Public Health Informatics 2023: Alternative Scenarios

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Introduction

Public Health Informatics 2023: Alternative Scenarios was created to consider the range of forces, challenges, and opportunities shaping public health informatics in the United States, so that leaders and practitioners can make strategic decisions that more effectively take the future into account. Public health informatics, like health care and public health, faces major uncertainties and challenges, but may also take advantage of major opportunities.

These 2023 scenarios are part of the Public Health Informatics Institute project "Using Public Health Information in the eHealth Decade," funded by the Robert Wood Johnson Foundation. The purpose of the project is to develop a better understanding of the key forces shaping the future of public health informatics in the United States, and to help public health practitioners create strategies that ensure the quality and resilience of public health informatics in light of emerging challenges, opportunities, and uncertainties. The scenarios are an important component of this effort, and have been developed by the Public Health Informatics Institute (PHII) and the Institute for Alternative Futures (IAF). Our objective is to engage public health informatics leaders using the 2023 scenarios to consider a broader range of forces shaping current implications and future possibilities for public health informatics. These scenarios were used at the *National Workshop on Public Health Informatics 2023*, held October 10 and 11, 2013, in Park City, Utah. Participants considered potential public health information goals and strategies for the future, as well as implications for the "robustness" of their current strategies in light of the various scenarios. Participants also developed recommendations as public health informatics moves forward into the coming decade.

Why Scenarios?

Scenarios are different stories describing how the future may unfold. Scenarios force us to consider the systems surrounding our topic and to clarify our assumptions. Given persistent uncertainty, a set of scenarios can be used to bound that uncertainty into a limited number of paths. These paths help us think about different probabilities in a larger space of possibilities. People who work with scenarios find more creative options than those who plan based only on the past and present. Strategies, plans, and actions that are created can also be "future tested" against the different scenarios to assure robust initiatives rather than continued efforts based on outdated assumptions. Scenarios are a powerful method for systematically addressing the uncertain future.

Process of Developing These Scenarios

In developing these scenarios, IAF worked with PHII staff. We identified nine initial drivers for public health informatics (PHI) in three zones: the Macro Environment, Health Care and Public Health, and Public Health Informatics. We considered these drivers as well as expectable, challenging, and surprisingly successful alternative forecasts for several of the drivers. These three alternative forecasts relate to the "Aspirational Futures" approach (see **Figure 1** below) which IAF has evolved over the last three decades. This technique develops forecasts and scenarios in three zones:

- A "zone of conventional expectation" reflecting the extrapolation of known trends, the expectable future (scenario 1);
- A "zone of growing desperation" which presents a set of plausible challenges that an organization or field may face, a challenging future (scenario 2); and
- A "zone of high aspiration" in which a critical mass of stakeholders pursues visionary strategies and achieves surprising success (scenarios 3 and 4). Two scenarios are developed in this zone in order to offer two alternative pathways to highly preferable or visionary futures.

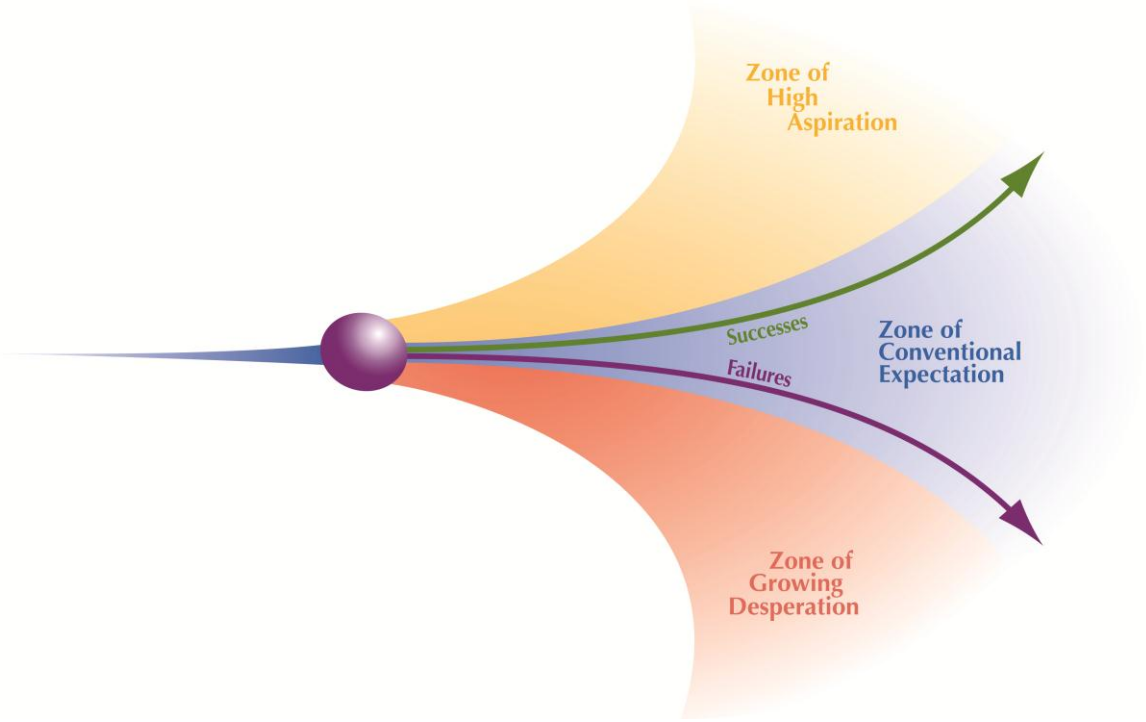

Figure 1. IAF's "Aspirational Futures" Technique

The PHII team, led by IAF, discussed the drivers and their alternative forecasts, and then outlined four scenarios. Using those outlines and driver discussions, initial drafts of the four scenarios were developed and shared with the PHII team for review and then subsequently refined. The following scenario narratives are the result of this effort. A matrix identifying several key elements across the scenarios follows these narratives to provide a summary comparison.

These scenarios identify general directions for public health informatics. Given the complexity of public health informatics and the forces in health care and the economy, there are many topics that are not addressed explicitly in the scenarios. For example, the role of physicians in the public health workforce,

public health leadership, and public health education and training are not necessarily discussed. Readers may also notice that the scenarios contain “crossroads” where other plausible paths could have been taken (i.e., the scenario could have been written differently). For example, Federal funding of public health is severely cut in one scenario and constrained in the other three of the scenarios, while most state and local governments do not increase their funding. One or more of the scenarios could have identified opportunities for increased local, state, and federal funding. Ultimately, we recommended at the workshop that the scenarios be used and considered as they are written to explore their implications. The participants were invited to imagine adjustments to any of the scenarios and then reconsider the implications.

Public Health Informatics 2023 Scenarios

Scenario 1: Information for Health Action

"Zone of Conventional Expectation"

> *Over the years to 2023, constrained economic circumstances, in conjunction with health departments' role in prevention and supporting national security, drive up the demand for a more strategic public health. While public health agencies (PHAs, both state and local health departments) continue to do "what others cannot or will not do" to enhance the opportunities for all to be healthy, most shift away from the delivery of clinical health care services and enhance their assessment, protection, and prevention efforts. Yet challenges with funding, resources, data quality, and actionable analytics in the face of rising chronic disease and climate change impacts the full promise of public health and public health informatics. By 2023, the aggregate health of the nation has improved only marginally.*

Over the years to 2023, the economy continued its slow recovery from the Great Recession of 2008. Yet it was punctuated by another mild recession in the late 2010s, and ongoing federal government debt and deficits led to reduced federal spending in many areas, including public health. While categorical programs remained in place, health departments were provided slightly greater flexibility about how they used it. Most state and local governments also reduced their per capita spending on public health over the decade. State and local public health agencies (PHAs) sought to maintain their budgets—including the "freed up" funds from their transition away from clinical services and some other direct services for individuals—by pursuing accreditation, and using cost estimates for a newly defined "minimum package" of essential public health services. While many successfully justified their funding this way, numerous others struggled to shield themselves from additional cuts. By 2023, many smaller, especially rural departments were consolidated or had their local services taken over by the state. Most state and local departments also shared some types of services, facilitated by the use of the cloud infrastructure and access to a consistent data architecture. The real threat and frequent occurrence of natural disasters also led many PHAs to have "mutual assistance" agreements for pooling resources and services for community disasters as well as for disease prevention. This was particularly the case in "tornado alley" and other areas with expectable major weather or environmental challenges.

