

FORENSIC EPIDEMIOLOGY A COMPREHENSIVE GUIDE FOR LEGAL AND EPIDEMIOLOGY PROFESSIONALS

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Abstract

The field of forensic epidemiology is an example of an interdisciplinary field that bridges the gap between the fundamentals of epidemiology and the frameworks of the legal system. In order to provide experts in the fields of law and epidemiology with the key information and skills necessary to use epidemiological approaches in legal situations, this thorough handbook was written with the intention of providing assistance. When it comes to public health concerns that cross with legal investigations, judicial processes, and policy-making, forensic epidemiology is the field that handles these challenges. The utilization of epidemiological data, methodologies, and reasoning to provide insight into legal challenges and choices is the core emphasis of this area. The investigation of disease outbreaks, the assessment of health risks resulting from occupational and environmental exposures, the analysis of patterns of injuries and violence, and the assistance of legal proceedings relating to product safety and consumer protection are among the most important uses. By providing scientific evidence to influence legal choices, facilitating collaboration across disciplines, and assuring the establishment and implementation of health rules, forensic epidemiology contributes to the enhancement of public health protection. In terms of methodology, it makes use of descriptive and analytical epidemiology, in addition to statistical analysis, in order to provide trustworthy data and findings. Forensic epidemiologists encounter a number of challenges, some of which include assuring the quality and integrity of data, protecting individuals' privacy and confidentiality, and successfully communicating between the scientific community and the legal community. In spite of these obstacles, forensic epidemiology plays an essential part in bridging the gap between public health and the legal system. It does this by helping to the making of well-informed decisions and protecting public health and safety. By supporting a collaborative approach to tackling health-related legal concerns through the application of epidemiological concepts, this handbook serves as a basic resource for professionals working in the fields of epidemiology and law.

Keywords: Forensic, Epidemiology, Professionals

Introduction

The discipline of forensic epidemiology is an example of an interdisciplinary field that incorporates concepts from both the area of epidemiology and the administration of justice. The purpose of this initiative is to address public health concerns that overlap with legal frameworks. It offers a methodical approach to identifying and studying health-related occurrences, trends, and causes in populations from a legal point of view. Providing legal and epidemiology experts with the knowledge and resources necessary to effectively cooperate and implement epidemiological approaches within legal contexts is the goal of this thorough handbook, which was developed to provide them with relevant information.

Principles of Forensic Epidemiology

Over the course of the past few years, the role of epidemiology has become increasingly important in the context of judicial proceedings that involve the allegation of causal connections between the exposure to particular agents and the development of disease or harm. These cases include the association between environmental pollution and disease, mobile phones and cancer, vaccines and autism, asbestos and pleural mesothelioma, and so on. It is necessary to incorporate both legal and epidemiological skills into the management of these situations.

It is defined as "the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems." Epidemiology is a field of study that focuses on the study of health-related states and occurrences. "Forensics" is a phrase that originates from the Forum, which was an assembly in ancient Rome where processes were carried out. In modern times, the term "forensics" is used to refer to anything that is related to an inquiry or a legal matter. Both of these phrases have been merged to form the term "forensic science," which refers to all of the procedures and approaches that may be utilized in the process of resolving litigation. Both of these ideas were included into the phrase "forensic epidemiology" in the year 1999. This word refers to the utilization of epidemiological data in the procedures as well as the participation of epidemiologists in the legal proceedings. The idea of causation is a topic that is always being debated in the field of epidemiology, just like it is in other scientific fields; there is no one definition of cause. "A cause is an act or event or a state of nature which initiates or permits, alone or in conjunction with other causes, a sequence of events resulting in an effect," said Kennet Rothman, a professor of epidemiology at Boston University, in 1976. Rothman's proposal was an analytical framework for the concept of cause.

The definition of a cause is adequate when it causes or begins an event in an unavoidable manner, and it is required when an event cannot develop without the presence of the cause. Certain diseases can be attributed to singular factors, which are also referred to as "mono-factorial diseases." Infectious diseases are an example of this type of disease. However, the majority of the time, the disease is the result of an interaction between genetic, individual, and environmental factors. The term "environment" refers to any biological, chemical, physical, psychological, or other factor that can have an effect on health. There are four categories of elements that have a role in the development of the disease: predisposing factors, activating factors, precipitating factors, and reinforcing factors. The techniques used in epidemiology assess two things: i) the extent to which each risk factor contributes to the development of the illness, and ii) the ultimate decrease in the disease that would occur if the risk factors were eliminated.

