnesene-derived products for cosmetics and for flavors and fragrances. An informant described a low-cost ventilator that met the same end, after which the nonprofit developing it closed. In these cases, the constraint on California innovations reaching patients was not the innovation.

What California receives in exchange is described consistently and measured nowhere.

Across the 10 interviews, the benefit endorsed most often was predictable demand at scale. One investor stated that without an advance purchase agreement, a late-stage investment would have been very difficult to underwrite. The promise of procurement was described as the difference between a market and none for a vaccine in development. Two companies tied forecast volume to production planning and to the price they could offer, and one committed contract manufacturing capacity more than 18 months before approval on the strength of a verbal commitment from two purchasers. Informants also described continued purchasing as sustaining the contract manufacturer relationships that hold their input prices down, funding sales and support functions, keeping instruments in the field that run every assay in the portfolio and returning evidence from products in use, including drug resistance data, into their own discovery work. One named WHO prequalification rather than procurement as what produces registration. A second diagnostics company rejected the premise, describing the channel as receiving products it had already developed.

What California receives in exchange is described consistently and measured nowhere. Neither the five companies in this study, the procurement agencies that purchase from them nor the funders that finance those purchases hold data that would establish it. Informants at 10 organizations reported that no data exist to quantify what participation returns to a company, and this study located no study, database or funder report that measures it. The federal spending analysis identifies $19.029 billion in obligations to California between 2016 and 2025 and states that its regional simulation is an accounting exercise rather than a causal estimate. The surveillance analysis documents a 27-day interval between international warning and California's first confirmed cases of COVID-19 and states that the record cannot yet price a day of potential lead time. California can account for the funding it receives and the health outcomes its systems support elsewhere, and cannot yet state its own return.

That gap matters for policy. The America First Global Health Strategy directs U.S. global health purchasing toward products developed by U.S. companies, yet what that purchasing returns to those companies, and to the states where the products are developed, is measured by none of the companies, procurement agencies or funders.

The funding reductions described in Section 4.1 are reducing donor purchasing across products, diseases and countries at the same time: development assistance for health fell by about a fifth between 2024 and 2025, the Global Fund's eighth replenishment raised less than its seventh, and the value of orders placed through the Global Fund's pooled procurement mechanism fell by 43% in 2025. Whether California-based products continue to reach patients under those conditions is an observable question, and the observation period has already begun.

Appendix A:
CASE SELECTION

Criterion	Operational definition	Decision rule	Required evidence
Substantive California connection	A material component of discovery or academic research, research and development, engineering, product development leadership, manufacturing, commercialization or organizational headquarters located in California, assessed **at the time of the pathway** events under analysis rather than at present ownership	**Met:** ≥1 qualifying basis documented in ≥1 non-interview source naming the California entity or site. **Not met:** the only California link is product sales, distribution or in-state use. Corporate acquisition or relocation after the pathway events does not void the connection but is recorded	Company or institutional filings, regulatory submissions, peer-reviewed author affiliations, site or facility records
Identifiable global health partnership	≥1 named counterparty (multilateral funder or procurer, bilateral donor, product development partnership, philanthropic funder, implementing organization or LMIC public purchaser) engaged through ≥1 partnership input specified in the analytical framework	**Met:** named counterparty **and** named input type, both dated to a year or narrower, in ≥1 source independent of the innovating organization's promotional material. **Partly met:** counterparty named in interview only. **Not met:** partnership described only in aggregate ("donors", "the global community")	Counterparty grant, award, procurement or allocation records; regulatory or prequalification records; company filings. Press releases alone are insufficient
Outcome coverage (≥2 of 4)	Charted evidence bearing on ≥2 of: **speed** (change in timing of a development, trial, regulatory, launch or introduction milestone); **scale** (change in volume, manufacturing capacity, supply commitment, installed base or population reached); **rigor** (change in trial design, populations studied, endpoints, data quality or the regulatory grade of evidence generated); **uptake** (change in country introduction, guideline inclusion, procurement or programmatic use)	An outcome counts only if **(a)** the matrix holds ≥1 coded segment in that outcome domain for the case, **(b)** the segment's elicitation value is spontaneous or prompted with elaboration (bare assent to the closed lists in Questions 6 and 7 does not count) and **(c)** ≥1 document indicator with a date or magnitude speaks to it. **Met:** ≥2 outcomes qualify. Evidence that **contradicts** a claimed effect counts toward coverage	Framework matrix cells with elicitation attribute; dated or quantified document indicators from the extraction table
Reconstructable pathway timeline	A milestone sequence sufficient to establish temporal ordering between partnership input, intermediate change and outcome	**Met:** ≥4 milestones with independent documentary dates, comprising a pre-partnership anchor, ≥1 partnership input, ≥1 intermediate organizational, research, manufacturing or market decision, and ≥1 outcome, with input preceding intermediate change preceding outcome. Dates resolved to month and year where the interval under assessment is under 24 months. **Partly met:** ordering established but the intermediate step rests on interview account alone	Trial registry entries, regulatory decision dates, filings, procurement and allocation records, publication dates
Evidence sufficient to test mechanisms and rival explanations	Enough independent evidence to examine the proposed mechanism and to seek disconfirming evidence for at least one competing account of the same outcome	**Met:** ≥2 interview records carrying the case's relevance tag, from ≥2 distinct organizations, of which ≥1 is external to the innovating organization; **and** ≥3 documents of ≥2 types; **and** ≥1 named rival explanation for which evidence can be sought (for example concurrent high-income market demand, internal corporate strategy independent of the partnership, a regulatory pathway change, platform maturation, competitor entry). **Partly met:** single interview record with unusually strong document evidence — permitted, but the constraint is stated in the Results. **Not met:** single interview record and no independent documentation	Framework matrix; document extraction table; analytic memos recording the rival explanation and the evidence sought

Pathways Screened Against the Five Criteria (n = 6)

Pathway	Outcome	Basis for Decision
Lenacapavir (Gilead Sciences)	Selected	All five criteria met. Three interview records. Licensing, regulatory, procurement and country-introduction milestones dated independently. Speed claims are interview-reported without a documented benchmark.
Semisynthetic artemisinin (UC Berkeley, Amyris)	Selected	All five criteria met. One first-hand interview record. Research funding, prequalification, production and delivery milestones documented in peer-reviewed and PATH sources. Interview and documentary accounts of price parity differ and are both reported in the case.
GeneXpert and Xpert MTB/RIF Ultra (Cepheid)	Selected	All five criteria met. One first-hand interview record. Public investment, price reductions, WHO endorsement and prequalification dated independently. The informant's account of margin is reported alongside independent production-cost estimates.
CpG 1018 adjuvant	Not selected	One interview record. Funder support and pricing could not be corroborated from a second source, and the California basis for the partnership pathway was not established.
cobas platform assays	Not selected	The interview record describes five assay pathways rather than one, and a single pathway with a milestone sequence could not be isolated. The record contains the study's only current, datable instance of California-located development destined for a federally funded program, reported under Theme 10.
Artemisinin-based combination therapy	Not selected	Reach in the billions of treatments through donor purchase on a no-profit, no-loss basis is interview-reported. Research effort and discovery are reported as California-located, but the California basis for this product was not documented.

Pathways excluded before criterion assessment (n = 11)

Pathway	Reason for Exclusion
Malaria vaccine	No California connection
Oral cholera vaccine	No California connection
Vaccine platform developed outside California and sold for a high-income indication	No California connection
Long-acting HIV prevention product of another manufacturer	Described as a comparator, not as the informant's own pathway
Dengue therapeutics	In development; no purchaser identified
Low-cost portable ventilator	No purchaser identified; developing organization subsequently closed
Nonprofit intermediary for introducing high-income-country products in low- and middle-income countries	Pre-product
Microarray patch delivery platform	California-linked and publicly funded; evidence insufficient to assess
Phototherapy device	Outcome reported at product-category level rather than for a named product
Autonomous drone medical delivery	Mentioned without detail sufficient to assess
East African biodesign training program	Training program rather than a product; grant ended after three years

Accounts identified in transcripts and not treated as innovation-to-partnership pathways (n = 5)

Account	Reason
Catheter-based cardiovascular device	Adopted internationally without a global health partnership
HIV vaccinology laboratories, San Diego	Funder not established from the record
Antibiotic developer, San Diego	Financing and employment described at firm level; no product pathway
Synthetic-biology producer of pharmaceutical starting materials	Funded through biosecurity programs outside the study's definition of a global health partnership
Biotechnology company acquired at scale, San Diego	Funder outside the study's definition of a global health partnership

REFERENCES

Access to Medicine Foundation. (2024). 2024 *Access to Medicine Index*. https://accesstomedicinefoundation.org/resource/2024-access-to-medicine-index

Acemoglu, D., & Linn, J. (2004). Market Size in Innovation: Theory and Evidence from the Pharmaceutical Industry. *The Quarterly Journal of Economics, 119*(3), 1049–1090. https://doi.org/10.1162/0033553041502144

AVAC. (2026). *Lenacapavir Arrives in South Africa on Friday*. https://avac.org/blog/lenacapavir-arrives-in-south-africa-on-friday/

Biocom California. (2026). *2026 life science economic impact report*. Biocom California. Biocom California

Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology, 18*(3), 328–352. https://doi.org/10.1080/14780887.2020.1769238

CAL MATTERS. (2026). *White House admits it used keywords to kill billions worth of California research grants*. https://calmatters.org/education/higher-education/2026/07/research-grants-california-2/

California Senate Bill 895: California Science and Health Research Bond Act.

Cavalcanti, D. M., de Oliveira Ferreira de Sales, L., da Silva, A. F., Basterra, E. L., Pena, D., Monti, C., Barreix, G., Silva, N. J., Vaz, P., Saute, F., Fanjul, G., Bassat, Q., Naniche, D., Macinko, J., & Rasella, D. (2025). Evaluating the impact of two decades of USAID interventions and projecting the effects of defunding on mortality up to 2030: A retrospective impact evaluation and forecasting analysis. *The Lancet, 406*(10500), 283–294. https://doi.org/10.1016/S0140-6736(25)01186-9

Cernuschi, T., Furrer, E., Schwalbe, N., Jones, A., & Berndt, E. R. (2011). *Advance market commitment for pneumococcal vaccines: Putting theory into practice*. Bulletin of the World Health Organization, 89(12), 913–918. https://doi.org/10.2471/BLT.11.087700

Chen, Y. (2026). *The impact of federal global health spending on California's economy* [Unpublished report]. California Global Health Leadership Initiative.

Cho, J., Singh, M., & Lo, A. W. (2024). How does news affect biopharma stock prices?: An event study. *PLOS ONE, 19*(1), e0296927. https://doi.org/10.1371/journal.pone.0296927

Christen, P., Audibert, C., Mulligan, J.-A., Bubb-Humfryes, O., von Drehle, C., & Conteh, L. (2026). Measuring the impact of global research and development investment in product development partnerships: A case study on return on investment in antimalarial drug development. *The Lancet Global Health, 14*(3), e427–e434. https://doi.org/10.1016/S2214-109X(25)00456-5

Collins, S., & HIV i-Base. (2025). *Global Fund announces $11.3 billion in pledges for 8th round of funding: Still $7 billion short*. HIV i-Base. https://i-base.info/htb/52722

Daily Bruin. (2026). *$12 billion UC-sponsored research bond misses deadline to appear on ballot*. https://dailybruin.com/2026/07/03/12-billion-uc-sponsored-research-bond-misses-deadline-to-appear-on-ballot

Frasch, C., Preziosi, M.-P., & LaForce, F. M. (2012). Development of a group A meningococcal conjugate vaccine, MenAfriVacTM. *Human Vaccines & Immunotherapeutics, 8*(6), 715–724. https://doi.org/10.4161/hv.19619

Friends of the Global Fight Against AIDS, Tuberculosis and Malaria. (n.d.). *Barbara Lee*. Friends of the Global Fight Against AIDS, Tuberculosis and Malaria. Retrieved https://www.theglobalfight.org/team-member/barbara-lee/

Friends of the Global Fight Against AIDS, Tuberculosis and Malaria. (2025). *California's future depends on global health*. https://www.theglobalfight.org/californias-future-depends-on-global-health/

Galkina Cleary, E., Beierlein, J. M., Khanuja, N. S., McNamee, L. M., & Ledley, F. D. (2018). Contribution of NIH funding to new drug approvals 2010–2016. *Proceedings of the National Academy of Sciences, 115*(10), 2329–2334. https://doi.org/10.1073/pnas.1715368115

Galkina Cleary, E., Jackson, M. J., Zhou, E. W., & Ledley, F. D. (2023). Comparison of Research Spending on New Drug Approvals by the National Institutes of Health vs the Pharmaceutical Industry, 2010-2019. *JAMA Health Forum, 4*(4), e230511–e230511. https://doi.org/10.1001/jamahealthforum.2023.0511

Gates Foundation. (2025). *Gates Foundation Will Double Spending Over Next 20 Years to Accelerate Progress on Saving and Improving Lives*. Gates Foundation. https://www.gatesfoundation.org/ideas/media-center/press-releases/2025/05/25th-anniversary-announcement

GHTC Impact Global Health. (2024). *Doing Well by Doing Good: Why Investing in Global Health R&D Benefits the United States and the World*. Global Health Technologies Coalition. https://www.ghtcoalition.org/resources-item/doing-well-by-doing-good-why-investing-in-global-health-r-d-benefits-the-united-states-and-the-world

Gilead Sciences. (2026). *Access Strategy for Lenacapavir for PrEP in Low- and Middle-Income Countries*. Gilead. https://www.gilead.com/responsibility/global-health-and-access/access-in-low--and-middle-income-countries/access-strategy-for-long-acting-prep

Global Health Technologies Coalition. (n.d.). *Across the US. Global Health Technologies Coalition*. Retrieved October 22, 2026, from *https://www.ghtcoalition.org/across-the-us/california*

Impact Global Health. (2026). *Funding for global health R&D in 2024*. G-FINDER. *https://www.impactglobalhealth.org/insights/report-library/funding-for-global-health-rd-in-2024*

Institute for Health Metrics and Evaluation (IHME). (2025). *Financing Global Health 2025: Cuts in Aid and Future Outlook* (Financing Global Health).

International Finance Facility for Immunization. (2025). *Statement about IFFIm and Gavi replenishment. https://iffim.org/news/statement-about-iffim-and-gavi-replenishment*

Kaiser Family Foundation. (2025). *The Trump administration's foreign aid review: Status of PEPFAR*. KFF. *https://www.kff.org/global-health-policy/the-trump-administrations-foreign-aid-review-status-of-pepfar/*

Kaiser Family Foundation. (2026). *The Trump Administration's Foreign Aid Review: Status of U.S. Support for Gavi, the Vaccine Alliance*. KFF. *https://www.kff.org/global-health-policy/the-trump-administrations-foreign-aid-review-status-of-us-support-for-gavi-the-vaccine-alliance/*

Kevany, S. (2015). Global Health Diplomacy, "San Francisco Values," and HIV/AIDS: From the Local to the Global. *Current Topics in Global Health, 81*(5), 611–617. *https://doi.org/10.1016/j.aogh.2015.12.004*

KFF. (2025). *The America First Global Health Strategy and pooled procurement*. Kaiser Family Foundation. *https://www.kff.org/global-health-policy/the-america-first-global-health-strategy-and-pooled-procurement/*

Kulkarni, P. S., Socquet, M., Jadhav, S. S., Kapre, S. V., Laforce, F. M., & Poonawalla, C. S. (2015). Challenges and Opportunities While Developing a Group A Meningococcal Conjugate Vaccine Within a Product Development Partnership: A Manufacturer's Perspective From the Serum Institute of India. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America, 61,* S483–S488.

Loft, P., & Brien, P. (2026). *UK aid: Reducing spending to 0.3% of GNI by 2027/28*. House of Commons Library. *https://researchbriefings.files.parliament.uk/documents/CBP-10243/CBP-10243.pdf*

Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample Size in Qualitative Interview Studies: Guided by Information Power. *Qualitative Health Research, 26*(13), 1753–1760. *https://doi.org/10.1177/1049732315617444*

Mazzucato, M. (2013). *The Entrepreneurial State: Debunking Private vs. Public Sector Myths.*

Medicines Patent Pool & Boston Consulting Group. (2024). *Voluntary licensing: Right for health, smart for business*. MPP. *https://medicinespatentpool.org/uploads/2025/09/MPP_VALUE-Report_2024_EN_WEB.pdf*

Nagar, S., Cacodcar, A., & Kesselheim, A. S. (2025). Advance Market Commitments and Their Role in Public Innovation. *Journal of Law, Medicine & Ethics, 53*(3), 478–481. Cambridge Core. *https://doi.org/10.1017/jme.2025.10153*

Nandi, A. (2009). *The importance of the global health sector in California: An evaluation of the economic impact*. University of California Global Health Institute. *https://escholarship.org/uc/item/69v7f2jz*

O'Brien, B. C., Harris, I. B., Beckman, T. J., Reed, D. A., & Cook, D. A. (2014). Standards for Reporting Qualitative Research: A Synthesis of Recommendations. *Academic Medicine, 89*(9), 1245–1251. *https://doi.org/10.1097/ACM.0000000000000388*

OECD. (2026). *A historic decline in foreign aid: Preliminary 2025 ODA data*. OECD. *https://www.oecd.org/en/data/insights/data-explainers/2026/04/a-historic-decline-in-foreign-aid-preliminary-2025-oda-data.html*

Office of Governor Gavin Newsom. (2025). *California is now the 4th largest economy in the world. https://www.gov.ca.gov/2025/04/23/california-is-now-the-4th-largest-economy-in-the-world/*

PATH. (2013). *Semisynthetic artemisinin achieves WHO prequalification*. PATH. *https://www.path.org/our-impact/media-center/semisynthetic-artemisinin-achieves-who-prequalification/*

Plahte, J. (2012). Is the pneumococcal vaccine Advance Market Commitment motivating innovation and increasing manufacturing capacity? Some preliminary answers. *Vaccine, 30*(14), 2462–2466. *https://doi.org/10.1016/j.vaccine.2012.01.046*

PPIC. (2026). *California's population*. Public Policy Institute of California. *https://www.ppic.org/publication/californias-population/*

Suzman, M. (2026). *The 2026 Gates Foundation annual letter: Reaching 2045*. Gates Foundation. *https://www.gatesfoundation.org/ideas/articles/2026-gates-foundation-annual-letter*

The G-FINDER. (2024). *Neglected disease research and development (Impact Global Health)*. The G-FINDER. *https://cdn.impactglobalhealth.org/media/G-FINDER%202024_Full%20report.pdf*

The Global Fund. (2024a). *Sourcing & management of health products*. The Global Fund. *https://www.theglobalfund.org/en/sourcing-management/*

The Global Fund. (2024b). *The Global Fund's procurement system*. The Global Fund. *https://extranet.who.int/prequal/sites/default/files/document_files/day3_session8_2_globalfundprocurement.pdf*

The Global Fund. (2026a). *Global Fund and U.S. Expand Commitment to Long-Acting HIV Prevention as Country Rollout of Lenacapavir Accelerates. https://www.theglobalfund.org/en/updates/2026/2026-04-14-us-global-fund-expand-commitment-long-acting-hiv-prevention-country-rollout-lenacapavir-accelerates/*

The Global Fund. (2026b). *Global Fund Board Welcomes Final Eighth Replenishment Outcome of US$12.64 Billion, Backs Strategic Shifts to Advance Countries' Path to Self-Reliance*. *https://www.theglobalfund.org/en/news/2026/2026-02-18-global-fund-board-welcomes-final-eighth-replenishment-outcome/*

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care, 19*(6), 349–357. *https://doi.org/10.1093/intqhc/mzm042*

Unitaid. (2025). *Lenacapavir use kicks off in South Africa and Brazil through Unitaid partnership with Wits RHI and Fiocruz*. *https://unitaid.org/news-blog/lenacapavir-use-kicks-off-in-south-africa-and-brazil-through-unitaid-partnership-with-wits-rhi-and-fiocruz/*

US Census Bureau. (2021). 2020 *Census apportionment results*. US Census Bureau. *https://www.census.gov/data/tables/2020/dec/2020-apportionment-data.html*

U.S. Department of State. (2025). *America First global health strategy report. https://www.state.gov/wp-content/uploads/2025/09/America-First-Global-Health-Strategy-Report.pdf*

US House of Representatives, History, Art & Archives. (2025). *Changes in state delegation party majorities*. US House of Representatives, History, Art & Archives. *https://history.house.gov/Institution/State-Delegations/State-Delegation-Majorities/*

World Health Organization. (n.d.). *WHO prequalification*. *https://extranet.who.int/prequal/*

World Health Organization. (2025). *Guidelines on lenacapavir for HIV prevention and testing strategies for long-acting injectable pre-exposure prophylaxis*. WHO. *https://www.who.int/publications/i/item/9789240111608*

Yamey, G., Thoumi, A., Gonzalez-Smith, J., Binanay, C., Bharali, I., Johar, Z., Ridley, D., & Chapman, N. (2017). *Strengthening the United States government's role in product development for global health*. Duke Global Health Institute, Duke Margolis Center for Health Policy. *https://healthpolicy.duke.edu/sites/default/files/2019-11/strengthening_the_us_governments_role_in_product_development_for_global_health.pdf*

CHAPTER 4

Global Biosurveillance and Infectious Disease Detection in California



AMBER REZA and SASKIA POPESCU

EXECUTIVE SUMMARY

California's ability to prepare for, detect and respond to emerging infectious disease threats depends on two complementary forms of biosurveillance capacity: international systems that recognize and communicate threats, and domestic public health systems capable of acting on that information. Protecting this interconnected biosurveillance infrastructure is an investment in preparedness, timely detection and effective public health response. A central policy challenge is how to sustain both and ensure that information moves rapidly between them.