In parallel, the prevalence of chronic diseases, complications, and risk factors, continued to climb while climate change spurred environmental and health disruptions across most areas of the nation. As complaints from the business community and the US military about overweight and unhealthy young people who could not work effectively reached a tipping point, public health received wider recognition for its value in national security—both by maintaining vigilance in identifying emerging infectious and chronic disease outbreaks, and in successfully enhancing the health of the population. While PHAs thus stepped up their role in planning and coordinating emergency responses to environmental threats, many health departments also increased their focus on improving nutrition and physical activity. This recognition proved particularly important for public health funding when the 2020 elections resulted in a political shift towards a more conservative president and Congress.

Public health informatics—the systematic application of information and computer science and technology to public health practice, research, and learning—grew in importance alongside changes in health care and the increasingly significant use of Internet and social media platforms. Health care generally improved as most primary care providers shifted to patient-centered medical homes (PCMHs),

and took advantage of greater amounts of high quality information being gathered on their patients through “app-rich” smart phones, ubiquitous electronic health records (EHRs), and enhanced personal biomonitoring. The patient’s vital signs, diagnoses and prescriptions, personal biomonitoring data, and even genomic data were downloaded to the patient's home records and to his/her health care provider’s EHR via smart phones.

The large amounts of data allowed the development of personalized risk assessments and personalized prescriptions, often for activity and nutrition. In fact, by 2020, most individuals had a digital health coach that routinely and effectively communicated with the person, letting that person know his/her health risks and offering recommendations or behavioral protocols that reflected the most accurate data. These recommendations guided people’s personal behavior as well as their contribution to community health. Community health recommendations were tailored to the person’s neighborhood and city or region. IPhone’s Siri became a popular digital health coach but had many competitors. Some digital health coach apps were provided by large integrated health care systems (given to their members/patients) while others were given away free by Google or Microsoft, supported by advertising.

Community health assessments also became standard tools for accelerating health promotion. Nonprofit hospitals were routinely conducting them, and many websites emerged that allowed anyone to do free or low-cost mapping. Local Health Departments (LHDs) collaborated or played a role in these community health assessments, sometimes providing leadership on them.

Using cloud storage and services became more common. Data was increasingly stored in secure state-controlled data vaults in the cloud, including protected health information, yet allowed for aggregation and cross-provider analysis of large numbers of records. In some states, data was also added from sophisticated environmental monitoring that had grown in many communities, supported by individuals and companies, along with driver’s license information, and social services information.

As the use of cloud services dramatically reduced some of the informatics costs for PHAs, sharing data within states—along with sharing anonymized data across states and other organizations—yielded many big data advanced analytic opportunities to identify patterns in infectious and chronic diseases and risk factors, and even to predict incidents or disease trends.

However, the more sophisticated big data applications required significant resources. Some PHAs had the resources needed to effectively use others’ data and play in the big data fields. However, most had to partner with other organizations, including health care provider organizations, large employers, Google, Microsoft and others for the use of big data opportunities to conduct enhanced surveillance and develop evidence for health care and public health interventions. Private companies also provided advanced analytics services to these partners.

By 2023, most state PHAs and many local agencies became leaders in using data aggregated from a variety of sources to conduct enhanced surveillance, identify trends in chronic and infectious diseases, consider patterns in risk factors, and develop evidence for health care and public health interventions. There is robust population health assessment, which includes good decision support tools and health information technology. Furthermore, regional consortia of Accountable Care Organizations (ACOs), LHDs, and others emerged around data use and data analytics capabilities, overcoming traditional barriers to moving health and health care data across state borders. PHAs collaborate with ACOs, universities, and private entities in order to better analyze data and improve population health.

The role of public health in developing these population health recommendations, however, varies widely as some health departments have been able to make the transition to doing advanced analytics on big data (most often data gathered by others and stored in the cloud).

The largest health care providers were among the first to integrate information from their members' personal monitoring devices, EHRs, and other public and private sources of data to support broader population health and risk management. After health care reform was largely put in place and gave most US citizens and residents access to health care, large health care organizations, particularly the ACOs, became the dominant form of health care provider. Most ACOs took responsibility for increasing population health for the communities they served and for that purpose sought to identify the social determinants of health (SDH) that were having the greatest impact on health in their communities. These SDH varied widely but included factors such as poverty, employment, housing, social exclusion, neighborhood safety, and access to healthy food. In some states and communities, PHAs became service delivery partners working on SDH-related issues with funding from ACOs. In other communities, however, ACOs did this population health work with their own staff or other community partners, depending on what was most cost-effective.

Few health departments maintained their primary research functions and expenditures (especially for surveys), but rather relied on data collected by others; that is, they were almost exclusively "secondary users" of data. The most effective PHAs moved up the value ladder by providing more significant analysis of the collected data. These PHAs often also expanded their collaboration efforts, working with partners to promote prevention and wellness, as well as enhancing protection and emergency preparedness against environmental and other threats. However, many PHAs were not able to do this and became less influential in the population health assessment and improvement space—even as they worked to maintain their costly surveys with dwindling budgets.

This gap in public health informatics capacities—between PHAs that could transition effectively into advanced analytics and big data and those that could not—mirrored larger inequities in health outcomes and access to health-enabling technologies in communities. While the aggregate health of the nation improved slightly, many disparities were maintained or became worse. Low-income communities and many communities of color experienced increases in chronic and communicable diseases when compared to more affluent communities that had been more easily able to adopt more advanced health-enabling technologies. Lower income populations also suffered more from recurring and increasingly severe environmental events than other groups that benefited from enhanced emergency preparedness technologies (either via financially secure PHAs or from individuals who could use personal and community emergency preparedness technologies effectively).

Public health informatics workforce competencies shifted from maintaining and improving information system functionality and interoperability toward the analysis, visualization, and other uses of information to drive population health improvement initiatives. Although some public health informaticians remained in 2023—mostly at senior levels—informatics skills, functions, and knowledge became more embedded throughout the PHA workforce. This enabled agencies to more effectively keep up with advances in risk assessment, provide useful population health assessment information, enable higher levels of interoperability and accessibility for EHRs and other data, find more useful ways of analyzing big data, evaluate public health interventions, and find more cost-effective methods for all public health activities. However, PHAs continued to have the problem of their informatics-savvy staff getting hired away to higher salaries in the private sector and academia.

