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Concepts of Public Health Surveillance to Support Infectious Disease Cluster Control Efforts in Rural Rajasthan, India

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ABSTRACT

As previously reported, the high number of COVID-19 cases and deaths in Rajasthan, India, is a concern. Given the current situation, this is an appropriate time to review the concepts of public health surveillance to assist in epidemiologic efforts in response to infectious disease outbreaks. In the past five years, a search of Google Scholar did not reveal the existence of published works detailing the concepts of a public health surveillance for use in rural Rajasthan. This paper is the second part of a review of concepts that could help in the preparation of a response to infectious disease outbreaks in Rajasthan. The purpose of this review is to succinctly describe the main concepts of public health surveillance for public health emergency professionals and community leaders responding to any infectious disease outbreak in Rajasthan. This paper is the second part of a published review paper entitled "Concepts of field epidemiology in preparation for response to infectious disease outbreak in rural Rajasthan, India" in International Journal of Science & Healthcare Research. 2020; 5(2): 47-55.

Key Words: Public Health Surveillance; Data Sources; Public Health Epidemiologist; Data Collection Systems; Epidemiologic Statistical Measures; Odds Ratio

INTRODUCTION

"The reason for collecting, analyzing, and disseminating information on a disease is to control that disease. Collection and analysis should not be allowed to consume resources if action does not follow." ---William Foege, 1976 (William Foege, MD, former Director, U.S. Centers for Disease Control and Prevention, played a substantial role in the global effort to eradicate smallpox from the human population.)

This paper is the second part of a review of concepts that could help in the preparation of a response to infectious disease outbreaks in Rajasthan, India. As previously reported, [1] the high number of COVID-19 cases and deaths in Rajasthan is a concern. COVID-19 is an infectious disease outbreak of significant impact throughout India. Circulating in nature, there are other infectious diseases that may or may not become a disease cluster that could lead to an outbreak in the human population. Given the current situation, this is an appropriate time to review both the concepts of field epidemiology [1] and public health surveillance to assist in epidemiologic efforts in response to infectious disease outbreaks. In the past five years, a search of Google Scholar did not reveal the existence of published works detailing the concepts of a public health surveillance for use in rural Rajasthan. Many graduates of Indian public health and epidemiology master's degree programs could help in efforts to advance public health in India, [2] as well as work in the important area of public health surveillance.

The response to a disease cluster includes the collection of data that could be incorporated into a public health surveillance system. In fact, the approach to an outbreak investigation includes

epidemiologic services that incorporates, among other professional services, contract tracing and surveillance activities. [1] The purpose of this review is to succinctly describe the main concepts of public health surveillance for public health emergency professionals and community leaders responding to any infectious disease outbreak in Rajasthan. This paper is organized using four sections: Public Health Surveillance-Basic Concepts; Sources of Data; Types of Surveillance Systems and Operational Issues; and Descriptive Epidemiology and Related Concepts. This paper is the second part of a published review paper entitled "Concepts of field epidemiology in preparation for response to infectious disease outbreak in rural Rajasthan, India" in International Journal of Science & Healthcare Research. 2020; 5(2): 47-55.

Section 1: Public Health Surveillance-Basic Concepts

Public health surveillance is the continuous, systematic collection, analysis and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice. [3-4] This activity concerns itself with continuous data collection, data analysis, data interpretation, and taking action based on the data to address a public health matter of concern. The concept is often used in connection with infectious or communicable disease impacting a population.

The objectives of public health surveillance can include any of the following: [4-6]

- To serve as an early warning system for impending public health emergencies
- To document the impact of an intervention, or track progress toward specified goals
- To assess the public health impact of events and assess trends (including changes in disease patterns)
- To recognize isolated or clustered cases
- To monitor and clarify the epidemiology of health problems, to allow priorities to be set and to inform public health policy and public health program strategies

Public health surveillance activities should include only those conditions that are likely to lead to public health action for the population/community. Theoretically, nearly everything can be counted, but it will have its cost- in terms of technology, physical space, human resources, money, and economic "opportunity costs." So in reality, everything cannot be counted or recorded given the resources available. Therefore, we must consider the public health objectives for which we need the public health surveillance system to provide data and insights for public health action.

