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EPIDEMIOLOGICAL INVESTIGATION TOOLS USED DURING OUTBREAKS

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ABSTRACT

Investigation tools give us a statistical analysis of the outbreak, courses, preventive measures, transmissibility and magnitude of risks. It also helps in reducing the transmissibility rate by making people aware of the infected person around them. It gives us the proper proportions and ratios about the infected and the number of deaths during the outbreak. It has always been important to investigate a particular disease and there has been a surge in interest in statistical methods for early detection. This interest has led to rising new methodological works for better surveillance and illustration. Emerging infections continue to disrupt the healthcare system and are becoming increasingly complicated to detect and treat successfully. Presently the public health system is continually reminded of the challenges it faced during the COVID-19 outbreak. It is important for every public health agency to regularly and systematically collect, assemble, analyse and make available information on the health of the community. Statistics on health status, community health needs and epidemiological problems must also be taken into care. Thus these tools play an important role in detection, diagnosis and statistically analysing the outbreak. It allows you to recognise and respond to the outbreaks that have been improvised in recent

years. There are now computerised databases which are low outbreaks to be more rapidly recognised. Use of internet-based systems allows us to share the information collected rapidly with the public. It is the responsibility of state and local health departments to focus on outbreak investigation and control. It is important to focus on the outbreak when it has a low impact. There have been several epidemiological investigation tools introduced by world health organisations and several private organisations. This review gives us a brief knowledge of some of the investigation tools used during the outbreak.

Keywords: Epidemiological investigation tools; outbreak; investigation; Epidemiology

INTRODUCTION

An outbreak is a condition where there is an increased frequency of a disease above the usual rate (endemic rate) in a given population or geographic area. Investigating an outbreak is time-consuming and requires proper analysis and response. Proportions, ratios, rates, prevalence, incidence, study designs, bias, confounding, effect modification, odds and risk ratios, statistical power, and confidence intervals are defined and discussed in the epidemiological investigation **[1]**. They can quantify the probability and have the potential to control for other risk factors. Descriptive epidemiology deals with describing the distribution of disease by person, place, time and its demographic risk factors. Epidemiology identifies the distribution of diseases, factors underlying their source and cause, and methods for their control **[2]**. Tools to assist with outbreak investigations can be developed by building upon existing databases. It is designed to deal with complex emergencies and limited-resource settings. Epidemiological tools improve the efficiency and accuracy of the investigations and ultimately lead to a reduction in transmission. It is necessary to use a systematic approach in outbreak investigation using available reports **[3]**. This strengthens the quality and transparency of outbreak investigations while reporting. There are several tools to support and guide outbreak preparedness, investigation and response activities. Epidemiologists and field investigators use comprehensive tools for use in the investigation of outbreaks of infectious and non-infectious diseases and hazards. Infectious disease epidemiological issues are usually addressed by molecular epidemiology. This primarily involves tracking the geographic and temporal distribution of the infectious agent. It is necessary to differentiate epidemics from

endemic diseases **[4]**. There is a need for standardization of tools to improve comparability and sharing of data collected between investigation teams, locations, and time frames **[5]**. The challenge of public health practitioners, decision-makers and researchers to plan, prepare, identify and respond to outbreaks in near real time frames are made easier by using proper standardised epidemiological investigation tools.