Scenario 2: Write-Only Misinformatics

"Zone of Growing Desperation"

> *In 2023, informatics in public health is in a dire state. Severe economic decline has led to drastic cuts in federal, state, and local funding for public health and public health informatics. The Second Great Depression has hindered the nation from implementing crucial elements of the Patient Protection and Affordable Care Act, including effective uptake and use of electronic health records (EHRs) and other health IT. Many public health agencies (PHAs, which include both state and local health departments), have failed to keep up with advances in information systems, and still use outdated methods of collecting and analyzing data that do not meet demands for real-time information. An internal culture of ownership over data (the adage that data is spelled "TURF") prevented many PHAs from sharing data externally and internally. This prevents PHAs from partnering with the private sector, which has more advanced informatics capacities and greater collections of health data. Many local health departments (LHDs) and some state health departments have been unable to expand or obtain the necessary informatics skill set shifts within their workforce. By 2023, many PHAs have largely become irrelevant when it comes to population health information, due to public distrust, restrictions in cloud computing services, a fast-shrinking workforce of public health informaticians, silos within PHAs, lack of funding, and lack of interoperability among surveillance and other information systems.*

The Great Recession of 2008 proved to be a warm-up for another huge economic downturn, the Second Great Depression, in 2015. Many states and cities were already fiscally challenged when the Depression tipped them over the edge. Many states dramatically lowered their pension payments and health care obligations to retirees. Many cities went bankrupt. Federal, state, and local spending—including public health financing—was reduced across the board. Funding for PHAs' prevention activities had largely disappeared, severely limiting public health capacities. The Internet, social media, and cloud-based storage and computing continued to evolve. The cloud was used by many, including health care organizations, but ultimately did not work as a common storage platform for PHAs.

As public health financing decreased, PHAs lost much of their informatics capacity. Organizational units within PHAs did not readily join forces as funding was slashed, and silos remained the norm. Bureaus and units within PHAs chose to rely upon their own streams of revenue and categorical funding in order to continue their work. These bureaus and units recognized that sharing funding came with the risk that spending cuts for the other units would inevitably reduce funding for their own units. In the worst situations, counties severely reduced and even eliminated their LHD services. Many counties were forced to consolidate with other counties' LHDs or with their human services agencies.

In a larger context, the Second Great Depression hindered states from effectively implementing several elements of the Patient Protection and Affordable Care Act. For example, electronic health records (EHRs) were implemented throughout the mid- and late 2010s to varying degrees of effectiveness in localities and states. However, there was limited interoperability among EHR systems between states, individual health providers, hospitals, and health care systems.

A similar lack of interoperability also proved to be the case for data management in general. Turf wars continued between PHAs and health care providers. For example, while EHRs gained prominence throughout the 2010s, much of this data was not made available to PHAs. However, in the few cases

where PHAs had partnered with providers, these PHAs found it extremely difficult to extract and analyze data from EHRs and compare this with other data areas accessed by the health department. Even when PHAs were able to upload data to the cloud for storage and analytics, many local and state health departments had stored their data in ways that prevented other legitimate users from accessing data. This ultimately hindered PHAs from optimally using data to support population health. Furthermore, units within PHAs often did not share or aggregate their data with others in the department.

While PHAs and their partners did get access to collections of data, PHAs in many cities were actually unable to analyze much of the data streams that they obtained. Like a "write-only database," information could be collected (by other, usually private, organizations), but there was no way to extract this data. In some successful cases, cloud services did allow for more joint development and shared services. Generally, however, fragmentation continued across jurisdictions when it came to sharing data. PHAs' informatics competence declined relative to that of health providers and some private companies.

With regards to community health, throughout the mid- and late 2010s, PHAs' reputation hindered them from being an effective partner in supporting lifestyle changes to combat chronic disease. People who did not trust PHAs with effective use and dissemination of information also did not trust PHAs to give useful advice. Thus, the very population they were trying to serve frequently thwarted chronic disease prevention efforts. In some cases, PHAs tried to initiate community-wide efforts to improve population health and prevent chronic disease. However, opponents to prevention unleashed more powerful public relations campaigns to disparage PHAs and cast doubt on their expertise and policies, frequently focusing on uncoordinated actions, poor informatics capabilities and, in extreme cases, the mishandling of data, particularly private information, by the PHAs. Privacy issues kept re-emerging, as universal opt-in in many states for electronic health information exchange required patients to agree on every exchange transaction, including with PHAs. Given that most PHAs were not trusted to effectively protect personal privacy, large numbers of patients did not consent to share with PHAs, severely limiting the value of surveillance and other data needed by agencies.

Furthermore, throughout the mid- and late 2010s, disease outbreaks and extreme weather events became more common throughout the nation. Many PHAs became central players for their communities in planning for these events and in coordinating some parts of the evacuation, response, and recovery (particularly for individuals in nursing and long-term care settings). However, among PHAs, there was limited implementation of mutual assistance/disaster recovery agreements for state public health and agriculture laboratories and other services in times of community or regional disasters. The lack of data sharing and aggregation among state laboratories ultimately slowed disaster response and recovery. A severe avian flu epidemic shone light on this problem. PHAs had not pooled resources and services for labs or for data management. However, public demand for instant response to the pandemic put pressure on PHAs to take action. In several regions, health departments acted too hastily, had not coordinated effectively with other governmental emergency response units or with each other, and were not able to analyze the real-time data emerging in their communities. Response to the avian flu outbreak in these cases was wildly inefficient, as PHAs underestimated the number of cases and could not coordinate optimal flu vaccine distribution, vaccination, and treatment strategies. Tens of thousands of people died.

In light of such egregious and dangerous displays of informatics ineptitude on the part of PHAs, citizens and the private sector began to take personal and population health informatics into their own hands. In some localities, local citizen science (i.e., science and data collection collaboratively conducted and crowd-sourced by non-scientists or amateur scientists) was able to perform surveillance and monitoring functions, though to varying degrees of effectiveness. Since the 2010s, more and more individuals and

groups used tools and methods to self-track and quantify environmental, behavioral, physical, or biological indicators, as part of a broader movement that had been classified as the Quantified Self Movement. These individuals and communities sometimes shared data, and their activities created large data pools for trusted friends, relatives, co-workers, and community members who chose to share data. However, health improvements were uneven, as the best outcomes were generally seen among members with the greatest technological resources and who lived in the healthiest neighborhoods.

Throughout the 2010s, Google and other private companies—particularly those involved in biomonitoring—often had the means to conduct broader surveillance, monitoring, data collection, and big data analysis, without requiring individual/patient cooperation or approval. However, their techniques were not uniform, and results and conclusions often varied widely. Health disparities increased as the more affluent or educated were able to access and effectively use surveillance data to protect themselves and their communities.

Throughout the 2010s, many PHAs chose not to partner with the private sector (technology companies, health care providers, hospitals, etc.) because they held onto a distinct culture of ownership. PHAs were generally less advanced in terms of collecting and analyzing data, and their techniques did not generally meet demand for real-time information. Whenever PHAs were able to obtain information on the health status of the community or a certain population of local patients, bureaucratic interests and lack of technical and informatics capacities hindered cooperation between PHAs and health care entities. Some large health care systems were working to increase population health, but PHAs could do little to help them. Many LHDs in particular retained their role as safety net providers and wanted to provide more direct care services, but legislatures did not find it politically or economically feasible to expand funding for PHAs.

Given the lack of funding, lack of networked information technology, and the increasingly siloed nature of PHAs, there were few training or job opportunities for informaticians, and few chose to go into public health. Most health departments had confined their activities to mandated tasks, e.g., restaurant and facility inspections, and the information gleaned from these tasks was handled by the program staff. In 2023, public health information is constricted within PHAs, and is often not effectively collected and analyzed. PHAs are not trusted as secure repositories of personal health data or providers of credible recommendations.

Scenario 3: Pearl Harbor for Public Health

"Zone of High Aspiration"

> *Public health and public health informatics evolved quickly into a federated enterprise over the decade thanks to a series of challenges that public health helped prepare for and respond to. The "Pearl Harbor for Public Health," a pandemic that got wildly out of control, set up public health to lead more effectively in future pandemics. Beyond the emergencies, as the availability of personal biomonitoring, medical, environmental risk, and population health information grew exponentially, public health continued to evolve away from providing personal health care services to having a major role in the aggregation and analysis of population health data and setting health policy. As more information was routinely gathered and analyzed by health care providers, citizen science groups, and marketing companies, public health agencies (PHAs, which include both state and local health departments) provided advice on analysis and provided leadership in collaboratively addressing the social determinants of health.*

The economy picked up its pace in 2014 and grew steadily over the next decade. Government deficits and debt were reduced. State and local government revenues likewise increased enough to make most health departments secure in their funding. The minimum package of public health services was increasingly seen as the floor beneath which no local health department should go. Public health department accreditation became common.