We must define the purpose of the public health surveillance system for a specific situation, as well as make a commitment to support said system with money, resources, and personnel. Then, we must decide what to measure-say, devising a list of notifiable communicable diseases that will be reported to the public health surveillance system. [5] The conditions included in a public health surveillance should be related to the burden of disease impacting the population or community. Alternatively, a list of population health status indicators could also be reported to a public health surveillance system in order to track and respond to population health status indicators for a country. Needless to say, developing a public health surveillance system takes thoughtful health planning.

A major concern when it comes to infectious diseases impacting a population is what will determine whether or not a disease is placed on the list of notifiable communicable diseases reported to the public health surveillance system. Criteria must be established and they might include: [6]

Case definition on what constitutes a specific disease

- Incidence
- Prevalence
- Mortality rate

- Index of lost productivity
- Medical costs
- Preventability
- Epidemic potential
- Information gaps on disease/condition in a specific location

It is important to keep in mind that a functional public health surveillance system is more than computer hardware and software system (including a relational database) that are used to generate data reports on infectious diseases. A public health surveillance system is essential to support evidence-based public health practice. Figure 1 shows the basic structure of a public health surveillance system. The darker box names the activity phase of a surveillance system while the lower box includes a brief description of what is happening during that phase.

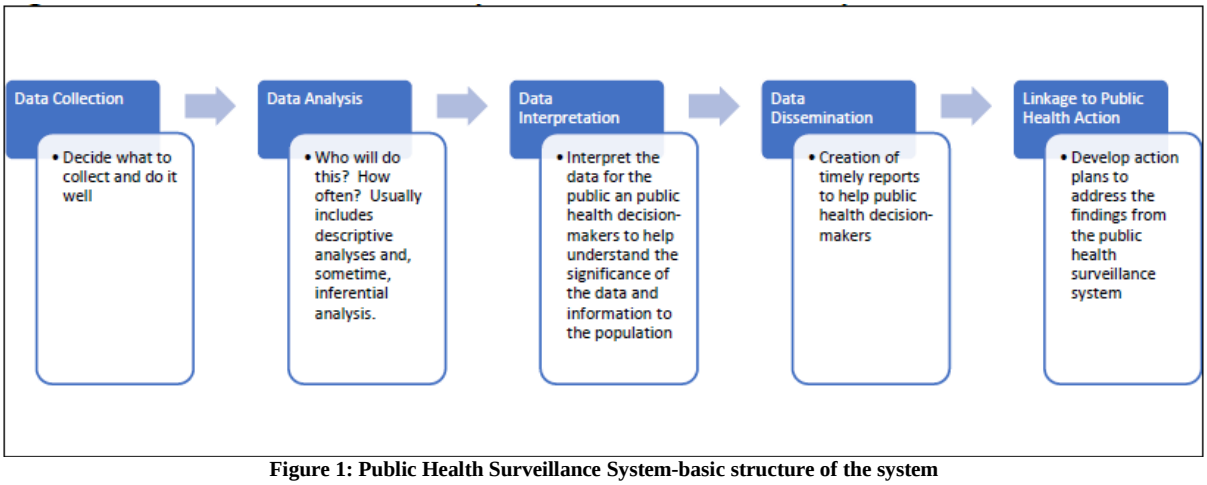


Figure 1: Public Health Surveillance System-basic structure of the system

Section 2: Sources of Data

Common sources of data for a public health surveillance system are not dissimilar from the data used in other public health or epidemiologic activities. They include: [6-8]

- Reported diseases or syndromes (from outbreak investigations or public health laboratories)
- Electronic health records (e.g., hospital data collected from patients with protected identities)
- Vital records (e.g., birth and death certificates)
- Registries (e.g., cancer, immunization)
- Survey data
- Census data
- Administrative data

An example description of these sources of data can be found in an epidemiologic text. [8] The point of identifying the above data is that much planning and thought goes into determining the relevant data sources that will support the purpose of the public health surveillance system. The technical details for how these data can be transferred to the public health surveillance system in a secure manner, along with how the data will be cleaned and prepared for analysis, must be considered.

Section 3: Types of Surveillance Systems and Operational Issues

Public health surveillance systems are classified into two broad types: [9]

- Passive Surveillance: Routine collection and reporting of defined condition(s) by provider or laboratory to public health authority for analysis and reporting.
- Active Surveillance: Representatives from the public health authority go into the community to collect data on defined condition(s) that is then analyzed and reported by the public health authority.

Other types of public health surveillance systems: Registry; Syndromic Surveillance;

Sentinel Surveillance. (Please consult an epidemiology text for further descriptions.)