There is a wide range of software tools developed by major epidemic response teams. Generally, these tools are simplified for operational and practical reasons. These tools should be user friendly and should focus on its ability to be effectively and adaptively used by decision-makers, health system managers and subject matter experts during an outbreak [6,7]. A tool must be able to Stratify the data to refine the study designs and to identify all the modes of transmission of the infectious disease. This must be taken into care while studying the epidemiology of healthcare and institutions associated with infectious diseases. A successful investigation of an outbreak relies on the analysis of increasingly complex and diverse data. The collected database offers prospects for gaining knowledge about the disease transmission processes and creating awareness among the public about the outbreak **[8, 9]**. Outbreak investigation also has an important task under covering the containment strategies and prophylaxis of the disease **[10]**. At the beginning of the outbreak, it is important to identify as many confirmed cases as possible to find the source of the outbreak. There are several algorithms for initial assessment and management of the patients **[11]**. It is necessary to understand the types of equipment that can be used to study the outbreak. The health department should provide the necessary resources during the outbreak. It is important to make a periodic and regularly scheduled collection of information and databases. Communication with other health departments and sharing information is necessary. This makes the investigation much detailed and reduces the number of errors. It is important to make frequent updates to keep the media correctly informed. The population should be aware of the outbreak and its transmissibility and the preventive measures to be followed to overcome the disease. The health department should be provided with the fact sheets of the outbreak. The number of people affected, recovered and dead should be properly updated **[12]**. These basic tools for outbreak investigation should facilitate the implementation of novel integrative

approaches, being able to exploit various types of data collected simultaneously **[13]**. Due to dynamic and changing epidemiological patterns during an outbreak, the decision-makers must revisit decisions. These are the various challenges faced by epidemiologists **[14]**. There are many R statistical packages available used for statistical computing, graphics and data analysis. Some of these are freely available for download and use without restriction. These are broadly used by the epidemiologists and decision-makers. This review deals with understanding and analysing the capabilities of existing modelling and simulation software tools to support the future development of more effective and capable epidemic modelling and simulation, and decision support and management tools **[15]**.

These are important resources for analysis of the magnitude of the risks, the incidence of the disease, transmission rate, for early detection and effective control of the epidemics. Clinical trials and microbiological investigation helps in studying the disease and pathogen-associated with it[16]. It is necessary to learn the basic knowledge about the suspected disease with the use of fact sheets and other disease information pages like WHO public web pages and papers. Next, it is important to develop a case definition and to organise the data collected using investigation tools using a set of variables. It is necessary to construct a proper report list and to confirm the outbreak with laboratory confirmation **[17]**. Foundations of the disease and the response tools and resources can be studied online via videos and reports. These tools provide us with some knowledge about the emergence of new diseases **[18]**. The steps involved in the outbreak investigation are describing the disease, developing a hypothesis, hypothesis testing and sampling the databases **[19]**. Further, let's discuss some of the investigation tools used during outbreaks and the role of community and the healthcare workers for the proper investigation **[20]**.

Dynamic Statistical Tools

These are widely used during the outbreaks and help in the early detection of the disease and the causative agent. This has a statistical approach and is a much newer methodological work **[21]**. It should consist of a set of reliable parameters in disease transmission. It is a wide range of ICT tools developed for handling data **[22]**. Spatial statistical modelling has been used for the prospective detection of infectious disease outbreaks **[23]**. There has been a new platform for disease outbreak analysis using

the R software. This can be used for studying the synoptic and dynamic aspects of the outbreak **[24]**.

Syndromic Surveillance

It has been used for early detection of outbreaks. It expands and improves the traditional methods of Public health surveillance. It enhances the connection and collaboration among public health agencies and health care providers. But it does not support or substitute for direct physicians reporting of unusual or suspect cases of Public health importance **[25]**. This approach is likely to detect the epidemic sooner than being reported by the alert clinicians. The detection depends on the population characteristics, availability, use of health services, the surveillance method and capacity of the health department **[25, 26]**. This has been well-established in the public health practice in New York City and other countries **[27]**. There are several Devices for tracking flu-related diseases on the web for syndrome surveillance **[28]**. Thus spatial and syndromic surveillance plays an important role in concerns with the impact of potential bioterrorism attack **[29]**. This system uses molecular epidemiological tools intervention with greater resolution of the data collected by the clinicians **[30]**.

