Short Communication

Epidemiology and forensics

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Abstract

Epidemiology is a science that studies the spread and disease factors of the human population and the application of this science to addressing health problems. Epidemiology is considered a fundamental set of methods in all public health research and has great application in clinical medicine in determining the risk factors of the disease and determining the best health effect in clinical practice. Epidemiology as a science deals with factors affecting the health and illness of individuals and societies, and in that sense serves as the basis and logical basis for interventions in the interest of public health and preventive medicine.

Keywords: epidemiology, forensics, health

Introduction

Forensic epidemiology is the behind-the-scenes world where possible cause and effect are studied to change and save lives [1]. Through studies of statistical data of such things as cancer, smallpox, car crashes with and without seatbelts, motorcycle deaths with and without helmets, healthy aging, airborne illnesses, homicides, natural deaths, suicides, and so on, a possible risk population or pattern may be determined. Once the at-risk pattern or population is determined, a safer alternate model may be put in place to prevent injury and save and change lives. The scientific method, compiled data, studies, and research are heavily used to determine specific, documented, and verifiable facts in order to deter or stop future outbreaks or occurrences.

Public health

Public health may be defined as the community effort to protect, maintain, and improve the health of a population by organized means, including preventive programs, hygiene, education, and other interventions [2]. Preventive medicine and health care are important components of public health, but the reach of public health extends beyond medicine to clean water, sanitation, housing, sex education, and other areas that affect the health of communities. Among the fields that contribute to public health, epidemiology plays a crucial role, but many other disciplines are involved. Public-health efforts may involve contributions from fields as diverse as engineering, architecture, biology, social science, ecology, and economics.

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The origin of public health dates from the first aggregation of small clans into larger, settled communities. Some basic needs, such as the provision of potable water and disposal of bodily waste, were best addressed as community concerns. Public wells that provided clean water for drinking and aqueducts that transported water from mountain springs or creeks into towns, cities, and agricultural fields were community efforts that had obvious health benefits.

Health is the optimal balance among physical, mental, and social functioning [3]. A component of health status assessed after an intervention may also be referred to as a health outcome. Health status can be quantified with proxy measures (such as mortality or morbidity rates), determined by a health care provider, or be self-reported. The method used to measure and classify the health status of populations depends on the nature of the health need, the goal of the assessment (e.g., to evaluate populations with or without interventions, with interventions requiring more detailed assessment), the validity and reliability of the measure, and the scope of the evaluation (international, national, local, or provider-specific). International or other across-geographic-area comparisons of health status may be performed using the infant mortality rate (the number of deaths under 1 year of age per 1000 live births) and the life expectancy (the average number of years that an individual is expected to live assuming current mortality rates continue to apply) because of the universality of recording deaths among countries. Infant mortality is felt to be the most sensitive indicator for evaluating the health status of populations for short-term interventions such as immunization or prenatal care programs. Life expectancy is the preferred indicator of health status for long-term interventions, for interventions evaluating the availability of medical intervention, or for changes in the economic conditions. With the appropriate and timely use of health services, health status should be improved. Lack of achievement of optimal health status after health services uses results in unmet needs and further utilization of health care services.

A health indicator is a marker of health status (physical or mental disease, impairments or disability, and social well-being), service provision, or resource availability [4]. It is designed to enable the monitoring of health status, service performance, or program goals. Monitoring is a process in which changes in health status over time or among populations are identified in order to assess progress toward health goals or objectives.

No single health indicator can be expected to reflect all dimensions of health. Therefore, several indicators are commonly used to reflect various dimensions of health. In addition, to fully understand health, it should be studied in the context of economic circumstances, education and employment status, living conditions, social support, sexual relationships, cultural norms, and legal structures. Hence, several categories of indicators are in use today, including the following:

- Health and well-being (e.g., physical fulfillment, psychosocial comfort, closeness)
- Health resources (e.g., family planning, opportunities for choice, satisfaction with and perceived quality of services)
- Collective justice (e.g., level of disparity in individual health indicators)
- Social capital (e.g., community involvement, trust in others, perceived enabling factors)
- Collective capacity (e.g., community participation)
- Resiliency (e.g., a community’s ability to cope with natural disasters that may adversely affect reproduction)
- Functionality (e.g., peace, safety, and factors associated with poor reproductive health, such as abuse, exploitation, unwanted pregnancy, disease, death)

In short, health indicators should be complementary and, in combination, reflect the broad scope of health.