Because of the fact that it is sometimes essential to take into consideration the interplay of numerous factors, this is a very complicated procedure. When two or more causes interact with one another, the effect of the interaction is frequently greater than what would be anticipated based on the total of the effects of the individual causes.

Applications of Forensic Epidemiology

In the field of forensic epidemiology, these theories are still being put into practice, and they are considered to be the basis of the field in the modern day. Specifically, the criteria developed by A.B. Hill, which were discussed earlier, serve as the foundation for the technique utilized by the International Agency for Research on Cancer (IARC) in the process of determining the carcinogenic risk derived from epidemiological research.

Over the past few years, forensic epidemiological principles and knowledge have become increasingly necessary in numerous civil and criminal litigations. In these cases, epidemiologists have been asked to express their expertise in order to verify the possible causal relationships that exist between the exposure to risk factors and the development of a disease. Environmental catastrophes, occupational epidemiology, which focuses on diseases and injuries associated to the job environment, and vaccine safety are some examples of the types of forensic epidemiological investigations that fall under this category.

Environmental and occupational epidemiology

During the 1970s, the United States of America was the first nation to initiate legal processes with the purpose of providing compensation to victims who had suffered significant harm as a result of exposure to dangerous chemicals. The nation, on the other hand, decided to use the civil process in order to determine the causative attribution of detrimental events that were caused by exposure to poisonous chemicals. This is in contrast to the Italian system, which manages these events within the context of the criminal process. Nevertheless, the standards of proof for criminal responsibility in Italy and civil liability in the United States are distinct from one another. In the case of criminal liability, the standard of proof is "beyond any reasonable doubt," whereas in the case of civil liability, the bar of proof is "most likely." It is important to note that the epidemiological evaluation known as "Beyond all reasonable doubt" is distinct from the evaluation that determines whether or not the causal nature of a connection is "most likely." In the criminal liability processes, such as those that take place in Italy, it is required to evaluate each subject "beyond any reasonable doubt" on the possible causal nature of an association. However, in the case of multifactorial pathologies, it is difficult to determine whether or not subjects would not be ill if they were not exposed to the pathogen.

In Italy, epidemiologists - have been involved especially in environmental disasters including the processes of: i) the Eternit case in Turin (Piedmont region) where the Italian company "Eternit" exposed around 3000 people to asbestos; ii) the case of Ilva steel-plant in Taranto (Apulia region); iii) the Tirreno Power in Savona (Liguria region) where the death of a hundred of people was attributed to the emissions of the power plant; iv) the Enel Spa of Porto Tolle a coal-fired central in the Veneto region and v) the shipyards of Porto Marghera in Venice (in the Veneto region) that poured into the atmosphere toxic fumes and into the sea carcinogenic substances. The Cozzini Cassation verdict reflected an epidemiological evaluation that was to be used as an example for its thoroughness. It is pertinent to draw reference to the epidemiological report that was carried out in 2010 as part of the Eternit Process. An explanation of the intricate epidemiological evaluation that is captioned "knowledge of asbestos hazard and asbestos-related pathologies" may be found in the last part of the verdict. The findings of a number of epidemiological studies provide evidence that the communities that are the subject of the inquiry into the Eternit case are at risk of being exposed to asbestos risk. It was discovered via these cohorts and case-control studies that there is a link that is statistically significant between the exposure to asbestos and the instances of asbestosis, lung cancer, and mesothelioma. It is one of the first cases of public safety offenses in Italy, which has been widely broadcast by the media, that the epidemiological evidence has been highly motivated and comprehensive. The case in question is known as Eternit. The Ilva case has also received a lot of coverage in the media in Taranto, which is located in the Apulia area. The Ilva company is one of the largest steelworks in Europe; yet, epidemiological examinations were conducted to determine whether or not there was an increased frequency of various diseases in the people that were located in close proximity to the enormous industrial pole and were consequently particularly exposed to emissions. In the epidemiological study that was carried out in 2012 and signed by renowned Italian

epidemiologists, it was stated that "the continued exposure to pollutants in the atmosphere emitted by the steel plant caused and still causes in the population degenerative phenomena in various organs that result in disease and death." The approaches that were utilized made it feasible to estimate the risks of illness and the morbidity that were produced by both current and previous exposures. Additionally, these methodologies made it possible to eliminate the role of misunderstanding that stemmed from potential external causes. It is necessary to perform constant monitoring of both the environment and the health of the people in order to improve the ability to evaluate temporal changes, as well as to guarantee preventive and effective health treatment.