Whole Genome Sequencing

This technique involves the determination of complete DNA of an organism in a single time. This technique has been applied to estimate the timing and directionality of transmission and to exclude cases from an investigation. This has been used for the analysis of tuberculosis outbreak **[31, 32]**. For the tracking of a hospital outbreak of carbapenem-resistant Klebsiella pneumoniae **[33]** And for the investigation of neonatal MRSA outbreak **[34]**. Surveillance of the disease provides opportunities to devise more focussed and targeted interventions **[35]**. Previous researches have gained a lot of attention on genome typing which is an accurate method **[7]**. But it involves a lot of time and money and is a tedious process. They provide opportunities to assess microbiological subtyping tests **[36, 37]**.

Cloud-Based Systems

It is the disease surveillance system designed for the global community of public health practitioners and researchers **[38]**. It provides an easy data entry form and database construction. It gives a customised data entry experience and data analysis using epidemiologic statistics, maps and graphs. EpiInfo is one of the most commonly used surveillance systems with accurate analysis, visualisation and reporting **[39]**. Cloud-based systems have been widely used during the

hepatitis outbreak, Staphylococcus aureus-virus interaction and for detecting mosquito-borne diseases **[40]**.

AI-based Automated CT Image analysis tools

It helps in the detection, quantification and tracking the diseases. It has been used to demonstrate and differentiate the affected patients. Presently it is an important tool used during COVID-19 outbreak **[41, 42]**. It has also been used for imaging acute and subacute ischaemic stroke lesions **[34]**. During COVID-19 outbreak it has been an alternative diagnosis option to prevent COVID-19 spread and for detection of the disease. It gives 97 % accuracy for inceptionV3 and 87 % accuracy for inception ResNet V2. Analytical cohort epidemiological studies help in studying the dynamics of the disease, other several risk factors and the efficacy of the treatment against a particular disease **[8]**. Surveillance based tools are used as a reference to validate new genomic typing tests **[43, 44]**.

Online Traditional Tracking

It is a real-time web-based tracker which gives us updates about the distribution of disease in a particular geography. These web tools include ARG-ANNOT and ResFinder for detection of the outbreak. JHU CSSE dashboard's interactive map gives the location and tallies confirmed infections, fatalities and recoveries **[45]**. Viewers can see the day and time of the most recent updates and data sources. This is one of the most useful systems used during outbreaks[46]. It provides us with information about the number of deaths, affected and recovered. It gives us rapid information and can be used by everyone easily. It provides us with an important clue how quickly the pandemic can transmit and provides accurate data on which the epidemiologists can work. It is one of the widely used systems **[47]**.

Close Contact Detector

This is the technology introduced by the Chinese government for the close surveillance of its population **[48]**. This has been widely used for COVID-19tracking. It was also used for tuberculosis detection and diagnosis. It is a powerful tool which covers the contact between people who work together, family members, medical staff, patients, caregivers, passengers and crew who have been on planes, trains etc with an infected person. This gives us details about who all the infected person has been in contact with. Thus can help in identifying other infected persons. This is a tedious process which requires a lot of time and money **[49]**.

CONCLUSION

An outbreak is a condition where there is an increased frequency of disease about the usual rate which is the epidemic rate in a given geographical area. Although outbreaks always represent challenges in investigation and implementation of appropriate control measures, It is necessary to use standard outbreak protocols. Outbreak investigation tools thus need to follow recommendations to prepare for the emerging outbreaks. Proportions, ratios, rates, prevalence, incidence, study designs, bias, confounding effect, modification, odds and as factors, statistical power and confidence interval are defined and discussed by an epidemiologist. It is necessary to use a systemic approach in outbreak investigation to strengthen the quality of the investigation. It is important to identify the number of confirmed cases up to date. Though there is a wide range of software tools developed by epidemic response teams it is important to carefully choose a proper investigation tool. The tool should be user-friendly and should focus on its ability to investigate an outbreak. It should be designed to deal with complex emergencies and should be able to work accurately even in limited-resource settings. Epidemiological tools improve the efficiency and accuracy of the investigation and ultimately leads to a reduction in transmission. Thus these tools play an important role in detection, diagnosis and statistically analysing the outbreak.

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