BRIEF COMMENTARY: USING A LOGIC MODEL TO INTEGRATE PUBLIC HEALTH INFORMATICS INTO REFINEMENTS OF PUBLIC HEALTH SURVEILLANCE SYSTEM

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ABSTRACT

The COVID-19 pandemic has been a watershed moment in public health surveillance, highlighting the crucial role of data-driven insights in informing health actions and policies. Revisiting key concepts—public health, epidemiology in public health practice, public health surveillance, and public health informatics—lays the foundation for understanding how these elements converge to create a robust public health surveillance system framework. Especially during the COVID-19 pandemic, this integration was exemplified by the WHO efforts in data dissemination and the subsequent global response. The role of public health informatics emerged as instrumental in this context, enhancing data collection, management, analysis, interpretation, and dissemination processes. A logic model for public health surveillance systems encapsulates the integration of these concepts. It outlines the inputs and outcomes and emphasizes the crucial actions and resources for effective system operation, including the imperative of training and capacity development.

KEYWORDS

public health surveillance system; public health informatics; information and data technologies; logic model

1. INTRODUCTION

The COVID-19 pandemic has been a watershed moment in public health surveillance, highlighting the crucial role of data-driven insights in informing health actions and policies [1,2]. In this critical period, major public health entities such as the World Health Organization (WHO), the US Centers for Disease Control and Prevention (CDC), and various state and local health departments played a pivotal role in disseminating essential data on COVID-19's incidence and prevalence across different regions. The strategic release and interpretation of this data were key in guiding significant public health decisions and customizing public health interventions to meet the specific needs of affected communities. Beyond COVID-19, the continuous monitoring of over 120 communicable diseases [3] by public health professionals worldwide underscores the imperative for robust and agile public health surveillance systems to facilitate prompt interventions and effective disease control.

This commentary revisits foundational concepts vital to public health surveillance systems, illuminating the collaborative role of advanced information technologies and the deep expertise of public health professionals in enhancing these systems. As we move forward, the application of public health informatics emerges as an indispensable element. Through this commentary, we aim to discuss how public health informatics can influence the refinement of public health

surveillance systems. Our focus is on illustrating how the incorporation of informatics not only amplifies public health surveillance capabilities but also reinforces our collective preparedness and response to public health emergencies.

2. KEY CONCEPTS RELATED TO PUBLIC HEALTH SURVEILLANCE SYSTEMS

These are key concepts that are included in any discussion of a public health surveillance system:

Public health[4,5]: "The science and art of preventing disease, prolonging life, and promoting health through the organized efforts and informed choices of society, organizations, public and private communities, and individuals."

Public health epidemiology[5-8]: Based on the definition of epidemiology: "the study of the distribution and determinants of health conditions or events among populations and the application of that study to control health problems." We also consider the CDC definition of public health practice: as "encompassing the assessment, policy development, and assurance which are performed in the field and represent the function of government agencies for providing public service."Functionally, public health epidemiology is the application of epidemiology to the assessment, policy development, and assurance functions that are carried out by government agencies.

Public health surveillance[4, 6,7, 9, 13]: The systematic collection, analysis, interpretation, and dissemination of health data on an ongoing basis, to gain knowledge of the pattern of disease occurrence and potential in a community, in order to control and prevent disease in the community.

Public health informatics[9,12]: "The systematic application of information, computer science, and technology to public health practice, research, and learning." The central purpose of public health practice is to prevent disease or injuryto improve the health of communities. Activities such as program evaluation and disease surveillance along with the use of decision tree analytics to guide public health action are just a few examples of public health practice [10].

These definitions are useful as a common frame of reference for application in the public health arena.

3. PUBLIC HEALTH INFORMATICS IN PUBLIC HEALTH SURVEILLANCE

In the wake of the COVID-19 pandemic and the work of the WHO to report COVID-19 public health data [1], the transformative power of data and information technologies, public health data, and data visualization techniques can plan an integral role in reshaping public health surveillance systems.

This section, drawing upon published works[10-11] and reflecting on recent public health surveillance challenges, explores the potential of public health informatics in planning and refining a public health surveillance system for a nationwide healthcare network. The synergy between public health epidemiology, public health informatics, and advanced data technologies proved to be indispensable for enhancing the response capabilities of public health surveillance systems during the COVID-19 pandemic, which began in late 2019. The pandemic experience underscored the critical importance of data-driven public health responses, where state-of-the-art information and data technologies play a central role in guiding public health measures to curb the spread of infectious diseases.

