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Concepts of Field Epidemiology in Preparation for Response to Infectious Disease Outbreak in Rural Rajasthan, India

GV Fant

Visiting Professor, Public Health (Epidemiology & Biostatistics), Jodhpur School of Public Health (JSPH);
Executive Director, Society for Epidemiology at JSPH;
Practicing Public Health Epidemiologist in Northern Virginia, USA

ABSTRACT

Recent *World Health Organization (WHO)-India COVID-19 Situation Update Reports* have documented the status of the epidemic. COVID-19 is an infectious disease outbreak of significant impact throughout India. There are other infectious diseases, also circulating in nature that may or may not become a disease cluster that leads to an outbreak. Given the current situation, this is an appropriate time to review the concepts of field epidemiology to assist in epidemiologic efforts in response to infectious disease outbreaks. The main purpose of this review is to succinctly describe some main concepts of field epidemiology to assist public health professionals preparing to investigate infectious disease outbreaks in rural Rajasthan or similar regions in India.

Key Words: Field Epidemiology, Outbreak, Epidemic Curve, Epidemiologic Disease Control Methods, Team-work

INTRODUCTION

Recent *World Health Organization (WHO)-India COVID-19 Situation Update Reports* have documented the status of the epidemic. [1,2] In the report from April 5, 2020, 3,577 COVID-19 cases (including some cases from outside of India) had been reported in 29 states/union territories, and there were 83 reported deaths from the disease. The next report, dated April 12, 2020, showed some differences: 8,447 confirmed COVID-19 cases in 31 states/union territories and 273 reported deaths. The Indian Ministry of Health and Family Welfare (MoHFW) continues to work with the WHO Country Office-India "on preparedness and response measures for COVID-19, including surveillance and contact tracing, laboratory diagnosis, risk communications and community engagement, hospital preparedness, infection prevention and control (IPC) and implementation of containment strategies". [2]

The high categorization of COVID-19 cases and deaths in Rajasthan [1] is a concern. Part of the response effort is likely to include field epidemiological services. 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 leads to an outbreak among humans. Given the current situation, this is an appropriate time to review the concepts of field epidemiology to assist in epidemiologic efforts in response to infectious disease outbreaks. In the past five years, a search of Google Scholar did not reveal any prior efforts to describe the concepts of field epidemiology for use in Rajasthan, India.

The purpose of this review is to succinctly describe the main concepts of field epidemiology for public health emergency professionals and community leaders responding to any infectious disease outbreak in rural Rajasthan. This paper is organized using four sections: Field Epidemiology and related concepts;

Outbreak Investigation, the Chain of Infection and the Epidemic Curve; Overview of Epidemiologic Disease Control Methods; and Team Approach to Outbreak Investigation and Emergency Response.

Section 1: Field Epidemiology and Related Concepts

Epidemiology is considered the fundamental science of public health practice and population health. [3,4] Let us define what we mean by the term: Epidemiology is the study of the distribution and determinants of health-related states or events in a specified population, and the application of this study to the control of the health problem in the population. [5] This highly quantitative science is known for its methods of action-orientation epidemiological intelligence and has a history of significant events such as: [6-8]

- Acknowledgement of the environment in disease (460-370 BCE)
- Compilation of mortality statistics (1662)
- Publication of "Diseases of Workers" (1700)
- Containment of cholera at the water-pump handle at Broad Street (ca. 1850)
- Characterization of the influenza pandemic (1918)
- Elimination of smallpox (1977)
- Recognition of "Ebola Fighters" as the "Persons of the Year" by Time Magazine (2014)

The scientific, action-oriented focus of epidemiology has been recognized to have seven uses in the broad public health field. [6,9] To understand the health status of a population and its utilization of health services, epidemiology is used to study the history of health in a population, diagnose the health of a community, and examine the workings of health services by the population. To understand the causes of disease, epidemiology is used to estimate disease risk in the population, identify syndromes, provide scientific evidence to complete a clinical picture of disease, and use epidemiologic methods to search for causes of disease.