An effective public health surveillance system has the following characteristics: [10]

- Well-planned
- Supported by stakeholders
- Uses both active and passive surveillance techniques
- Timely notification of events
- Timely and comprehensive action taken in response to notification
- Utilizes appropriate and up-to-date information technology
- Provides for secure electronic data transfer from various courses
- Data are clean and of good data quality
- Highly educated and competent and motivated personnel--public health epidemiologists; database administrators; computer programmers; and health communication specialists
- Effective, actionable public health surveillance system reports

The role of the public health epidemiologist is important to highlight. Functionally, the public health epidemiologist possesses expertise on "the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society". [11] These epidemiologists often study quantitative data from various sources to understand the cause and effect of disease (or some negative health outcome) in a community or population and work with others to develop evidence-based programming activities to control the negative health outcome in the community or population. [11]

Public health epidemiology is not clinical epidemiology. [12] The public health epidemiologist, as a role in the team of professionals operating a public health surveillance system, seeks to understand and analyze the data from a public health surveillance system and turn it into information reports that lead to public health action.

Ideally, each professional involved in public health surveillance system activities comes to the central tasks of the system with a specific area of professional expertise, along with skills in collaboration, communication, and using public health data to help devise public health action to address the negative health outcome. Furthermore, the professionals operating a public health surveillance system desire to help and support those who are collecting the "raw data" either at bed-side, in the laboratory, at intake, from the field, or collecting "big data" that forms the basis for any public health surveillance system.

Section 4: Descriptive Epidemiology and Related Concepts

A public health surveillance system for infectious diseases in a particular geographic location looks for patterns in the collected data by describing the data in terms of person, place, and time. [10,13] In fact, the basis of descriptive epidemiology is to describe disease in a population by person, place, and time. [14] The examination of data trends is also an important perspective derived from public health surveillance data.

Descriptive Epidemiology

Descriptive epidemiology is defined [10] as: *The aspect of epidemiology concerned with organizing and summarizing data regarding the persons affected (e.g., the characteristics of those who became ill), time (e.g., when they become ill), and place (e.g., where they might have been exposed to the cause of illness).*

Common Epidemiological Statistical Measures

Common epidemiological statistical measures used in many public health surveillance systems are presented in the following table (Table 1).

Table 1: Common Epidemiological Statistical Measures

Measure	Numerator	Denominator	Multiplied by
Incidence	New cases or events in a given time period	Population at-risk during the same time period	1,000 or 100,000
Prevalence	Number of existing cases (Old + New) in a given time period	Population at-risk during the same time period	1,000 or 100,000
Mortality	Total number of deaths in a time period	Total number of people at-risk during the same time period	1,000 or 100,000
Case Fatality Rate	Total number of people dying in an episode of the disease	Total number of episodes of the disease	100
Attack Rate	Number of people contracting a disease	Total number of people at-risk	100
Relative Risk	Incidence rate of disease in exposed group	Incidence rate of disease in unexposed group	Not Done
Attributable Risk	Incidence rate in exposed group minus incidence rate in unexposed group	Incidence rate in exposed group	100
Odds Ratio* (*see Technical Box 1)	Odds that a case was exposed to the risk factor	Odds that a control was exposed to the risk factor	Not Done