It is comparable to the situation that occurred with Tirreno Power in Savona, which is a power station located in the Liguria region: the emissions from the power plant were responsible for the deaths of one hundred persons between the years 2000 and 2007. And in 2014, according to the findings of the epidemiological investigation, the judge in charge of preliminary investigations made the decision to seize the firm and to halt a significant portion of the production activity. This decision was made for the same reasons that were postulated to be detrimental to public safety in Turin and in Taranto.

Public health

To preserve, maintain, and enhance the health of a population by organized measures, such as preventative programs, hygiene, education, and other interventions, public health can be described as the communal effort to protect, maintain, and improve the health of a population. Although preventive medicine and health care are essential aspects of public health, the scope of public health encompasses not just medicine but also other aspects that have an impact on the health of communities, such as housing, sanitation, clean water, and sexuality education. Although epidemiology is one of the sciences that makes a significant contribution to public health, there are a great number of other disciplines that must also be considered. In the realm of public health, contributions may come from a wide variety of disciplines, including but not limited to engineering, architecture, biology, social science, ecology, and economics. The first known instance of the consolidation of smaller clans into bigger, more stable communities is considered to be the beginning of public health. The best way to meet some fundamental requirements, such as the provision of drinking water and the disposal of body waste, was to approach them as communal problems. Community activities that had clear health advantages included the construction of public wells that provided clean water for drinking and aqueducts that brought water from mountain springs or rivers into towns, cities, and agricultural areas. Both of these structures were constructed by the community. Health is achieved when one's physical, mental, and social functioning are all in a state of optimal balance. A health outcome is another term that may be used to refer to a component of a person's health condition that is evaluated after an intervention. There are three ways to quantify one's health status: by the use of proxy measures (such mortality or morbidity rates), through the determination of a health care practitioner, or through self-reporting. The nature of the health need, the goal of the assessment (for example, 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) all play a role in determining the method that is utilized to measure and categorize the health status of populations. As a result of the universality of recording deaths across countries, it is possible to perform international or other across-geographic-area comparisons of health status by utilizing the infant mortality rate (the number of deaths under the age of one per thousand live births) and the life expectancy (the average number of years that an individual is expected to live assuming that current mortality rates continue and continue to apply). When it comes to analyzing the health condition of communities for short-term interventions like vaccination or prenatal care programs, it is generally agreed that infant mortality is the most

sensitive indicator to use. For initiatives that are intended to be long-term, for interventions that evaluate the availability of medical assistance, or for interventions that are intended to evaluate changes in economic conditions, life expectancy is the preferable measure of health status. A better health status need to be achieved through the utilization of health services in a timely and suitable manner. The failure to reach ideal health status following the consumption of health services leads to expectations that are not satisfied, which in turn leads to more utilization of health care services. A health indicator is a marker of health status (physical or mental sickness, impairments or disability, and social well-being), service provision, or resource availability. Health indicators may be used to examine the health condition of individuals. It is intended to make it possible to monitor the current state of health, the performance of services, or the objectives of the program. Monitoring is a technique that recognizes changes in health status over a period of time or among populations in order to evaluate the degree to which progress is being made toward achieving health goals or objectives.

It is not possible to anticipate that a single health indicator would accurately reflect all aspects of health. As a result, a number of indicators are often utilized in order to precisely reflect the many aspects of health. In addition, in order to get a comprehensive understanding of health, it is necessary to investigate it in the context of economic situations, educational and occupational position, living conditions, social support, sexual relationships, cultural norms, and legal systems. The following are some of the categories of indicators that are now being utilized in today's world:

- Health and well-being (consisting of things like bodily fulfillment, psychological and social comfort, and proximity)
- Health resources, such as family planning, options for choice, satisfaction with received services, and the perception of the quality of those services
- For example, the extent of discrepancy in individual health indicators is an example of collective justice.
- Social capital, which includes things like engagement in the community, trust in other people, and perceived enabling factors
- The ability to work together (for example, through community involvement)
- The capacity of a community to withstand the effects of natural calamities, which can have a negative impact on reproduction, is examples of resilience.
- Functionality (such as peace and safety, as well as aspects linked with poor reproductive health, such as abuse, exploitation, unwanted pregnancy, sickness, and death)

In a nutshell, health indicators need to be complimentary to one another and, when taken together, should reflect the comprehensive nature of health. It is necessary to have a variety of health indicators in order to accurately represent the prevalent health problems or difficulties that are of the utmost concern in areas where intervention is being sought. This is because social health concerns are in a state of perpetual change. Providing epidemiologists with information on a health indicator, such as the incidence of maternal mortality, enables them to better comprehend the issue at hand and devise strategies for addressing and enhancing the situation. It is possible that other indicators that indicate other important health issues will emerge as priority even when a particular health condition is being remedied. For instance, when the rates of infant mortality continue to decrease and population expansion continues to follow, it is necessary to take into consideration the economic and social ramifications, and new indicators are required.