Functionally, field epidemiology is used in situations where a cluster of communicable or infectious disease cases have been found in a population that was previously not impacted by the disease. [10] Epidemiologists travel to the location of the disease cluster, along with other public health professionals and medical professionals, to help characterize the disease, control the disease, and institute public health control measures in the community. The medical treatment of those community members in need may, also, be provided by medical professionals.

There are many terms used by field epidemiologists in the course of investigating communicable disease in a community. These terms are defined as such: [11,12]

Mortality: death

Morbidity: any departure, subjective or objective, for a state of physiological or psychological well-being; in this sense, sickness and illness may be used as synonyms.

Prevalence: the number or proportion of cases or events or attributes among a given population; describes the number of existing cases in population at a given time-period; prevalence rate.

Incidence: measure of the frequency with which new cases of illness, injury, or other health condition occurs among a population during a specific time period; describes the number of new cases in a population at a given time-period; incidence rate.

Attack Rate: form of incidence that measures the proportion of persons in a population who experience an acute health event during a limited period.

Virulence: the ability of an infectious agent to cause severe disease, measured as the proportion of persons with the disease who become severely ill or die.

Infectivity: the ability of an infectious agent to cause infection, measured as the proportion of persons exposed to an infectious agent who become infected.

Herd Immunity: the resistance to an infectious agent of an entire group or community (and, in particular protection of susceptible persons) as a result of a substantial proportion of the population being immune to the agent.

Outbreak: the occurrence of more cases of disease, injury, or other health condition than expected in a given area or among a specific group of persons during a specific time-period.

Epidemic: the occurrence of more cases of disease, injury, or other health condition than expected in a given area or among a specific group of persons during a specific time-period; the cases are presumed to have a common cause or to be related to one another in some way.

Pandemic: an epidemic occurring over a widespread area (multiple countries or continents) and usually affecting a substantial proportion of the population.

Public health practice: refers to the essential public health services of a public health system.

In the terms presented above, the reader will notice the quantitative aspect of nearly all of the terms. Rates, proportions, and ratios are common types of calculations which applied epidemiologists or field epidemiologists encounter during their practice. In public health practice, the public health variables of interest are often categorical, discrete, or continuous, and it is from these public health variables that calculations are performed.

Section 2: Outbreak Investigation, the Chain of Infection, and the Epidemic Curve

During an outbreak investigation, the central aims of epidemiologic activities are to find the cause of the disease outbreak and to stop the transmission of the infectious disease in the community. There are two, basic types of infectious disease transmission: direct transmission and indirect transmission. Direct transmission includes the immediate transfer of the infectious pathogen to a susceptible host via direct contact (e.g., touching someone) or spread by droplets (e.g., sneezing). Indirect transmission includes the transfer of the infectious pathogen to a susceptible host via a vector (e.g., think a Desert Sand-fly transmitting leishmaniasis to a susceptible host) or an inanimate object (e.g., think of contaminated water coming in contact with human skin and transmitting leptospirosis).

In order to stop the transmission of the infectious disease in a community, the WHO has identified the systematic approach used by field epidemiologists: [5]

- Undertaking preliminary investigation
- Identifying and notifying cases
- Collecting data and analyzing data
- Managing and controlling (including community health education)
- Disseminating findings and follow-up

These main activities are designed to identify the cause of a communicable disease and the best means to control it. A team of public health professionals (along with others) assist in an outbreak investigation.