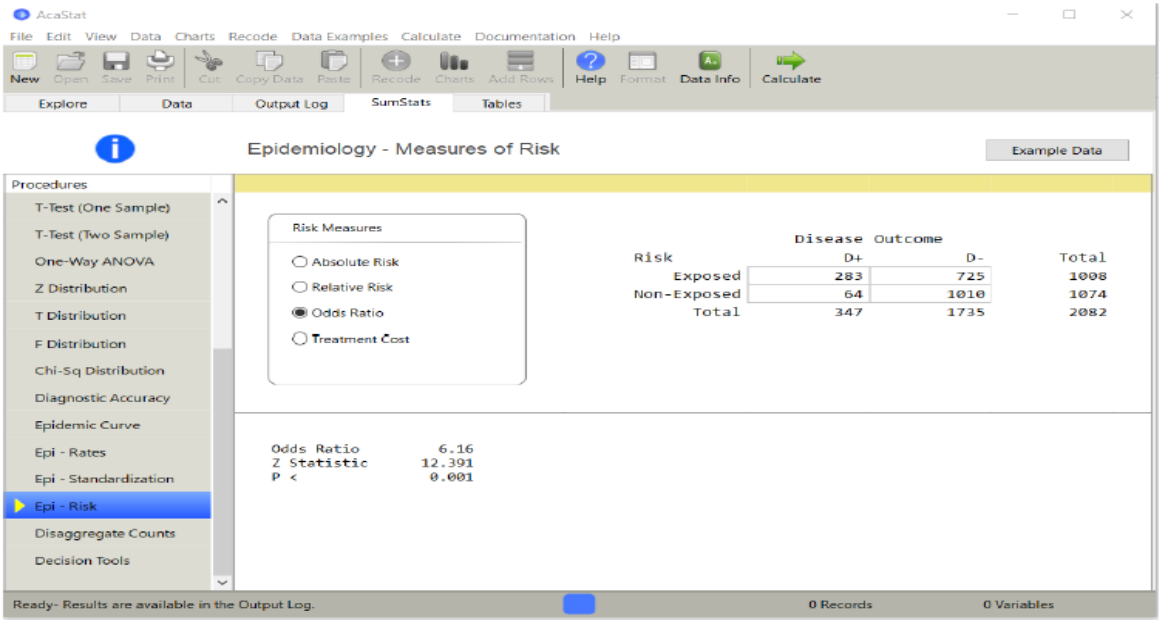
Sources: Bhattacharya S. Epidemiology-principles and practices. Mumbai: Jaypee, 2010; Glaser AN. High-Yield Biostatistics, second edition. Philadelphia: Lippincott Williams & Wilkins, 2001.

Software Example

Statistical software can support the quantitative efforts of epidemiologists. The use of statistical software (and related calculators) reduces computational errors. In fact, most statistical software packages can calculate the odds ratio as part of specific statistical procedures (such as a Fisher's Exact Chi-Square test or the Logistic Regression). For example, AcaStat (URL: www.acastat.com) is a low-cost, easy-to-use statistical software package that can be used to calculate the odds ratio (see Technical Box 1).

Technical Box 1
AcaStat: Risk Measures from the SumStats Module

Enter data into the 2x2 table in the appropriate cell. Then, press the "Calculate" button and the output will appear, as shown below. Notice: Those exposed to an established risk factor are six times more likely to get the disease than those not exposed (OR = 6.16). This fact would be included with other data from the public health surveillance system and presented to public health decision-makers to guide development of an appropriate public health control measure for the population.



From AcaStat 10.5.1 © 2020 (used with permission)