This chapter examines whether and how U.S.- and California-linked global biosurveillance investments have strengthened California's preparedness for infectious threats and potentially reduced the time required to detect threats that later affected the state. It also assesses the implications of recent disruptions to federal global health programs and international biosurveillance partnerships. Using a retrospective, mixed-methods approach, the study combines investment-to-capability mapping, outbreak timeline reconstruction, documentary analysis and three key informant interviews to examine how California's role in the global biosurveillance ecosystem contributes to early warning, preparedness and detection capabilities, all of which are potentially life-saving benefits.

The findings identify two interconnected pathways through which global biosurveillance can benefit California. The first is preparedness and response (Pathway A): international warnings can enable public health authorities to alert clinicians, prepare diagnostic and treatment capabilities, strengthen infection-control measures and coordinate protective actions. The second is enhanced biosurveillance (Pathway B): international pathogen early warning signals can prompt additional data collection through laboratory testing, electronic reporting, genomic sequencing, traveler monitoring and other measures intended to identify threats within California. These pathways frequently overlap. Crucially, evidence that biosurveillance prompted preparedness or additional testing is not equivalent to proof that an infection was detected earlier.

Selected case studies on influenza, COVID-19, mpox, Ebola, dengue and measles, together with a discussion of novel engineered threats, illustrate how biosurveillance supports Califor-

• KEY TAKEAWAYS •

- **Global biosurveillance and California detection and response capacity are mutually reinforcing.** Federal and state investments in global biosurveillance systems have strengthened California's capacity to detect and respond to life-threatening infectious threats by (a) providing early warning from outside that enables preparedness and public health response and (b) enhancing state biosurveillance activities, including changes to laboratory testing, reporting and case identification. California is a national leader in outbreak detection, identifying the first U.S. cases of pandemic H1N1 influenza in 2009 and of clade I mpox in 2024.
- **Outbreak timelines show that when international warnings reach California before confirmed local cases, the state has time to prepare.** Reconstruction of selected outbreak timelines documents intervals between upstream warning and the first confirmed California case (27 days in the case of COVID-19) during which the state can alert clinicians, prepare laboratories and initiate response. The course of different recent Ebola outbreaks in Africa demonstrates the critical importance of time, laboratory capacity, screening and response in potentially making the difference between catastrophe and containment.
- **California relies on global field programs and monitoring capacity for its outbreak response.** Recent disruptions to federal global health funding endanger the international partnerships, laboratory networks, trained personnel and relationships needed in an outbreak emergency. Sustaining the field programs of California universities and other institutions, as well as the capacity of California public health laboratories, genomic and wastewater monitoring and public health workforce, is a critical complement to California's participation in the World Health Organization's (WHO) Global Outbreak Alert and Response Network (GOARN) and is essential to state health security.

nia's public health response and its role as a local, national and international pathogen detection node. For example:

- The Dec. 30, 2019, Program for Monitoring Emerging Diseases (ProMED) report concerning an unexplained pneumonia cluster in Wuhan preceded the California Department of Public Health's (CDPH) Jan. 26, 2020, announcement of the state's first two confirmed cases of **COVID-19** by 27 days, providing a potential window for preparedness, although this interval does not represent 27 days of detection time saved.
- In 2024, international awareness of **clade I mpox** prompted California to implement daily screening of electronic laboratory reports, contributing to the identification of the first confirmed U.S. clade I mpox case in San Mateo County.
- A 2024 **dengue** outbreak in Los Angeles County similarly demonstrated the value of coordinated public health preparedness and enhanced case biosurveillance while identifying delays in clinical recognition and specimen collection.

Together, these and other cases show why timely international biosurveillance information must be accompanied by effective local detection systems. For policymakers, these timelines help identify where delays arise and where investments in laboratory readiness, clinical recognition, reporting and coordinated biosurveillance may improve the translation of early warning into public health action.

Across the mapping, timeline reconstruction, document review and interviews, the evidence indicates that federal investments and California-linked institutional contributions have supported the development and maintenance of laboratory networks, diagnostic capabilities, syndromic biosurveillance systems, trained personnel, genomic and environmental biosurveillance and international reporting relationships. The value of these investments lies partly in creating the conditions for timely recognition and response. However, the available evidence cannot establish precisely how many days of detection time were saved by individual investments or provide a reliable financial return per additional day of warning. These limitations make it especially important for future evaluations to measure the intervals between pathogen detection, communication and public health response across biosurveillance platforms, and to assess whether the actions enabled by these investments prevent infections and deaths and reduce costs.

Recent disruptions to federal global health funding, biosurveillance programs, workforce capacity and international partnerships raise concerns about the sustainability of California's detection and response capacity. While these developments do not establish that a future California outbreak will necessarily be detected later, they show that programs, funding streams and institutional relationships supporting biosurveillance have been disrupted or placed at risk. California's participation in global biosurveillance efforts such as GOARN may help mitigate this risk, but it cannot replace the frontline biosurveillance systems that generate warnings in the countries where threats first emerge.

The findings of this chapter underscore at least four policy priorities:

1. **Preserve global early warning capacity.** The U.S. government should sustain federal support for overseas biosurveillance networks, laboratories, diagnostic systems, trained personnel and international partnerships that enable emerging threats to be recognized and reported.

2. **Protect California's domestic detection and response capabilities.** U.S. and California actors should maintain investment in public health laboratories, genomic and wastewater biosurveillance, veterinary and environmental monitoring, clinical preparedness and the state and local workforce required to recognize and respond to infectious threats.

California cannot depend solely on international biosurveillance, and no domestic system can fully compensate for threats that go undetected at their source, often abroad.

3. **Strengthen the translation of international biosurveillance to improve California's preparedness, surveillance and response.** Federal, state, local and academic partners should maintain and improve coordination; clarify procedures for responding to global alerts; strengthen information-sharing systems; and maintain international engagement, including through GOARN.

4. **Measure biosurveillance timeliness and investment value.** California should establish more consistent measures of the intervals between international warning, communication to California authorities, initiation of preparedness and biosurveillance activities and local case confirmation. These measures can identify operational delays, inform resource allocation and support future evaluations without assuming that biosurveillance investment automatically produces faster detection.

California cannot depend solely on international biosurveillance, and no domestic system can fully compensate for threats that go undetected at their source, often abroad. The evidence supports sustaining both international and domestic capabilities, strengthening the systems that connect them and measuring their performance. For California and other U.S. states, protecting this interconnected biosurveillance architecture is an investment in preparedness, timely detection and the ability to respond when the next infectious threat emerges.

1. INTRODUCTION AND PROBLEM DEFINITION

This chapter is concerned with whether and how U.S. investments in global disease biosurveillance, coupled with contributions from California-linked institutions, strengthen the state's health security. California faces infectious disease threats associated with international travel, international trade and human-animal exposure in agricultural settings (CDPH, 2024a, 2025, Linthicum et al., 2003). Pathogens emerging abroad may become relevant to California before an infection is recognized

locally. International biosurveillance can help California address these risks through two analytical pathways elaborated for this study: early warning can inform preparedness and public health response (Pathway A), while the same warning can prompt enhanced local biosurveillance that may support timely detection and reporting (Pathway B). These pathways may operate simultaneously, depending on the threat and response. However, enhanced biosurveillance capacity does not, by itself, demonstrate that an infection was detected sooner than it otherwise would have been. The chapter therefore distinguishes preparedness benefits, biosurveillance capacity and demonstrated changes in detection timeliness.

Biosurveillance, which provides critical information for early warning and encompasses pathogen identification, reporting and the communication of actionable information, is fundamental to public health security (The White House, 2012). Biosurveillance integrates clinical and laboratory testing, genomic sequencing, wastewater monitoring, event-based biosurveillance (EBS) and One Health approaches. It also relies on the cooperation of a global ecosystem of partners in which California and its institutions play a critical role.

When describing how California contributes to and benefits from global biosurveillance, it is important to differentiate between detection time and early warning lead time. Detection time refers to the interval between two identified events, such as symptom onset and laboratory confirmation of a case, or the earliest documented illness and recognition of an outbreak by public health authorities. This approach is consistent with the CDC One Health Timeliness Analysis framework, which assesses timeliness using defined milestones for outbreak detection, notification and response (Centers for Disease Control and Prevention [CDC], 2026c).

Early warning lead time, by contrast, describes the period between a documented warning about a threat outside California and its first reported detection within the state. That period represents a potential opportunity for preparedness, not necessarily the time before the pathogen arrives in a particular place such as California. Early-warning systems are intended to support earlier detection and more timely public health response, including through surveillance, alert management and outbreak investigation (WHO, 2022). These intervals provide important measures of detection timeliness and early warning, although additional evidence is needed to determine the extent to which biosurveillance investments contribute to reducing detection time.

Biosurveillance, which provides critical information for early warning and encompasses pathogen identification, reporting and the communication of actionable information, is fundamental to public health security.

The timeliness of case detection, reporting and outbreak recognition depends on multiple components of the biosurveillance system. Threats can be recognized and communicated more rapidly where the underlying biosurveillance capacity is already in place: functional laboratory networks, a trained and deployed epidemiologic workforce, active data-sharing agreements and operational genomic sequencing pipelines (Brito et al., 2022; Frieden et al., 2021).

When these systems are weak or absent, pathogens may circulate undetected until clinical severity or increasing case numbers prompt recognition. Evidence from outbreak timeliness research supports the importance of timely detection, with longer detection times associated with greater numbers of cases and deaths and longer outbreak duration (Kim et al., 2025). An important question, however, is whether assessed preparedness adequately reflects real-world performance. Kandel et al. (2020) found substantial variation in countries' reported capacities to prevent, detect and respond to public health threats at the onset of COVID-19.

Despite a robust global literature on biosurveillance architecture, little work has examined how these investments translate into early warning, preparedness and detection capabilities for a single U.S. state, particularly one as globally connected as California. This gap has become increasingly important. Beginning in 2025, the U.S. initiated substantial changes to the federal infrastructure supporting global health security and disease biosurveillance, including the termination of a large share of U.S. Agency for International Development (USAID) programming (Brown, 2025; Rubio, 2025), proposed reductions to CDC funding (CDC, 2025a) and the initiation of U.S. withdrawal from WHO (Exec. Order No. 14155, 2025). These changes occurred as California confronted H5N1 in its dairy sector and continued to face infectious disease threats associated with international travel and human-animal interfaces (CDPH, 2024a). In January 2026, shortly after the U.S. withdrawal from WHO took effect, California became the first U.S. state to join GOARN (Emanuel, 2026; Office of Governor Gavin Newsom, 2026). Understanding California's contributions to global biosurveillance and its reliance on these systems is important for informing future investment decisions.

This chapter examines California's role in global biosurveillance and addresses one of four research questions within the broader California Global Health Leadership Initiative: How have U.S.- and California-linked global disease biosurveillance investments contributed to stronger detection systems and potentially reduced the time to detect infectious threats? In addressing this question, this chapter considers how biosurveillance investments support preparedness, public health response and enhanced detection capabilities, while separately assessing whether the available evidence demonstrates reductions in detection time attributable to those investments.

2. METHODOLOGY

2.1 Study Design and Rationale

This study used a convergent mixed methods design (Creswell & Creswell, 2023) to examine how global biosurveillance influences California's detection and response capacity. The study integrated documentary analysis, descriptive quantitative reconstruction

of outbreak timelines and qualitative key informant interviews within six pathogen-specific case studies. These complementary forms of evidence were analyzed in parallel and integrated during interpretation to examine how biosurveillance investments contribute to specific preparedness and detection capabilities, while recognizing the limitations of attributing observed outcomes to individual investments.

After providing background on the global biosurveillance architecture and U.S. contribution to it, the study examines how this architecture influences detection and response in California through three complementary analytic layers: (1) mapping of the interplay between local, state, federal and global biosurveillance functions and their relationship to detection and response capacity; (2) descriptive quantitative reconstruction of selected outbreak timelines, distinguishing international early warning from detection within the state; and (3) qualitative analysis of documentary evidence and key informant interviews. Six pathogen-specific cases provide the empirical basis for examining these relationships and are assessed according to their public health relevance, available documentary evidence, identifiable biosurveillance mechanisms and documented preparedness or detection activities.

To distinguish the different ways global biosurveillance benefits California, the analysis considers two interconnected, but not mutually exclusive, pathways. **Pathway A** relates to how international biosurveillance provides early warning that can enable preparedness and public health response. **Pathway B** relates to how the same warning can prompt enhanced biosurveillance activities, including changes to laboratory testing, reporting and case identification. Both pathways originate from international pathogen early warning signals and may operate simultaneously. Although enhanced biosurveillance may improve the timeliness of local detection, evidence of increased biosurveillance capacity is distinguished from evidence demonstrating an actual reduction in detection time. Whether either pathway results in a measurable reduction in detection time is assessed separately as an outcome, rather than treated as a third pathway.

Detection timelines were reconstructed for the selected pathogen case studies using a standardized set of milestones, where documented: earliest retrospective symptom onset; first clinical or laboratory recognition; first informal global signal; first formal notification under the International Health Regulations, where applicable; first public genomic characterization; first confirmed U.S. case; and first confirmed California case. These milestones provide a basis for examining the sequence of outbreak recognition, international communication and detection within California while acknowledging differences in data availability across events.

Specifically, the milestones provided a basis for calculating, where sufficient data were available, three descriptive intervals: the undetected-transmission interval, the global-to-national interval and the global-to-California interval. In instances where California served as the point of first detection, as with the 2009 H1N1 pandemic, the analysis instead documents the detection-to-characterization interval. The global-to-California interval is interpreted as a potential early warning lead time rather than a direct measure of the time required to detect an introduced pathogen within California. Where sufficient data are available, the chapter also examines intervals between symptom onset, specimen collection, laboratory confirmation and public health reporting to assess detection and reporting timeliness. When multiple sources provided differing dates, the earliest well-supported date was used, and discrepancies were noted. Because pathogens differ in their clinical presentation, transmission dynamics and biosurveillance context, these intervals are interpreted descriptively rather than as directly comparable measures of biosurveillance effectiveness.

Early warning can both enable preparedness and public health response and prompt enhanced biosurveillance activities.

The documentary analysis draws on publicly available, attributable sources, including congressional testimony, agency statements, after-action reports and expert commentary, together with three semi-structured key informant interviews conducted between July 21 and Aug. 4, 2026, with a senior California-based academic epidemiologist (KI-1), a former senior federal public health official (KI-2) and an academic infectious disease epidemiologist with expertise in EBS (KI-3). To protect confidentiality, informants are identified in the text only by code and general professional role. The interviews examined global biosurveillance and reporting pathways, federal coordination, state and county biosurveillance capacity, laboratory infrastructure, informal detection systems, biosurveillance innovations and outbreak-specific examples.

Given the limited number of illustrative interviews, the interview data were analyzed using a rapid qualitative approach aligned with the Planning for and Assessing Rigor in Rapid Qualitative Analysis (PARRQA) framework (Kowalski et al., 2024). Structured summaries were developed for each interview using common analytic domains, followed by construction of a cross-case matrix to identify areas of convergence, divergence and unique contribution across participants. Documentary evidence was reviewed alongside the interview findings for recurring themes related to detection latency, institutional dependency, biosurveillance capacity and the effects of funding disruption. Findings were retained when supported across multiple sources or clearly attributed to individual experts when they represented a distinct perspective. The resulting analysis provides insight into aspects of biosurveillance performance that quantitative timelines alone cannot capture, including how institutional relationships affect the movement of information and how disruptions to established capacity can create gaps in detection.

Across all sections of the chapter, sources were included if they were peer-reviewed; issued by an official public health authority; or constituted attributable testimony, interview evidence, agency documentation or reporting from established news organizations. To be included, sources needed to address biosurveillance performance, investment, preparedness or detection timing relevant to the selected pathogen groups or to California specifically. Preference was given to primary and original sources. Quantitative claims were cross-checked against at least one independent

Biosurveillance investments strengthen public health infrastructure internationally and nationally, and timeliness is an important measure of their value.

source whenever possible. The evidence base spans peer-reviewed scientific literature, technical documentation from national and international health authorities, preparedness assessments, California-specific documents and key informant interviews. This breadth allows the synthesis to examine both global biosurveillance architecture and state-level operational realities.

2.2 Limitations

Three limitations of the methodology may shape the interpretation. First, timeline intervals describe different aspects of outbreak recognition, early warning and detection timeliness but cannot isolate the contribution of any single biosurveillance investment from concurrent factors. The mapping and qualitative analysis are therefore interpreted alongside the timeline reconstruction, recognizing that time to detection can also be influenced by pathogen characteristics, including incubation period, clinical presentation and transmissibility (Fraser et al., 2004). Furthermore, as noted above, evidence that international biosurveillance signals informed California's preparedness and public health response or prompted enhanced local detection and reporting activities does not, by itself, establish that detection time within California was reduced. The value of these early warnings also depends on how effectively upstream detection and reporting systems connect with downstream institutions capable of verifying the information and initiating an appropriate public health response (Frieden et al., 2021). Triangulation across the three analytic layers strengthens interpretation where independent evidence points in the same direction, while the case studies provide additional context for understanding how specific biosurveillance capabilities operated during individual outbreaks.

Second, the qualitative component is based on a small sample of key informant interviews and a documentary record that may not capture the full range of perspectives across global, federal, state and local biosurveillance systems. The interview findings are therefore used to provide expert operational context rather than statistical generalization. Structured cross-case analysis and triangulation with documentary and peer-reviewed evidence were used to reduce the risk of overinterpreting individual perspectives.

Third, the policy environment has changed rapidly since 2025. Figures related to program terminations, staffing reductions, funding changes and institutional restructuring are therefore reported for specified time points rather than treated as fixed conditions. This applies in particular to the 2026 Ebola disease epidemic in the Democratic Republic of the Congo (DRC), which remained active at the time of writing (WHO, 2026c); figures for that event are reported for the specified reporting dates in the corresponding case study. These limitations do not negate the patterns identified in the analysis, but they require caution in attributing changes in detection time to individual investments and in interpreting the implications of an evolving policy environment.

3. BACKGROUND

To help interpret the key findings that follow, this section describes the legal and reporting frameworks, genomic biosurveillance systems and preparedness mechanisms through which emerging infectious disease threats relevant to California are identified and communicated. Particular attention is given to U.S. contributions to global detection capacity. This context establishes how investments in biosurveillance create the capabilities through which emerging threats can be detected and communicated to California. Furthermore, it highlights that biosurveillance investments strengthen public health infrastructure internationally and nationally, and that an important measure of their value is timeliness, including how quickly threats are recognized, how much warning reaches local officials and how effectively that information supports preparedness and enhanced biosurveillance.

3.1 The Scope and Importance of Biosurveillance

Public health, pandemic prevention and response, biodefense and global health security all rely on biosurveillance as critical infrastructure. While definitions vary, U.S. policy defines biosurveillance as the process of gathering, interpreting, integrating and communicating essential information related to all hazards, threats or disease activity to achieve early warning and detection and to support better decision-making (Homeland Security Presidential Directive 21, 2007; The White House, 2012). A central goal of biosurveillance is to identify biological threats early enough to inform public health action. Historically, pathogen identification and reporting were central components of public health practice. Since the 2001 anthrax attacks and the broader securitization of health, the term biosurveillance has increasingly described both a core element of biodefense and the wider systems used to detect and monitor biological threats, whether naturally occurring, deliberate or accidental (Elbe, 2010; Homeland Security Presidential Directive 21, 2007).

In practice, biosurveillance involves the collection, characterization (laboratory and genomic), analysis and communication of information on potential biological threats. Collection generally draws upon two strategies — indicator-based surveillance (clinical and notifiable disease reporting, syndromic surveillance, laboratory and sentinel networks, genomic sequencing and mortality data) and event-based surveillance, which draws on unstructured information from open-source reporting platforms such as ProMED and social media (WHO, 2022). These collection strategies are further complemented by an increasingly wide range of information sources, including environmental sampling (wastewater, air and soil sampling), animal and livestock biosurveillance, vector and entomological biosurveillance, food and agriculture biosurveillance, non-traditional data collection (e.g., prescription and over-the-counter sales patterns, absenteeism rates, mobility data), intelligence threat reporting and travel data (The White House, 2012). For these systems to be effective, it is critical to have not only laboratory testing capabilities but also functioning data systems, a trained workforce, governance and legal frameworks, specimen transport, coordinated cross-sector partnerships for information sharing, sustained funding and the capacity to communicate findings (WHO, 2016).

Biosurveillance systems can take many forms, from a hospital reporting a case of tuberculosis via state communicable disease reporting requirements, to the CDC's Traveler-based Genomic Surveillance program at an airport (CDC, 2025b), to international programs such as the WHO's Global Antimicrobial Resistance and Use Surveillance System (GLASS) (WHO, n.d.-b). These systems, no matter how local or focused, represent a concerted effort to rapidly identify known or unknown pathogens that might pose a health risk, thereby enabling timely public health intervention. Ultimately, the public health value of biosurveillance depends in part on whether information is sufficiently timely and reliable to inform action by public health officials, clinicians and policymakers.