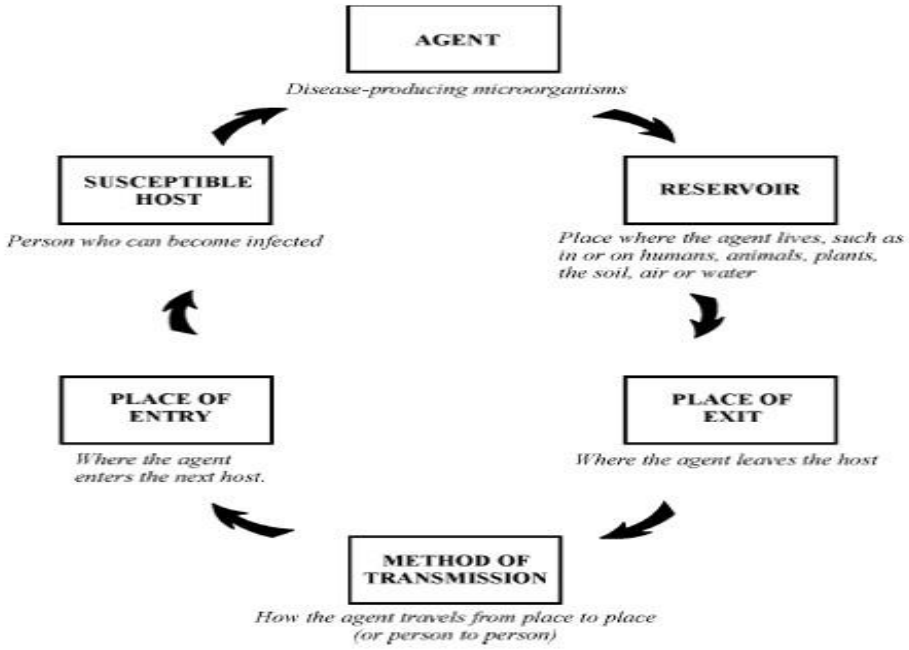


Figure 1: "Chain of Infection" [13]

The "Chain of Infection" (Figure 1) is an important concept for the field epidemiologist. [13] The "chain of infection" is the progression of an infectious agent as it leaves its reservoir or host through a portal of exit, is conveyed by a mode of transmission, and then enters through an appropriate portal of entry to infect a susceptible host. An outbreak can be stopped by breaking the "chain of infection" at any point.

The incubation period and the period of communicability are the two "time periods" often used to describe the natural history of an infectious disease. The "incubation period" is defined as the time between initial contact with the infectious agent and the development of clinical signs of illness in and individual. The "period of communicability" is defined as the time during which the infectious pathogen may be transmitted to another susceptible host.

The epidemic curve (or "Epi Curve") is a histogram that shows the cases of an infectious disease during an outbreak in a specific area for a specific time period. The shape of the "Epi Curve" is determined by the number of cases of the infectious disease in the community, the period of time over which persons are exposed, and the minimum, average, and maximum incubation periods of the disease in question. [13] There are four basic patterns that can be seen in an "Epi Curve" (Figure 2).

During the COVID-19 pandemic, the phrase "flattening the curve" has frequently been used. Basically, the phrase refers to how public health control methods can be employed during an outbreak to reduce the number of infectious cases. The reduction in the number of cases could occur because public health control methods were, in fact, slowing the spread of the infectious disease in a community. This means that few people are developing the infection and, thereby, reducing demand on the healthcare system for medical treatment during the outbreak.

Any software package can be used to construct an epidemic curve. For example, AcaStat (URL: www.acastat.com) is a low-cost, easy-to-use statistical software package that can be used to construct an "Epi Curve" (see Technical Box 1a and 1b). Statistical software can support the quantitative efforts of epidemiologists.