As social health issues are in a constant state of change, an array of health indicators is needed to reflect the prevailing health issues or challenges of greatest concern where intervention is sought. Reporting a health indicator, such as the maternal mortality rate, helps epidemiologists understand the problem and create ways to intervene and improve the situation. As a given health problem is improved, new indicators reflecting other major health concerns may surface as priorities. For example, as infant mortality rates fall and population growth ensues, economic and social implications must be considered, and new indicators are needed.

**Epidemiology**

Epidemiology has been defined as the study of the distribution of a disease or a physiological condition in the human population and the factors that influence this distribution [1]. Epidemiology uses the scientific method to locate and describe these patterns of disease in a defined population and identify factors that may play a role. Focus on the patterns of disease is in terms of time, place, and person.

- **Time:** An attempt is made to determine whether there are increases or decreases in the incidence of a specific disease over a set period of time.
- **Place:** Efforts are exerted to establish whether a specific geographic region has a higher frequency of disease than another similar region and, if so, then why.
- **Person:** Work is completed to determine personal characteristics that distinguish those that develop a disease from those that do not.
Epidemiology relies heavily on statistics for establishing and quantifying the relationships between risk factors and disease and for establishing whether or not a particular disease is occurring excessively in a specific geographic area. Medical records can provide invaluable historical data for establishing trends in the incidence of diseases. Vast collections of medical record information are stored all over the world, and sorting through the data can be a very expensive and time-consuming process. In addition, the types of data that can be obtained from these records are only as good as the information that they contain, and often the information is scanty or impossible to verify. Sources of information commonly used in epidemiological studies include medical records, registries, and death certificates.

An epidemiological study can never prove causation, that is, it cannot prove that a specific risk factor actually caused the disease being studied. Epidemiological evidence can only show that this risk factor is associated (correlated) with a higher incidence of disease in the population exposed to that risk factor. The higher the correlation is, the more certain the association is; however, it can never prove the causation.

Methods of epidemiological investigation have evolved since the mid-nineteenth century [5]. The case-control study reentered medicine from the social sciences in the third decade of the twentieth century. The cohort study came into use after World War II, as a means of identifying risks associated with heart disease, lung cancer, and other emerging public health problems. Epidemiological “experiments” as now conducted in randomized trials are essentially modern innovations. Statistical methods and electronic computation have greatly improved epidemiological analysis. Present indications suggest expanding potential and an exciting future for epidemiology. Population-based medicine makes community assessment and diagnosis important for determining the need for health services. An increasingly broad interface between clinical medicine and epidemiology is called clinical epidemiology. Molecular epidemiology promises to let epidemiologists link genetic and many other biological markers to health conditions, thereby creating new potential approaches to intervention. Case-control studies are adding rapidly to our understanding of cause effect relationships in many chronic and disabling disorders. Epidemiological methods can also help in evaluating health services.

**Forensics**

The term “forensics” in general means the application of science to law [1]. In other words, applying scientific methods or principles to a legal issue is forensic science. When the principles of physics can determine the trajectory of a fatal bullet, that is forensic science; when DNA recovered from the stamp on a ransom letter can be matched to the estranged husband, that is forensic science; when the chemical breakdown of a paint chip is used to determine the make and model of the hit-and-run vehicle, that is forensic science; and when a chemical test can spot a fake $20 bill, that is forensic science. Forensics is the investigation and establishment of fact or evidence by applying the knowledge and technology of the basic sciences to issues of the law. Forensic sciences are used in both criminal and civil courtrooms. The principles of scientific crime-detection methods such as serology, fingerprinting, firearm identification, and questionable documents were first popularized by Arthur Conan Doyle’s fictional character Sherlock Holmes.

The fundamental fields of forensic science include forensic medicine, forensic toxicology, forensic photography, fingerprints, serology, chemistry, trace, ballistics, and document examination. With the development of the microscope, the field of trace evidence developed. In the late 1980s, DNA profiling was being perfected.