Forensics

When used to the field of law, the term "forensics" refers to the application of scientific principles [1]. In a nutshell, forensic science is the application of scientific ideas or procedures to the investigation of legal issues. 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 process of applying the knowledge and technology of the fundamental sciences to problems that arise in the legal system in order to conduct investigations and establish facts or bodies of evidence. It is common practice to employ forensic sciences in both civil and criminal courtrooms.

Detective Sherlock Holmes, a fictional character created by Arthur Conan Doyle, is credited with being the first person to popularize the fundamentals of scientific procedures for detecting criminal activity. These methods include serology, fingerprinting, weapon identification, and suspicious papers. Forensic medicine, forensic toxicology, forensic photography, fingerprints, serology, chemistry, trace, ballistics, and document inspection are some of the core subjects that fall under the umbrella of forensic science. At the same time as the microscope was being created, the field of trace evidence was also developing. By the late 1980s, DNA profiling had reached its pinnacle of development.

Forensic epidemiology

Throughout the course of history, law enforcement and public health authorities did not interact with one another very regularly when it came to the process of performing testing. An examination of a restaurant would be carried out by the customary health inspector, who would have the ability to, without the interference of the police, determine whether or not to impose a fine or even to decide whether or not to close the establishment. In the early stages of the pandemic, the major source of the hazard to public health was food contamination. This contamination might have been caused by improper storage, cross-contamination, or poor hygiene measures. Both of these factors could have contributed to the outbreak.

On the other hand, in the contemporary society, the prospect of an act of bioterrorism, which may include the purposeful poisoning of water, food, air, or land, is a possibility that is well within the realm of possibilities. In the event that law enforcement were to function independently, they would be unable to recognize the danger that is posed by bioterrorism. The same is true for those who work in public health. There is a problem with the fact that individuals who work in law enforcement do not have sufficient training to recognize particular types of illegal behavior. Those who work in the field of public health would be concerned about an increase in a certain type of virus that is thought to be uncommon or that occurs outside of the typical season. However, those who work in law enforcement would not be concerned about such an increase. On the other hand, employees of public health agencies do not receive training in the legal procedures and procedures of evidence collection and recording, in addition to other legal structures that are required in order to put a case to trial. It was standard practice in the latter half of the 1990s to use the term "forensic epidemiologist" to refer to epidemiologists who were called upon to testify as expert witnesses in civil cases.

The purpose of these persons' testimony was to provide information regarding the methodology of the investigation, the number of subjects, the duration of the study, the importance of the findings, and any restrictions that may have been present. They were deployed extensively in order to investigate ideas such as whether or not carpal tunnel syndrome may be produced by exposure to specific chemicals that are associated

with a birth defect or by continually performing a job. In spite of the fact that the field of forensic epidemiology was first established with the intention of focusing on acts of bioterrorism, it is also capable of being applied in the examination of other types of criminal behavior. When it comes to a wide range of various types of health emergencies and other threats to public health, a forensic epidemiologist can play a crucial supportive role in a number of different situations. They are able to conduct investigations into a wide range of offence types, including those that involve the environment as well as those that involve illnesses that are transmitted through food. Because of the high degree of connection that occurs between the alleged exposure and the outcome of interest, the idea of causation is commonly unchallenged in the context of criminal trials. This is because of several reasons. Due to the temporally proximate nature of the tools used to commit murder (firearms, blunt trauma, and sharp instruments), as well as the high degree of lethality associated with these techniques, there is minimal opportunity for consideration of competing causes of damage and death in the majority of instances. This is because of the fact that these methods are associated with significant levels of lethality. As an illustration, in circumstances where death is the result and the exposure is a gunshot wound (GSW) to the head that was sustained moments before the manifestation of signs of injury (unconsciousness followed by cardiorespiratory arrest), there is no requirement for an expert forensic medical assessment to determine the cause of death. This is because the GSW was sustained in the moment before the signs of injury manifested themselves. The notion that a penetrating trauma to the brain is associated with a mortality probability that is more than ninety percent is something that is widely understood and accepted by the general public. There is a possibility that there is another cause of death. It is not something that should be taken into consideration in the majority of situations since the likelihood of it having an effect on a deceased person who passed away soon after sustaining a gunshot wound to the head is so unlikely that it is not something that should be considered. However, even if there is a causal relationship that is plainly obvious, we must not forget the fundamental principle that grounds the practice of FE, which is that it is impossible to identify causation.