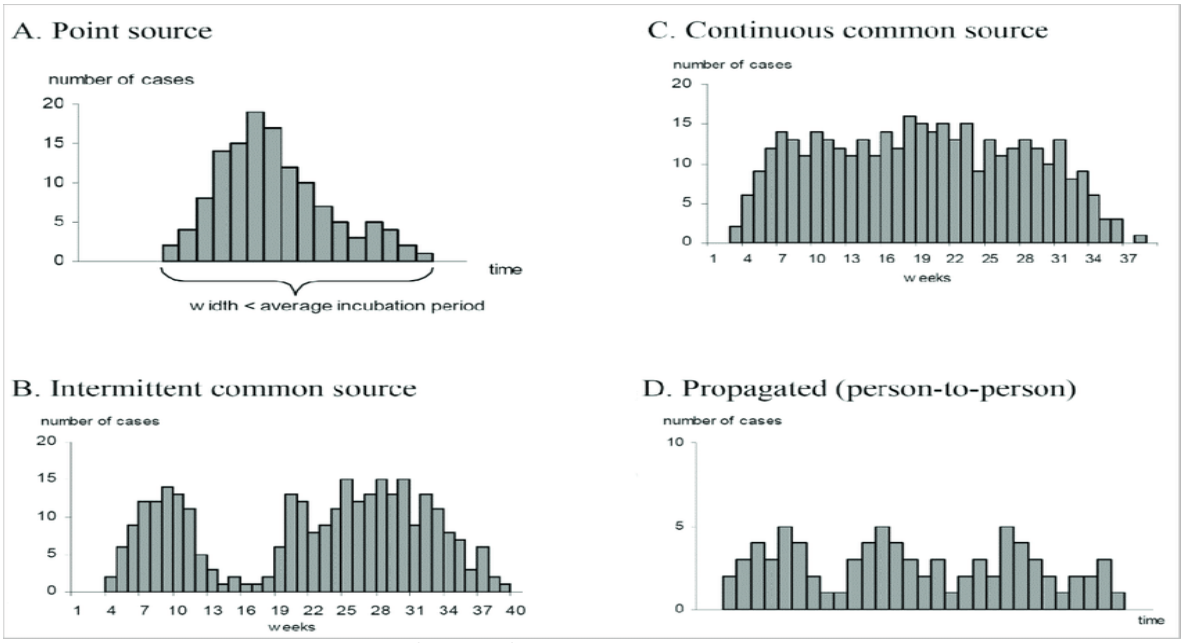
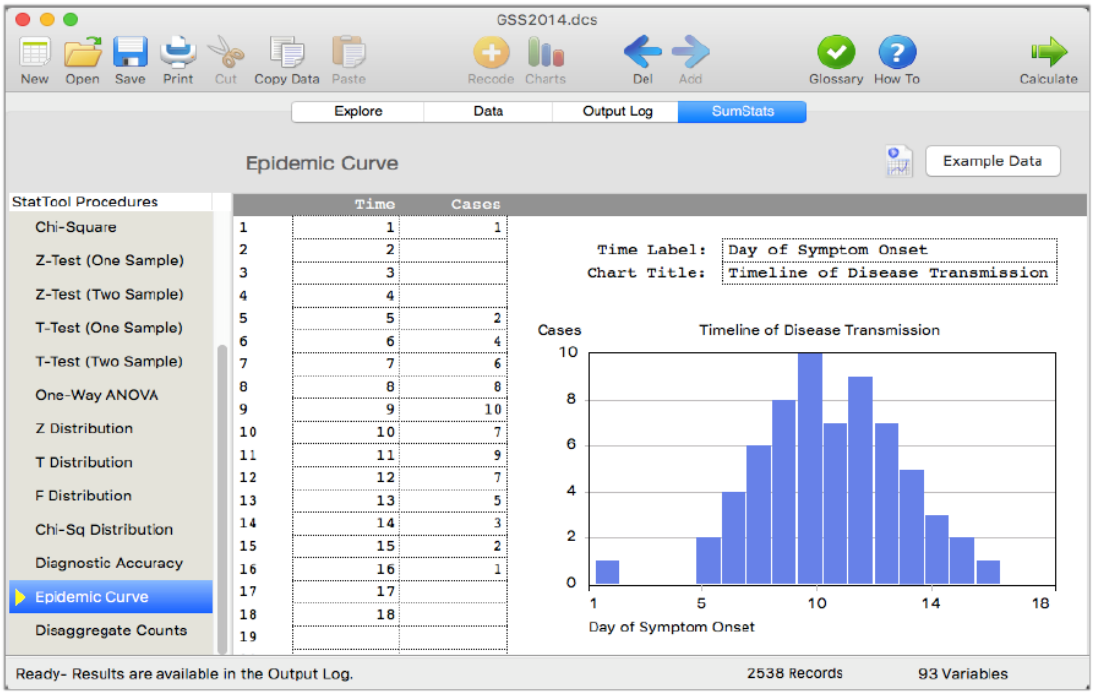