**Forensic epidemiology**

In the past, law enforcement and public health authorities did not interact much when they conducted examinations [1]. The classic health inspector would examine a restaurant and had the power to fine or even close the establishment without the involvement of the police. In the early days, the risk to public health was mainly from food contamination due to improper storage, cross-contamination, or poor hygiene practices. However, in today’s society, the threat of deliberate contamination of water, food, air, or land as an act of bioterrorism is very real. Working alone, law enforcement would not recognize the bioterrorism threat; the same holds true for public health personnel. The problem is that law enforcement personnel are not trained to spot these types of crimes. An unusual or off-season increase in a particular type of virus would not raise suspicion among police officers, but it would be alarming to those in the public health setting. In turn, public health personnel are not trained in the legal methods and procedures of collection and documentation of evidence and other legal structures required to bring a case to trial.

In the late 1990s, the term “forensic epidemiologist” typically referred to epidemiologists that functioned as expert witnesses in civil trials. They were testifying as to the methodology of the study, the number of subjects, length of the study, the meaning of the results, and any limitations. They were frequently used to resolve such suppositions as whether exposure to certain chemicals related to a birth defect or performing a task repeatedly could cause carpal tunnel syndrome.
The field of forensic epidemiology, while initially developed to focus on acts of bioterrorism, can also be used to investigate other types of crimes. A forensic epidemiologist can play a vital role in many other types of health emergencies and further threats to public health. He or she can examine a number of diverse crimes ranging from environmental to food-borne illness.

Causality in criminal cases is often undisputed because of the high degree of association between the alleged exposure and the outcome of interest [6]. The temporally proximate nature and a high degree of lethality of the methods used to commit homicide (firearms, blunt trauma, sharp instruments) typically leave little room for consideration of competing causes of injury and death. As an example, when death is the outcome and the exposure is a gunshot wound (GSW) to the head that was sustained moments before the exhibition of signs of injury (unconsciousness followed by cardiorespiratory arrest), there is no need for an expert forensic medical assessment of the cause of the death. The fact that penetrating trauma to the head is associated with a more than 90% death risk is widely understood and accepted. The chance that a competing cause of death acted on a decedent who died directly after sustaining a GSW to the head is so small that it is not worth considering in most circumstances. Even with a causal relationship that is obvious, however, we still have to keep in mind the basic underlying principle of the practice of FE, which is that causation cannot be observed. Thus, even in the prior example, it is still possible that the decedent died due to an untraceable and 100% fatal poison that killed him just prior to sustaining a survivable GSW. A forensic pathologist who finds a bullet in the brain of the decedent will stop looking for a cause of the death because it is, of course, impractical to consider an alternative cause of death that is so nearly (but not completely) implausible. In some cases, however, death and injury investigations applicable to the prosecution or defense of criminal action are aided by the use of epidemiologic data or concepts.

Epidemiology has received increasing stature in the resolution of disease-related litigation [7]. Consequently, more and more epidemiologists are being asked to serve as experts in such cases in any of several capacities. Many epidemiologists, however, may believe that involvement in litigation interferes with their primary responsibilities as scientists, that such involvement requires a large commitment of time, and that the conflict inherent in litigation may be extremely unpleasant. Unfortunately, all those perceptions may be accurate. Also, with increasing participation comes a need for the epidemiologist-expert to address a number of ethical issues that may arise during the course of the legal proceedings.

Litigation begins before a suit is actually filed [8]. The investigation must be done and experts may be involved in this process. However, once a case has been filed, the parties generally begin the discovery phase. During this phase, each side to the litigation attempts to “discover” facts, documents, and other pieces of evidence held by the other side that may be relevant or helpful to the preparation of its own case. Attorneys will also have the opportunity to file motions, in which they seek a court’s ruling on specifically identified issues prior to proceeding to trial. While some motions that are filed may be dispositive of the case, a case that survives the motion will ultimately be tried. In complex litigation, such as toxic torts, products liability, and environmental cases, the assistance of experts will be necessary in both the discovery and trial phases of the case.

Conclusion

Forensics is the name for applying a wide range of scientific branches to determine facts in court or administrative proceedings. Forensics is also the use of science in criminal and civil law, mainly on the criminal side during the criminal investigation, as regulated by legal standards of admissible evidence and criminal proceedings. Forensic scientists collect, preserve, and analyze scientific evidence during the investigation. While some forensics travel to the crime scene to collect evidence, others take on a laboratory role, carrying out analyses of cases brought by other individuals. In addition to their laboratory role, forensic scientists testify as expert witnesses in criminal and civil cases and they can work for prosecution or for defense. Although any area could be technically forensic, certain parts developed over time to cover most of the forensic cases.

Conflict of interest

All authors declare that they have no conflict of interest.

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References