What most affected the visibility of public health and its informatics capabilities was first the failure to prevent 150,000 deaths in the first major avian flu pandemic, and then its success a few years later during a subsequent pandemic.

In 2015, a novel and virulent strain of avian flu erupted and rapidly spread around the world. In the United States, millions were quickly infected. The 20% case fatality rate globally (5% in the United States) led to hundreds of thousands of deaths across the globe, and tens of thousands in the United States. The fatalities could have been reduced had vaccine distribution been better coordinated, even in the United States. Rapid development of the vaccine was a well-coordinated effort across European and American governments and vaccine manufacturers. But distribution of the vaccine fell apart in the face of pent-up public demand and panic, and the lack of nationwide tracking systems in most countries, including the United States. CDC provided the initial distribution plan based on the virus' expected geographic spread. The initially limited supply of vaccine was delivered to targeted communities, along with other Strategic National Stockpile supplies. But then public panic, lack of clear communication about priority populations for vaccination, turf wars among governmental agencies about who was in charge, and hoarding of supplies began to undermine operations in a publicly visible way.

To make matters worse, the virus then spread with unexpected speed to unexpected communities, further stressing the uncoordinated system. Neither CDC nor the state and local health departments were able to determine with any accuracy or timeliness how much vaccine was left in the initial communities that could be moved to new ones. It took crucial days to have the local campaigns stopped and the remaining vaccine moved. The impact of the pandemic in the United States was beyond anything in living memory—nearly 50,000 people died before adequate vaccine supplies and distribution, along with effective and consistent social isolation policies, halted the virus' virulent spread. The impact across the globe was much more devastating, especially in low- and middle-income countries.

As often happens in public health, the disaster had a silver lining in terms of increased attention paid to the need for improved public health infrastructure and coordination. Many public health voices had been calling for years for more of a national enterprise approach to information management and exchange. After the first pandemic, they argued that had such an enterprise approach and architecture been in place, accurate and timely information would have been available to local, state, and federal decision makers simultaneously. Congressional leaders proposed creating the nationwide public health information enterprise and it quickly passed. The enterprise included features such as consistent and standardized terminologies and code sets, an infrastructure for secure exchange of encrypted information, interoperability standards to link vaccine registries with supply chain management systems, standards for bi-directional query exchanges with EHR systems, linkages with SNS tracking systems, data aggregation and analytic tools, and clear data stewardship responsibilities for state and local health departments, as well as for the CDC.

By 2018, the nationwide public health information enterprise approach was in place, supported by cloud-based data repositories and open source applications. The next year, a second avian flu erupted. This one was a mutation from the virus in 2015 yet it nevertheless proved challenging as most of the millions of people vaccinated did not have protection from this evolved virus. Again, this time the targeted vaccine distribution and tracking went smoothly, based on timely surveillance data, all available simultaneously at all levels of government and used to drive joint decision making on vaccine distribution, school closures, and other policy decisions.

While public health did become more of an enterprise, state and local variabilities in capabilities, services, funding, etc. still existed. But a floor of core capabilities was established by Congress to consistently define levels and types of services, workforce requirements, and information capabilities. The core capabilities were built into the Public Health Accreditation Board (PHAB) uniform package of services and capabilities needed for accreditation. This included core information management, entailing optimal information storage and use, privacy and security protection, having the necessary tools to transform data into useable information, and the capacity to share anonymized information with other appropriate organizations. The Federal government loosened its categorical grant funding requirements to allow PHAs to spend a portion of the grant on their foundational capacities and accreditation.

Much community health data was aggregated into state-controlled data vaults in the cloud that enabled sharing and analysis across programs and jurisdictions. In addition to using data for mapping, state, local, and federal public health collaborated with Google and other corporations with large data sets on consumer behavior and community conditions to map relevant community patterns. Markets developed for this advanced analytics and private companies stepped forward to provide these services. Buyers included PHAs, health care providers and insurers.

Local residents' involvement in community health was stimulated by effective communication from and with PHAs. Local media hosted advertising on the CDC's role and efforts, as well as ads by PHAs and local partners for coalitions to confront your community's health challenges. PHAs took part in and often lead these local healthy community coalitions.

On a larger scale, the mid- and late 2010s proved to be strong economic years for the United States, and health care reform made health care accessible to nearly all. PHAs largely moved out of providing direct health care services. A uniform chart of accounts and consistent reporting allowed PHAs to relate expenditures to outcomes in a uniform way across the nation. PHAs were focusing on health threat monitoring, health promotion, and policy development for community health. Health equity was built into the accreditation standards and became a more consistent aspect of PHAs' work.

In addition to the first pandemic and the second threatened pandemic, there were ongoing climate-related weather disasters throughout the country. PHAs often played a lead role in coordinating preparation and response to these. PHAs also increasingly focused on pre-disease conditions, using the big data available in public health, commercial, and other data collections to identify and reduce risk factors. For the advanced analytics, PHAs often had to rely on other partners for the analysis that relates the available personal health data with community conditions and the outcomes of interventions to develop local recommendations. Among these tools were expert systems that combine all available information and provide evidence-based recommendations—e.g., the "Doc Watson for Public Health."

The effective response to the second threatened pandemic and the recurring weather and disease threats also accelerated the success of public relations campaigns that had been waged throughout the 2010s to expand the awareness of public health and its contribution. Public health was viewed as a cost-effective means to keep populations physically, mentally, and emotionally adept to combat threats and contribute to domestic growth, while simultaneously combating threats of communicable disease (particularly in light of new, climate-induced outbreaks of disease).

The growth of personal biomonitoring led to collections of data in consumers' electronic personal health records (PHRs). By 2020, 80% of all individuals in the United States had a PHR that included information on personal health and health care history, medical conclusions, biomonitoring, genomics, and decision support tools that included selected social determinants as part of decision support rules. Public health authorities were provided access to stores of anonymized data from some of these PHRs as part of population health assessment.

Furthermore, many public health inspections and monitoring were automated so that human capital could be redirected to population health, community health, prevention, and disease management. For example, technologies that allowed automated sensing for bacteria and cleanliness in restaurants relayed the data to the health department where it was monitored and problems were immediately reported—fewer human inspectors were therefore needed.

In the late 2010s, *Health in All Policies* required adept use of data by public health, and thus demand for public health information was high. Coming from backgrounds like public health, anthropology, and economics, public health staff skillfully worked within and across both the public and private sectors. At PHAs, they coordinated and collaborated with ACOs, community-centered health homes (CCHHs), various state and federal government entities, the armed forces, providers and provider groups (hospitals, community health centers [CHCs], individual practices, and solo practitioners) and private organizations in order to address population health. In 2023, public health informatics-savvy individuals are in high demand both in PHAs and by higher paying ACOs and private companies.

Looking back, the combination of strengthened funding, development of a strong and adept public health informatics workforce, increasing cross-sector collaboration, and the consistency of the federated public health enterprise, made the greatest difference for public health agencies and public health outcomes, especially with regards to preventable conditions. The enhanced informatics capacities that resulted from these factors contributed to fulfilling directives and goals in community health, population health, and addressing the social determinants of health. By 2023, public health outcomes, particularly with regards to preventable conditions, have noticeably improved along with public health's identity. Schoolchildren and adults know what public health practitioners do just like they would know what a firefighter does. Public health is now efficient, desired, and proactively sought in light of its contributions to communities and the nation.