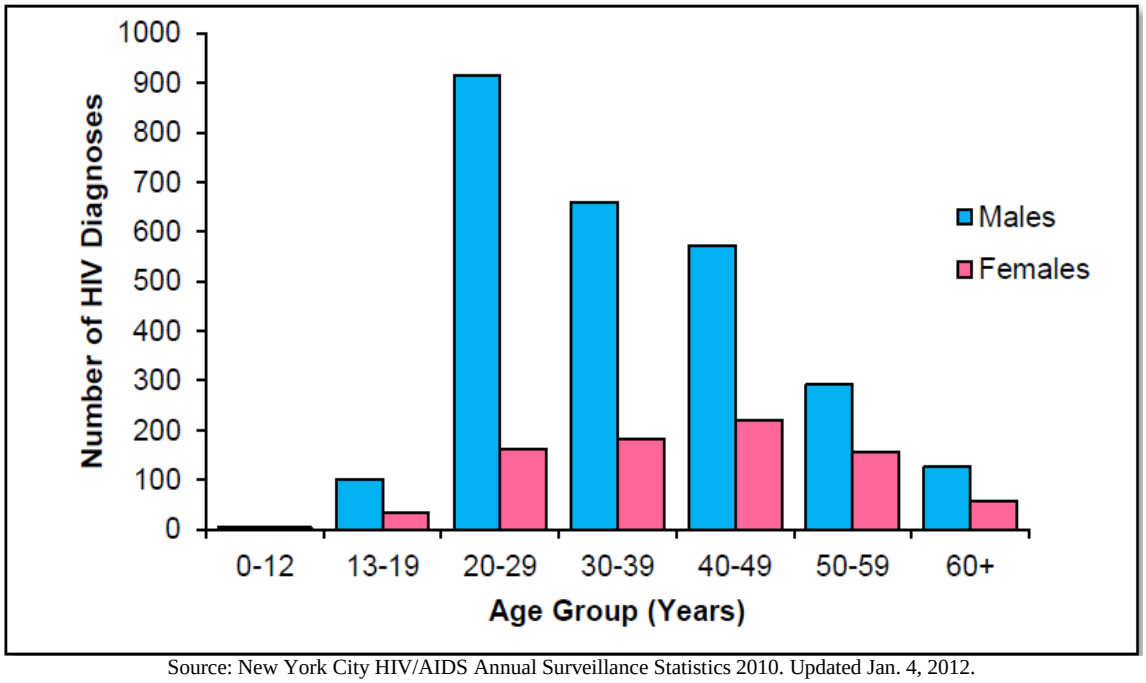
Rate Standardization

It is problematic to compare the crude mortality rates between two different populations (say, India and a neighboring country) because the rates have a meaning that is based upon the number of births and deaths in each population. The structure of the Indian population in terms of birth rates and death rates is different from that of a neighboring country. As such, comparing crude mortality rates is difficult. [15,16] A direct method of rate adjustment and an indirect method rate adjustment are two methods that may be used to compare the mortality rates from two different populations. [15-17]

Common Epidemiologic Methods for Presenting Public Health Surveillance Data

A key component of a public health surveillance system is the presentation of data. [10] The data from a public health surveillance system are presented in terms of person, place, and time using common methods. [6,8,10,13,14] The presentation of data may also include reporting common statistical measures. Three examples are shown below.

Example 1: Reported HIV/AIDS Diagnoses, by Age and Sex, New York City, 2010

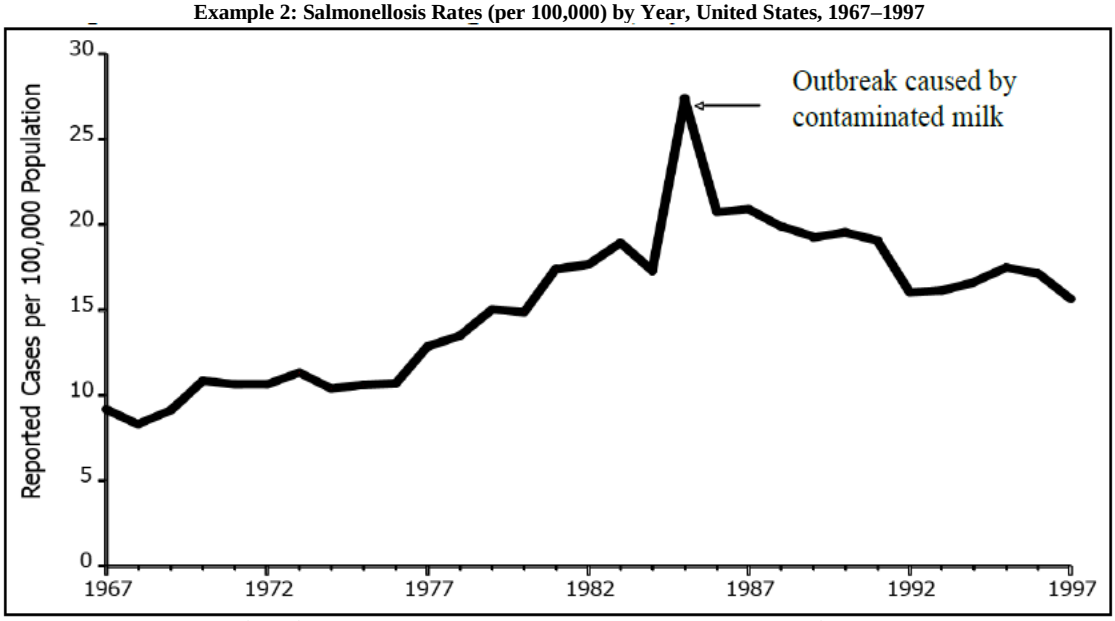


Source: New York City HIV/AIDS Annual Surveillance Statistics 2010. Updated Jan. 4, 2012.

The challenge of those leading and analyzing data from a public health surveillance system is how to make understandable and actionable the plethora of data contained within the system. Descriptive analyses are used, including the use of graphics. The presentation of public health surveillance data for a particular disease by person (here, age and sex) is often presented using a bar chart. In Example 1, notice that the bar graph includes a "title" for the information presented and a "source" of the data. Clear labels are found in the graph and it does not include unnecessary ornamentation. A data table could also be used to present this information.