This is the underlying concept that underpins the practice of empirical evidence. It is therefore possible that the deceased individual went away as a result of an undetectable and 100 percent fatal poison that terminated his life just before he suffered a GSW that may have been survived. This is the case even in the illustration that was shown before. In the case where a bullet is found in the brain of the deceased, a forensic pathologist will stop looking for a cause of death and will instead focus on determining the cause of death. Due to the fact that it is obviously not feasible to investigate an alternate cause of death that is so close to being impossible (but not completely impossible), this is the reason why this is the case. On the other hand, when it comes to investigations of fatalities and injuries that are pertinent to the prosecution or defense of criminal action, the usage of epidemiologic data or ideas can be of aid in some circumstances.

This is specifically the case when it comes to the investigation of fatalities and injuries. When it comes to the resolution of lawsuits that are connected to diseases, epidemiology has been acquiring an increasing degree of significance. Due to this, a rising number of epidemiologists are being asked to serve as experts in cases of this sort in a variety of different capacities. This is a result of the situation. A significant number of epidemiologists, on the other hand, would be of the opinion that their participation in litigation could potentially interfere with their core obligations as scientists, that such participation would need a significant time commitment, and that the inherent conflict that is present in litigation could be exceedingly unpleasant. It is disheartening to consider the possibility that each of those perspectives is accurate.

Additionally, as the number of participants rises, there is an increasing necessity for the epidemiologist-expert to handle a range of ethical considerations that may arise throughout the course of the legal proceedings that

are being carried out within the context of the study. The procedure of litigation starts even before a case is ever submitted to the court. It is necessary to carry out the inquiry, and it is possible that certain persons who are competent will be part in the procedure. To put this into perspective, after a lawsuit has been submitted, the parties will normally initiate the discovery phase of the process from the beginning. Each party undertakes an attempt to "discover" facts, documents, and other pieces of evidence that are possessed by the other side and that may be relevant or advantageous to the preparation of its own case during this stage of the litigation process. This stage is also known as the discovery stage. In addition, counsel will have the opportunity to submit motions, which are requests for a ruling from the court on certain issues that have been identified prior to the proceeding moving forward to trial.

There is a possibility that some motions that are presented will result in the dismissal of the case; nonetheless, a case that is permitted to advance will finally be put to the test. When dealing with circumstances that are particularly challenging to settle, such as those involving dangerous torts, product liability, and environmental difficulties, it is very necessary to have the assistance of professionals throughout the whole cycle of the case, beginning with the discovery phase and continuing through the trial phase.

Conclusion

As a result of its ability to enhance the capacity to protect public health through the utilization of legal procedures, the field of forensic epidemiology is an important one. When it comes to the settlement of complex health problems that have significant ramifications for both society and the legal system, forensic epidemiologists make a significant contribution to the process. These individuals are able to do this by combining the analytical abilities of epidemiology with the rigorous procedures of the judicial system. The objective of this handbook is to provide professionals in the disciplines of law and epidemiology with a comprehensive understanding of forensic epidemiology. This is done with the intention of facilitating collaboration and the effective use of epidemiological principles in legal contexts. In the context of legal or administrative procedures, the term "forensics" refers to the utilization of a wide range of scientific fields for the purpose of conducting investigations and establishing facts. Forensics is also a term that describes the use of scientific concepts in both civil and criminal law, with the major emphasis being placed on the criminal aspect of the investigation. This is because the criminal side of the investigation is regulated by legal standards regarding the admission of evidence and the conduct of criminal proceedings. The acquisition, preservation, and examination of scientific evidence are all tasks that fall within the purview of forensic scientists during the duration of the investigation. When it comes to forensics, some workers travel to the scene of the crime to collect evidence, while others work in laboratories to lead investigations of cases that have been brought forward by other individuals. Both types of staff are responsible for gathering evidence. Furthermore, forensic scientists are able to testify as expert witnesses in both criminal and civil trials, and they can work for either the prosecution or the defense. This ability allows them to testify in both types of cases. Besides their work in the laboratory, they are also responsible for this. In spite of the fact that any field might be legally classified as forensic, there are some features that have expanded over the course of time to comprise the bulk of forensic cases.

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