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ACCIDENT RESEARCH is highly heterogeneous in content and emphasis. It ranges from intensive studies of the role of specific variables to broad-scale investigations of accident incidence. There are many types of accidents, and many factors, often interrelated, that may be significant. This complexity is soon apparent to those approaching the subject for the first time, and it remains a source of concern to established investigators. In view of this, it is our purpose in this chapter to introduce some of the general concepts which have proved useful. We shall consider also the use of incidence rates derived from large populations—for example, that of the United States—and note the limited usefulness of such compilations in the determination of causation. Finally, we shall emphasize that, unless he uses appropriate methods and bears in mind the complexity of the field, the research worker is likely to overemphasize the importance of the variables with which he is particularly concerned.

THE NEED FOR A BALANCED APPROACH

Despite their frequent biases and lack of specificity, data summarizing the incidence of accidents in large populations can be used profitably, especially in identifying the general types, numbers, and trends of accidents. They are also used to support statements to the effect that accidents constitute a major *practical* problem and that as such they justify the application of those same concepts and methods that have proved fruitful in the understanding and control of related problems.

This emphasis on the practical has proved very useful to those seeking encouragement and support for accident research and control programs; it has, in fact, facilitated many of the investigations cited in this volume. It tends, however, to divert attention from theoretical and interdisciplinary problems not recognized as directly relevant to the solution of specific, practical problems. This emphasis on what is thought to be the obviously practical has been coupled with and has engendered a narrowness of subject matter, concept, and methodology which has unquestionably impeded progress in the field. The literature is largely parochial, fragmented, and divergent, and even where this is not the case it is difficult to find contributions which are constructively synthetic rather than merely eclectic.

These deficiencies are well illustrated by a number of the selections in this volume, even those chosen as the best available examples of their types. With the exception of the paper by Gordon, however, which follows below, and of the many papers that are to various extents in its lineage, there have been few even partially successful attempts to provide conceptual frameworks within which the *entire* subject of accidents, regardless of type, might be approached systematically.

Such an over-all synthesis must provide a framework within which it is possible to consider not only accidents in large populations but also those occurring to individuals. It must be equally adaptable to accidents in which the physical characteristics of the environment are of primary importance and those in which medical, physiological, behavioral, and other more "human" factors are dominant. For example, it must be equally useful in the analysis of accidents as diverse as those involving explosions, falling cornices, and equipment failures, at the one extreme,

and those involving ruptured aneurisms and psychological upsets, at the other. It must serve also as a device for the recognition and categorizing of factors and their interactions, to be considered in the systematic analysis of any accident or group of accidents.

Ideally, the approach must be intentionally multifactorial and must avoid *unsupported* presuppositions as to the primary causes either of accidents in general or of those in the specific group under study. Unsupported presuppositions, as we shall note in subsequent chapters, have proved a stumbling block to many who, in discerning the unique contributions of their own disciplines, have attempted to explain essentially all accident phenomena in terms of the concepts and groups of variables with which they are customarily concerned. Nonetheless, it must be recognized that much good work can be, and has been, done with the use of approaches which are not generally satisfactory.

Attempts to explain phenomena in narrow terms are characteristic of the development of a new area of scientific concern. This has been seen repeatedly in medicine and biology, as indicated, for example, by the formerly common phrase "the germ theory of disease." This early phase is followed by a second, in which more sophisticated research is accompanied by increasing emphasis on the apparent complexity of the field and, concomitantly, by despair as to the possibility that a relatively simple, unifying conceptual framework might be developed. Accident research in general has reached this second phase,[1] and we could cite many dogmatic statements that it is impossible for it to progress further. This view, however, is not supported by the evidence and is challenged in the first reading—a discussion of an open-ended but nonetheless structured approach to accident phenomena.

THE EPIDEMIOLOGY OF ACCIDENTS

—John E. Gordon, M.D.

According to Westbrook[2] the importance of a scientific paper can be measured in part by the frequency with which it is referred to in others' work. Judged by this criterion, Gordon's work ranks high, since it has been referred to, discussed, and productively applied by many of the authors represented in this volume. This is not to say that the use of its framework poses no problems, a point to be discussed below; but it represents that great rarity in accident literature, a practically useful device for at least approaching the entire field.