3.2 The Global Biosurveillance Architecture

The International Health Regulations (IHR), as amended, remain the international legal framework governing the detection, assessment, notification and response to public health events with potential international implications. They require 197 States Parties, as of 2026, to develop and maintain core capacities for detecting, assessing, reporting and responding to public health threats (WHO, n.d.-d). Under the IHR, countries are expected to assess reports of urgent public health events within 48 hours and notify WHO within 24 hours of assessing an event that may constitute a Public Health Emergency of International Concern (WHO, 2016, 2025). The IHR require States Parties not only to maintain relevant public health capacities but also to communicate events that may pose a threat beyond national borders.

In addition to the IHR, global partnerships have worked to strengthen global health security capacity, which includes biosurveillance and reporting infrastructure. These include a range of programs led by WHO, such as the Global Influenza Surveillance and Response System (GISRS; WHO, n.d.-c), the WHO Hub for Pandemic and Epidemic Intelligence (WHO, n.d.-e), the Global Polio Laboratory Network (Diop et al., 2017) and GLASS (WHO, n.d.-b). Additional capacity-building initiatives are financed through the World Bank-hosted Pandemic Fund (World Bank, 2022). Programs such as Preventing Zoonotic Disease Emergence (PREZODE; CIRAD, 2021) and joint initiatives between WHO and the World Organisation for Animal Health (WOAH) focus on the intersection of human, animal and environmental health (One Health). Regional initiatives include Africa CDC's Pathogen Genomics Initiative (African Union, 2020) and the Southern African Centre for Infectious Disease Surveillance (Rweyemamu et al., 2013).

Many government-funded, nongovernmental, philanthropic and private programs also contribute to biosurveillance, such as the digital biosurveillance platform HealthMap, developed at Boston Children's Hospital (Freifeld et al., 2008), ProMED, run by the International Society for Infectious Diseases (Rolland et al., 2020), the commercial platform BlueDot (Bogoch et al., 2020), the Global Initiative on Sharing All Influenza Data (GISAID), the open-source genomic analysis and visualization platform Nextstrain (Hadfield et al., 2018), the U.K. Fleming Fund (Fleming Fund, n.d.) and the Rockefeller Foundation's Pandemic Prevention Institute, launched in 2021 (Prest, 2021). While this is not an exhaustive list, it highlights the range of initiatives that contribute to the larger global biosurveillance ecosystem that California both relies on and contributes to in critical ways.

3.3 Evolving Biosurveillance Modalities and an Expanding Threat Landscape

In addition to the broad range of biosurveillance strategies encompassed by the programs described above, countries seeking to strengthen their detection capabilities have increasingly incorporated event-based platforms such as HealthMap and WHO's Epidemic Intelligence from Open Sources (EIOS) (WHO, n.d.-a), alongside genomic analysis platforms such as Nextstrain. EBS — the systematic monitoring of reports, stories, rumors and other information about potential public health events — can additionally identify signals before they enter formal reporting channels (WHO, 2022). ProMED-mail illustrates this function: Rolland et al. (2020) found that 34% of 371 distinct undiagnosed disease events reported through ProMED-mail between 2007 and 2018 were subsequently diagnosed. ProMED's Dec. 30, 2019, report of an unexplained pneumonia cluster in Wuhan, one day before WHO's China Country Office identified the Wuhan Municipal Health Commission statement on the same cluster, demonstrates how informal event-based reporting can provide an early signal alongside official reporting systems (ProMED-mail, 2019; WHO, 2020).

COVID-19 shifted pathogen sequencing from primarily a research activity into a core operational tool of infectious disease biosurveillance. Capacity, however, remains uneven. Brito et al. (2022) documented substantial international disparities in sequencing coverage and turnaround time during the COVID-19 pandemic. Their analysis showed that sequencing approximately 0.5% of cases with a turnaround time of less than 21 days could provide a benchmark for genomic surveillance, although the probability of detecting an emerging lineage before it reached 100 cases remained limited under those conditions. These disparities matter because genomic biosurveillance is useful for early warning only when specimens are collected, sequenced, analyzed and shared quickly enough to inform public health action. Furthermore, there have been efforts to strengthen biosurveillance through emerging technologies, such as artificial intelligence (AI; Kraemer et al., 2025) and metagenomic sequencing (Chiu & Miller, 2019). Such efforts highlight the challenges of advancing the biosurveillance field, as novel technological investments should not detract from the need to ensure stable systems in resource-limited regions.

While much attention has been given to emerging infectious diseases, it is also vital to consider re-emerging diseases. Vaccine-preventable diseases, such as measles, not only contribute to morbidity and mortality within communities but are also costly to respond to (Sriudomporn & Patenaude, 2026). Frequent outbreaks of measles and polio require swift response, and sustained investment in this response capacity is translatable to other settings and response scenarios, as when polio eradication infrastructure was redeployed for Nigeria's response to Ebola in 2014 (Vaz et al., 2016).

While much attention has been given to emerging infectious diseases, it is also vital to consider re-emerging diseases.

Biosurveillance infrastructure is also inherently dual-purpose, as the laboratories, genomic networks and event-based systems that detect natural outbreaks are

also relevant to detecting and investigating an accidental or deliberate release. These systems are also important for generating the genomic evidence investigators need to trace the outbreak source during bioattribution. Investment in routine biosurveillance therefore strengthens biodefense and may contribute to biodeterrence without requiring a separate system (The White House, 2012), as illustrated in the case studies below.

3.4 U.S. Contributions to Global Biosurveillance

U.S. government investments in global biosurveillance have helped countries improve their ability to detect and investigate emerging infectious diseases. Much of this support has gone toward developing laboratories, training public health workers and improving surveillance networks in places where new infectious threats may first appear. Some of these investments and their documented outcomes are listed in Appendix A.

CDC's Global Disease Detection (GDD) program is one example of this work. Established after the severe acute respiratory syndrome (SARS) outbreak, the program worked with regional centers and local laboratory partners to strengthen disease detection within existing public health systems (Montgomery et al., 2019). Between 2006 and 2016, GDD centers supported more than 2,000 outbreak investigations and provided laboratory assistance to more than 1,300 investigations. They also developed more than 380 diagnostic tests across 59 countries and contributed to the identification of 11 pathogens or organisms previously unknown to the world (Centers for Disease Control and Prevention, Center for Global Health, 2017). Together, these efforts illustrate how federal investments have supported the development of laboratory services, trained personnel and the capacity to investigate infectious disease outbreaks in countries where emerging threats may first be detected.

U.S. funding for global health security has changed considerably over the years, with major disease outbreaks often prompting increases in federal support. Before COVID-19, annual funding generally ranged from $400 million to $500 million, with a notable increase to $1.34 billion in FY2015 due to emergency funding provided in response to the West African Ebola epidemic. Funding later reached $1.67 billion in FY2021 and $1.49 billion in FY2023. The President's FY2024 budget requested approximately $1.9 billion for global health security (Michaud et al., 2023). Although these increases have helped expand global surveillance capacity, maintaining that capacity between outbreaks remains a concern.

The Global Health Security Agenda (GHSA) has provided a framework for helping countries improve their ability to prevent, detect and respond to infectious disease threats.

Once an emergency has passed, laboratories still need funding to operate, health workers need continued training and public health institutions need to maintain their partnerships. These needs do not disappear when an outbreak ends, although the attention and resources directed toward them may decline. Without continued support, countries may struggle to retain experienced personnel or keep their surveillance systems functioning at the same level. The concern is that investments made during one emergency may not be fully sustained in the years that follow, even though those systems will be needed to identify and investigate future threats.

The Global Health Security Agenda (GHSA) has provided a framework for helping countries improve their ability to prevent, detect and respond to infectious disease threats. USAID supported these efforts through investments in laboratory capacity, workforce training and surveillance of zoonotic diseases, including infections that can spread between animals and humans (Michaud et al., 2023; U.S. Agency for International Development, 2023). Among these initiatives was USAID's PREDICT program, led by the University of California, Davis (UC Davis) One Health Institute. Working in more than 30 countries, PREDICT strengthened zoonotic disease detection capabilities in more than 60 laboratories and trained nearly 7,000 professionals across Africa, Asia and Latin America (Burns, 2020).

Other federal agencies have also contributed to international surveillance efforts. The Department of Defense, through its Global Emerging Infections Surveillance (GEIS) program, supports a network of military laboratories and partner institutions involved in infectious disease surveillance (Early et al., 2024). The U.S. Department of State has similarly supported international partnerships focused on global health security and reducing biological threats (U.S. Department of State, 2024). While these programs differ in their objectives and the agencies responsible for them, they have helped address many of the same gaps in disease surveillance. Providing equipment and technical assistance is part of that work, but countries also need people who can use those resources and institutions capable of carrying out investigations. The longer-term value of these programs therefore depends, at least in part, on whether the capacity developed through them can be maintained locally after external support or individual projects have ended.

4. KEY FINDINGS

The findings that follow are presented in three parts corresponding to the analytic layers described in the methodology. The analysis first examines the biosurveillance capabilities supported by federal and California-linked investments, with a focus on how California contributes to and benefits from a global biosurveillance ecosystem. It then examines these capabilities in relation to documented detection timelines and outbreak outcomes. The final subsection draws on a small sample of illustrative key informant interviews and documentary evidence to examine how biosurveillance systems function in practice and how recent institutional and funding disruptions may affect detection capacity.

4.1 From Biosurveillance Investments to California Detection Capability: Local, National and International

4.1.1 California contributions to global biosurveillance

California plays a dual role as both a beneficiary of global biosurveillance information and a producer of biosurveillance capacity.

Communicable disease reporting is a core function of medical providers in coordination with local health jurisdictions and the CDPH (CDPH, n.d.; Reporting to the Local Health Authority, 2022). A range of programs also illustrates how California-based institutions contribute to interlocking local, national and global biosurveillance efforts, extending their contributions beyond the state. For example:

- As noted above, UC Davis has contributed to zoonotic disease biosurveillance and pathogen-risk assessment through its One Health programs and led the USAID-funded PREDICT program described in Section 3.4 (Burns, 2020).
- Other California partners extend this footprint into regions where emerging threats often first appear. The UCLA-DRC Health Research and Training Program, established by the UCLA Fielding School of Public Health with the Kinshasa School of Public Health and the DRC's National Institute of Biomedical Research, has trained Congolese and U.S. scientists and conducted research on mpox and Ebola in the DRC since its founding in 2004 (UCLA Fielding School of Public Health, 2023).
- The UCSF Institute for Global Health Sciences, drawing on strategic information expertise first developed in response to HIV, has worked with CDC support alongside ministries of health in Latin America and the Middle East and North Africa to develop viral disease biosurveillance that uses hospital data, media reports and other non-conventional sources to identify emerging threats (UCSF Institute for Global Health Sciences, n.d.).

California's academic and laboratory institutions became important components of the state's genomic biosurveillance infrastructure during the COVID-19 pandemic. California COVIDNet brought together public health, academic and private laboratories in a statewide genomic biosurveillance network. By March 2023, the network included 50 laboratory partners and had generated more than 450,000 SARS-CoV-2 genomes; when sequences generated by CDC-contracted laboratories were included, the database contained nearly 800,000 genomes representing all 61 local health jurisdictions (Wadford et al., 2023).

California-linked institutions have also contributed to environmental biosurveillance. Stanford-associated wastewater biosurveillance programs, including WastewaterSCAN, expanded the use of wastewater as a complementary source of population-level infectious disease information (Wolfe et al., 2024). Together with genomic and laboratory biosurveillance, these systems illustrate how California-based institutions both use intelligence generated through wider networks and contribute information and technical capacity back to those networks.

Other California institutions contribute to the human and institutional foundations on which detection depends. Charles R. Drew University of Medicine and Science conducts HIV prevention, testing and linkage-to-care research in Angola, Rwanda, Zambia and South Africa with support from the National Institutes of Health, the Department of Defense and the Health Resources and Services Administration/PEPFAR, contributing to testing and clinical research platforms in regions where U.S. global health investment has been concentrated (Charles R. Drew University of Medicine and Science, n.d.). The Alliance for Innovation in Global Health (formerly the Bay Area Global Health Alliance), whose members include UCSF, Stanford and UC Davis, convenes academic, technology, nonprofit and public health organizations and has served as secretariat for the WHO Tech Task Force (Alliance for Innovation in Global Health, n.d.; Global Health Technologies Coalition, n.d.). The University of Southern California (USC), through its Institute on Inequalities in Global Health, contributes the policy and health security research relevant to this analysis.

This translation latency represents an important gap in the evidence.

Taken together, these programs illustrate how U.S. federal investments and California-linked institutional contributions support the development of laboratory networks, trained workforces, diagnostic and sequencing capabilities, environmental biosurveillance systems and institutional partnerships that support detection capacity. Whether earlier detection actually occurs depends on several additional factors, including how these capacities function together and on the characteristics of the specific threat.

4.1.2 The translation pathway from global detection to California Historically, global biosurveillance signals have reached California through overlapping formal and informal pathways. WHO and EBS systems identify emerging threats; CDC evaluates and communicates relevant information through federal biosurveillance and alert mechanisms; and CDPH, state laboratories and local health jurisdictions determine appropriate biosurveillance and response activities within California (CDC, 2026a; CDPH, 2026a; WHO, 2016). California's Viral and Rickettsial Disease Laboratory and networks such as COVIDNet provide additional laboratory and genomic capacity once a threat has been identified (Wadford et al., 2023). Researchers and public health agencies also utilize genomic data-sharing platforms such as GISAID (Shu & McCauley, 2017) and event-based reporting platforms such as ProMED (Rolland et al., 2020) to obtain information on emerging threats that can inform preparedness and response through clinical alerts, resource allocation and other public health actions.

This pathway illustrates an important distinction between signal generation and signal translation. Detecting a threat internationally does not itself constitute detection in California but can inform risk assessments and provide situational awareness. Information must be assessed, communicated, interpreted and translated into appropriate state and local biosurveillance activities. Depending on the threat, this may involve preparedness and public health response (Pathway A), enhanced biosurveillance activities (Pathway B) or both. The speed of this process depends on both upstream biosurveillance and the capacity of downstream institutions to receive and act on the information.

The structural components of this pathway are well documented, but the evidence reviewed in this chapter does not provide a systematic measure of the end-to-end interval between an initial global signal and actionable state-level response (Frieden et al., 2021). This translation latency represents an important gap in the evidence. The sections that follow therefore examine documented detection timelines while distinguishing earlier preparedness actions from demonstrated reductions in detection time within California.

4.1.3 From local to national to international Through California, it is possible to trace the network of detection systems that start at a local level, such as a sick individual seeking med-

Internationally, California-associated programs help expand detection to the places where emerging infectious disease threats are likely to emerge

ical care in an emergency department, to the state, national and international levels, where traveler genomics and international biosurveillance data are shared to inform health agencies of a novel pathogen identified overseas. Consider H5N1, in which (1) testing occurred at the farm level for sick farmworkers and animals (CDPH, 2024a) and was complemented by both (2) air, farm wastewater and milk sampling by academic and veterinary partners with support from funders such as Flu Lab alongside federal milk testing coordinated by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) (Campbell et al., 2026; U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 2024) and (3) monitoring of livestock (California Department of Food and Agriculture [CDFA], 2024). In California, this infrastructure operates at, relies on and contributes to every level of biosurveillance, from local to international.

Locally, California comprises 61 health jurisdictions, which conduct case investigation, contact tracing and traveler monitoring and are supported by larger statewide reporting systems, such as the California Reportable Disease Information Exchange (CalREDIE), operated by CDPH (CDPH, n.d.). CDPH and various state labs, such as the Viral and Rickettsial Disease Laboratory, maintain the confirmatory testing needed for further response. California also maintains the California Animal Health and Food Safety Laboratory System (CAHFS), which provides veterinary detection capabilities (California Animal Health and Food Safety Laboratory System, n.d.). Statewide efforts also include the COVIDNet system of 50 public, academic and private laboratories that form a genomic network across local health jurisdictions (Wadford et al., 2023).

Nationally, California's institutions and investments in biosurveillance systems help to build and sustain shared systems, such as WastewaterSCAN led by Stanford University in California and Emory University in Georgia, as well as environmental biosurveillance networks across the U.S., such as H5 influenza monitoring (Wolfe et al., 2024). Data from military sources in California, such as the Naval Health Research Center in San Diego and the GEIS network, contributed to identifying the first U.S. cases during the 2009 H1N1 pandemic (Burke et al., 2011; CDC, 2009). The Department of Homeland Security BioWatch program supports environmental monitoring for potential bioterrorism events through national air sampling (U.S. Government Accountability Office, 2024), whereas CDC's National Syndromic Surveillance Program and its BioSense Platform share syndromic data from participating health care facilities with state and local health departments (CDC, n.d.-a).

Internationally, California-associated programs help expand detection to the places where emerging infectious disease threats are likely to emerge, producing potential benefit to any jurisdiction that relies on this detection, including California itself. Scripps Research maintains initiatives such as the WestNile 4K Project (Scripps Research, n.d.), as well as the Modjadji Initiative, which is building affordable, scalable wastewater-based and pathogen biosurveillance systems for low- and middle-income countries (Scripps Research, 2026). As discussed elsewhere in this chapter, California-linked initiatives such as UC Davis's PREDICT program and biosurveillance partnerships involving UCLA and UCSF contribute to international detection capacity alongside federally supported global health security programs (Burns, 2020; Centers for Disease Control and Prevention, Center for Global Health, 2017). California's 2026 entry into the WHO GOARN also provides another channel for international outbreak information and technical collaboration (Office of Governor Gavin Newsom, 2026).

In characterizing California's role in the global biosurveillance architecture, it is important to note that many of these programs are not just lab-focused but also include initiatives to utilize open-source data, train health workers and build sustainable identification and reporting infrastructure globally (Burns, 2020; Montgomery et al., 2019). Many of these programs work to increase overall capacity, which ranges from supporting timely detection and improving operational efficacy to improving resource allocation, critical workforce resilience and community engagement. At an April 2025 roundtable convened by the ranking member of the U.S. Senate Foreign Relations Committee, USAID's former assistant administrator for Global Health described a 50-country network of global health security advisers working with governments to detect outbreaks, reporting 21 serious outbreaks beyond COVID-19 over four years, response times reduced to less than 48 hours and 11 outbreaks of Ebola and related viruses stopped before they could reach the United States. The same testimony described the DRC as having moved from Ebola outbreaks that spread for months to responses measured in 24 to 48 hours (U.S. Senate Committee on Foreign Relations, 2025). These figures reflect testimony about program performance and should not be interpreted as independent evidence that specific investments reduced detection time within California.

Across these layers, from the local to the national to the international, biosurveillance functions through interconnected systems. Local detection depends on state and national laboratories and public health reporting to evaluate and assess data and inform response, and these state and national systems, in turn, depend on local reporting and detection capabilities. An effective detection and response system requires sustained relationships and resources across all layers because these systems are interdependent. California's participation across these layers contributes to its detection capacity and ability to act on international warnings.

4.2 Detection Timelines and Outcome Evidence

4.2.1 Detection timelines and California lead time Building on this characterization of California's role in a global biosurveillance ecosystem, Table 1 reconstructs detection timelines for selected infectious disease events. Where an upstream warning preceded a California case, the reported lead-time interval extends from the earliest relevant signal to a specified California detection or reporting milestone. This interval may offer an opportunity for the state to alert clinicians, prepare laboratories and initiate response before confirmed local detection, although the pathogen may already have been introduced. For each event, the table identifies the earliest signal, the first U.S. and California detections and the primary channel through which detection

TABLE 1 : Detection Timelines for Major Pathogens Relevant to California

Pathogen / event	Earliest relevant signal or detection	First U.S. case	First California detection or reporting milestone	Timing relevant to California	Primary detection channel
COVID-19 (2019-2020)	ProMED alert concerning unexplained pneumonia in Wuhan, Dec. 30, 2019 (ProMED-mail, 2019; WHO, 2020).	First U.S. case publicly announced in Washington state, Jan. 21, 2020 (CDC, 2020b).	CDPH announced two confirmed cases, one in Los Angeles County and one in Orange County, Jan. 26, 2020 (CDPH, 2020).	27-day interval from the Dec. 30 ProMED alert to the Jan. 26 California announcement; this is a descriptive interval between documented milestones, not evidence of reduced detection time (CDPH, 2020; ProMED-mail, 2019; WHO, 2020).	Event-based surveillance and clinical recognition, followed by specimen collection and CDC rRT-PCR confirmation (CDC, 2020b; CDPH, 2020).
Pandemic H1N1 (2009)	Novel A/H1N1 detected through biosurveillance in Southern California, April 2009 (CDC, 2009).	The first two recognized U.S. infections were detected in Southern California (CDC, 2009; Fry et al., 2012).	San Diego and Imperial counties; CDC confirmation April 15 and 17, 2009 (CDC, 2009; National Center for Immunization and Respiratory Diseases, 2019).	California served as an initial detection location rather than receiving upstream warning from a previously recognized outbreak; therefore, an international warning interval for California cannot be calculated (CDC, 2009)	Active influenza biosurveillance; DoD/GEIS-supported Naval Health Research Center; CDC confirmation (Early et al., 2024; Fry et al., 2012).
Mpox clade II (2022)	Multinational outbreak recognized in May 2022, with cases reported in countries where mpox was not endemic (Minhaj et al., 2022).	Massachusetts laboratory detected orthopoxvirus DNA May 17; CDC testing confirmed West African clade monkeypox virus May 18, 2022 (Minhaj et al., 2022).	California investigated its first suspected case shortly after the Massachusetts case (CDPH, 2022b) and reported its first confirmed positive case May 25, 2022 (California Governor's Office of Emergency Services [Cal OES], 2025).	California detection followed international recognition of the multi-country outbreak by roughly one week (Cal OES, 2025; Minhaj et al., 2022).	Clinical recognition; travel history; orthopoxvirus laboratory testing (Minhaj et al., 2022).
Ebola virus disease, Guinea (2021)	Index case symptom onset Jan. 15, 2021; outbreak announced Feb. 14, 2021 (WHO, 2021).	No U.S. case.	No California case.	International comparator: outbreak recognized about one month after index-case symptom onset and contained at 23 cases.	Local biosurveillance; laboratory confirmation; trained outbreak workforce.
H5N1 in dairy cattle (2024)	H5N1 confirmed in U.S. dairy cattle in March 2024 (Campbell et al., 2026).	U.S. livestock detection preceded California.	Three Central Valley dairy herds confirmed Aug. 30, 2024 (CDPH, 2024a).	About five months from first U.S. dairy-herd detection to California livestock confirmation (Campbell et al., 2026; CDPH, 2024a).	Veterinary biosurveillance; CAHFS/NVSL laboratory testing; subsequent genomic and wastewater biosurveillance (Campbell et al., 2026; CDFA, 2024; Wolfe et al., 2024).