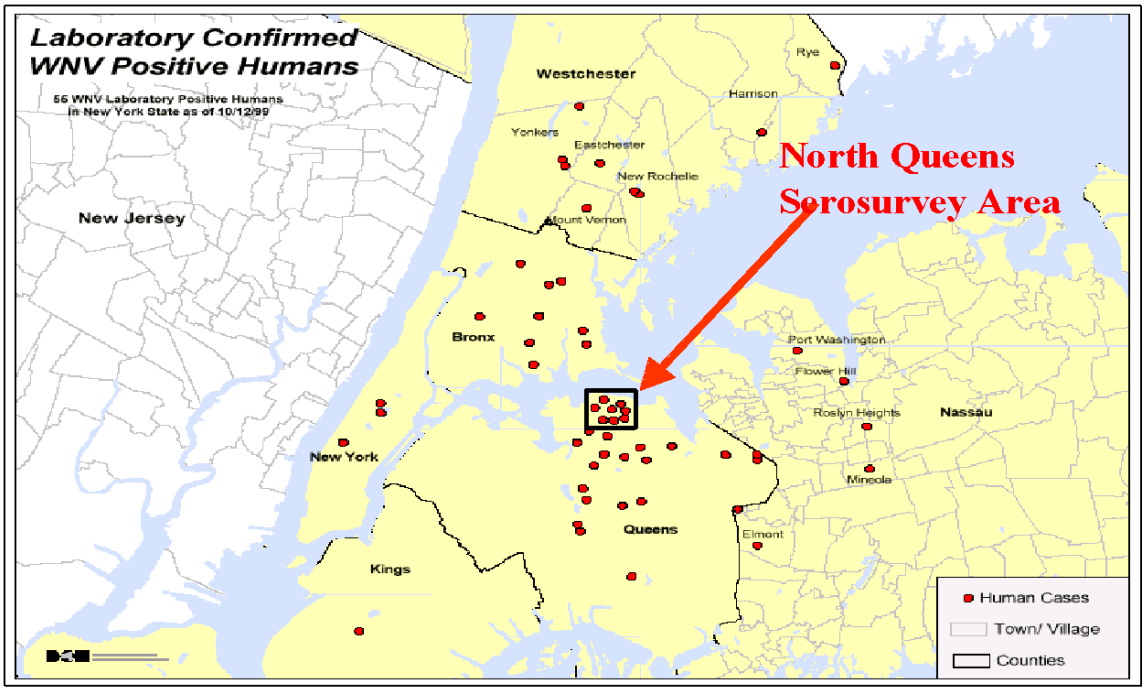
The presentation of public health surveillance data by time is often accomplished using a line graph (Example 2). This type of graph is frequently used to show a trend of data points over time where number of cases or, even, rates are on the y-axis over time in years or months (or some other time periods) is shown on the x-axis. In Example 2, notice the inclusion of a comment on the line graph to highlight a temporal event.

Example 2: Salmonellosis Rates (per 100,000) by Year, United States, 1967–1997



Source: MMWR Summary of Notifiable Diseases, United States, 1997 (Figure 39), US Centers for Disease Control and Prevention.

Example 3: West Nile Virus Positive Humans in New York City area, 1999



Source: Map Courtesy of the New York City Department of Health and Mental Hygiene

Finally, the presentation of public health surveillance data by place may utilize a map (Example 3). A map indicates location of cases and prompts related public health control questions for the public health decision-maker.

A functioning public health surveillance system staffed by public health professionals (including public health epidemiologists) who analyze and interpret data collected and stored in the system can offer crucial insights when it comes to public health action. The interpretation of the surveillance information and data might include narratives and presentations of data in charts and graphs that can subsequently appear in public health reports, internal documents, or published in peer-review journals. The purpose of published public health reports is to inform leaders of various

public health surveillance systems of noteworthy findings. This information can guide decision making and have leaders on alert for similar findings in their area.

When participating in an outbreak investigation (think: rural Rajasthan), it is important to keep in mind that the collected data are often provided or transmitted to public health officials. These data are, then, added to the public health surveillance system along with other data sources for the specific geographic location. Collectively, these data are available for use in public health monitoring and public health action to protect the population from a disease or control a negative health outcome.