Figure 2. Types of patterns found in epidemic curves (source: WHO 2008)

Technical Box 1a
AcaStat: Epi Curve from the SumStats Module

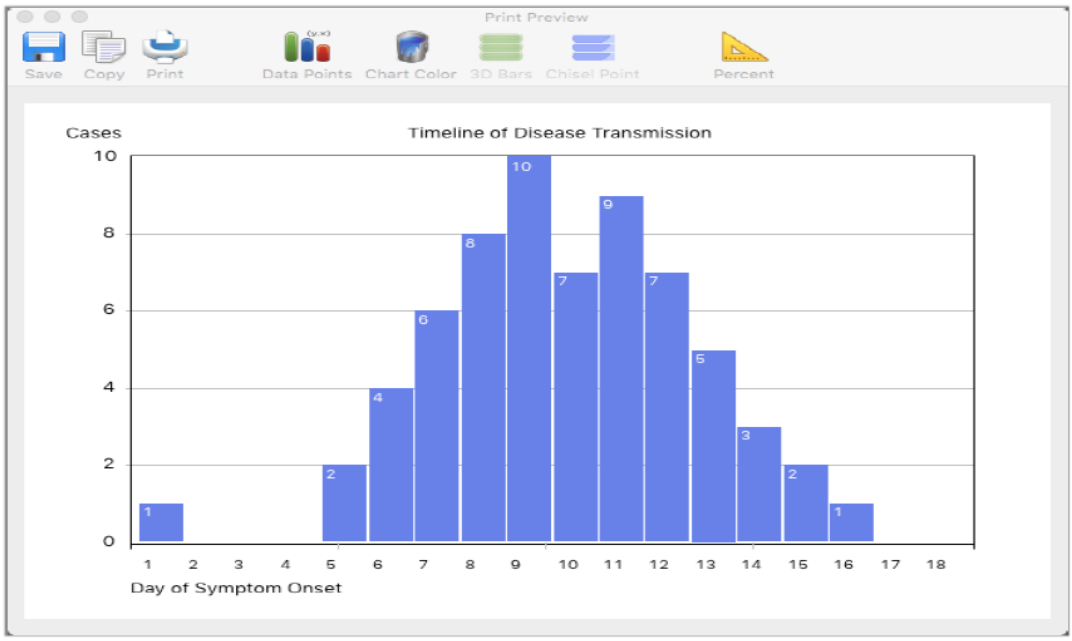
Enter time and case data to create an Epidemic Curve. The time column data must include consecutive dates even if there are no cases for that date. Data entry can be copied and pasted into spreadsheet or document software for saving and later pasting back into the Epidemic Curve procedure. Input Screen is below.



From AcaStat 10 User Manual (used with permission)

Technical Box 1b
AcaStat: Epi Curve from the SumStats Module

Click on the chart to enter Chart Preview. Click show data values to display counts in the chart columns. Click on the main chart body and a pop-up color picker will be displayed to change the color of the data values displayed in the columns. Output Screen is below.



From AcaStat 10 User Manual (used with permission)

The emergence of the infection in a community cannot be predicted, but preparing for the possibility of an infectious disease outbreak in a community is appropriate. An epidemic has phases as described by the WHO: [14]

Phase 1-Early Detection. *Early detection allows the rapid implementation of containment measures, which are the key to reducing the risk of amplification and potential international spread. Early detection begins at the health care setting, so health care workers must be trained to recognize potential epidemic disease, report quickly an unusual event (such as an unusual cluster of cases or deaths).*

Phase 2-Containment. *Effective and rapid containment of emerging diseases is just as vital as early detection in order to avoid a large scale epidemic. Rapid containment should start as soon as the first case is detected regardless of the etiology, which is most likely to be unknown. It requires skilled professionals to safely implement the necessary countermeasures.*