NOTE: The intervals are descriptive and are not interpreted as biosurveillance-attributable causal effects. The events are not fully comparable: California was an initial detection site for H1N1; Ebola did not reach California; and the H5N1 interval refers to livestock rather than human cases.

occurred. Because the outbreaks differ substantially in pathogen characteristics, geography, transmission dynamics and biosurveillance context, the intervals are descriptive rather than directly comparable measures of biosurveillance performance.

The timelines point to two related findings. First, information about an emerging threat may become available before the first confirmed case is reported in California, giving public health authorities an opportunity to prepare. Second, the amount of warning California receives depends partly on how quickly an outbreak is recognized where it begins. If the initial signal is delayed, that time cannot be recovered simply by communicating the information more quickly afterward. This makes it necessary to consider both the performance of international surveillance systems and California's ability to investigate a threat once it becomes known.

4.2.2 Detection time and outbreak magnitude Investment in biosurveillance, globally, nationally and within California strengthens public health infrastructure at multiple levels. It can influence how quickly threats are recognized abroad, how rapidly information reaches federal and state authorities and how effectively California can detect and respond once a threat arrives. The literature provides empirical support for the importance of detection time. The 7-1-7 framework establishes targets of detecting a suspected outbreak within seven days of emergence, notifying public health authorities within one day and completing essential early response actions within seven days. The framework was developed to make outbreak timeliness measurable and to identify specific bottlenecks in detection, notification and response (Frieden et al., 2021).

If the initial signal is delayed, that time cannot be recovered simply by communicating the information more quickly afterward.

A retrospective analysis of 84 outbreaks in Uganda between 2017 and 2022 found that longer time to detection was significantly associated with more cases (effect size = 1.092; p = .010), more deaths (effect size = 1.106; p < .001) and longer outbreak duration (effect size = 1.032; p = .019) after adjustment for disease category (Kim et al., 2025).

These findings do not establish that every additional day of delayed detection independently causes a fixed increase in cases or deaths. Outbreak magnitude is also influenced by pathogen characteristics, population susceptibility, transmission setting and response capacity (Fraser et al., 2004). They do, however, provide empirical support for treating detection time as an important measure of biosurveillance performance and reinforce the policy relevance of the timeline differences documented in this report.

4.2.3 California as a detection node A California-centered review of the evidence shows that the state does more than receive warnings generated elsewhere; it also generates them. In some outbreaks, California biosurveillance systems have contributed directly to national or international pathogen detection or characterization, including COVIDNet's genomic biosurveillance during the COVID-19 pandemic (Wadford et al., 2023). The 2009 H1N1 pandemic provides the clearest example: the first two laboratory-confirmed U.S. cases were detected in San Diego and Imperial counties through active influenza biosurveillance, including a Department of Defense-supported biosurveillance project (Burke et al., 2011; CDC, 2009; Fry et al., 2012).

Applying the benchmarks described by Brito et al. (2022) helps place California's COVID-19 genomic biosurveillance capacity in context. California COVIDNet and CDC-contracted laboratories sequenced more than 5% of reported positive tests, with representation across all 61 local health jurisdictions. During January through June 2021, approximately 7.9% of positive tests were sequenced, compared with 0.7% during March through December 2020 (Wadford et al., 2023).

This level of coverage exceeded the approximately 0.5% sequencing benchmark discussed in the international genomic-biosurveillance literature (Brito et al., 2022). However, sequencing coverage alone does not establish faster variant detection, which also depends on diagnostic testing and sequencing turnaround times. The significance is operational rather than simply numerical. Broad sequencing coverage increased California's ability to identify and monitor emerging SARS-CoV-2 lineages across different parts of the state and strengthened its capacity to characterize locally circulating variants through its own biosurveillance network (Wadford et al., 2023). Together, these examples demonstrate California's bidirectional role within the biosurveillance architecture. The state depends on upstream global and federal information, but its own laboratory, genomic, academic and public health infrastructure also generates information that contributes to national and global biosurveillance.

4.3 Illustrative Interviews

To illustrate how the above findings work in practice, we conducted three key informant interviews with experts whose work is central to biosurveillance in California. Across the three key informant interviews, biosurveillance performance was consistently described as dependent not only on technical infrastructure but also on trained personnel, established communication pathways, laboratory capacity and institutional relationships that develop over time. Although the three experts emphasized different components of the biosurveillance system, their accounts converged on several factors that influence how quickly an emerging threat moves from an initial signal to actionable public health information.

4.3.1 Cross-interview findings KI-1, a senior California-based academic epidemiologist, emphasized variation in biosurveillance capacity across California jurisdictions and the state's dependence on federal information flows. The informant's account highlighted differences in resources between larger and smaller counties, the importance of laboratory-based reporting and the role of California's academic and public health institutions in sequencing and variant detection. KI-1 also identified the weakening of federal and international information pathways as a concern for California biosurveillance.

KI-2, a former senior federal public health official, focused on the processes through which global signals are verified and communicated. KI-2 described WHO and International Health Regulations pathways as important sources of global alerts and emphasized that laboratory confirmation and pathogen-specific verification affect the timing of federal advisories. This account reinforces a central finding of this chapter: Detection is not a single event but a sequence in which an initial signal must be assessed, verified, communicated and translated into state and local action.

KI-3, an academic infectious disease epidemiologist, emphasized laboratory capacity as a recurrent rate-limiting component of detection, both domestically and internationally. KI-3 also highlighted the importance of informal biosurveillance systems, including ProMED, and described the growing role of wastewater biosurveillance, metagenomics and automated approaches to signal detection. At the same time, the informant cautioned that earlier detection through newer technologies does not automatically translate into effective intervention, underscoring the distinction between generating a signal and acting on it. This informant's prior professional involvement with an EBS platform is disclosed here because the testimony bears directly on EBS.

Across the interviews and documentary evidence, four cross-cutting themes emerged, providing context for the implications of recent changes to the biosurveillance infrastructure on which California depends.

4.3.2 Implications of recent biosurveillance contraction The interview findings are reinforced by documented changes to U.S. biosurveillance infrastructure beginning in 2025. In March 2025, the Secretary of State announced the cancellation of ap-

TABLE 2 : Themes from Key Informant Interviews and Documentary Analysis

Theme	Synthesis	Evidence base
1. Biosurveillance capacity is relationship-dependent and slow to rebuild.	Interview and documentary evidence emphasized that detection capacity resides not only in equipment or appropriations but also in trained personnel, laboratory networks, institutional trust and established reporting relationships. These capabilities accumulate over time and may not be rapidly restored after disruption.	KI-1, KI-2 and KI-3 interviews; Montgomery et al., 2019; CDC, Center for Global Health, 2017; Ranking Member's Press, 2025
2. Translation latency exists between global signal and state action.	Experts described multiple verification, communication and operational steps between an international signal and California action. The pathway is identifiable, but the end-to-end interval is not routinely measured, limiting the ability to determine where avoidable delay occurs.	KI-1 and KI-2 interviews; CDC/CDPH communication pathways; Wadford et al., 2023
3. Laboratory capacity is a recurrent determinant of detection speed.	Across interviews, laboratory confirmation and sequencing capacity repeatedly emerged as determinants of whether a suspected event becomes an actionable public health signal. Documentary evidence from GDD, GEIS, COVIDNet and the 2021 Guinea Ebola response supports this interpretation.	KI-1, KI-2 and KI-3 interviews; Montgomery et al., 2019; CDC, Center for Global Health, 2017; DoD GEIS; Wadford et al. (2023); WHO, 2021; CDC, 2024
4. Biosurveillance value is most visible when capacity is disrupted.	Interviewees and documentary sources described biosurveillance as a preventive capability whose benefits are often difficult to observe when systems function normally. The 2025 termination of large numbers of USAID awards, federal workforce reductions and attempted termination of state public-health grants illustrate how quickly established capacity can be destabilized.	Key informant interviews; Rubio, 2025; Ranking Member's Press, 2025; CDC, 2025a; Colorado v. U.S. Department of Health & Human Services, 2025

NOTE: The table is a cross-source synthesis, not a frequency count. Interview findings are interpreted alongside documentary evidence.

proximately 5,200 USAID awards, representing 83% of USAID programs worldwide, with the remaining programs to be administered by the Department of State (Rubio, 2025). Testimony at an April 2025 Senate Foreign Relations Committee roundtable subsequently described the loss of USAID's 50-country Global Health Security program and other global health security capabilities (Ranking Member's Press, 2025). The FY2026 President's Budget requested $4.243 billion for CDC, substantially below prior funding levels (CDC, 2025a). That request was not enacted. The FY2026 appropriation signed on Feb. 3, 2026, provided approximately $9.1 billion for CDC, close to the prior-year level, so proposed funding reductions must be distinguished from enacted appropriations (Tollestrup & Lynch, 2026).

The same testimony described a separate emergency response system that had cut response times to global outbreaks from more than two weeks to less than 48 hours and reported that it, too, had been lost (Ranking Member's Press, 2025). These statements should be read as testimony about the operational effects of the terminations rather than as independently measured estimates of future detection delays. They nonetheless identify the specific functions placed at risk: in-country biosurveillance advisers, laboratory and animal health partnerships, outbreak investigation capacity, technical personnel and rapid-response mechanisms that connected unusual local events to national and international biosurveillance systems. A freeze on foreign assistance in early 2025 led partner organizations to dismiss staff and halt disease prevention and detection activities, including Ebola-focused work in Uganda and the DRC; waivers later allowed some outbreak detection and response programs to resume, but the underlying system had already been disrupted (Michaud & Kates, 2026).

Separately, the U.S. Department of Health and Human Services announced the termination of approximately $11 billion in pandemic-era public health grants to states and local jurisdictions (Colorado v. U.S. Department of Health & Human Services, 2025). The terminations were challenged in federal court, resulting in a temporary restraining order and, as of the most recent ruling reported here, a preliminary injunction (Colorado v. U.S. Department of Health & Human Services, 2025). Taken together, these developments do not establish that a future California outbreak will necessarily be detected later. They do show that programs, funding streams and institutional relationships supporting biosurveillance have been disrupted or placed at risk. The policy concern is therefore not simply reduced spending. It is the potential loss of capabilities that require sustained investment to build, and that may be difficult to reconstruct during an emerging outbreak.

5.
CASE STUDIES

The value of biosurveillance lead time depends on whether public health authorities can convert an external signal into concrete preparedness and detection activities before or during introduction of a pathogen into California. Across the events examined in this chapter, state and local authorities used information generated outside the state to alert clinicians and laboratories, establish testing pathways tailored to the new pathogen, screen and monitor arriving travelers, prepare hospitals and protect exposed workers and mobilize emergency authorities and resources. Biosurveillance lead time is therefore a product of an ecosystem, not a single agency or technology, and California is a node within this ecosystem, both relying on warnings generated elsewhere and contributing information through its own laboratories, genomic networks and academic partners.

The six case studies that follow bring together the preceding findings by examining how biosurveillance architecture operated during specific infectious disease events. Influenza, COVID-19,

Biosurveillance lead time is therefore a product of an ecosystem, not a single agency or technology.

mpox, Ebola, measles and dengue were selected because they represent different transmission pathways, detection challenges and relationships among global, federal and state biosurveillance systems. Taken together, the cases illustrate how laboratory capacity, workforce, reporting networks, genomic biosurveillance and environmental monitoring support disease detection and provide opportunities for earlier warning, while also showing where biosurveillance systems remain constrained.

5.1 Influenza Variants: California as the World's Detection Node

Among the six pathogen groups examined in this chapter, influenza stands out because California has repeatedly served as a point of first detection rather than solely as a downstream recipient of external warning. The 2009 H1N1 pandemic is the clearest example. In April 2009, the novel influenza A (H1N1) virus was first identified through biosurveillance conducted in Southern California. Patient A, a 10-year-old child in San Diego County with symptom onset on March 30, and Patient B, a 9-year-old child in Imperial County with symptom onset on March 28, were confirmed by CDC on April 15 and April 17, respectively (CDC, 2009; National Center for Immunization and Respiratory Diseases, 2019). One specimen was identified through a clinical biosurveillance study and the other through the Department of Defense's Naval Health Research Center, part of the GEIS network (CDC, 2009; Fry et al., 2012). CDC subsequently reported the first two infections publicly on April 21 (CDC, 2009).

This was not an incidental discovery. Both cases were identified because biosurveillance systems were positioned to investigate influenza A specimens that could not be subtyped using available assays (CDC, 2009; Fry et al., 2012). The episode demonstrates how established biosurveillance protocols, reference laboratory capacity and federal and California-based infrastructure can identify an emerging pathogen before widespread recognition occurs. In this instance, California was not simply protected by biosurveillance intelligence generated elsewhere; it generated information that contributed to national and international recognition of the emerging pandemic.

California's biosurveillance infrastructure was tested again with H5N1, this time through veterinary channels. Highly pathogenic avian influenza was confirmed in U.S. dairy cattle in March 2024 (Campbell et al., 2026). On Aug. 30, 2024, H5N1 was confirmed in three Central Valley dairy herds after animals developed compatible clinical signs and samples were tested through CAHFS and confirmed by the National Veterinary Services Laboratories (CDFA, 2024). California subsequently identified human infections among dairy workers exposed to infected cattle, demonstrating the importance of integrating animal and human biosurveillance within a One Health framework (Zhu et al., 2025).

The CDFA began monitoring California herds immediately after the March 2024 reports from Texas and Kansas, and when H5N1 was confirmed in three Central Valley herds on Aug. 30, 2024, CDPH immediately activated its Medical Health Coordination Center. The state subsequently distributed millions of pieces of personal protective equipment to high-risk dairy workers, provided additional seasonal influenza vaccine to agricultural workers to reduce the risk of co-infection, conducted multilingual outreach, and, in December 2024, proclaimed a state of emergency to give agencies additional flexibility in staffing and contracting (Office of Governor Gavin Newsom, 2024).

Wastewater biosurveillance provided a complementary layer of monitoring. WastewaterSCAN, a program led by Stanford University and Emory University, developed H5-specific testing and detected H5 influenza signals at wastewater treatment plants in a state with affected dairy cattle, demonstrating the potential of environmental biosurveillance to provide population-level information independent of individual health-care-seeking behavior (Wolfe et al., 2024). Wastewater signals, however, do not by themselves identify the infected species or establish human transmission, so their value lies in complementing rather than replacing veterinary and clinical biosurveillance.

The H5N1 response illustrates preparedness and surveillance mechanisms similar to Pathways A and B, informing public health response and prompting enhanced veterinary, laboratory and environmental biosurveillance, although the warning came from detections in other U.S. states rather than from an international signal. California's monitoring of dairy herds following the initial U.S. detections, subsequent laboratory confirmation and protective measures for agricultural workers demonstrate how these activities can operate together. However, while these measures strengthened California's preparedness and biosurveillance capacity, the available evidence does not establish how much, if any, they reduced the time required to detect H5N1 in the state.

5.2 COVID-19: Lead Time from Global Biosurveillance

The SARS-CoV-2 timeline is the most thoroughly reconstructed example of global-to-state biosurveillance translation and illustrates both the strengths and limitations of global detection systems. Retrospective analyses place the earliest recognized symptom onset in Wuhan in December 2019 (Li et al., 2020). On Dec. 31, WHO's China Country Office identified information concerning a cluster of pneumonia of unknown cause in Wuhan, while WHO's Epidemic Intelligence from Open Sources platform also detected the ProMED report concerning the same cluster (WHO, 2020). The virus was identified in early January, and publication of its genome soon afterward enabled laboratories outside China to begin developing molecular diagnostics (WHO, 2020).

The first confirmed U.S. case was identified in Washington state in January 2020, and California reported its first confirmed cases on Jan. 26 (CDC, 2020b; CDPH, 2020). Using the Dec. 30 ProMED report as the first international signal, the interval between that signal and California's Jan. 26 announcement of its first confirmed cases was 27 days (CDPH, 2020; ProMED-mail, 2019; WHO, 2020). In this chapter, lead time refers to the interval between recognition of a threat through an upstream biosurveillance signal and its confirmed detection in California. The 27-day interval should not be interpreted as a causal estimate of the number of days produced by biosurveillance investment.

Rather, it represents the period during which information about the emerging threat was available before the state announced its first confirmed cases.

International warning informed preparedness ahead of California's first confirmed cases, then shaped the response measures that followed their identification. Before California's first cases were confirmed, CDC had begun entry screening of travelers from Wuhan at San Francisco and Los Angeles international airports; once cases were confirmed, county health departments moved immediately to trace contacts, and the Riverside County Public Health Officer later issued a local quarantine order during the repatriation of travelers to March Air Reserve Base (CDC, 2020a; County of Riverside, 2020; Los Angeles County Department of Public Health, 2020). These measures did not prevent later community transmission, but they show how upstream warning supported preparedness before confirmed detection and informed subsequent public health response activities.

The timeline also illustrates the limits of biosurveillance. The interval between the earliest infections in Wuhan and international recognition represents transmission that downstream biosurveillance systems could not independently recover. Early warning for California therefore depended first on recognition of the event at its source and then on the rapid movement of information through international and national channels, illustrating Pathway A (global early warning and preparedness). Once the signal became available, California's own laboratory and genomic infrastructure influenced how effectively the state could identify and characterize subsequent introductions, reflecting Pathway B (enhanced local biosurveillance), although the available evidence does not establish that these capabilities reduced time to detection.

5.3 Mpox: The Value and Limits of Biosurveillance Translation

The 2022 mpox outbreak tested biosurveillance systems that had largely been designed around sporadic zoonotic transmission against a virus spreading through sustained human-to-human transmission in previously underrecognized epidemiological networks. Multi-country signals emerged in May 2022 (Minhaj et al., 2022). California began investigating its first suspected case in Sacramento County on May 21 after a traveler developed compatible illness; preliminary testing was positive for an orthopoxvirus, and CDPH publicly reported the investigation on May 24 (CDPH, 2022b).

The case illustrates how an international signal can alter state-level biosurveillance before widespread local transmission is fully characterized. On May 20, 2022, the same day CDC issued a national health advisory (CDC, 2022) following a confirmed case in Massachusetts and clusters in several other countries, CDPH issued a California advisory titled Enhancing Surveillance in California. It directed health care providers to notify their local health jurisdiction immediately of any potential case and directed local health jurisdictions to report suspected cases immediately to CDPH (CDPH, 2022a).

The 2022 outbreak also showed the limits of converting early warning into effective response when countermeasures are federally controlled: San Francisco received less than one third of the vaccine doses it requested, and local and state emergency declarations followed in late July and early August (Peters et al., 2022; Thompson, 2022).

California was not simply protected by biosurveillance intelligence generated elsewhere; it generated information that contributed to national and international recognition of the emerging pandemic.

Mpox also illustrates the limits of detection. Early case definitions and clinical expectations were informed by previous outbreaks and therefore did not fully reflect the transmission patterns and presentations observed in 2022. Biosurveillance performance depended not only on laboratory capacity but also on whether clinicians and public health systems recognized who should be tested (Minhaj et al., 2022). The case therefore demonstrates that biosurveillance sensitivity is partly determined by the assumptions embedded in case definitions, testing criteria and clinical awareness.

When a different mpox threat emerged in 2024, California again served as a national detection point. In November 2024, CDPH laboratory testing confirmed the first U.S. case of clade I mpox in a traveler who had recently returned from an affected area. State, local and federal authorities initiated contact investigation, and no additional U.S. cases had been identified at the time of the initial advisory (CDPH, 2024b). This later event demonstrates how travel history, laboratory capacity and heightened biosurveillance for an emerging international threat can converge to support early detection. The case was identified through a biosurveillance process implemented in the context of response to the international outbreak. CDPH had established daily statewide screening of electronic laboratory reports for results suggestive of clade I infection once the African outbreak was recognized internationally, and San Mateo County Health moved from a suspicious laboratory report to specimen collection on the same day (Levy et al., 2025).

The 2024 clade I response illustrates how international outbreak information can inform preparedness (Pathway A) while also prompting enhanced laboratory biosurveillance and case identification within California (Pathway B). The documented sequence establishes a connection between international outbreak awareness and California's biosurveillance response. However, without a suitable comparison, it does not establish how much detection time was reduced.