Epidemiologic Methods in Accident Research

To understand the importance of Gordon's paper, it is necessary to recall that it was written in 1948. That decade, despite the world conflict which dominated its first half, witnessed dramatic progress in the control of important infectious diseases. The sulfa drugs, the first of the antibiotics, DDT, and greater understanding and use of immunization and related measures had all contributed to sharp declines

in the incidence and prevalence of such diseases. As a consequence, those concerned with public health slowly began to realize that the substantial increases in the *relative* importance of accidents could no longer be ignored. This realization is reflected in many of the papers that follow. Many public health workers, however, then, as now, appeared to have had little understanding of or feeling for this area and for its close relationship to the concepts, subject matter, and methods which had classically been the concern of the profession. Gordon's paper contributes toward the resolution of this continuing problem.

In this context, it stands as a carefully organized and well-documented statement of the appropriateness and potential utility of applying to accidents an approach long applied to more traditional problems. Gordon points out that epidemiology has been successfully "extended from its original restriction to the communicable diseases to a broad application to mass disease of man; to cancer, diabetes, congenital anomalies, and many others." He adds, however, "It is not so generally appreciated that injuries, as distinguished from disease, are equally susceptible to this approach, that accidents as a health problem of populations conform to the same biologic laws as do disease processes and regularly evidence comparable behavior." This introduction is strongly supported by a series of examples drawn in parallel from the infectious disease and accident literature.

Gordon makes quite clear that by "the epidemiology of accidents" he means those aspects of human ecology that are especially pertinent to the occurrence of accidents in human populations. Since these unplanned events relate to virtually all of the interminably complex aspects of the human situation, he explicitly extends to this area the conceptual framework found useful in handling the same types of variables in the study of the gross incidence of infectious and noninfectious diseases. Within this framework he demonstrates that it is possible to delineate patterns in the distribution of these otherwise seemingly chance events which may lead (and in many instances have led) to an understanding of their causation and to the possibilities for their control. The approach is used both to describe the frequency and distribution of accidents, especially in large populations, and to organize the search, particularly in more homogeneous groups, for factors etiologically associated with increased incidence, facets of the epidemiologic method which MacMahon *et al.*[3] have defined as "descriptive" and "analytic."

Applied to any medical problem, this approach involves essentially sorting out the mixture of factors associated with increased incidence. It is an ordering process analogous to that used in approaching any other similarly mixed bag of events whether, for example, "fevers" or meteorological phenomena. It is the first step in focusing down from the gross to the specific.

The readings in this chapter, in contrast with those in Chapters 4 through 9, are concerned chiefly with the descriptive epidemiology of accidents as they occur in large, heterogeneous groups. Such patterns are usually so general that their description contributes but little to the understanding of causation in any immediate sense, a fact well understood by many of those working at this level of analysis. Work of this type represents, however, a necessary step without which it is often impossible, in practical situations, to identify the general areas from which an accident problem is originating and to determine their relative importance.

The Concept of Cause

Although the terms "cause" and "causation" are often used in these descriptive papers, emphasis is placed on the qualitative and quantitative definition in statistical terms of the parameters, and their relationships, associated with high rates of occurrence. This level of analysis is often far removed from those which emphasize the identification of specific "causes." Half a century ago Bertrand Russell pointed out that the "notion of cause" is foreign to what he referred to as the more established sciences, and that their concern, rather, is with the delineation in mathematical terms of the interrelationships of the variables with which they deal.[4] Without taking sides in the attack on determinism launched by Russell and others, one may note that this emphasis is becoming increasingly widespread in accident research. A paper by Shaw and Sichel, for example, claims the successful identification, for uniform exposure, of *individual* accident rate patterns, derived without substantial attention to the activity of specific "causes."[5] Other examples, easily identified by their complete or substantial avoidance of the terms "cause" and "causation," are to be found in the chapters that follow. Other authors use the term "cause" chiefly as a synonym for mechanisms of injury (*e.g.*, "piercing instruments") without indicating or recognizing that this often contributes little to the understanding of the factors that led up to the accident.