Scenario 4: Everybody Is an Informatician

"Zone of High Aspiration"

> *In 2023, public health focuses on prevention of unhealthy conditions and creation of optimal health conditions, ranging across factors such as the social determinants of health, genomics, epigenetics, disease, pre-disease, nutrition, health care, behavior, and the ever-changing built and natural environments. Public health agencies (PHAs, both state and local health departments), and public health informaticians have proven almost too effective for their own good. Health care reform proved highly successful, as the US economy gradually recovered from the recession period of the mid- and late 2010s. However, budget deficits required financial accountability and cost-effectiveness. While Accountable Care Organizations (ACOs) sought to reduce costs and improve outcomes of health care throughout the 2010s, PHAs in the late 2010s were required to implement an evidence- and experience-based minimum package of services and capabilities that included advocacy, partnership formation, and communication. To this end, PHAs worked with various community organizations and agencies to help people understand, access, and use the information that was gathered by individuals, citizen science, private organizations, and governmental groups. In 2023, public health informatics was no longer just within the realm of health departments. Accreditation standards require that PHAs demonstrate significant capacity in informatics and that they have informatics plans based on a national set of standards, yet private actors, consumers, and even schoolchildren had begun to use public health information to improve health. Public health information use has become a widespread societal capacity and is enabling some communities to pursue the revolutionary concept of "universal public health."*

Throughout the mid- and late 2010s, the increasing prevalence of self-care, technological advancements for consumers, and automation freed PHAs to refocus their informatics capacities on prevention, disaster response, addressing the social determinants of health, and training communities in public health. A major new tool became disease and risk factor forecasting maps. These maps combined disease mapping with the mapping of data on community conditions/social determinants, environmental data, weather conditions, and emergency preparedness data. Private companies and increasingly competent local citizen science groups consolidated data in map overlays to help individuals forecast influenza incidence in their community and to take preventive measures earlier than would otherwise have occurred.

This breakthrough highlighted the result of a trend of private citizens becoming active in surveillance and monitoring functions previously in the sole domain of PHAs, which still have to meet national informatics standards. For example, PHAs—some begrudgingly, but many eagerly—gradually limited their roles in surveillance and reporting throughout the mid- and late-2010s as new data collection systems of environmental monitoring tools and wearable biomonitoring devices increasingly gathered broad ranges of personal and community health data and sent it to companies and participating business partners (e.g., gyms, fitness centers, wellness centers, and health care providers). By 2020, public interest in population health, coupled with personal biomonitoring and a culture of crowdsourcing information, led to a shift from governmental surveillance to self-surveillance and commercial surveillance, and ultimately to automated self-reporting of conditions by individuals to trusted private companies and PHAs. Cloud capabilities enabled cost-effective solutions to storage and analysis of surveillance data, as well as sharing of open source software modules and tools to support functionalities such as data quality checking,

record de-duplication, commercial transactions, report generation, provider directories, and geographic information system mapping. Population health, community health, and prevention efforts greatly benefited from cloud computing solutions for analysis, safe sharing, and storage of data from both biomonitoring tools and from nearly universal uptake of interoperable electronic health records (EHRs) that included individual information on genomics, personal health and health care history, medical conclusions, biomonitoring, and personal history with regards to the social determinants of health.

In addition to letting go of their roles in surveillance and reporting, PHAs also began to see their roles change in regulation and inspection. Real-time polymerase chain reaction (PCR) automation technologies were used for a host of environmental monitoring tools. This enabled continuous "inspection" of parts of restaurants and food services organizations, and the resulting information was made publicly available. Restaurants were ranked on their safety and cleanliness via rating sites such as Angie's List and Yelp! By the late 2010s, restaurants were investing in low-cost devices that displayed information on food, water, and air quality and safety within and around each restaurant for potential customers. Food inspectors no longer needed to come to the restaurants on an annual basis, as consumers were able to see the restaurant safety ratings online and through mobile apps.

Such developments in automation of regulation and inspection reflected a broader trend in automation of data collection, apart from the PHAs. Furthermore, non-governmental entities—including well-funded private companies, citizen science groups, and members of the Quantified Self Movement who use tools and methods to self-track their health and monitor and quantify any relevant environmental, behavioral, physical, or biological information—developed advanced analytics capacities. By 2020, having offloaded the burden of many tasks in assessment, analytics, and regulation, PHAs were able to use this community-gathered information to enhance prevention.

Strong informatics capacities also enabled PHAs individually and collaboratively to track and evaluate which prevention methods were most effective (e.g., exercise at school, community walkability, mixed-use neighborhoods, improving literacy, and increasing employment and/or living wage policies). Comparative effectiveness research requires higher levels of evidence to validate prevention techniques, and frequently utilized genomics information. PHAs advocated for appropriate adjustments to common prevention methods according to national and local data findings and projections, and created localized incentives to improve behavioral health and address the social determinants of health. By 2020, almost all PHAs were conducting community health assessments, often in collaboration with local hospitals and other partners. Some also began experimenting with enhanced "community health records" of aggregated, anonymized health data, indicators, and trends that an entire community could access and analyze. These developments provided a "neighborhood health view" that led to improved health indicators in many areas, even in localities with historically poor health, and allowed for a neighborhood health record that could be tracked over time.

PHAs also became leaders in using informatics for highly effective and coordinated disaster response, which had unfortunately become more frequent in the face of climate change. PHAs successfully established multiple "mutual assistance" agreements for pooling resources and services for laboratories during community disasters as part of local sustainability and resilience plans. These mutual assistance agreements also included highly interoperable cloud computing services, with aggregated data open to the public. High levels of regional consolidation proved beneficial, as PHAs collaboratively provided and developed basic sets of services, products, and cloud computing capacities for their catchment areas.

Most PHAs took one more bold and comprehensive step as part of a "prevention through societal informatics training" initiative. Throughout the late 2010s and early 2020s, in order to enhance societal

population health informatics capacities, PHAs had strenuously worked and advocated for educating children and teens in public health principles and information. This included gamification platforms for children, teens, and adults, particularly those using biomonitoring tools, to learn the basics of prevention, public health, and particularly, community health promotion. This took advantage of the fact that technological adoption, particularly in personal monitoring, among individual consumers had skyrocketed by 2018. The rate at which individuals or other parties could use information to inform health accelerated to a point where PHAs did not need to do what they had traditionally done in terms of assessment. The public can just as easily access and use informatics tools as they can access and use tools like Fitness Pal. By 2023, there is therefore not much need for formal public health informaticians. Those who had served as public health informaticians in the 2010s could now choose among working at PHAs in an informatics capacity, training citizens in using public health information, consulting with consumers and stakeholders, or working at private companies. Informaticians who remained in PHAs were highly skilled and helped harvest and make sense of large amounts of disparate data sources while also contributing to assessing financial accountability and the dollar impact of prevention techniques.

Perhaps even more radical is the fact that in 2023, many communities are working towards "universal public health"—a concept embedded in how people live and work that could ultimately ensure that all have the conditions to be healthy. All the different factors that relate to health (e.g., the social determinants, genetics, epigenetics, health care, environment, and behavior) are included in community analyses accessible to individuals. Many individuals and communities routinely pursue universal public health, and public health is culturally and politically accepted as crucial to national security and to the national economy.