5.4 Ebola Virus Disease: Detection Under Changing Biosurveillance Conditions, 2014-2026

Ebola provides the strongest historical comparison in this chapter for examining how biosurveillance capacity relates to detection and outbreak response. The 2014 and 2021 outbreaks occurred

in Guinea under markedly different biosurveillance conditions, with substantial investment in laboratory infrastructure, workforce development, emergency response and biosurveillance capacity occurring between the two events. A third, still-evolving outbreak, in the DRC in 2026, is examined in Section 5.4.1.

The 2014 West African epidemic began in Guinea in December 2013 but was not identified as Ebola until March 2014. Retrospective investigation identified symptom onset in the index case on Dec. 26, 2013. Ebola virus was laboratory-confirmed on March 21, approximately three months later, after the disease had already spread beyond the initial community (WHO, 2015). The epidemic ultimately resulted in more than 28,600 reported cases and 11,325 deaths across the affected countries, primarily Guinea, Liberia and Sierra Leone, demonstrating the scale of the epidemic that followed delayed recognition and spread within fragile health systems (CDC, 2024).

When Ebola re-emerged in Guinea in 2021, the response environment was substantially different. The index case developed symptoms on Jan. 15 and died on Jan. 28. A cluster of Ebola cases was subsequently identified, and Guinea declared the outbreak on Feb. 14. Laboratory testing confirmed Ebola; national emergency mechanisms were activated; and contact tracing, vaccination, case management and biosurveillance were rapidly deployed. The outbreak ended with 23 reported cases, including 16 confirmed and seven probable cases (WHO, 2021).

The comparison should not be interpreted as a controlled experiment. The two outbreaks differed in epidemiological circumstances, and the available evidence cannot assign the difference in outcomes to biosurveillance investment alone. The contrast is nevertheless informative. After the 2014-2016 epidemic, Guinea retained laboratory infrastructure, trained personnel, biosurveillance experience and institutional relationships that were available when Ebola returned. WHO identified this accumulated experience and strengthened infrastructure as important components of the 2021 response (WHO, 2021; WHO Regional Office for Africa, 2021).

Neither outbreak produced a confirmed California case, but the comparison remains directly relevant to the chapter's central question. California's protection from threats emerging abroad depends partly on whether affected countries can recognize and report outbreaks before extensive international spread occurs. The Guinea experience demonstrates why global biosurveillance capacity matters to jurisdictions far beyond the country in which an outbreak begins: Earlier recognition at the source increases the opportunity for downstream health systems to prepare before a threat reaches them.

Biosurveillance sensitivity is partly determined by the assumptions embedded in case definitions, testing criteria and clinical awareness.

In November 2014, CDPH and the California Division of Occupational Safety and Health issued hospital requirements for protecting health care workers from Ebola that went beyond federal standards, and by December 2014 all five UC medical centers, including UCSF and UCLA, and three Kaiser Permanente hospitals had been designated as Ebola treatment centers following CDC on-site assessments (California Healthline, 2014; UCLA Health, 2014).

5.4.1 The 2026 Bundibugyo outbreak in the DRC: detection under constrained biosurveillance The 2026 Bundibugyo Ebola outbreak in the DRC provides a third and more contemporary biosurveillance context. Unlike the retrospective comparison between Guinea in 2014 and 2021, this outbreak is still evolving and should be interpreted cautiously. The DRC has more experience responding to Ebola than almost any other country, and U.S. agencies had invested heavily in its response capacity; USAID and CDC together contributed $361 million during the 2018-2020 outbreaks (Michaud & Kates, 2026).

On April 24, 2026, a DRC health worker was the first to report Ebola-like symptoms (Bendix et al., 2026). WHO was first alerted to suspected Ebola cases on May 5, but initial tests were negative because they were not designed to detect the Bundibugyo species (Ekberg et al., 2026); laboratory confirmation led the DRC to declare the outbreak on May 15. By the time CDC issued its health advisory, 246 suspected cases and 80 deaths had been reported, and WHO had declared a Public Health Emergency of International Concern on May 17 (CDC, 2026a). Genomic sequencing later indicated that the virus had been circulating since mid-February, roughly three months before the declaration, and many early cases were likely misdiagnosed as malaria or typhoid fever (Soucheray, 2026).

The epidemic has since become the second-largest Ebola outbreak on record (WHO, 2026b). By Sept. 13, 2026, the DRC had reported 7,258 confirmed cases and 3,510 deaths (WHO Regional Office for Africa, 2026b). At its August 2026 meeting, the IHR Emergency Committee concluded that the late detection of the epidemic and the resulting unprecedented growth in cases had outpaced the combined response capacity of the government and partners, despite what may be the fastest scale-up on record: 21 laboratories with Bundibugyo testing capacity and approximately 1,000 treatment beds, against an estimated need of 3,000 beds (WHO, 2026b). The Committee estimated that the true size of the epidemic was three to four times larger than what biosurveillance data showed (WHO, 2026b). CDC's own monitoring found that, for the three weeks ending Aug. 21, only 72% of validated alerts were tested; an average of 10.6 contacts were identified per confirmed case against a target of at least 20; and 59% of confirmed deaths occurred outside Ebola treatment units (Kabasele et al., 2026).

There is also direct, although largely qualitative, evidence that recent funding disruptions affected biosurveillance in the DRC. A physician in an affected area told Physicians for Human Rights that biosurveillance could no longer be carried out properly because of the disruption in USAID funding, and that health workers were paying for phone credit, fuel and transport themselves to continue surveillance activities (Physicians for Human Rights, 2026). Former USAID officials described several consequences of the decrease from more than $900 million to $179 million in humanitarian funding for DRC during the first year of the current administration: loss of support for sample transport, health worker training and community-based alerting, which ultimately led to delays in shipping samples and improperly shipped specimens that hampered testing (Lambert, 2026). The CDC's incident manager reported that the U.S. learned

of the outbreak only one day before it was declared (Lambert, 2026). The State Department has rejected these claims, with one official stating that no USAID person or program in the region would have detected the outbreak, and CDC has noted that it retains staff in both Uganda and the DRC (Kent & Hansler, 2026). These accounts are consistent with WHO's documented biosurveillance and operational gaps (WHO, 2026b), but they do not establish that the USAID terminations caused the delay or the scale of the epidemic.

Causal attribution therefore requires particular care. The 2026 outbreak involves a rare Ebola virus species for which standard field tests were not designed and no licensed vaccine or treatment exists (WHO, 2026a). Amid armed conflict, population displacement, high mobility and attacks on health facilities, specimens from Ituri had to travel more than 600 miles to Kinshasa for confirmation (Lambert, 2026; Reuters, 2026; WHO, 2026a). The interval between likely emergence and declaration may have been as long as three months (Ekberg et al., 2026; Soucheray, 2026). Each of these conditions independently complicates detection and containment. The outbreak should not be presented as proof that the termination of U.S. programs caused delayed detection. It is more appropriately interpreted as a contemporaneous stress test of what happens when a difficult outbreak emerges where biosurveillance and response systems are simultaneously under substantial resource and operational constraints. This case illustrates the continuing vulnerability of biosurveillance systems to diagnostic, operational and resource constraints, even in settings with substantial prior investment.

During the 2026 outbreak, CDPH issued a California Health Alert Network advisory on May 20, five days after the DRC declared its Bundibugyo virus outbreak (CDPH, 2026a). The advisory instructed clinicians to take Ebola-specific infection control precautions and notify the local health department when the disease was suspected, to isolate and manage symptomatic patients with exposure risks in a health care facility while test results were pending and to plan for possible transfer of confirmed patients to a Regional Emerging Special Pathogen Treatment Center. Local health departments were asked to notify CDPH of organizations sending California-based personnel to affected areas and of any person developing symptoms within 21 days of leaving them, and CDPH made its CalREDIE and CalCONNECT platforms available for daily symptom monitoring of returned travelers. CDC subsequently issued interim guidance recommending post-arrival assessment and 21-day monitoring of travelers from affected countries, including in-person monitoring for travelers who had been in the DRC (CDC, 2026b); CDPH issued an updated advisory on June 17 (CDPH, 2026b); and local health departments, working with CDPH, began monitoring returning travelers identified through federal entry screening (Sonoma County Department of Health Services, 2026).

California's response to the 2026 outbreak illustrates both pathways. Clinical advisories, infection-control precautions and coordination with specialized treatment centers demonstrate preparedness and response (Pathway A), while enhanced traveler monitoring and symptom surveillance reflect additional biosurveillance activities (Pathway B). No cases linked to the 2026 outbreak have been confirmed in California or elsewhere in the U.S., and the CDC continues to assess the risk to the American public as low (CDC, 2026d). Uganda brought the outbreak under control, with the last confirmed case reported on June 21, 2026. WHO and Africa CDC announced the end of the outbreak on August 27, following a 42-day monitoring period after the final patient's discharge on July 16 (WHO Regional Office for Africa, 2026a). These measures illustrate how international warnings can prompt both forms of action without establishing a measurable reduction in local detection time.

Clinical advisories, infection-control precautions and coordination with specialized treatment centers demonstrate preparedness and response, while enhanced traveler monitoring and symptom surveillance reflect additional biosurveillance activities.

An important constraint was the timing of recognition at the source. By the time the DRC declared the outbreak on May 15, it was already large and had crossed an international border (CDC, 2026a; CDPH, 2026a). Because downstream systems cannot recover time lost at the source, the prolonged period of undetected transmission in Ituri narrowed the window for an earlier international warning and raised concerns about the potential for exported cases, including during the elevated international travel associated with 2026 FIFA World Cup matches hosted in the Bay Area in June and July (County of Marin Department of Health and Human Services, 2026).

The 2026 outbreak therefore illustrates the interdependence of international biosurveillance and California's preparedness and monitoring activities. In 2021, earlier recognition at the source gave downstream health systems time to prepare. In 2026, delayed upstream recognition limited the opportunity for earlier warning, while international recognition, once it came, still allowed the state to undertake meaningful preparedness before any importation.

5.5 Dengue: Preparedness, Enhanced Biosurveillance and Delays in Detection

Dengue provides another key example of how international infectious disease activity can become a local public health concern in California through travel-associated introductions and mosquito-borne transmission. The presence of established Aedes mosquito populations creates conditions in which infected travelers may introduce dengue virus into communities where local transmission is possible. In 2024, California reported 720 dengue cases, including 702 travel-associated cases and 18 locally acquired infections across Los Angeles, San Diego and San Bernardino counties (California Department of Public Health, Vector-Borne Disease Section, 2025; Kiplagat et al., 2026). These cases illustrate the relevance of international dengue biosurveillance to California's infectious disease risk profile.

The 2024 Los Angeles County outbreak illustrates how biosurveillance information can inform public health preparedness and response.

The 2024 Los Angeles County outbreak illustrates how biosurveillance information can inform public health preparedness and response (Pathway A). From August through November, 14 locally acquired dengue cases were identified in the county. Los Angeles County had previously developed and exercised a dengue response plan using CDC Public Health Emergency Preparedness funding. Following identification of locally acquired infections, public health authorities implemented coordinated mosquito biosurveillance and control, community outreach, household investigations and health care provider advisories. These activities drew upon established relationships among local public health agencies, vector control districts, laboratories and state and federal partners (Vaughan et al., 2026).

The outbreak also highlighted the importance of enhanced biosurveillance (Pathway B). Public health authorities expanded case-finding activities through household testing, review of emergency department data and additional epidemiological investigations. Four of the 14 locally acquired infections were identified through household testing rather than routine clinical diagnosis. Nevertheless, delays in clinical recognition and testing remained significant. The investigation reported a median interval of 10 days from symptom onset to specimen collection in its detailed results, revealing missed opportunities for earlier diagnostic testing. In response to local transmission, public health advisories emphasized the importance of considering dengue in patients with compatible symptoms regardless of travel history, obtaining appropriate diagnostic tests and promptly reporting suspected infections (Vaughan et al., 2026).

For California, dengue demonstrates how preparedness and enhanced biosurveillance can operate together. International transmission and travel-associated introductions reinforce the need for early warning and coordinated public health response, while locally acquired cases reveal the importance of effective clinical recognition, laboratory testing and reporting. The investigation provides evidence that enhanced biosurveillance supported case identification and identified opportunities to reduce diagnostic delays. However, it does not establish that global biosurveillance investments produced a measurable reduction in the time required to detect dengue within California.

5.6 Measles: Detection of Vaccine-Preventable Disease

The U.S. has seen an increase in measles cases over the last 20 years, associated with declining vaccination coverage and vaccine hesitancy. In 2025, CDC data showed that childhood vaccination rates were continuing to decrease nationally, with vaccination exemptions reaching an all-time high, and many states reporting well below the measles, mumps and rubella (MMR) vaccination coverage of 95% generally needed for herd immunity (Johns Hopkins International Vaccine Access Center, 2025). With California having experienced several measles outbreaks, this vaccine-preventable disease illustrates how local, national and global biosurveillance systems protect the state from imported infections and potential local transmission.

In 2008, an intentionally unvaccinated child returning to California from Switzerland initiated an outbreak in San Diego that produced 11 further measles cases, exposed 839 people and required 48 infants too young for vaccination to be quarantined, at an estimated net public-sector cost of $10,376 per case (Sugerman et al., 2010). In December 2014, an exposure at the Disneyland theme parks in Orange County started the largest California measles outbreak since elimination. The index patient in that case developed a rash on Dec. 28, 2014, but CDPH was not notified until Jan. 5, 2015, roughly two and a half weeks after the likely exposure. As of Feb. 11, 2015, the outbreak had reached 125 cases nationally, including 110 in California. All 30 genotyped California specimens were genotype B3, which had recently caused a large outbreak in the Philippines and had been detected in at least 14 countries and six U.S. states in the preceding six months (Zipprich et al., 2015). More recently, the U.S. has been experiencing substantial measles outbreaks, with 4,410 confirmed cases reported as of Oct. 15, 2026 (CDC, 2026e). These figures exceed the annual totals reported in earlier outbreak years: 140 U.S. cases in 2008 and 667 in 2014. Given the surge in cases and the transmission capacity of such a contagious disease, the ability to rapidly respond through post-exposure prophylaxis and vaccination is vital (CDC, 2026e).

Responding to measles outbreaks can cost taxpayers upwards of tens of thousands of dollars per case, given the extensive public health and health care response required. A 2026 analysis found that the average outbreak cost per case is roughly $43,200, which increases to $58,600 when public health costs are included, and the fixed costs of public health response were estimated at $297,700 with an incremental cost of $16,300 for each additional case (Sriudomporn & Patenaude, 2026). In 2026, the investigation of just three cases cost Los Angeles County approximately $231,000, in the midst of which county health departments were struggling to absorb federal funding reductions (Hwang, 2026). As of Sept. 14, 2026, California had recorded 59 confirmed measles cases (CDPH, 2026c). In a September 2026 statement, CDPH reported that 94% of cases involved patients who were unvaccinated or whose vaccination status was unknown.

Importantly, in each case and subsequent outbreak, the time between introduction and recognition is important because delays may increase the potential impact through additional cases, contact tracing, quarantine, post-exposure prophylaxis and other pressures on the California public health system. Such outbreaks are resource-intensive and can strain public health systems while also stressing the trust communities have in their leaders. Post-pandemic vaccine hesitancy and declining vaccination coverage are likely to require additional interventions in outbreak response, further emphasizing the need for rapid detection and response (Johns Hopkins International Vaccine Access Center, 2025).

Amid the growing burden of measles in the U.S., there have been efforts to harness existing local, national and global biosurveillance networks to support rapid detection. There are CDC-supported wastewater testing programs across dozens of

Emerging Risks: Novel and Modified Pathogens

In addition to the emergence and re-emergence of known threats described in the case studies, California's biosurveillance system must also be prepared for threats that are novel and/or engineered, and may be overlooked compared to known pathogens. Simply put, it is vital to invest in biosurveillance programs that go beyond existing case definitions and diagnostic assays for prioritized pathogens.

The COVID-19 pandemic highlighted the testing challenges when defining and responding to a novel infectious disease, but this has also raised concerns about the adaptability of biosurveillance and biosecurity capabilities for novel pathogens (National Academies of Sciences, Engineering, and Medicine, 2025). Whether they emerge through natural evolution, deliberate engineering or an accidental release related to laboratory work, biosurveillance systems must be agile and robust in detecting and responding. These capabilities extend beyond laboratory methods to detecting surges in nonspecific illness in hospitals and changes in epidemiological trends (CDC, n.d.-a). Concerns around the risk of engineered and novel pathogens have only increased with AI-enabled biotechnology advancements, which further underscore the importance of adaptable detection capabilities (National Academies of Sciences, Engineering, and Medicine, 2025). Additionally, these capabilities are necessary for attribution should an intentional act occur (The White House, 2012).

While it is vital to invest in pathogen-agnostic biosurveillance capabilities, such as metagenomic sequencing (Chiu & Miller, 2019), it is also important to expand such programs to detect serious but often neglected threats, such as bacterial antimicrobial resistance (AMR), to which an estimated 1.14 million deaths globally were attributable in 2021 (GBD 2021 Antimicrobial Resistance Collaborators, 2024). The U.S. was estimated in 2019 to experience more than 2.8 million antimicrobial-resistant infections a year, with detection occurring mainly at the patient level (CDC, 2019). Wastewater-based surveillance offers a population-level complement for monitoring antimicrobial resistance (Kim et al., 2026).

California's role in a biosurveillance ecosystem capable of detecting emerging and converging risks extends beyond surveillance of known or prioritized pathogens. Investing in laboratory and genomic infrastructure and partnerships that support the detection of resistance genes in wastewater can help identify emerging threats. However, detecting resistance genes does not by itself establish a system's ability to identify novel or engineered biological threats, which underscores the importance of adaptable biosurveillance systems.

jurisdictions, with a total of 143 wastewater samples from 21 jurisdictions detecting the virus in 2025 — but many jurisdictions did not implement testing until after a case was already identified (Taibl, 2026). Additionally, some wastewater biosurveillance assays may not detect all circulating measles virus variants (Pray et al., 2026). This limitation underscores the importance of validating wastewater assays against circulating variants and confirming environmental signals through appropriate laboratory methods.

Despite these challenges, in June 2026, the Merced County Department of Public Health reported detection of the virus in local wastewater biosurveillance systems, which led to a community alert (The Merced Focus, 2026). The detection came through WastewaterSCAN, a national monitoring network run by Stanford University and Emory University, illustrating how participation in a broader biosurveillance network can extend early-warning capacity to smaller jurisdictions (Merced County Department of Public Health, 2026; WastewaterSCAN, n.d.). At the time of the alert, no clinical measles case had been confirmed locally. The wastewater finding therefore provided an environmental biosurveillance signal in the absence of confirmed case-based detection, although it does not establish that subsequent clinical detection occurred earlier. These lessons mirror those from mpox and Ebola experiences, in which early warning systems and corresponding interventions depended not only on effective detection tools, but also on global genomic data sharing and laboratory validation to ensure these tools match the pathogens posing a threat. The Merced County example illustrates how enhanced environmental biosurveillance can provide actionable information for local public health awareness and response. However, its direct contribution to reducing clinical detection time, or the extent to which it can be attributed to global biosurveillance investments, remains uncertain.

6. DISCUSSION

This chapter has examined whether and how U.S. and California-linked investments in global disease biosurveillance have contributed to earlier detection of infectious threats relevant to California. Across the three analytic layers, the evidence indicates that biosurveillance investments build capabilities that support early warning, preparedness and detection, although their contribution to reducing detection time within California is not equally established across the cases examined. The findings also show that California's health security depends on two interconnected forms of capacity: biosurveillance systems that recognize and communicate emerging threats internationally and California's own ability to detect and characterize threats once they arrive.

6.1 Interpreting the Evidence and the Counterfactual

Across all three layers of the analysis, the evidence supports a consistent relationship between biosurveillance investment and the capabilities needed for timely threat recognition and response. The investment-to-capability mapping identifies the laboratory systems, trained workforce, diagnostic capacity, reporting networks and genomic and environmental biosurveillance infrastructure created or sustained through U.S. and California-linked investment (Burns, 2020; Centers for Disease Control and Prevention, Center for Global Health, 2017; Montgomery et al., 2019). The timeline reconstruction shows how quickly selected threats were recognized in relation to their emergence or arrival in California, while the qualitative evidence provides operational

Biosurveillance resilience depends on maintaining both upstream detection and downstream state capacity.

context for understanding how those capabilities function in practice. The case studies add further detail by showing how specific biosurveillance capabilities operated under different outbreak conditions.

This relationship operates at two complementary levels. At the global level, biosurveillance capacity is relevant to the interval between a pathogen's emergence and its recognition and reporting. At the state level, California's own biosurveillance capacity affects how quickly an emerging threat can be detected and characterized once it reaches the state. The first detection of pandemic H1N1 in Southern California, COVIDNet's genomic sequencing capacity, wastewater monitoring for H5N1 and the first U.S. detection of clade I mpox demonstrate different ways in which California contributes to infectious disease detection rather than functioning solely as a recipient of external warnings (CDC, 2009; CDPH, 2024a, 2024b; Fry et al., 2012; Wadford et al., 2023; Wolfe et al., 2024).