Suppose we consider efforts to enhance public health surveillance in a large, integrated healthcare system that has over 1300 facilities and serves at least nine million eligible care recipients, annually [14]. The professional practice of public health informatics might be instrumental in helping to update and enhance the public health surveillance system capabilities of such a healthcare system. Considerations of public health informatics can guide the planning of a public health surveillance system in the following way [11]:

Planning and System Design

Developing public health surveillance systems for national notifiable diseases, prioritizing the selection of relevant data sources and defining specific access methodologies. This approach is geared toward enhancing the system's efficiency in disease surveillance and ensuring integration with other health information systems for robust analysis and actionable insights.

Healthcare system application and topics to consider: Identify the updated purpose of the surveillance system and its goals. Describe what the intended outcomes of the surveillance will be. Data flow. Data safety and transmission. Identify the diseases that will be included and for which public health interventions exist. Reporting flow.

Data Collection

Tailoring data collection methods to address biases, particularly in the context of national notifiable diseases. This includes balancing structured and unstructured data and employing advanced technologies such as GPS and RFID to ensure accurate and efficient disease data collection.

Healthcare system application and topics to consider: Case definitions and data collection fields for interoperability (e.g., USCDI [15]). Case ID management.

Data Management and Collation

Ensuring smooth data integration and management across diverse platforms, particularly focusing on data related to notifiable diseases. This involves maintaining high standards of data quality and security, essential for sensitive health data, while facilitating interoperability with legacy health systems.

Healthcare system application and topics to consider: Data flow and Case ID management. Data transmission protocols. Monitoring for data quality. De-identified data sets. Technologies for data management and data preparation (e.g., MS-Fabric; Python; SQL; GIS) [4,12].

Statistical Analysis

Applying sophisticated statistical methods and visualization tools specifically suited for monitoring and analyzing data on national notifiable diseases. Emphasize the use of high-performance computing to manage and interpret extensive datasets, crucial for effective disease surveillance.

Healthcare system application and topics to consider: Data technologies to support analysis and reporting (e.g., MS-Fabric; Python data analysis and machine learning NCSS; MS PowerBI).Longitudinal data analysis. Feature engineering. Data visualization [4].

Epidemiologic and Public Health Interpretation

Conducting comprehensive analyses of surveillance data against other health datasets, with a specific focus on national notifiable diseases. This integration aims to provide deeper insights and enhance understanding in the public health domain, particularly in disease monitoring and response.

Healthcare system application and topics to consider: Descriptive epidemiology and time-series analysis [4]. Data visualization. Data storytelling with public health implications.

Public Health Information Dissemination

Crafting strategies for effective dissemination of information regarding national notifiable diseases to diverse stakeholders. Focuses on accessibility and clarity, recognizing the significant role of data providers in the surveillance process.

Healthcare system application and topics to consider: Data storytelling for public health action; data quality and data applications for those involved with data capture and data entry; public health interpretation of public health surveillance system data by geographic areas and epidemiological variables.

Possible Use By Public Health Decision-Makers

Assessing the direct integration of notifiable disease surveillance data into public health interventions. Identifying key informational elements and standards that facilitate the linkage of surveillance data to actionable health initiatives, thereby enhancing field workers' and healthcare providers' access to crucial health information.

Healthcare system application and topics to consider: Interpretation of public health surveillance data for the decision-maker, pointing out salient public health data insights. Linking the public health data insights to categories of public health action. Helping public health decision-makers see and understand the public health surveillance data for public health action.

One way to combine the prior elements of public health informatics into a public health surveillance system would be to construct a logic model of such a public health surveillance system for decision-makers to review (Fig. 1)