Scenario Matrix | A side-by-side comparison of the scenarios across multiple dimensions

Scenario Dimensions	Scenario #1 Information for Health Action	Scenario #2 Write-Only Misinformatics	Scenario #3 Pearl Harbor for Public Health	Scenario #4 Everybody is an Informatician
Economy & fiscal conditions	Slow economic recovery, mild recession in late 2010s	Severe economic decline, "Second Great Depression"	Steady economic growth; slowed by first pandemic, followed by recovery	Gradual economic recovery
Infections & environmental challenges	New and re-emerging disease, more extreme weather events	Recurring disease outbreaks, including an avian flu epidemic and extreme weather events	Two pandemics, along with other disease outbreaks and extreme weather events	Increasing frequency of climate-related events and disease outbreaks
Public Health and Health Care				
Role of health care in improving population health	Provide referrals and funding to community organizations for population health activities	Community health centers, and some large health systems work to improve population health, but with little PHA collaboration	Largest health care providers and ACOs integrate data to identify barriers to improving population health; provide funding to community organizations and PHAs for population health activities	Largest health care providers and ACOs integrate data to identify barriers to improving population health; provide funding to community organizations and PHAs for population health activities
Competitors for public health informatics functions	Health care provider organizations and the private sector share or take over some analytics functions in collaboration with PHAs; private companies do big data analytics (both for PHAs and in competition with them) Inspections are automated, done by the	Citizen science groups and private companies take over some surveillance, monitoring, data collection, and big data analysis with varying degrees of effectiveness	The federated public health enterprise leads in public health informatics functions but collaborates with companies, community groups, and health care providers for community mapping, and advanced analytics Inspections are automated, done	Automation, individuals, and the private sector take over many tasks in assessment, analytics, and inspection/regulation Health department surveillance and reporting supplemented, sometimes replaced by self-surveillance, commercial surveillance, and citizen-science and individual self-reporting

Scenario Dimensions	Scenario #1 Information for Health Action	Scenario #2 Write-Only Misinformatics	Scenario #3 Pearl Harbor for Public Health	Scenario #4 Everybody is an Informatician
	institutions, with results reported to PHAs and local consumer ratings groups		by the institutions, with results reported to PHAs and local consumer ratings groups	
Public Health Informatics				
Electronic Health Records (EHRs)	Widespread use of EHRs Vary in access, and interoperability for PHA use Generally focus on clinical history; with incomplete ability for PHAs to identify syndemic patterns among diseases & risk factors	EHRs are in use in most health care systems, but vary in access and ease of use; limited interoperability standards Generally focus on clinical history; with incomplete ability for PHAs to identify syndemic patterns among diseases & risk factors	Nearly universal uptake of EHRs, influenced by the public health federated enterprise requirements Highly interoperable, easy for PHAs to access and use Include personal health and health care history, medical conclusions, biomonitoring, and SDH-related history; allow syndemic pattern analysis	Nearly universal uptake of EHRs Highly interoperable, easy for PHAs to access and use Include personal health and health care history, medical conclusions, biomonitoring, and SDH-related history; allow syndemic pattern analysis
Big data analytics	Provision of increasingly personalized recommendations that take into account state and local public health and SDH	PHAs cannot analyze much of the data; when they can, they do so in a siloed manner Fragmentation across jurisdictions continues when it comes to sharing data	PHAs access information from a wider array of sources “Doc Watson for Public Health” expert systems and other tools	PHAs track, evaluate, and compare prevention methods Health departments provide “community health dashboards” that provide immediate and up-to-date community health information and advice

Scenario Dimensions	Scenario #1 Information for Health Action	Scenario #2 Write-Only Misinformatics	Scenario #3 Pearl Harbor for Public Health	Scenario #4 Everybody is an Informatician
Evidence of public health interventions	Public health recognized as essential to national security, and able to effectively reduce prevalence of obesity and chronic disease	Overshadowed by uncoordinated health department efforts, poor informatics capabilities, and mishandling of data; evidence available only among better-off communities	Public health seen as cost-effective in aiding populations to combat health and environmental threats and contribute to economic growth	PHAs use their capabilities and expertise to successfully improve and coordinate local prevention and emergency response efforts
The goals or benefits of public health informatics—what outcomes or contributions or value has public health informatics provided by 2023	Enable robust population health assessments Help overcome traditional barriers to moving health and health care data across organizational and jurisdictional borders	Collect and monitor regulatory data	Help establish national and regional public health networked enterprises Improve emergency response to pandemics	Offer tracking, evaluation, and comparison of prevention efforts to improve behavior, emergency response, and address the social determinants of health Help communities move towards "universal public health"
Health outcomes	Communicable disease rates begin to decrease significantly in several regions, but disparities continue; chronic disease continues to increase, particularly in low income populations; health disparities are often maintained or sometimes worsen	Communicable diseases rise, including avian and other flu outbreaks; chronic disease increases (the Depression reduces caloric intake but raises stress and anxiety); health disparities increase significantly	Noticeably improved outcomes, especially for preventable conditions; disparities are narrowing for some health indicators	Improvements in several indicators, disparities decrease
Mutual assistance agreements	Most PHAs share some type of services through "mutual assistance" agreements	Limited mutual assistance agreements for pooling resources and services	Highly effective agreements in place regarding public health labs for disaster response and	Highly effective agreements regarding public health labs as part of sustainability plans

Scenario Dimensions	Scenario #1 Information for Health Action	Scenario #2 Write-Only Misinformatics	Scenario #3 Pearl Harbor for Public Health	Scenario #4 Everybody is an Informatician
			community health	
Public perceptions of PHAs	Have greater public awareness and some trust for handling personal data; recognized for their roles in national security and emergency preparedness	Are less visible to the public, and thought of as ineffective and undeserving of funding; some state and local departments are not trusted to hold or analyze personal health records	Are highly respected; trusted for holding personal data and doing secondary analysis; and as everyone knows what firefighters do, everyone knows what public health practitioners do	Are respected for coordinating prevention efforts and emergency preparedness; trusted with data; and praised for their efforts at empowering community groups and individuals to do their own analysis
Public health informaticians	Increasing demand, often hired away from PHAs for higher salaries Receive training from private entities and the public sector Collaborate across the public and private sectors to prevent disease, reduce costs, and optimize data use	Workforce in PHAs downsized, some informatics specialists remain, but there are better opportunities elsewhere, outside the PHA	High demand for public health informaticians Are readily employed and have completed excellent training programs Collaborate with actors across the public and private sectors to address population health	No longer a distinct workforce, informatics widely taken up by other public health professionals and general public Informatics training integrated into other disciplines and K-12 Citizens trained in basic informatics, consult with consumers and stakeholders about techniques or questions, or work with private entities

Section II: Recommendations for Actions

Introduction

Through a series of small group and full group meetings, participants articulated strategies and concrete actions that should be taken over the next 10 years by public health practitioners, government, funders and others to advance public health and the public's health—the health of populations—through public health informatics. While participants rated Scenario 1 ("Information for Health Action") more likely to play out, as it closely resembles the current state of public health informatics, they thought the optimistic scenarios were not implausible. The group expressed a slight preference for Scenario 4 ("Everybody Is an Informatician") over Scenario 3 ("Pearl Harbor for Public Health"). (See Table 1.)

The consensus of the group was that although the availability and use of information technology to impact health outcomes has increased dramatically over the last 10 years, they anticipate that the rate of change will accelerate over the next 10 years. However, in an age when data and information are increasingly available to those who are motivated to improve health and decrease costs—individuals, health care providers, provider groups, payers, employers, government officials, and other stakeholders—public health practitioners and policymakers have struggled to define and communicate the value they provide through public health informatics.

Table 1. Participants' ratings of the likelihood and preferability of the four scenarios[1]

	Likelihood (%)	Preferability (%)
Scenario 1: Information for Health Action	55%	37.5%
Scenario 2: Write-Only Misinformatics	30%	0%
Scenario 3: Pearl Harbor for Public Health	40%	80%
Scenario 4: Everybody Is an Informatician	50%	82.5%

[1] Instructions to the workgroup were to select a value for each scenario, but they did not need to total 100%. The table reflects the median value to assure the measure was not skewed by outliers, although the median and mean values were very similar.

Themes

Recurrent themes emerged throughout the discussion of the scenarios and guided the development of the recommendations. They fell into three groups:

I. **The strengths of public health.**
- Recognition that the role of public health is convening, collaborating, and provision of analytic services.
- Recognition that the vagaries of public funding mean that public health may need to rely largely on its role as an "honest broker" between public/non-profit and private/for-profit entities, rather than assume the role of implementer of all recommendations.