These two levels are interdependent. California's internal biosurveillance infrastructure cannot fully compensate for delayed recognition of a threat at its source, just as an early international warning has limited value if state and local systems lack the capacity to act on it. Biosurveillance resilience therefore depends on maintaining both upstream detection and downstream state capacity. Taken together, the evidence traces a four-step chain: investment can strengthen detection capacity abroad; detection can provide lead time; California can use that warning to initiate specific preparedness and detection actions; and the loss of upstream capacity may compromise the timeliness and reliability of the information on which those actions depend. These actions may involve preparedness and public health response (Pathway A), enhanced biosurveillance (Pathway B) or both, depending on the threat and the documented response.

A central interpretive challenge is the counterfactual: What would California's detection timelines have looked like in the absence of these investments? The available evidence cannot answer this question directly. However, the 2024 clade I mpox case provides a limited example of what might have occurred without a specific biosurveillance capability. In the absence of California's enhanced electronic laboratory-report screening, identification of the case would have depended on other clinical and laboratory reporting pathways. The available evidence cannot establish whether those mechanisms would have identified the infection as promptly or whether detection would have been delayed. This illustrates the potential contribution of enhanced biosurveillance to timely detection without establishing a measurable reduction in detection time (Levy et al., 2025). Not all biosurveillance programs mapped in this study were operational during every outbreak examined, and the analysis therefore does not attribute individual detection events to the biosurveillance architecture as a whole. Instead, the investment mapping identifies capabilities that existed during different periods, while the case studies provide outbreak-specific evidence of which systems contributed in particular contexts.

The comparison between the 2014 and 2021 Ebola outbreaks provides a useful, although imperfect, approximation of how biosurveillance conditions can alter outbreak recognition and response. The 2014 outbreak emerged in a setting with substantial biosurveillance and laboratory limitations and remained unrecognized as Ebola for approximately three months (WHO, 2015). By 2021, Guinea had accumulated laboratory infrastructure, trained personnel, biosurveillance experience and institutional relationships developed in the aftermath of the West African epidemic. The later outbreak was recognized and contained substantially more rapidly (WHO, 2021; WHO Regional Office for Africa, 2021). Differences between the two events prevent causal attribution to biosurveillance investment alone, but the comparison illustrates the practical importance of having detection and response capacity in place before an outbreak occurs.

This also illustrates the asymmetric value of biosurveillance. When biosurveillance functions effectively, its benefits may be difficult to observe because early detection and containment can prevent a threat from developing into a larger emergency. The consequences of weakening biosurveillance capacity, by contrast, may become apparent only when the next threat emerges. Because trained personnel, laboratory networks, reporting relationships and institutional trust take time to develop, capacity lost during periods of retrenchment may not be rapidly restored during an emergency. For California, this means that the recent contractions in federal global health and biosurveillance funding, alongside disruptions to established partnerships, may carry costs that are not yet visible, including potential losses in early warning capacity during future outbreaks. In this context, sustaining the state's international partnerships and collaborations, through its academic institutions and its entry into GOARN, may help maintain access to international outbreak information and technical expertise alongside existing federal and international biosurveillance arrangements (Office of Governor Gavin Newsom, 2026).

6.2 What the Evidence Cannot Yet Establish

Three gaps define the limits of the current evidence and identify priorities for future research. First, although the evidence supports a pathway linking investment to biosurveillance capabilities and those capabilities to detection, it does not support a precise estimate of how much detection time was saved relative to the cost of specific investments. Such an estimate would require standardized accounting of biosurveillance investments, paired with comparable detection timelines across substantially more outbreak events. The qualitative analysis and investment-to-capability mapping should therefore be interpreted in aggregate as context for the timeline reconstruction rather than as evidence that a particular expenditure produced a specified reduction in detection time.

Second, translation latency, defined here as the interval between an initial global signal and actionable information reaching California public health authorities, remains inadequately measured. Quantifying this interval would require access to internal agency timestamps and additional structured key informant interviews across the WHO, CDC, CDPH and local health jurisdiction pathway. The interviews conducted for this study identify the importance of this process but do not provide sufficient data to quantify it.

Third, the economic value of an additional day of warning for California has not been established. A California-specific economic model could estimate the value of earlier warning and detection by linking changes in the timing of preparedness, detection and response to avoided morbidity, mortality, health-system burden and economic disruption. Such an analysis would provide a stronger basis for comparing the costs of maintaining biosurveillance capacity with the potential losses associated with delayed detection and response.

These limitations do not negate the relationships identified in this study. Rather, they define the boundary between demonstrating that biosurveillance investment contributes to detection capacity and determining precisely how much reduction in detection time can be attributed to a specific investment.

6.3 Implications for California Health Security and Other U.S. States

California's population size, international connectivity, agricultural sector and extensive human-animal interfaces create multiple pathways through which infectious threats emerging elsewhere can become relevant to the state (CDPH, 2024a, 2025; U.S. Census Bureau, 2026). Managing these risks requires both the state's internal biosurveillance capacity (e.g., CDPH, the Viral and Rickettsial Disease Laboratory, COVIDNet, university laboratories, wastewater biosurveillance and local health jurisdictions), and the wider national and international biosurveillance architecture on which that capacity depends (Wadford et al., 2023).

Yet this dependence is not unique to California. Other U.S. states also rely on federal and global systems to identify emerging threats, develop diagnostics, share genomic information, coordinate laboratory testing and communicate epidemiological intelligence. California is particularly useful as a case study because it combines extensive international connectivity with substantial state-level biosurveillance capacity and has repeatedly functioned as both a recipient and a producer of infectious disease intelligence.

Recent disruptions to federal and global biosurveillance programs therefore have implications beyond the programs directly affected. Reductions in laboratory networks, international partnerships, funding streams or information-sharing mechanisms may weaken the upstream systems on which states depend for early warning. California's internal capacity provides an important layer of protection, but it cannot fully substitute for biosurveillance at the point where an emerging pathogen first appears.

As such, weakened upstream detection capacity may increase California's vulnerability to a broad range of biological threats, including naturally emerging, accidental and deliberate events. Early detection and credible attribution are particularly important in responding to suspected deliberate or engineered threats, while sustained biosurveillance capabilities may also contribute to deterrence (The White House, 2012).

The erosion of federal channels described in this chapter has made California's direct engagement with the WHO GOARN increasingly consequential. GOARN provides an additional mechanism through which California can maintain three forms of global connection. First, it supports the sharing of epidemiological information: members participate in weekly operational calls, receive regular outbreak updates and have access to WHO's Epidemic Intelligence from Open Sources platform, which continuously scans open sources for signals of outbreaks and health events (WHO, n.d.-a). The CDPH director has described participation as helping the state anticipate threats earlier (Emanuel, 2026). Second, GOARN links California to technical expertise across a network of more than 350 institutions, including laboratories and academic centers (Emanuel, 2026). Third, it provides a pathway to coordinated emergency response capacity for events with cross-border or pandemic potential (Office of Governor Gavin Newsom, 2026).

Key informants viewed this development through the lens of federal retrenchment. KI-1 described California's entry into GOARN as an experimental approach amid gaps in federal engagement, and KI-2 identified GOARN as one of the channels through which global alerts are translated into California readiness actions. Both perspectives support the chapter's broader finding that global signals reach the state through layered and partly redundant pathways, with weakening of one pathway potentially increasing reliance on others. GOARN also creates an opportunity to formalize the global role of California's academic partners. UCSF, UCLA, Stanford, USC, Charles R. Drew University and members of the Alliance for Innovation in Global Health (formerly the Bay Area Global Health Alliance) hold epidemiological, laboratory, genomic and field expertise, including long-standing programs in the DRC (Alliance for Innovation in Global Health, n.d.; UCLA Fielding School of Public Health, n.d.), that could be linked to CDPH's participation in the network. Whether GOARN participation measurably shortens California's translation latency has not yet been documented and should be evaluated as part of the future research on translation latency outlined in Section 6.2.

GOARN participation also has clear limits. California participates as a subnational partner rather than a WHO member state, and WHO had not publicly clarified the state's status when it joined (Emanuel, 2026). Federal officials have stated that states do not set U.S. foreign policy, and observers have warned that states inside and outside the network could come to have unequal access to outbreak information; Illinois announced on Feb. 3, 2026, that it was joining GOARN (Office of Governor JB Pritzker, 2026). Most importantly, GOARN improves California's access to information once a signal exists. It does not restore the in-country advisers, laboratory support and frontline biosurveillance that generate those signals, and the 2026 DRC epidemic illustrates that this upstream gap cannot be closed through information sharing alone.

The policy implication is not that California should attempt to replicate the global biosurveillance architecture within the state. Rather, the evidence supports protecting the state-level capabilities that allow California to receive, interpret, verify and act on global signals while preserving its connections to federal and international biosurveillance networks. The lessons learned set out in Section 7 focus on strengthening those capabilities and reducing vulnerabilities identified across the three analytic layers.

Recent disruptions to federal and global biosurveillance programs have implications beyond the programs directly affected.

7.
LESSONS LEARNED AND CONCLUSION

7.1 Lessons Learned

One of the clearest lessons from this analysis is that California's biosurveillance capacity cannot be understood independently of the international systems on which it relies. The Ebola experience illustrates the importance and fragility of these systems in the case of a deadly pathogen that California and other jurisdictions are working to prevent from reaching their populations. The 2014-2016 West African epidemic began in Guinea in December 2013 but remained unrecognized as Ebola until March 2014 (WHO, 2015). It ultimately resulted in more than 11,000 deaths across the affected countries (CDC, 2024). When Ebola re-emerged in Guinea seven years later, it was recognized within about a month of the index case's first symptoms and contained at 23 cases, in a setting with laboratory capacity, trained personnel and response experience gained during the 2014–2016 epidemic (WHO, 2021; WHO Regional Office for Africa, 2021). In 2026, amid disruptions to international health programs and substantial diagnostic and operational constraints, Ebola caused by the Bundibugyo virus may have circulated in the DRC for approximately three months before the outbreak was declared, and it became the second-largest Ebola outbreak on record (WHO, 2026b). Differences between these outbreaks prevent attributing their outcomes to investment alone, but together they show that delays at the source reduce the opportunity for California to prepare, regardless of the strength of its domestic biosurveillance systems. California's participation in the WHO GOARN, together with the international partnerships of UCLA, UC Davis, UCSF and other California institutions, helps maintain scientific relationships and channels for exchanging outbreak information. These partnerships cannot, however, replace the overseas detection infrastructure historically supported through federal investment.

A related lesson is that the effectiveness of biosurveillance depends on the continuity of the institutions and personnel that sustain it. Laboratory networks, genomic sequencing capabilities and public health reporting systems are not established overnight. They rely on accumulated technical expertise, stable funding, established relationships and the ability of different organizations to work together. California's COVIDNet, Viral and Rickettsial Disease Laboratory and environmental biosurveillance networks demonstrate how these capabilities can be applied across different infectious disease threats. The termination of USAID programs and disruption of overseas health security partnerships have placed established laboratory support, trained personnel and reporting relationships at risk, although proposed reductions to CDC funding must be distinguished from enacted appropriations. Capabilities and relationships developed over many years may be difficult to restore once lost, particularly during an emerging public health emergency, which is why preserving workforce expertise and established partnerships is as important as investing in new detection technologies.

The case studies also demonstrate that early warning alone is insufficient unless public health authorities can translate information into appropriate action. Following international recognition of the clade I mpox outbreak in 2024, CDPH enhanced its screening of electronic laboratory reports, contributing to the identification of the first U.S. case. The H5N1 response similarly depended on coordination among veterinary, clinical, laboratory and environmental biosurveillance systems, and on connecting environmental signals with clinical and animal health investigations rather than relying on any single source of information. These examples reflect the two interconnected pathways identified in this chapter: international warning can support preparedness and public health response (Pathway A), while also prompting enhanced local biosurveillance and case identification (Pathway B). The effectiveness of both depends on communication, established operational procedures and coordination among the institutions responsible for receiving, interpreting and acting on information.

Finally, this analysis shows how little is known about what happens between the initial recognition of a threat and the subsequent public health response. Although this chapter documents international warning signals and subsequent preparedness and detection activities in California, the time required for information to move through international, federal, state and local systems remains inadequately measured. Understanding this translation latency would help distinguish delays in initial outbreak recognition from those associated with information sharing, verification, laboratory testing and implementation of public health measures. More systematic documentation of outbreak milestones and agency communication timelines would strengthen future assessments, including assessments of California's engagement with GOARN, and would provide a stronger basis for estimating the value of an earlier warning in avoided illness, health-system burden and economic disruption.

7.2 Conclusion

The experiences of influenza, COVID-19, mpox, Ebola, dengue and measles demonstrate that California's health security depends on an interconnected biosurveillance ecosystem extending from local laboratories to international detection networks. Together, international and domestic biosurveillance systems support the state's preparedness, detection capabilities and public health response. An international warning signal was available 27 days before California publicly announced its first confirmed COVID-19 cases, representing a potential preparedness window rather than detection time saved. Federal, state and local authorities used these international warnings and subsequent case detections to screen travelers, trace contacts, establish pathogen-specific laboratory testing, protect exposed workers and prepare hospitals. California has also contributed directly to pathogen detection, identifying the first laboratory-confirmed U.S. cases of pandemic H1N1 in 2009 and the first U.S. clade I mpox case in November 2024. Its genomic and wastewater networks provide additional information about circulating pathogens and environmental signals, including influenza A(H5), although wastewater findings alone cannot establish whether the source is human or animal.

These findings also reinforce important distinctions. Investments can strengthen early warning, preparedness and detection capabilities, yet demonstrating that any particular pathogen was detected sooner as a result is a separate matter and is more difficult to establish. Moreover, although research on outbreak timeliness associates longer detection intervals with worse outbreak outcomes, the extent to which specific investments reduced California's detection time remains uncertain. The evidence is therefore stronger for the contribution of biosurveillance investments to preparedness and detection capabilities than for quantifiable reductions in detection time attributable to individual investments. Rather than assuming that greater biosurveillance capacity necessarily results in shorter detection times, our findings underscore the importance of maintaining the capabilities that generate timely information, preserving the institutional relationships that allow it to reach California and strengthening the systems that translate it into public health action to support California's preparedness and response to future infectious disease threats.

Appendix A:

BIOSURVEILLANCE INVESTMENTS AND DOCUMENTED CONTRIBUTIONS TO DETECTION CAPACITY

To understand how U.S. investments in global biosurveillance architecture can affect time to detection, this table catalogs major biosurveillance programs supported through CDC, USAID and the Department of Defense, together with the U.S.-led GHSA and California-linked academic, laboratory and philanthropic partnerships. Each program was mapped according to its biosurveillance function, including laboratory strengthening, workforce development, genomic sequencing, event-based monitoring and environmental biosurveillance, and its documented outcomes, such as diagnostic tests established, outbreaks supported, personnel trained, laboratories strengthened and pathogens identified.

The mapping is intentionally conservative. It links investments to documented biosurveillance capabilities and examines how those capabilities relate to detection events, but it does not attempt to assign precise dollar-per-day reductions in detection time because the available evidence does not support that level of causal quantification. Instead, it provides a structured account of how biosurveillance capacity is built and how that capacity can contribute to earlier detection.

Program / partner	Primary funder	Biosurveillance function	Documented contribution	Approximate scale / period
Global Disease Detection (GDD)	CDC	Laboratory strengthening; outbreak response; workforce development	2,000+ outbreak investigations supported; 1,300+ received laboratory support; 380+ diagnostic tests established in 59 countries; 11 pathogens/organisms new to the world identified	GDD Centers; accomplishments reported for 2006-2016
PREDICT (UC Davis One Health Institute)	USAID	One Health zoonotic biosurveillance; laboratory and workforce capacity	Worked in 30+ countries; enabled zoonotic disease detection in 60+ laboratories; trained nearly 7,000 professionals; detected hundreds of novel viruses	2009-2020; approximately $207 million reported for 2009-2019
Global Health Security Agenda (GHSA)	Multilateral, U.S.-supported	Prevent-detect-respond capacity building	Framework involving more than 70 countries; U.S. investments supported partner-country health-security capacities and assessment against IHR/JEE-related targets	Launched 2014; ongoing framework
STRIDES	USAID	Infectious disease detection systems; human and animal laboratory networks	Designed to strengthen detection, monitoring, data collection, analysis and early-warning capacity in partner countries	$245 million activity; launched 2024; potential work in up to 50 countries
Global Emerging Infections Surveillance (GEIS)	U.S. Department of Defense	Global laboratory network; respiratory and other infectious disease biosurveillance	GEIS-supported biosurveillance contributed to detection of the first two U.S. novel H1N1 cases in 2009 and supports early warning through global partner laboratories	Established 1997; ongoing
California COVIDNet	CDPH and partners	Statewide genomic biosurveillance	50 laboratory partners; >450,000 genomes sequenced by COVIDNet partners; nearly 800,000 genomes with CDC-contracted laboratories; all 61 local health jurisdictions represented; >5% of reported positive tests sequenced	Implemented 2021; results reported through March 2023
VISTA / SpillOver (UC Davis)	UC Davis / Coalition for Epidemic Preparedness Innovations and partners	AI-assisted zoonotic and pandemic risk assessment	SpillOver initially ranked 887 wildlife viruses; VISTA now calculates risk scores for more than 1,000 viruses using AI-assisted tools and expert assessment	SpillOver launched 2021; VISTA ongoing
WastewaterSCAN	Stanford/Emory and philanthropic partners	Environmental biosurveillance and early warning	National wastewater network with H5 influenza monitoring; current dashboard includes approximately 196 sites nationally	Ongoing; site coverage changes over time

NOTE: Programs operated during different periods and should not be interpreted as contributing to every outbreak in Table 1. The table maps investments to documented capabilities and outputs; it does not estimate a dollar-per-day effect on detection time. Sources: CDC, Center for Global Health (2017) and Montgomery et al. (2019) for GDD; UC Davis One Health Institute (n.d.) and Salaam-Blyther (2020) for PREDICT; Global Health Security Agenda (n.d.) for GHSA; PATH (2024) for STRIDES; Early et al. (2024) and Burke et al. (2011) for GEIS; Wadford et al. (2023) for California COVIDNet; UC Davis Grand Challenges (n.d.) for VISTA/SpillOver; WastewaterSCAN (n.d.) for WastewaterSCAN.

REFERENCES

African Union. (2020, October 12). *US$100 million Africa Pathogen Genomics Initiative to boost disease surveillance and emergency response capacity in Africa* (Press Release No. 114/2020). *https://au.int/sites/default/files/pressreleases/39401-pr-pr_114_-_launch_of_africa_pgi_-_au.pdf*

Alliance for Innovation in Global Health. (n.d.). *Our story.* Retrieved October 19, 2026, from *https://aigh.org/our-story/*

Bendix, A., Smith, A., Edwards, E., & Williams, A. (2026, May 22). *Absence of USAID likely slowed Ebola detection and response, former officials say.* NBC News. *https://www.nbcnews.com/health/health-news/absence-usaid-likely-slowed-ebola-detection-response-former-officials-rcna345779*

Bogoch, I. I., Watts, A., Thomas-Bachli, A., Huber, C., Kraemer, M. U. G., & Khan, K. (2020). Pneumonia of unknown aetiology in Wuhan, China: Potential for international spread via commercial air travel. *Journal of Travel Medicine, 27*(2), Article taaa008. *https://doi.org/10.1093/jtm/taaa008*

Brito, A. F., Semenova, E., Dudas, G., Hassler, G. W., Kalinich, C. C., Kraemer, M. U. G., Ho, J., Tegally, H., Githinji, G., Agoti, C. N., Matkin, L. E., Whittaker, C., Howden, B. P., Sintchenko, V., Zuckerman, N. S., Mor, O., Blankenship, H. M., de Oliveira, T., Lin, R. T. P., . . . Faria, N. R. (2022). Global disparities in SARS-CoV-2 genomic surveillance. *Nature Communications, 13,* Article 7003. *https://doi.org/10.1038/s41467-022-33713-y*

Brown, N. M. (2025). *The Trump administration's foreign assistance review: Nuts and bolts issues and Congress's role* (CRS Report No. IN12567). Congressional Research Service. *https://www.congress.gov/crs_external_products/IN/PDF/IN12567/IN12567.1.pdf*

Burke, R. L., Vest, K. G., Eick, A. A., Sanchez, J. L., Johns, M. C., Pavlin, J. A., Jarman, R. G., Mothershead, J. L., Quintana, M., Palys, T., Cooper, M. J., Guan, J., Schnabel, D., Waitumbi, J., Wilma, A., Daniels, C., Brown, M. L., Tobias, S., Kasper, M. R., . . . AFHSC-GEIS Influenza Surveillance Writing Group. (2011). Department of Defense influenza and other respiratory disease surveillance during the 2009 pandemic. *BMC Public Health, 11*(Suppl. 2), Article S6. *https://doi.org/10.1186/1471-2458-11-S2-S6*

Burns, K. (2020, March 31). *PREDICT receives extension for COVID-19 pandemic emergency response.* University of California, Davis. *https://www.ucdavis.edu/coronavirus/news/predict-receives-extension-covid-19-pandemic-emergency-response*

California Animal Health and Food Safety Laboratory System. (n.d.). *California Animal Health & Food Safety Lab System.* University of California, Davis. Retrieved October 19, 2026, from *https://cahfs.vetmed.ucdavis.edu/*

California Department of Finance. (2021). *State of California total resident population, 1850 to 2020, and seats in House of Representatives, 1850 to 2020* [Data set]. *https://dof.ca.gov/media/docs/forecasting/Demographics/2020-census-demographics/California-Apportionment-1860-2020.pdf*