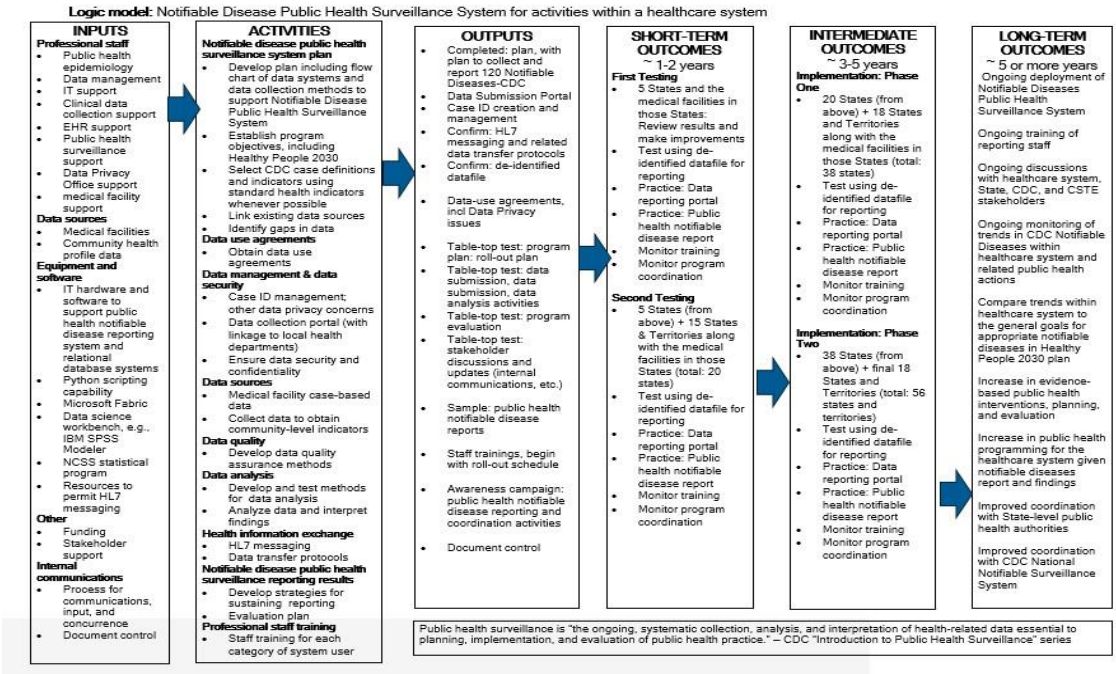

Figure 1: Notifiable Disease Public Health Surveillance System for healthcare system; adaptation [16]

The logic model integrates concepts from public health surveillance system and public health informatics. The model both describes the inputs and outcomes of an enhanced public health surveillance system, and it also shows key actions that need to occur. Consideration of these key actions permits the assemblage of personnel and materials necessary for system operation. Notice, as well, the importance of training and capacity development as an explicit element of updating this hypothetical public health surveillance system.

4. CONCLUSIONS

This commentary has highlighted how informatics are crucial in advancing the efficacy and responsiveness of public health surveillance, particularly in the context of monitoring and reporting on nationally notifiable diseases. The transformative role of modern information and data technologies—such as Microsoft Fabric, GenerativeAI, Data Science workbench, Python, and NCSS statistical software—has been underscored in reshaping public health surveillance systems for a more integrated and efficient approach.

Revisiting key concepts—public health, epidemiology in public health practice, public health surveillance, and public health informatics—lays the foundation for understanding how these elements converge to create a robust public health surveillance system framework. Especially during the COVID-19 pandemic, this integration was exemplified by the WHO efforts in data dissemination and the subsequent global response. The role of public health informatics emerged as instrumental in this context, enhancing data collection, management, analysis, interpretation, and dissemination processes in global public health practice.

Looking ahead, the application of public health informatics in planning and refining the public health surveillance systems for a nationwide healthcare network presents an opportunity to significantly enhance public health disease surveillance capabilities. This involves thoughtful planning and system design, meticulous data collection, rigorous data management, sophisticated

statistical analysis, comprehensive epidemiologic interpretation, and strategic public health information dissemination.

In particular, the development of a logic model for public health surveillance systems (appendix) encapsulates the integration of these concepts. It not only outlines the inputs and outcomes but also emphasizes the crucial actions and resources required for effective system operation, including the imperative of training and capacity development. The logic model could help organize thoughts, guide development, and be a useful collection of markers for enhancing a public health surveillance system.

In conclusion, the integration of public health informatics into a public health surveillance system is not merely a technological upgrade but a strategic re-envisioning of how public health data is collected, analyzed, and utilized. This integration promises to bolster operational capacities, enhance public health disease monitoring and response, and equip public health professionals with tools needed for more proactive and informed decision-making in both public health emergency situations and broader public health initiatives.

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Appendix: Logic model template for public health surveillance system, enlarged