II. **Needs and risks within the current environment.**
- The need to demonstrate the "systemness" in public health and public health informatics—a concept that describes coordinated, collaborative, standardized approaches to the use of information leading to improved operational effectiveness, the achievement of better health and outcomes, and ultimately, prevention and wellness for populations.
- The need to document how informatics solves public health problems.
- The need for greater informatics capacity across public health agencies.
- The need to address social determinants of health (SDH) in improving individual and population health.
- The risk that increasing use of information technologies may separate individuals from the persons that will help them.
- The risk that unequal access to health information technologies may increase health disparities.
- The risk that the focus on the health of communities is being lost with the increasing focus on individual health information.
- The risk that if public health does not meet its responsibility to provide appropriate "value added" in using new and enlarged data opportunities, health care providers and private sector information companies will provide that analysis. There is an opening in time in which public health can assume a prominent position.

III. **Opportunities for public health to build on its strengths.**
- Recognition that institutions within the health care system are motivated to engage with parties beyond their walls, particularly around the use of data to improve health outcomes.
- The potential of neighborhood health records to improve health.
- Recognition that a market opportunity exists to bring information from across public health, human services, and other public systems to provide insight on how to address the complex interactions of medical and social determinants on both individual health and the health of a population.
- Recognition that there is a role for private enterprise in advancing public health informatics, but public health needs to provide the vision and leadership to support collaborative action.

Recommendations

Reflecting these themes, the workgroup recommended strategies that develop the evidence base for public health informatics effectiveness and successes in improving

health outcomes and lowering health costs. The strategies as a whole capitalize on the greatest current assets of public health organizations: the population health data already under their purview, especially at the community and neighborhood level; its capacity to provide analytic services; and its role in fostering consensus and supporting collective action. But the workgroup went further in also recommending strategies that will provide explicit new value not only to public health agencies, but more importantly, to their partners: health care entities, payers, employers, municipalities, and others.

Recommendation 1: Accelerate evidence-generating practice for public health informatics and communicate the evidence base.

The future of public health informatics is largely dependent on demonstrating its effectiveness, e.g., its ability to improve health outcomes and to lower health care costs—to the public, health care providers, payers, government agencies, legislators, and other stakeholders. A concerted effort is necessary by public health to demonstrate public health informatics successes, document lessons learned, and pass them along to other locales.

Just as evidence-generating medicine embeds research practices at the point of care, a parallel effort should be made to generate evidence for public health informatics effectiveness, in effect, bringing the informatics enterprise into partnership with health services research.

Large urban areas where big, costly problems reside are proving to be crucibles for innovation in health care. Successful linkages are being made with public health and health care partners, including ACOs, and other parties in Seattle, Portland, San Diego, Minneapolis, and New York City. These locales can serve as "learning labs," where the value of the investment in public health informatics is measured, documented and communicated outward.

Gathering comparative effectiveness data needs to become routine, so that both the effective and ineffective—and costly—interventions can be identified.

Workforce training to assure a national cadre of public health informaticians skilled in analytics and visualization of data, as well as skills to communicate the knowledge derived from those data, will be necessary.

Actions

Local and state health officers

- Identify the data sources needed to build evidence. Collect information across sectors, beginning with government agencies.
- Combine clinical and individual data, including the "omics" (epigenomics, metabolomics, "zipcodeomics," etc.). Repurpose collected information.
- Build the partnerships and identify the data-sharing and data-dissemination champions across sectors.
- Acquire the capabilities and skills, internally and/or externally, to "do your part" in collaboratively generating, understanding, disseminating, and acting on evidence to improve public health informatics practice and community health outcomes within jurisdictions.
- Adapt promising and best evidence-generating practices from other jurisdictions.
- Communicate to and engage policy makers, elected officials, and others on the intentions and the results of public health informatics initiatives.

Foundations

- Fund/support/convene new partnerships that can serve as public health informatics models.

Foundations, associations, CDC

- Gather, curate, disseminate, and fund best practices/the evidence base for public health informatics.

Work group/PHII

- Promote principles, outputs, and information about Public Health Informatics 2023 at the 2014 Public Health Informatics Conference.

CDC

- Amend the Methods section of MMWR to reflect informatics methods/aspects of the articles so that awareness and knowledge of informatics principles, methods, and tools is increased. Do the same with journals.
- Develop a national informatics corps with common competencies that is available to large cities and states to assist with public health informatics data analysis, visualization, and communication.

Recommendation 2: Make public health data, information, and analytic tools widely available to public health and clinical delivery systems as part of a shared learning health system.

> *A central tenet of public health informatics holds that information gains value in being used. It follows that local, state, and federal public health agencies will gain value and instigate opportunities by making public health data more widely accessible to public health and clinical partners as part of a learning health system. Such a system is capable of studying and continuously improving its practices. A public-facing, centralized infrastructure would realize economies of scale by making public health data sets and tools to analyze them accessible to public health agencies and clinical partners that otherwise would be unable to use these data sets.*

The rapidly changing dynamics of data collection, storage, and analysis, including the availability of big data, have profound implications for public health. More data, more complex data, and more varied data, along with more advanced analytical tools, will bring potential new opportunities to share information with traditional data sharing partners, as well as new partners, including consumers.

In many institutions, the ability to generate data far outstrips the ability to effectively analyze and use it. Public health agencies, academic institutions, and other organizations have an opportunity to develop tools that enable integrating, analyzing, and visualizing a myriad of clinical and public health datasets that currently exist and will be generated in the future. Sharing of public health data tools and data sources would enable wider arrays of stakeholder and community groups to explore how best to improve population health outcomes.

Once defined and developed, these data assets and analytic tools will need to be evaluated, refined, and promoted to potential users in the public and private sectors, including communities. A continuous improvement feedback loop will be an essential part of these tools.

Actions

Local and state health officers

- Create public use data sets and queryable web sites that can be queried by other stakeholders, such as other public health agencies, provider organizations, insurers, academic institutions, community groups, and individuals. Post clear instructions on how to formally request information in the context of a memorandum of understanding or data use agreement.

Public Health Accreditation Board

- Create a new accreditation standard: a recommended list of well-defined, standard format data sets and downloadable web-based queries should be made available (unless prohibited by law).

Public Health Informatics Institute/Foundations

- Fund development of defined data sets and toolkits for creating web-based queries.

ASTHO and NACCHO (or Joint Public Health Informatics Taskforce)

- Inform, disseminate, and support implementation of toolkits and resources for data integration, analysis, and visualization. Support PHAB accreditation standards for informatics.

Centers for Disease Control and Prevention

- For any grant/cooperative agreement program, include requirements that the data be made publicly available or available to other potential stakeholders in well-defined, standardized formats.

Public Health Informatics Institute

- Identify potential new models for making public health analytical tools available to collaborators. The model might include a private enterprise vendor, with oversight from CDC and partners. Considerations include cost, privacy laws, use of clinical data, etc.

Recommendation 3: Focus on neighborhood health information for collaborative analytics and visualization of health data, and action by public health agencies and partners.

> *Public health agencies should apply the array of new informatics capabilities to develop real-time, evolving pictures of health and health determinants of the communities they serve, potentially starting with the concept of a neighborhood health record[2]. They should become proactively engaged with the health care provider community, as well as vendors of personal health data technologies, and they should be prepared to engage in 'collaborative analytics' with other institutions as equal partners. They should strive to provide access and visualization of data at the neighborhood or community level.*

An individual's health is determined by many factors beyond the influence of a provider in a health care setting. Policy, system, and environmental changes at the community level, and increasingly, the more granular neighborhood level, are recognized to be important drivers of improved health. Public health institutions have an opportunity to work with partners to provide collaborative analytics and visualization of data that enable targeted community—and even neighborhood—actions that improve health.