California Department of Food and Agriculture. (2024, August 30). *Avian influenza confirmed in three California dairy herds* (Release No. 24-099) [Press release]. *https://pressreleases.cdfa.ca.gov/HOME/PRESSRELEASE/62008965*

California Department of Public Health. (n.d.). *California Reportable Disease Information Exchange (CalREDIE).* Retrieved October 19, 2026, from *https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/CalREDIE.aspx*

California Department of Public Health. (2020, January 26). *Two confirmed cases of novel coronavirus in California* (NR20-001) [News release]. *https://www.cdph.ca.gov/Programs/OPA/Pages/NR20-001.aspx*

California Department of Public Health. (2022a, May 20). *Health advisory: Monkeypox virus infection in the United States and other non-endemic countries: Enhancing surveillance in California as of May 20, 2022* [Health advisory]. *https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/Health-Advisory-Monkeypox-Virus.aspx*

California Department of Public Health. (2022b). *Update on suspected case of monkeypox in Sacramento County* (NR22-090) [News release]. *https://www.cdph.ca.gov/Programs/OPA/Pages/NR22-090.aspx*

California Department of Public Health. (2024a, September 4). *Detection of highly pathogenic avian influenza (HPAI) A(H5N1) in California dairy cattle* [Health advisory]. *https://www.cdph.ca.gov/Programs/OPA/Pages/CAHAN/Detection-of-H5N1-in-California-dairy-cattle.aspx*

California Department of Public Health. (2024b, November 16). *California reports first known U.S. case of emerging mpox strain* (NR24-036) [News release]. *https://www.cdph.ca.gov/Programs/OPA/Pages/NR24-036.aspx*

California Department of Public Health. (2025). *Guidance for surveillance of and response to invasive Aedes mosquitoes and dengue, chikungunya, and Zika in California. https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/InvasiveAedesSurveillanceandResponseinCA.pdf*

California Department of Public Health. (2026a, May 20). *Ebola disease outbreak in the Democratic Republic of the Congo and Uganda* [Health advisory]. *https://www.cdph.ca.gov/Programs/OPA/Pages/CAHAN/Ebola-Disease-Outbreak-in-the-Democratic-Republic-of-the-Congo-and-Uganda.aspx*

California Department of Public Health. (2026b, June 17). *Ebola disease outbreak in the Democratic Republic of the Congo and Uganda update* [Health advisory]. *https://www.cdph.ca.gov/Programs/OPA/Pages/CAHAN/Ebola-Disease-Outbreak-in-the-Democratic-Republic-of-the-Congo-and-Uganda-Update.aspx*

California Department of Public Health. (2026c, September 18). [Measles exposure notice for an unvaccinated Amtrak passenger, with statewide case update] (NR26-031) [News release]. *https://www.cdph.ca.gov/Programs/OPA/Pages/NR26-031.aspx*

California Department of Public Health, Vector-Borne Disease Section. (2025, December 23). *Dengue infections in California* [Weekly update]. *https://westnile.ca.gov/pdfs/WeeklyUpdateDengueInfectionsCA.pdf*

California Governor's Office of Emergency Services. (2025). *After action report: 2022 monkeypox virus (mpox). https://www.caloes.ca.gov/wp-content/uploads/Preparedness/Documents/2022-Mpox-Virus-AAR-Final-Posted-508-Compliant-5.6.2025.pdf*

California Healthline. (2014, December 3). *CDC designates four California hospitals as Ebola treatment centers. https://californiahealthline.org/morning-breakout/cdc-designates-four-california-hospitals-as-ebola-treatment-centers*

Campbell, A. J., Shephard, M., Paulos, A. P., Pauly, M. D., Vu, M. N., Stenkamp-Strahm, C., Bushfield, K., Hunter-Binns, B., Sablon, O., Bendall, E. E., Fitzimmons, W. J., Brizuela, K., Quirk, G. E., Kumar, N., McCluskey, B., Shetty, N., Marr, L. C., Guthmiller, J. J., Santos, J. J. S., . . . Lakdawala, S. S. (2026). Surveillance on California dairy farms reveals multiple possible sources of H5N1 influenza virus transmission. *PLOS Biology, 24*(5), Article e3003761. *https://doi.org/10.1371/journal.pbio.3003761*

Centers for Disease Control and Prevention. (n.d.-a). *About NSSP.* Retrieved October 19, 2026, from *https://www.cdc.gov/nssp/php/about/index.html*

Centers for Disease Control and Prevention. (2024, February 20). *Ebola. https://www.cdc.gov/orr/responses/ebola-response.html*

CDC Centers for Disease Control and Prevention. (2009). Swine influenza A (H1N1) infection in two children: Southern California, March–April 2009. *Morbidity and Mortality Weekly Report, 58*(15), 400–402. *https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5815a5.htm*

Centers for Disease Control and Prevention. (2019). *Antibiotic resistance threats in the United States, 2019. https://www.cdc.gov/antimicrobial-resistance/data-research/threats/index.html*

Centers for Disease Control and Prevention. (2020a, January 17). *Public health screening to begin at 3 U.S. airports for 2019 novel coronavirus ("2019-nCoV")* [Press release]. *https://archive.cdc.gov/www_cdc_gov/media/releases/2020/p0117-coronavirus-screening.html*

Centers for Disease Control and Prevention. (2020b, January 21). *First travel-related case of 2019 novel coronavirus detected in United States* [Press release]. *https://archive.cdc.gov/www_cdc_gov/media/releases/2020/p0121-novel-coronavirus-travel-case.html*

Centers for Disease Control and Prevention. (2022, May 20). *Monkeypox virus infection in the United States and other non-endemic countries: 2022* (CDCHAN-00466) [Health advisory]. *https://archive.cdc.gov/www_cdc_gov/han/2022/han00466.html*

Centers for Disease Control and Prevention. (2024, February 20). *Ebola. https://www.cdc.gov/orr/responses/ebola-response.html*

Centers for Disease Control and Prevention. (2025a). *CDC budget overview: FY 2026*. U.S. Department of Health and Human Services. *https://stacks.cdc.gov/view/cdc/256297*

Centers for Disease Control and Prevention. (2025b, May 14). *About traveler-based genomic surveillance. https://www.cdc.gov/traveler-genomic-surveillance/about/index.html*

Centers for Disease Control and Prevention. (2026a, May 19). *Ebola disease outbreak in the Democratic Republic of the Congo and Uganda* (CDCHAN-00530) [Health advisory]. *https://www.cdc.gov/han/php/notices/han00530.html*

Centers for Disease Control and Prevention. (2026b, August 7). *Interim guidance for public health assessment and management of travelers from countries affected by the 2026 Ebola outbreak. https://www.cdc.gov/ebola/php/emergency-guidance/index.html*

Centers for Disease Control and Prevention. (2026c, September 4). *One Health Timeliness Analysis (OHTA) toolkit. https://www.cdc.gov/one-health/php/toolkit/timeliness-analysis.html*

Centers for Disease Control and Prevention. (2026d, October 13). *Ebola disease: Current situation. https://www.cdc.gov/ebola/situation-summary/index.html*

Centers for Disease Control and Prevention. (2026e, October 16). *Measles cases and outbreaks. https://www.cdc.gov/measles/data-research/index.html*

Centers for Disease Control and Prevention, Center for Global Health. (2017). *Global disease detection by the numbers: Select accomplishments from GDD centers, 2006–2016* [Infographic]. CDC Stacks. *https://stacks.cdc.gov/view/cdc/47650*

Charles R. Drew University of Medicine and Science. (n.d.). *Drew CARES*. Retrieved October 19, 2026, from *https://www.cdrewu.edu/community/drew-cares/*

Chiu, C. Y., & Miller, S. A. (2019). Clinical metagenomics. *Nature Reviews Genetics, 20*(6), 341–355. *https://doi.org/10.1038/s41576-019-0113-7*

CIRAD. (2021, January 11). *One Planet Summit: Launch of PREZODE, a first-ever international initiative to prevent future pandemics* [Press release]. *https://www.cirad.fr/en/press-area/press-releases/2021/prezode-preventing-pandemics*

Colorado v. U.S. Department of Health & Human Services, No. 1:25-cv-00121-MSM-LDA (D.R.I. May 16, 2025) (memorandum and order granting preliminary injunction). *https://www.rid.uscourts.gov/sites/rid/files/M%26O.pdf*

County of Marin Department of Health and Human Services. (2026, May 19). *Public health advisory: Ebola. https://hhs.marincounty.gov/public-health-notices/public-health-advisory-ebola*

County of Riverside. (2020, January 30). *Public Health Officer issues quarantine order. https://rivco.gov/node/190*

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE Publications. *https://us2.sagepub.com/en-us/nam/research-design/book270550*

Diop, O. M., Kew, O. M., de Gourville, E. M., & Pallansch, M. A. (2017). The Global Polio Laboratory Network as a platform for the viral vaccine-preventable and emerging diseases laboratory networks. *The Journal of Infectious Diseases, 216*(Suppl. 1), S299–S307. *https://doi.org/10.1093/infdis/jix092*

Early, J. M., Smith, H. J., Cinkovich, S. S., Gallaway, M. S., Stager, C. N., & Kasper, M. R. (2024). The central role of the Global Emerging Infections Surveillance program in supporting force health protection. *Emerging Infectious Diseases, 30*(Suppl. 14), 3–8. *https://doi.org/10.3201/eid3014.240304*

Ekberg, R., Ferragamo, M., & Roy, D. (2026, July 13). *The Ebola outbreak in the DRC is spreading. Here's what to know.* Council on Foreign Relations. *https://www.cfr.org/articles/africa-has-faced-a-rare-ebola-outbreak-for-months-heres-what-to-know*

Elbe, S. (2010). *Security and global health: Toward the medicalization of insecurity*. Polity. *https://gov.wiley.com/WileyCDA/WileyTitle/productCd-0745643744.html*

Emanuel, G. (2026, February 3). *As the U.S. bids adieu to the World Health Organization, California says hello.* CapRadio. *https://www.capradio.org/articles/2026/02/03/as-the-us-bids-adieu-to-the-world-health-organization-california-says-hello/*

Exec. Order No. 14155, 90 Fed. Reg. 8361 (2025). *https://www.federalregister.gov/d/2025-01957*

Fleming Fund. (n.d.). *The Fleming Fund*. Retrieved October 19, 2026, from *https://www.flemingfund.org/*

Fraser, C., Riley, S., Anderson, R. M., & Ferguson, N. M. (2004). Factors that make an infectious disease outbreak controllable. *Proceedings of the National Academy of Sciences, 101*(16), 6146–6151. *https://doi.org/10.1073/pnas.0307506101*

Freifeld, C. C., Mandl, K. D., Reis, B. Y., & Brownstein, J. S. (2008). HealthMap: Global infectious disease monitoring through automated classification and visualization of Internet media reports. *Journal of the American Medical Informatics Association, 15*(2), 150–157. *https://doi.org/10.1197/jamia.M2544*

Frieden, T. R., Lee, C. T., Bochner, A. F., Buissonnière, M., & McClelland, A. (2021). 7-1-7: An organising principle, target, and accountability metric to make the world safer from pandemics. *The Lancet, 398*(10300), 638–640. *https://doi.org/10.1016/S0140-6736(21)01250-2*

Fry, A. M., Hancock, K., Patel, M., Gladden, M., Doshi, S., Blau, D. M., Sugerman, D., Veguilla, V., Lu, X., Noland, H., Bai, Y., Maroufi, A., Kao, A., Kriner, P., Lopez, K., Ginsberg, M., Jain, S., Olsen, S. J., Katz, J. M., & Influenza Serology Working Group. (2012). The first cases of 2009 pandemic influenza A(H1N1) virus infection in the United States: A serologic investigation demonstrating early transmission. *Influenza and Other Respiratory Viruses, 6*(3), e48–e53. *https://doi.org/10.1111/j.1750-2659.2012.00339.x*

GBD 2021 Antimicrobial Resistance Collaborators. (2024). Global burden of bacterial antimicrobial resistance 1990–2021: A systematic analysis with forecasts to 2050. *The Lancet, 404*(10459), 1199–1226. *https://doi.org/10.1016/S0140-6736(24)01867-1*

Global Health Security Agenda. (n.d.). Membership. Retrieved October 31, 2026, from *https://globalhealthsecurityagenda.org/membership/*

Global Health Technologies Coalition. (n.d.). *Bay Area Global Health Alliance* [Member profile]. Retrieved October 19, 2026, from *https://blog.ghtcoalition.org/our-members/bagha*

Hadfield, J., Megill, C., Bell, S. M., Huddleston, J., Potter, B., Callender, C., Sagulenko, P., Bedford, T., & Neher, R. A. (2018). Nextstrain: Real-time tracking of pathogen evolution. *Bioinformatics, 34*(23), 4121–4123. *https://doi.org/10.1093/bioinformatics/bty407*

Homeland Security Presidential Directive 21: Public health and medical preparedness. (2007, October 18). *Weekly Compilation of Presidential Documents, 43*(42), 1364–1372. *https://www.govinfo.gov/content/pkg/WCPD-2007-10-22/html/WCPD-2007-10-22-Pg1364.htm*

Hwang, K. (2026, March 2). *Pockets of unvaccinated communities are driving measles outbreaks in California.* CalMatters. *https://calmatters.org/health/2026/03/measles-california-counties-surveillance-outbreak/*

Johns Hopkins International Vaccine Access Center. (2025, August 20). *Across the U.S., childhood vaccination rates continue to decline.* Johns Hopkins Bloomberg School of Public Health. *https://publichealth.jhu.edu/ivac/2025/across-the-us-childhood-vaccination-rates-continue-to-decline*

Kabasele, D., Meyer, E., Kabore, I., Dismer, A., Kabamba, J. K., Bratcher, A., Kabwe Kola, C., Eggers, C., Zomahoun, D., Hall, N., Ekwanzala, M. D., Peters, N., Schuh, A., Sealy, T., Ricks, P., Mpianga Mutombo, B., Kinzer, M., Dahl, B. A., Kabore, H., . . . CDC 2026 Ebola Response International Epidemiology and Laboratory Task Force. (2026). Notes from the field: Characteristics and monitoring of the 2026 outbreak of Ebola disease caused by Bundibugyo virus: Democratic Republic of the Congo, August 2026. *Morbidity and Mortality Weekly Report, 75*(35), 554–556. *https://doi.org/10.15585/mmwr.mm7535e1*

Kandel, N., Chungong, S., Omaar, A., & Xing, J. (2020). Health security capacities in the context of COVID-19 outbreak: An analysis of International Health Regulations annual report data from 182 countries. *The Lancet, 395*(10229), 1047–1053. *https://doi.org/10.1016/S0140-6736(20)30553-5*

Kent, L., & Hansler, J. (2026, May 22). *US funding cuts have hampered response to the deadly Ebola crisis, aid workers say.* CNN. *https://www.cnn.com/2026/05/22/africa/ebola-us-aid-cuts-drc-uganda-intl*

Kim, S., Zulli, A., Chan, E. M. G., Duong, D., Linfield, R. Y., McCormack, C. E. M., White, B. J., Wolfe, M. K., Boehm, A. B., & Pickering, A. J. (2026). Wastewater surveillance reveals patterns of antibiotic resistance across the United States. *Nature Communications, 17,* Article 4680. *https://doi.org/10.1038/s41467-026-71195-4*

Kim, S., Kayiwa, J., Fieldhouse, J. K., Nakiire, L., Lamorde, M., Makumbi, I., & Lee, C. T. (2025). Association between timeliness of detection, notification and response and the magnitude, severity and duration of disease outbreaks: A retrospective review of 84 outbreaks in Uganda, 2017–2022. *BMJ Global Health, 10*(11), Article e020034. *https://doi.org/10.1136/bmjgh-2025-020034*

Kiplagat, S. J., Rodriguez, D. M., Rivera, A., Paz-Bailey, G., Wong, J. M., & Adams, L. E. (2026). Increase in travel-associated and locally acquired dengue cases — United States, 2024. *Morbidity and Mortality Weekly Report, 75*(18), 227–233. *https://doi.org/10.15585/mmwr.mm7518a1*

Kowalski, C. P., Nevedal, A. L., Finley, E. P., Young, J. P., Lewinski, A. A., Midboe, A. M., & Hamilton, A. B. (2024). Planning for and assessing rigor in rapid qualitative analysis (PARRQA): A consensus-based framework for designing, conducting, and reporting. *Implementation Science, 19,* Article 71. *https://doi.org/10.1186/s13012-024-01397-1*

Kraemer, M. U. G., Tsui, J. L.-H., Chang, S. Y., Lytras, S., Khurana, M. P., Vanderslott, S., Bajaj, S., Scheidwasser, N., Curran-Sebastian, J. L., Semenova, E., Zhang, M., Unwin, H. J. T., Watson, O. J., Mills, C., Dasgupta, A., Ferretti, L., Scarpino, S. V., Koua, E., Morgan, O., . . . Bhatt, S. (2025). Artificial intelligence for modelling infectious disease epidemics. *Nature, 638*(8051), 623–635. *https://doi.org/10.1038/s41586-024-08564-w*

Lambert, J. (2026, May 21). *U.S. aid cuts may have delayed detecting this Ebola outbreak.* NPR. *https://www.npr.org/2026/05/21/nx-s1-5828951/aid-cuts-may-have-contributed-to-delay-in-identifying-current-ebola-outbreak*

Levy, V., Branzuela, A., Hsieh, K., Getabecha, S., Berumen, R., III, Saadeh, K., Snyder, R. E., Marek, G., Dodson, D., Newman, A., Hacker, J. K., Kath, C., Minhaj, F. S., Gigante, C. M., Gearhart, S., Kallen, A., Hutson, C. L., Jacobson, K., & Clade I Mpox Response Team. (2025). First clade Ib monkeypox virus infection reported in the Americas: California, November 2024. *Morbidity and Mortality Weekly Report, 74*(4), 44–49. *https://doi.org/10.15585/mmwr.mm7404a1*

Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., Ren, R., Leung, K. S. M., Lau, E. H. Y., Wong, J. Y., Xing, X., Xiang, N., Wu, Y., Li, C., Chen, Q., Li, D., Liu, T., Zhao, J., Liu, M., . . . Feng, Z. (2020). Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. *The New England Journal of Medicine, 382*(13), 1199–1207. *https://doi.org/10.1056/NEJMoa2001316*

Linthicum, K. J., Kramer, V. L., Madon, M. B., Fujioka, K., & Surveillance-Control Team. (2003). Introduction and potential establishment of Aedes albopictus in California in 2001. *Journal of the American Mosquito Control Association, 19*(4), 301–308.