CONCLUSION

Public health surveillance, along with field epidemiology, are exciting aspects of public health and epidemiologic practice. The key concepts of public health surveillance that were discussed included:

- Key concepts of public health surveillance
- Identification of data sources
- Types of surveillance systems and related operational issues
- Descriptive epidemiology
- Epidemiologic statistical measures (including technical details for calculating the odds ratio using software)
- Epidemiologic methods for presenting data

A functioning public health surveillance system that is staffed by public health professionals (including public health epidemiologists) who analyze and interpret data collected in the surveillance system and offer insights for public health action. This sentiment bears repeating: [1] *While not a comprehensive presentation, this review may be useful to field epidemiologists and public health professionals preparing to help rural communities in Rajasthan where an unexpected, infectious disease cluster is present.* Additionally, there is the potential for many graduates of Indian public health and epidemiology master's degree programs to help in efforts to advance public health in India, including contributions to the important area of public health surveillance.

Conflict of Interest: There are no financial conflicts of interest related to this brief review.

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Biographical Statement

Dr. GV Fant is a public health epidemiologist and visiting faculty member at JSPH having taught subjects in epidemiology, biostatistics, field epidemiology, and health database concepts to Indian MPH-degree students and public health professionals since 2013. He is, also, the Executive Director of the Society for Epidemiology at JSPH. Dr. Fant earned his doctorate (PhD) from University of Nebraska in 1997. He earned two master's degree-- in the health sciences/public health and public administration. Dr. Fant earned professional recognition as an Epidemiologist from the American College of Epidemiology (MACE) in 2002, the Society for Epidemiology at JSPH (MSEpi) in 2019, and as an International Practitioner of the Faculty of Public Health of the Royal Colleges of Physicians of the United Kingdom (IPFPH-UK) in 2017. Beginning in 1997, Dr. Fant has served as a U.S. civil servant and is an epidemiologist in Northern Virginia, USA.

REFERENCES

1. Fant GV. Concepts of field epidemiology in preparation for response to infectious disease outbreak in rural Rajasthan, India. International Journal of Science & Healthcare Research. 2020; 5(2): 47-55.
2. Fant GV, Purohit A, Reddy KS et.al. Colloquium report- public health in India: a call to action. Int J Health Sci Res. 2019; 9(9):215-218.
3. World Health Organization. "Health Topics-Public Health Surveillance" (URL:

http://www.who.int/topics/public_health_surveillance/en/; accessed January 14, 2016).
4. Bhattacharya S. Epidemiology-principles and practice. Mumbai: Jaypee, 2010.
5. Government of India, National Center for Disease Control. "Integrated Disease Surveillance Project: Training Manual for Medical Officers for Hospital Based Disease Surveillance." New Delhi: National Center for Disease Control, November 2004.
6. Bonita R, Beaglehole R, Kjellstrom T. Basic Epidemiology, second edition. Geneva: WHO, 2006.
7. Alemeyehu M. Communicable Disease Control-Lecture Notes. Atlanta: The Carter Center, 2004.
8. Friis R, Sellers T. Epidemiology for Public Health Practice, fourth edition. Boston: Jones and Bartlett Publishers, 2009.
9. Muthu VK. A Short Book of Public Health, second edition. New Delhi: Jaypee, 2014.
10. CDC. Principles of Epidemiology in Public Health Practice, third edition. Atlanta: US Department of Health and Human Services, Centers for Disease Control and Prevention, 2011.
11. "Public Health Epidemiology." Erasmus MC Netherlands Institute for Health Sciences (URL: https://www.nihes.com/education/masters-specialization-videos/; accessed: May 4, 2020)
12. "Clinical Epidemiology." Erasmus MC Netherlands Institute for Health Sciences (URL: https://www.nihes.com/research/researchdisciplines/; accessed: May 4, 2020)
13. Page RM, Cole GE, Timmreck TC. Basic Epidemiological Methods and Biostatistics. Boston: Jones and Bartlett Publishers, 1995.
14. Somerville M, Kumaran K, Anderson R. Public Health and Epidemiology – At A Glance. West Sussex: Wiley-Blackwell, 2012.
15. Carr, S., Unwin, N., Pless-Mulloli, T. An Introduction to Public Health and Epidemiology, second edition. Berkshire: Open University Press, 2007
16. Fant G. Examining Population Structure of Rajasthan with Implications for Public Health Planning and rate Standardization to support Eye and vision care Public Health Programming. Epidem Int 2018; 3(1): 15-21.
17. Sharrar R. "General Principles of Epidemiology." *In* Preventive Medicine and Public Health, BJ Cassens (ed). Media, PA: Harwal, 1990.

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