Phase 3-Control and Mitigation. *Once the infectious disease threat reaches an epidemic or pandemic level, the goal of the response is to mitigate its impact and reduce its incidence, morbidity and mortality as well as disruptions to economic, political, and social systems.*

Phase 4-Elimination or Eradication. *Elimination means that the disease is no longer considered as a major public health issue. However, intervention measures (surveillance and control) should continue to prevent its re-emergence. Eradication of a disease – much more difficult and rarely achieved - involves the permanent elimination of its incidence worldwide. There is no longer a need for interventions*

measures. Three criteria need to be met in order to eradicate a disease: there must be an available intervention to interrupt its transmission; there must be available efficient diagnostic tools to detect cases that could lead to transmission; and humans must be the only reservoir.

In the WHO document (including the extended passage) previously cited, global public health professionals have expertly described the processes needed to manage an epidemic.

Section 3: Overview of Epidemiologic Disease Control Methods

Control of an infectious disease can be achieved by "breaking the chain of infection" to control the agent, to control transmission, or to modify the environment. Several disease prevention and control measures are available to epidemiologists and public health officials when confronted with an infectious disease in a community: [15-17]

Vaccinate: commonly used to refer to procedures used to immunize (or vaccinate) against an infectious disease (e.g., MMR)

Control environmental factors: environmental control measures that can be used to disrupt the "chain of infection" (e.g., personal hygiene, use of clean water)

Control the agents or vectors of disease: actions taken "to kill" the agent or prevent the vector from reproducing (e.g., spraying insecticide "to kill" malaria-carrying mosquitos; killing the eggs of the mosquito)

Recall contaminated food products: removing infected food from consumption (e.g., food recalls)

Isolate and quarantine hosts: isolation refers to separation of ill persons while quarantine refers to the separation of a potentially exposed but well person (e.g., keeping a sick child at home and not permitting to go to school to infect others is a form of isolation that prevents infecting others)

Treatment and mass drug administration: treatment of the sick persons to reduce period of communicability; mass drug administration of the population with full dose of treatment drug against infectious disease (e.g., mass treatment of a population to control trachoma)

Educate the public and providers: teaching persons on what can be done to stop the infectious disease or prevent re-occurrence (e.g., teaching community members what they can do to prevent malaria; notifying health professionals of an outbreak, case definition, reporting procedures, and clinical measures)

These are examples of the disease control methods that can be used to help stop an outbreak.