Los Angeles County Department of Public Health. (2020, January 26). [Press release confirming the first case of 2019 novel coronavirus in Los Angeles County]. Reproduced in Long Beach Report. *https://www.lbreport.com/news/jan20/virus1.htm*

Merced County Department of Public Health. (2026, June 5). *Public health confirms measles wastewater detection in Merced* [Press release]. *https://myemail.constantcontact.com/Public-Health-Confirms-Measles-Wastewater-Detection-in-Merced.html?aid=SRLYAyA_4a4&soid=1134023258165*

The Merced Focus. (2026, June 5). *Measles virus detected in Merced County wastewater, public health officials say. https://themercedfocus.org/measles-virus-detected-in-merced-county-wastewater-public-health-officials-say/*

Michaud, J., & Kates, J. (2026, May 23). *Is the U.S. stepping up in the fight against Ebola?* KFF. *https://www.kff.org/global-health-policy/is-the-u-s-stepping-up-in-the-fight-against-ebola/*

Michaud, J., Moss, K., & Kates, J. (2023, July 25). *The U.S. government and global health security.* KFF. *https://www.kff.org/global-health-policy/the-u-s-government-and-global-health-security/*

Minhaj, F. S., Ogale, Y. P., Whitehill, F., Schultz, J., Foote, M., Davidson, W., Hughes, C. M., Wilkins, K., Bachmann, L., Chatelain, R., Donnelly, M. A. P., Mendoza, R., Downes, B. L., Roskosky, M., Barnes, M., Gallagher, G. R., Basgoz, N., Ruiz, V., Kyaw, N. T. T., . . . Monkeypox Response Team 2022. (2022). Monkeypox outbreak: Nine states, May 2022. *Morbidity and Mortality Weekly Report, 71*(23), 764–769. *https://doi.org/10.15585/mmwr.mm7123e1*

Montgomery, J. M., Woolverton, A., Hedges, S., Pitts, D., Alexander, J., Ijaz, K., Angulo, F., Dowell, S., Katz, R., & Henao, O. (2019). Ten years of global disease detection and counting: Program accomplishments and lessons learned in building global health security. *BMC Public Health, 19*(Suppl. 3), Article 510. *https://doi.org/10.1186/s12889-019-6769-2*

National Academies of Sciences, Engineering, and Medicine. (2025). *The age of AI in the life sciences: Benefits and biosecurity considerations.* The National Academies Press. *https://doi.org/10.17226/28868*

National Center for Immunization and Respiratory Diseases (U.S.). (2019, May 8). *2009 H1N1 pandemic timeline.* Centers for Disease Control and Prevention. *https://stacks.cdc.gov/view/cdc/79994*

Office of Governor Gavin Newsom. (2024, December 18). *Governor Newsom takes proactive action to strengthen robust state response to bird flu* [Press release]. *https://www.gov.ca.gov/2024/12/18/governor-newsom-takes-proactive-action-to-strengthen-robust-state-response-to-bird-flu/*

Office of Governor Gavin Newsom. (2025, April 23). *California is now the 4th largest economy in the world* [Press release]. *https://www.gov.ca.gov/2025/04/23/california-is-now-the-4th-largest-economy-in-the-world/*

Office of Governor Gavin Newsom. (2026, January 23). *Governor Newsom meets with World Health Organization Director-General, announces California becomes first state to join WHO-coordinated international network* [Press release]. *https://www.gov.ca.gov/2026/01/23/governor-newsom-meets-with-world-health-organization-director-general-announces-california-becomes-first-state-to-join-who-coordinated-international-network/*

Office of Governor JB Pritzker. (2026, February 3). *Illinois joins the World Health Organization's Global Outbreak Alert and Response Network* [Press release]. *https://gov-pritzker-newsroom.prezly.com/illinois-joins-the-world-health-organizations-global-outbreak-alert-and-response-network*

PATH. (2024, November 13). PATH as a major sub-partner for USAID-funded STRIDES activity. *https://www.path.org/our-impact/media-center/path-as-a-major-sub-partner-for-usaid-funded-strides-activity/*

Peters, L., Lee, T., & KTVU Staff. (2022, July 28). *San Francisco declares public health emergency over monkeypox*. KTVU FOX 2. *https://www.ktvu.com/news/san-francisco-declares-public-health-emergency-over-monkeypox*

Physicians for Human Rights. (2026, May 21). *"Failures of 'America First Global Health'": U.S. global health cuts and DRC conflict fuel Ebola crisis* [Press release]. *https://phr.org/news/failures-of-america-first-global-health-u-s-global-health-cuts-and-drc-conflict-fuel-ebola-crisis/*

Pray, I., Roguet, A., Dutcher, H. A., Schauer, S., Deraedt, M., Rasmussen, M., Westergaard, R., Antkiewicz, D., Henning, E., Everett, D., & Shafer, M. (2026). Genotype-specific detection of measles virus using wastewater surveillance — Wisconsin, February 2026. *Morbidity and Mortality Weekly Report, 75*(27), 344–348. *https://doi.org/10.15585/mmwr.mm7527a1*

Prest, M. J. (2021, November 3). *Rockefeller Foundation commits $150 million to Pandemic Prevention Institute*. The Chronicle of Philanthropy. *https://www.philanthropy.com/news/rockefeller-foundation-commits-150-million-to-pandemic-prevention-institute/*

ProMED-mail. (2019, December 30). *Undiagnosed pneumonia – China (HU): RFI* (Archive No. 20191230.6864153). International Society for Infectious Diseases. *https://scholar.harvard.edu/sites/scholar.harvard.edu/files/kleelerner/files/20191230_promed_-_undiagnosed_pneumonia_-_china_hu-_rfi_archive_number-_20191230.6864153.pdf*

Reporting to the Local Health Authority, Cal. Code Regs. tit. 17, § 2500 (2022). *https://www.law.cornell.edu/regulations/california/17-CCR-2500*

Reuters. (2026, July 16). *Ebola patients, responders flee attack on Congo hospital*. The Star. *https://www.thestar.com.my/news/world/2026/07/16/ebola-patients-responders-flee-attack-on-congo-hospital*

Rolland, C., Lazarus, C., Giese, C., Monate, B., Travert, A.-S., & Salomon, J. (2020). Early detection of public health emergencies of international concern through undiagnosed disease reports in ProMED-Mail. *Emerging Infectious Diseases, 26*(2), 336–339. *https://doi.org/10.3201/eid2602.191043*

Rubio, M. [@marcorubio]. (2025, March 10). *After a 6 week review we are officially cancelling 83% of the programs at USAID* [Post]. X. *https://x.com/marcorubio/status/1899021361797816325*

Rweyemamu, M., Kambarage, D., Karimuribo, E., Wambura, P., Matee, M., Kayembe, J.-M., Mweene, A., Neves, L., Masumu, J., Kasanga, C., Hang'ombe, B., Kayunze, K., Misinzo, G., Simuunza, M., & Paweska, J. T. (2013). Development of a One Health national capacity in Africa. In J. S. Mackenzie, M. Jeggo, P. Daszak, & J. A. Richt (Eds.), *One Health: The human-animal-environment interfaces in emerging infectious diseases* (pp. 73–91). Springer. *https://doi.org/10.1007/82_2012_244*

Salaam-Blyther, T. (2020, March 16). *The Global Health Security Agenda (GHSA): 2020–2024* (CRS In Focus No. IF11461). Congressional Research Service. *https://www.congress.gov/crs_external_products/IF/PDF/IF11461/IF11461.2.pdf*

Scripps Research. (n.d.). *Networks*. Retrieved October 31, 2026, from *https://www.scripps.edu/science/translational-institute/about/networks/*

Scripps Research. (2026, July 1). *Scripps Research scientists awarded $2M to advance global disease surveillance* [Press release]. *https://www.scripps.edu/news-events/news/scripps-research-scientists-awarded-2m-to-advance-global-disease-surveillance/*

Shu, Y., & McCauley, J. (2017). GISAID: Global initiative on sharing all influenza data – from vision to reality. *Eurosurveillance, 22*(13), Article 30494. *https://doi.org/10.2807/1560-7917.ES.2017.22.13.30494*

Sonoma County Department of Health Services. (2026, July 23). *Ebola disease outbreak in the Democratic Republic of the Congo and Uganda* [Health advisory]. *https://sonomacounty.gov/ebola-disease-outbreak-in-the-democratic-republic-of-the-congo-and-uganda*

Soucheray, S. (2026, August 10). *WHO: Ebola outbreak began in February, deaths near 2,000*. CIDRAP. *https://www.cidrap.umn.edu/ebola/who-ebola-outbreak-began-february-deaths-near-2000*

Sriudomporn, S., & Patenaude, B. (2026). Quantifying the cost of measles outbreaks in the U.S. and how costs scale with outbreak size. *Vaccine, 91,* Article 129040. *https://doi.org/10.1016/j.vaccine.2026.129040*

Sugerman, D. E., Barskey, A. E., Delea, M. G., Ortega-Sanchez, I. R., Bi, D., Ralston, K. J., Rota, P. A., Waters-Montijo, K., & LeBaron, C. W. (2010). Measles outbreak in a highly vaccinated population, San Diego, 2008: Role of the intentionally undervaccinated. *Pediatrics, 125*(4), 747–755. *https://doi.org/10.1542/peds.2009-1653*

Taibl, K. (2026, April 22). *National wastewater surveillance of wild-type measles virus to support measles outbreak response: United States, March–December 2025* [Conference presentation]. CDC Epidemic Intelligence Service Conference. *https://www.cdc.gov/eis-conference/php/abstracts/national-wastewater-surveillance-of-wild-type-measles-virus-to-support-measles-outbreak-response.html*

Thompson, D. (2022, August 2). *California governor declares monkeypox state of emergency*. AP News. *https://apnews.com/article/health-california-san-francisco-gavin-newsom-government-and-politics-535ad6616cf2551e57ae5d665816cac8*

Tollestrup, J., & Lynch, K. E. (2026). *Status of FY2026 Labor, Health and Human Services, and Education appropriations: In brief* (CRS Report No. R48616). Congressional Research Service. *https://www.congress.gov/crs-product/R48616*

UC Davis Grand Challenges. (n.d.). *CEPI Virus Intelligence and Strategic Threat Assessment (VISTA) project*. Retrieved October 31, 2026, from *https://grandchallenges.ucdavis.edu/vista/*

UC Davis One Health Institute. (n.d.). *PREDICT project*. Retrieved October 31, 2026, from *https://ohi.vetmed.ucdavis.edu/node/1106*

UCLA Fielding School of Public Health. (n.d.). *Anne Rimoin* [Faculty profile]. Retrieved October 19, 2026, from *https://ph.ucla.edu/about/faculty-staff-directory/anne-rimoin*

UCLA Fielding School of Public Health. (2023). A history of impact: 2000s–2010s. *https://ph.ucla.edu/news-events/ucla-fsph-public-health-magazine/ucla-magazine-60th-anniversary-issue-building-8*

UCLA Health. (2014, December 18). *All UC medical centers designated as Ebola treatment centers*. *https://www.uclahealth.org/news/release/all-uc-medical-centers-designated-as-ebola-treatment-centers*

UCSF Institute for Global Health Sciences. (n.d.). *IGHS's COVID work expands to include watching for new emerging viruses in high-risk countries*. Retrieved October 19, 2026, from *https://globalhealthsciences.ucsf.edu/news-ighss-covid-work-expands-include-watching-new-emerging-viruses-high-risk-countries-2/*

U.S. Census Bureau. (2026, January 27). *U.S. population growth slows due to historic decline in net international migration* [Press release]. *https://www.census.gov/newsroom/press-releases/2026/population-growth-slows.html*

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. (2024, December 6). USDA announces new federal order, begins National Milk Testing Strategy to address H5N1 in dairy herds [News release]. *https://www.aphis.usda.gov/news/agency-announcements/usda-announces-new-federal-order-begins-national-milk-testing-strategy*

U.S. Department of State. (2024, June 28). *Biosecurity Engagement Program (BEP)* [Biological Weapons Convention Article X assistance offer]. *https://bwc-articlex.unog.ch/node/278*

U.S. Agency for International Development. (2023). USAID's Global Health Security Program: Strengthening capacity to prepare the world for emerging infectious disease threats. *https://files.simpler.grants.gov/opportunities/356765/attachments/343663/USAID_Global_Health_Security_Framing_Document.pdf*

U.S. Government Accountability Office. (2024). *Weapons of mass destruction: DHS has made progress in some areas, but additional improvements are needed* (GAO-24-107426). *https://www.gao.gov/products/gao-24-107426*

U.S. Senate Committee on Foreign Relations. (2025, May 14). The dangerous consequences of funding cuts to U.S. global health programs [Press release]. *https://www.foreign.senate.gov/press/dem/release/the-dangerous-consequences-of-funding-cuts-to-us-global-health-programs*

Vaughan, A. M., Park, C., Ngo, V. P., Contreras, Z. A., Lee, J. J., Danza, P., Haddix, M., Moir, O., Green, N., Brown, M., Burleson, T., Marutani, A., Nicholas, A., Hallum, T., Vetrone, S., Ortiz, L., Fernandez, G., El-Tobgy, E., Escobar, J., . . . Halai, U.-A. (2026). Investigation of and response to autochthonous dengue, Los Angeles County, California, USA, August–November 2024. *Emerging Infectious Diseases, 32*(5), 720–727. *https://doi.org/10.3201/eid3205.251812*

Vaz, R. G., Mkanda, P., Banda, R., Komkech, W., Ekundare-Famiyesin, O. O., Onyibe, R., Abidoye, S., Nsubuga, P., Maleghemi, S., Hannah-Murele, B., & Tegegne, S. G. (2016). The role of the polio program infrastructure in response to Ebola virus disease outbreak in Nigeria 2014. *The Journal of Infectious Diseases, 213*(Suppl. 3), S140–S146. *https://doi.org/10.1093/infdis/jiv581*

Wadford, D. A., Baumrind, N., Baylis, E. F., Bell, J. M., Bouchard, E. L., Crumpler, M., Foote, E. M., Gilliam, S., Glaser, C. A., Hacker, J. K., Ledin, K., Messenger, S. L., Morales, C., Smith, E. A., Sevinsky, J. R., Corbett-Detig, R. B., DeRisi, J., & Jacobson, K. (2023). Implementation of California COVIDNet: A multi-sector collaboration for statewide SARS-CoV-2 genomic surveillance. *Frontiers in Public Health, 11,* Article 1249614. *https://doi.org/10.3389/fpubh.2023.1249614*

WastewaterSCAN. (n.d.). About. Retrieved October 31, 2026, from *https://www.wastewaterscan.org/about*

The White House. (2012). *National strategy for biosurveillance. https://obamawhitehouse.archives.gov/sites/default/files/National_Strategy_for_Biosurveillance_July_2012.pdf*

Wolfe, M. K., Duong, D., Shelden, B., Chan, E. M. G., Chan-Herur, V., Hilton, S., Paulos, A. H., Xu, X.-R. S., Zulli, A., White, B. J., & Boehm, A. B. (2024). Detection of hemagglutinin H5 influenza A virus sequence in municipal wastewater solids at wastewater treatment plants with increases in influenza A in spring, 2024. *Environmental Science & Technology Letters, 11*(6), 526–532. *https://doi.org/10.1021/acs.estlett.4c00331*

World Bank. (2022, June 30). *World Bank Board approves new fund for pandemic prevention, preparedness and response (PPR)* [Press release]. *https://www.worldbank.org/en/news/press-release/2022/06/30/world-bank-board-approves-new-fund-for-pandemic-prevention-preparedness-and-response-ppr*

World Health Organization. (n.d.-a). *Epidemic intelligence from open sources.* Retrieved October 19, 2026, from *https://www.who.int/initiatives/eios*

World Health Organization. (n.d.-b). *Global Antimicrobial Resistance and Use Surveillance System (GLASS).* Retrieved October 19, 2026, from *https://www.who.int/initiatives/glass*

World Health Organization. (n.d.-c). *Global Influenza Surveillance and Response System (GISRS).* Retrieved October 19, 2026, from *https://www.who.int/initiatives/global-influenza-surveillance-and-response-system*

World Health Organization. (n.d.-d). *International health regulations.* Retrieved October 31, 2026, from *https://www.who.int/health-topics/international-health-regulations*

World Health Organization. (n.d.-e). *The WHO Hub for Pandemic and Epidemic Intelligence.* Retrieved October 19, 2026, from *https://pandemichub.who.int/about*

World Health Organization. (2015). *Origins of the 2014 Ebola epidemic. https://www.who.int/news-room/spotlight/one-year-into-the-ebola-epidemic/origins-of-the-2014-ebola-epidemic*

World Health Organization. (2016). *International Health Regulations (2005)* (3rd ed.). *https://www.who.int/publications/i/item/9789241580496*

World Health Organization. (2020, June 29). *Listings of WHO's response to COVID-19. https://www.who.int/news/item/29-06-2020-covidtimeline*

World Health Organization. (2021, June 19). *Ebola virus disease: Guinea* (Disease Outbreak News). *https://www.who.int/emergencies/disease-outbreak-news/item/2021-DON328*

World Health Organization. (2022). *Early warning alert and response (EWAR) in emergencies: An operational guide. https://www.who.int/publications/i/item/9789240063587*

World Health Organization. (2025, September 19). *Amended International Health Regulations enter into force* [News release]. *https://www.who.int/news/item/19-09-2025-amended-international-health-regulations-enter-into-force*

World Health Organization. (2026a, May 16). *Ebola disease caused by Bundibugyo virus: Democratic Republic of the Congo and Uganda* (Disease Outbreak News). *https://www.who.int/emergencies/disease-outbreak-news/item/2026-DON602*

World Health Organization. (2026b, August 28). *Second meeting of the IHR Emergency Committee on the epidemic of Ebola Bundibugyo virus disease in the Democratic Republic of the Congo: Meeting report. https://www.who.int/news/item/28-08-2026-second-meeting-of-the-ihr-emergency-committee-on-the-epidemic-of-ebola-bundibugyo-virus-disease-in-the-democratic-republic-of-the-congo---meeting-report*

World Health Organization Regional Office for Africa. (2021, June 21). Guinea's Minister of Health explains what it took to end Ebola. *https://afro.who.int/countries/guinea/news/guineas-minister-health-explains-what-it-took-end-ebola*

World Health Organization Regional Office for Africa. (2026a, August 27). Uganda ends Ebola outbreak following completion of 42-day countdown [News release]. *https://www.afro.who.int/countries/uganda/news/uganda-ends-ebola-outbreak-following-completion-42-day-countdown*

World Health Organization Regional Office for Africa. (2026b, September). Ebola Bundibugyo virus disease outbreak: Democratic Republic of the Congo, Uganda. Weekly external situation report 18, data as of 13 September 2026. *https://afro.who.int/countries/democratic-republic-of-congo/publication/ebola-bundibugyo-virus-disease-outbreak-3*

Zhu, S., Harriman, K., Liu, C., Kraushaar, V., Hoover, C., Shim, K., Brummitt, S. I., Limas, J., Garvey, K., McNary, J., Gao, N. J., Ryder, R., Stavig, B., Schapiro, J., Morales, C., Wadford, D. A., Howard, H., Heffelfinger, J., Campagna, R., . . . Murray, E. L. (2025). Human cases of highly pathogenic avian influenza A(H5N1): California, September–December 2024. *Morbidity and Mortality Weekly Report, 74*(8), 127–133. *https://doi.org/10.15585/mmwr.mm7408a1*

Zipprich, J., Winter, K., Hacker, J., Xia, D., Watt, J., & Harriman, K. (2015). Measles outbreak: California, December 2014–February 2015. *Morbidity and Mortality Weekly Report, 64*(6), 153–154. *https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6406a5.htm*

CONCLUSION

This study establishes an empirical foundation for California's public officials to recognize, sustain and expand global health engagement as a matter of public interest.

Our research demonstrates that when California attracts federal funding for global health programs, invests in global health research, builds international partnerships and contributes to global disease surveillance, Californians benefit alongside people in other states and countries. Far from being a distant concern, global health has a tangible local relevance, serves identifiable constituencies and advances California's health, prosperity and security.

The responsibility of public officials to advance the interests of their constituents extends to recognizing and acting on the demonstrable benefits that global health engagement brings to California. Evidence supports concrete opportunities for expanded global health action at every level of government — from cities and counties to the state legislature and California's congressional delegation — as well as ways that California's universities, businesses, civil society organizations and other stakeholders can help advance these efforts.

Among the actionable priorities supported by this study's research are:

Exercise political leadership in Washington, D.C. to preserve and expand global health programs. No state, not even the most populous in the nation, can replace the U.S. government's established role in global health. U.S. global health investments provide the foundation for much of California's global health engagement, and Californians directly benefit. Members of the California delegation to the U.S. Congress are uniquely positioned to exercise their legislative, appropriations and oversight authority to reassert U.S. global health leadership; sustain their offices' own engagement in multilateral spaces; preserve and expand bilateral and multilateral global health programs; and study the benefits of these programs to Californians.

Sustain and expand global health engagement at the city, county and state level. An expanded role for state and other subnational actors will be a defining feature of global health this century. California's local and state officials have demonstrated leadership on global health issues from women's rights to pandemic preparedness, and the current federal retreat from global health leadership only makes this more important. State and local officials in California have an opportunity to review their financial and human capacity to sustain and expand engagement at the global level; strengthen these capacities in cooperation with university, business and community stakeholders; and establish dedicated global health budget lines and functions where appropriate. These activities and their financing can be continually monitored over time.

Convene a multistakeholder political dialogue about the future of California's global health leadership. The benefits of California's global health engagement reach to diverse communities and span multiple sectors. These benefits are not the same for all Californians, nor are they equally distributed. In order for political leaders to maximize and sustain California's global health dividend, these communities and sectors need to come together in a political dialogue to share experiences, exchange evidence and ideas and generate actionable recommendations. Such a dialogue, which could take the form of a California Global Health Commission, would also serve to identify and cultivate a new era of global health leadership in the state.

Develop and equip a new generation of California global health leaders. The next generation of California's global health leaders will inherit a legacy built from years of political engagement, mentorship and lived experience. Members of California's delegation to the U.S. Congress, in particular, have led or co-sponsored legislative initiatives that have defined U.S. global health leadership, supported California's contributions in the field and reaped benefits at home and abroad. Carrying forward this legacy will require a deliberate process of educating a new generation of elected representatives about the importance and opportunity of global health and the many benefits it brings to their constituents.

The benefits of California's global health engagement reach to diverse communities and span multiple sectors.

Ensure a supportive legal, policy and funding environment for California's global health engagement. Amid shifting funding priorities and

U.S. global health investments provide the foundation for much of California's global health engagement, and Californians directly benefit.

geopolitical conditions, it is important for California take steps to sustain its global health engagement over time. The evidence in this study points to several measures that could support this goal, including establishing a statutory mandate and dedicated funding for global health cooperation and partnerships with international institutions and networks. Building on existing partnerships, California could also formalize its participation in global disease surveillance and response networks, support long-term research collaborations and incorporate equitable access and international knowledge exchange into state-funded innovation. Clear legal mandates, multiyear funding and public accountability would help establish global health engagement as an enduring state commitment rather than a series of initiatives dependent on individual administrations.

Commission additional research on California's global health dividend. The issues examined in this study represent a small fraction of the ways in which global health benefits the people of California. Within each domain of benefit identified here — relational, economic, industrial and epidemiological — are myriad additional research questions that would enrich understanding of how Californians benefit from global health and how to optimize that benefit. By bringing diverse methodologies and disciplines to bear on a subset of these questions, this study aims to catalyze a research agenda. California's public officials, together with private philanthropy, are invited to support this research agenda and to propose questions and ideas for additional inquiry.

Replicate and expand this analysis to other states and subnational actors worldwide. California is far from the only U.S. state or subnational jurisdiction to benefit from global health programs. Other U.S. states, such as Georgia, Massachusetts, North Carolina and Washington, have similarly studied the benefits of global health engagement to their communities with a view to advocating for continued federal investment and nurturing state-based leadership and alliances. Subnational jurisdictions in other countries may similarly consider the benefits of global health to their residents and their potential leadership role. In this context, it is hoped that the research here will inspire similar efforts in other states and countries and catalyze global learning about the emerging role of subnational actors in global health. The partners in this study stand ready to support these efforts.