Gordon's approach represents an intermediate position well illustrated by his subtitles. Progressing from a discussion of "Movements of Disease and Injury According to Time," he considers "Accidents as an Ecologic Problem" and points out the usefulness in given situations of considering "causation . . . as something more than [a function of] the agent directly involved. . . . Rather it is a combination of forces from at least three sources . . . the host, . . . the agent, . . . and the environment in which host and agent find themselves." This stress on the interaction of multiple causes is further developed by consideration of categories of characteristics of host, agent (see below), and environment which, though always somewhat important, may be especially so in specific instances. Although characteristics of many types are considered, of particular interest in connection with Chapter 8 is his statement, "Whatever the kind or nature of mass disease or injury, the part exerted by the socioeconomic environment is probably the most neglected of any epidemiologic influence. . . ."

Unfortunately, in the accident literature and elsewhere, the term "epidemiology" is given a wide and confusing variety of meanings, and Gordon's usage differs from that represented in subsequent selections.* Moreover, members of collateral disciplines have tended to regard epidemiology as primarily an extension of the concerns and methods of their particular fields. This has been especially true of workers close to the classical subject matter of public health, and the increasing representation of additional disciplines in public health research has served to confuse the matter even further.

Such views overlook the fact that, although the variables and substance with which such disciplines commonly deal are relevant to epidemiology, they do not contribute the bulk of the subject matter with which it has been and is now concerned,

* Gordon has defined epidemiology as the study of medical ecology in all of its ramifications. This definition is preferred by the present authors.

including as it does matters as diverse as incubation periods, the ecology of nonhuman vectors, the effects of ionizing radiation and air pollutants on populations, secular variations in disease incidence and prevalence, and various medical correlates of sociocconomic indices. Since the wellsprings of accidents are similarly diverse and involve many of the same human and environmental variables, we have not in this volume approached accident research from only one disciplinary viewpoint but rather we have, in the manner of the epidemiologist, attempted to emphasize the manifold ways in which the particular concerns, viewpoints, and tools of various disciplines may be brought productively to bear on the subject. For this reason, Gordon's paper, with its emphasis on multiple causation, ecologically considered, is an appropriate introduction to this broad sampling of accident research.

EXISTING RATES for deaths from accidents and violence remain numerically at almost the identical level of 1900, 88 per 100,000 population in 1900 and 88 in 1946. The relative position among public health problems is at a higher level, since these conditions have advanced as a cause of death in the United States from sixth place in 1900 to third in 1946.

Industry and various governmental agencies have given much attention to the accidents that occur in the places where men work, in public areas, and in relation to motor cars. Accidents in homes outdistance any other class in the losses they cause, whether judged by deaths, by the permanent defects that follow, or by temporary disability. Like all programs for the prevention of mass disease and injury, that directed toward accidents is necessarily a team effort involving a number of agencies and a variety of disciplines. Although health departments have an obligation in all accident prevention, a better record for home accidents is believed to depend largely upon what health departments do in that field. If home accidents are primarily a public health problem, then that problem is reasonably to be approached in the manner and through the technics that have proved useful for other mass disease problems. This includes first an epidemiologic analysis of the particular situation, an establishment of causes, the development of specific preventive measures directed toward those causes, and finally a periodic evaluation of accomplishment from the program instituted.

No need exists in these days to trace the way in which the epidemiologic method has extended from its original restriction to the communicable diseases, to a broad application to mass disease of man; to cancer, diabetes, congenital anomalies, and many others. It is not so generally appreciated that injuries, as distinguished from disease, are equally susceptible to this approach, that accidents as a health problem of populations conform to the same biologic laws as do disease processes and regularly evidence a comparable behavior. This is readily indicated by an initial comparison of representative diseases and injuries according to frequency distributions in time, an epidemiologic characteristic of established value in separating one mass disease from another, and in distinguishing kinds of behavior.

MOVEMENTS OF DISEASE AND INJURY ACCORDING TO TIME

The point epidemic is perhaps the most arresting of all distributions in time, that circumstance where a sharp aggregation of cases occurs within a brief interval as the result of a single agent acting during a prescribed and limited time (Figure 1). A circus train backed up to a standpipe in the

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