Section 4: Team Approach to Outbreak Investigation and Emergency Response

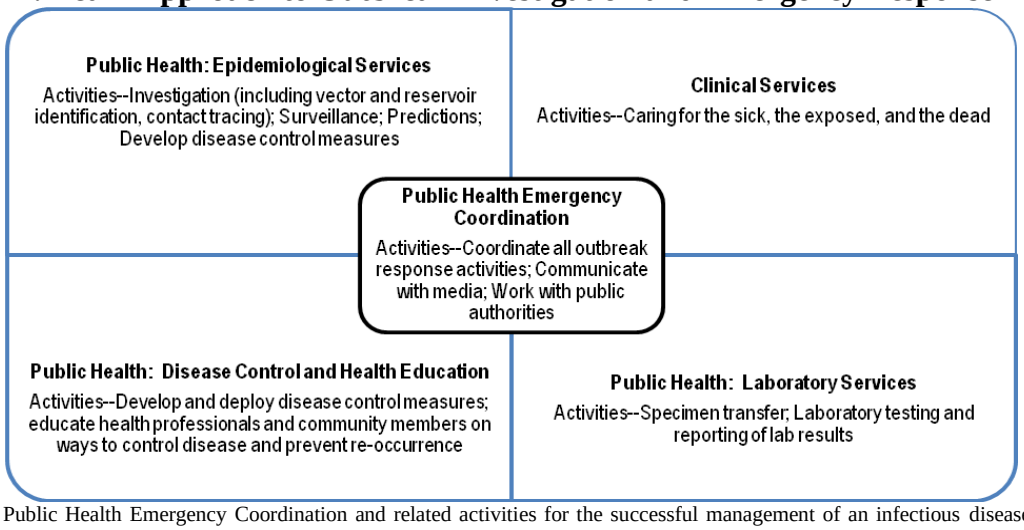


Figure 3: Public Health Emergency Coordination and related activities for the successful management of an infectious disease outbreak investigation and public health response. Adapted from: "Controlling Communicable Disease" by Norman Noah (Berkshire, England: Open University Press, 2006)

Finally, the field epidemiologist is part of a team of professionals working in a community to control or stop an infectious disease outbreak. In Figure 3, we see the basic categories of team activities necessary for organized response to a disease outbreak: epidemiological services; clinical services; laboratory services; disease control and health education; and public health emergency coordination. [18] In addition to highly advanced professional education, team-work, coordination, professionalism, integrity, and collaboration are just some of the additional competencies necessary for investigating an infectious disease outbreak in a population.

CONCLUSION

The study and practice of field epidemiology is exciting and meaningful. The key concepts of field epidemiology that were discussed included:

Key terms

- Outbreak investigation, the chain of infection, and related topics
- Epidemic curve (including technical details on making an "epi curve" with software)
- Epidemiologic disease control methods
- Framework showing the team-work necessary for effective outbreak investigation activities

COVID-19 is an infectious disease outbreak of significant impact throughout India. There are other infectious diseases, also circulating in nature, that may or may not become a disease cluster that leads to an outbreak in a human population. 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.

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, Rajasthan, India 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. World Health Organization-India. Novel Coronavirus Disease (COVID-19), Situation Update Report-10, April 5, 2020. URL: https://www.who.int/india/emergencies/india-situation-report
2. World Health Organization-India. Novel Coronavirus Disease (COVID-19), Situation Update Report-11, April 12, 2020.
3. Bhopal RS. Concepts of Epidemiology, third edition. Oxford: Oxford University Press, 2016.
4. Gordis L. Epidemiology, second edition. Philadelphia: WB Saunders, 2000.
5. Bonita R, Beaglehole R, Kjellstrom T. Basic Epidemiology, second edition. Geneva: WHO, 2006.
6. Friis R, Sellers T. Epidemiology for Public Health Practice, fourth edition. Boston: Jones and Bartlett Publishers, 2009.

7. Farmer R, Lawrenson R. Epidemiology and Public Health Medicine, fifth edition. Malden: Blackwell, 2004.
8. von Drehle D, Baker A. The Ebola Fighters-The ones who answered the call. Time Magazine-Persons of the Year edition. 2014: 10 December (URL: https://time.com/time-person-of-the-year-ebola-fighters/)
9. Morris JN. Uses of Epidemiology, third edition. Edinburgh: Churchill Livingstone, 1975.
10. Rasmussen SA, Goodman RA. The CDC Field Epidemiology Manual. New York: Oxford University Press, 2019.
11. 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.
12. CDC. "The Public Health System and the 10 Essential Public Health Services." URL: https://www.cdc.gov/publichealthgateway/publichealthservices/essentialhealthservices.html
13. Page RM, Cole GE, Timmreck TC. Basic Epidemiological Methods and Biostatistics. Boston: Jones and Bartlett Publishers, 1995.
14. World Health Organization. Managing epidemics: key facts about major deadly diseases. Geneva: WHO, 2018.
15. Webber R. Communicable Disease Epidemiology and Control, second edition. Oxfordshire: CABI Publications, 2005.
16. Webber R. Communicable Disease Epidemiology and Control, third edition. Oxfordshire: CABI Publications, 2009.
17. Alemeyehu M. Communicable Disease Control-Lecture Notes. Atlanta: The Carter Center, 2004.
18. Noah N. Controlling Communicable Diseases. Berkshire: Open University Press, 2006.

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