[2] Here, a record is not necessarily a static record, but is represented by a "view" of the information, in addition to the ability to create information on demand.

A common construct for framing many of these interventions is "place" at varying levels of geographic granularity, e.g., community, neighborhood, school, place of employment. Recent initiatives (i.e., Place Matters, RWJF/Federal Reserve Community Development Initiative) have highlighted the role of place and the profound differences that "place" can have in determining health status. The health impact of social networks that extend beyond geography, and even virtual social networks, also is increasingly recognized.

Most public health agencies employing current methodologies are not able to produce pictures of health that reveal these disparities and enable targeted community action. This is due in large part to the fact that individual level data have not been robust enough and local determinants have not been assayed and standardized.

New data sources—ranging from hospitalization and payor data to parks, land use, and neighborhood socio-economic status data—and new informatics techniques provide new opportunities to profoundly alter these historic limitations. A new appreciation for the broader determinants of health and well-being in multiple sectors provides an opportunity for investment in approaches other than individual-level biomedical interventions.

Actions

Health information-related foundations (RWJF, Kresge, de Beaumont, and others)

- Consider immediate formative investments to rapidly pilot, test, and evaluate different models of a neighborhood health record to determine what is most effective.
- Consider ways to link this model with the new community health needs assessment requirements of the Affordable Care Act.

Local health departments

- Capture precise, timely, specific, and relevant measures of disparities in the community. These will be seen as geographic as well as virtual neighborhood baselines.
- Engage consumers where they live at the beginning of interventions to ask the right questions and develop interventions that address real problems.
- Share data and information with community members.
- Train individuals who live in and are familiar with the community to work as paraprofessional community health workers, creating a bridge between public health and hard-to-reach populations. Use "low tech" information technology (cell phones, text messaging) to assure health access.

State health departments

- Establish consensus on standards for data and data sets to meet neighborhood needs.
- Make state data sets available in standardized formats for use at neighborhood level.
- Modify community funding efforts to support collection and analysis at the neighborhood and community levels.

Recommendation 4: Provide value to the health care delivery system with information on social determinants of health.

Health care providers are moving towards accountability for financial management, quality improvement, access, and patient loyalty. The public health sector can demonstrate its value by providing data and information related to the social determinants of health not captured at point of care.

Organizations moving towards value-based health and care through greater accountability represent an integrated strategy at the delivery system level to respond to health care payment reform. Composed variously of hospitals, providers, health systems, insurers, and even private companies, their focus is on managing the health of the population of patients enrolled in their care. Public health agencies, with their focus on the health of larger population, have been largely left out of the discussion.

Social determinants of health (SDH), including education, income, housing, job security, transportation, safe neighborhoods, and access to nutritional foods, are recognized as having significantly more impact on health than medical care. Public health has the opportunity to provide granular information on SDH at the individual and community levels to increase health equity. ACOs could have greater impact on quality of care, as well as realize greater cost containment, if they were to have access to SDH data. Other partners that would benefit from community-level SDH data include cities and large employers, thus decreasing health disparities on a larger scale.

Actions

Health departments (state, county, city)

- Convene other local governmental agencies to engage in data sharing and integration at the individual level, including Medicaid, Social Services, Department of Corrections, Behavioral Health, Education, Birth/Death Registrar, Nutrition Programs, and Maternal/Child Health. Such partnerships imply trust built by working together and recognition of value brought to these other agencies.
- Engage with the health care providers to understand and identify the high-priority problems with regard to the social determinants of health outcomes, e.g., non-compliance, high utilizers of multiple systems (clinical and social), community programming needs from an individual-centric perspective.
- Provide “economy of scale” value to policy makers, planners, and supporters of community-based programs by transparently sharing 1) relevant individual patient level SDH information, and 2) the knowledge derived from newer digital tools and services applied to the aggregated data set using advanced analytics.
- Identify community leaders for development of a sustainable business model that requires investment by all stakeholders.

Federal Health and Human Services

- Create a model for collaboration across HHS agencies (e.g., CMS, HRSA, CDC, ONC, SAMHSA, DSS) to affect support for cross-agency data integration at the local level through State Innovation Model (SIM) funding.
- Fund community partnerships through Center for Medicare and Medicaid Integration (CMMI) grants to support use, adaption, and, when necessary, design and development of new open-source data aggregation tools and advanced analytics services. Include grassroots crowd sourcing to put innovative power within the community.

Public health consortium (PHAs, NGOs, academia)

- Contract with an emerging leader in the field of scalable analytic services to license open source analytics tools to all participants for use with their own data sources. Costs for the software infrastructure and architecture could be allocated across consortium members based on usage of infrastructure components. Additional agreements for merging local datasets across members of the consortium could conform to all applicable laws and negotiations among members of the consortium.

Recommendation 5: Establish an NCQA for social determinants of health.

> *Establish a "National Committee for Quality Assurance (NCQA) for Social Determinants of Health" to create a validated evidence-based instrument for benchmarking, and support public health agencies in assessing and monitoring the programs that aim to impact social determinants of health. Provide open-access tools for all communities to use to advance progress in social determinants of health and track the contribution to advancing health and resilience of those communities.*

Multiple municipalities, regional authorities, as well as large employers, are addressing SDH through community-based health initiatives. However, there are not yet validated, standardized metrics by which these initiatives can be assessed.

The need for advanced community-based services is large and diverse, and it is very likely that commercial for-profit service providers will begin to bundle and sell these services. It will be difficult to assess and monitor the success and value of these programs and their claims without objective metrics and validated reporting instruments similar to what NCQA does for direct health outcomes. Validated assessment tools will become increasingly important to identify the gaps in care and services that characterize the support for vulnerable populations.

Linkage of these metrics and survey instruments to actual health outcomes will help refine the instruments and the CQI processes necessary to advance the ability of PHAs and their skillsets to maintain value-add services within and across communities.

Actions

TBD[3]*:*

- Develop a framework for conceptualizing social determinants of health that will guide development of metrics.
- Develop and validate tools that can be used to benchmark and assess progress of community-based interventions in addressing social determinants of health.
- Educate/advocate for an evidence base that links social determinants of health with desirable outcomes of both health and resilience (individual and community).
- Build out objectives, metrics, scalars, and narrative categories and validate with leading communities/public health agencies. Identify attributes that assure sustainability within communities. Coordinate with Community Preventive Services Task Force.
- Provide analytics or other related services to implement.
- Demonstrate the value proposition/business case for promulgation of these validated tools and an "NCQA for Social Determinants of Health."
- Initiate "blinded benchmarking" to provide the feedback that allows community-based programs to improve the effectiveness of their programs. Initiate public reporting once the metrics and their application have been sufficiently validated by the users involved in community health programs.

Public health leadership

- Once implemented, local, state, and federal public health leadership must evolve the role of Public health agencies in supporting various elements of this activity at both local and national

[3] TBD represented by many possible partners and partnerships to include ASTHO, NACCHO, Academy Health, Public Health Informatics Institute, etc.

levels, including developing infrastructure and processes for supporting diffusion within and across communities.

- Vet with communities already engaged with local political sponsorship/investment.

Conclusion

Through the exploration of alternative scenarios about public health and the role of informatics in 2023, the workgroup considered emerging forces, risks, and opportunities in a rapidly evolving landscape of health, health care, and technology over the next 10 years.

While common themes emerged throughout the meeting, the refrain that was most often heard was the call for public health leadership to step up—to "seize the day." A significant opportunity exists to apply and use informatics locally, e.g., in our neighborhoods, communities, and cities, in ways that can significantly impact the public's health.

The workgroup took the initial step in making recommendations and describing the actions that public health and its partners should take over the coming decade. These entities must take the next step: engaging partners in further developing the recommendations and embracing them to realize the positive impact that public health informatics can have and to assure the future they want to see for the public's health.

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