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AUTHOR Phillips, Don
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ABSTRACT

Background information is presented to indicate that accidents are an environmental health problem. While accidents are seldom thought to be a disease process, in many ways there are remarkable similarities--not only in terms of causal relationships, but also in preventive aspects. These parallels are described in terms of host-agent-environment relationships. The shortage of investigators in the accident research field is noted, and reasons why accidents have not become a matter of important concern to society are discussed. Such reasons relate to folklore, personal or psychological remoteness, apathy in public response, differences with cultural behavior, acceptance of violence by society, inconvenience and active cooperation, restrictions to personal freedom, threats to specific industries, time involved for change and complexity as a substitute for efficiency. [Not available in hardcopy due to marginal legibility of original document.] (DT)

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NOTE TO EDITORS AND SCIENCE WRITERS:

The following article provides background information on accidents--as an environmental health problem.

ABSTRACT

"The Host-Agent-Environment Concept of Accidents"

By

Don Phillips, Staff Associate
Department of Environmental Health
American Medical Association

Accidents are seldom thought to be a disease process, but in many ways, there are remarkable similarities --- not only in terms of causal relationships, but also in preventative aspects. These parallels are described in terms of host-agent-environment relationships. The shortage of investigators in the accident research field is noted, and reasons why accidents have not become a matter of important concern to society are discussed.

THE HOST-AGENT-ENVIRONMENT CONCEPT OF ACCIDENTS

If a child inadvertently ingests wild polio virus it is not considered to be an accident. If the same child unexpectedly ingests a harmful toxin, the result is an accident. The difference is as close or far apart as your definition of the words - inadvertently and unexpectedly. Despite the fact that accidents and disease involve remarkable parallel and frequently identical causal sequences and preventative measures, they are considered intrinsically different.

Parallels are not yet widely recognized, perhaps largely because of the common assumption that they do not and cannot exist. The failure to recognize these parallels may be the principal reason why accident prevention lags far behind the control of disease.

John E. Gordon, M.D. was one of the first investigators to apply the principles of epidemiology in accident research. Gordon notes in one of his studies (1) that epidemiology has been "extended from its original restriction to the communicable diseases to a broad application to mass disease of man; to cancer, diabetes, congenital anomalies, etc. It is not so generally appreciated that injuries, as distinquished from disease, are equally susceptible to this (epidemiologic) approach, that accidents as a health problem of populations conforms to the same biologic laws as do disease processes and regularly evidence comparable behavior."

Gordon notes that the cause of any disease or accident is a combination of forces from three sources --- the host, most often man; the agent; and the environment in which host and agent find themselves.

Research on accidents for the most part has been concerned with itemizing the factors involved within these three areas or with counting the numbers of different types of accidents.

The result is an enormous amount of statistical data which, standing by itself, is not very revealing with regard to the exact nature of accidents --- the why's and how's of an accident. Missing in most studies are interrelationships between the factors involved.

These incomplete investigations are comparable to studying nutritional diseases by examining only the different physical, biological, and behavioral factors that determine diet. Most research concerned with accidents has emphasized their unexpectedness and the factors leading up to their occurrence rather than the nature and prevention of the damaging insults themselves.

Accidents are the occurrence of unexpected physical or chemical damage to living or nonliving structures. Using the host-agent-environment model, the control of accidents, as with any disease, could involve the following tactics:

a) Reducing exposure to the host. Sanitary measures are taken to prevent man's contact with harmful organisms. The installation of safety-glass in windshields or guards on machinery, warnings on labels, traffic lights and signs are examples of attempts to separate man from a dangerous event.

b) Reducing the hazard associated with the agent. The term "agent" refers to the specific cause of injury production. In many accident studies, it is often confused with the means by which the

agent are transmitted. Dr. William Haddon explains that all agents are actually some form of abnormal energy transfer --- either mechanical, chemical or electrical.

> "Engergy which may reach the body, and the substances which may interfere with its normal function, are usually carried by inani ate objects or living organisms. These correspond to the "vehicles" and "vectors" of infectious diseases. Thus electric lines are vehicles of electricity, hot rivets are vehicles of thermal energy, poison containers are vehicles of their contents, and moving objects are vehicles of mechanical energy. Similarly, poisonous plants and animals are vectors of their toxins, and animals which injure by tearing and crushing are vectors of mechanical energy. This concept is a useful one, since many preventive measures (and much research) must be directd against the vehicles and vectors rather than against the physical and chemical agents that they transmit."(2)

Any attempt to reduce the hazard associated with the agent would entail either diverting or dissipating the energy of the agent when it strikes. Just as the body is capable of fending off the effects of infection by either natural or acquired immunity, it is also capable of resisting the forces which accidents may present. The structure and substance of the human body provide a certain degree of natural resistance. A child who falls down a staircase is often unscathed because the bones in his body are elastic enough to absorb the abnormal levels of energy delivered to his system. The human body also acquires additional resistance through exposure to such forces, as seen by a decreased injury susceptibility with athletic training. Other examples of acquired resistance are: callusing of skin with work; skin tanning with exposure to sunlight, and increased tolerance to arsenic with repeated exposure of small amounts.

Many safety features used particularly on moving vehicles, are actually devices which divert or absorb mechanical energy in the event of collision before transfer to the human body. Examples are break-away steering wheels and cushioned dash boards.

c) Changing the environment. Swamps are drained to prevent breeding of infection-bearing mosquitoes. In terms of accident prevention, man finds himself in two environments. First there is the natural environment which includes weather and climatic conditions, changes in illumination with the passing of day and night, and geographical conditions such as the presence of toxic agents in soil and the proximity of earthquake or volcanic destruction.

Secondly, man is faced with artificial environmental hazards. According to James J. Gibson,

> "By and large, the paths, bridges, fences, shelters, tools, machines, clothing, radiators, food, water faucets, air conditioners, and all other goods of the artificial environment have alleviated old sources of danger, but they have also introduced new ones Human children are now in less danger from rock-falls but in more danger from electrical outlets." (3)

Accident prevention has been primarily concerned with the modification of man's artificial impliments. A few noteworthy examples are the changes made in power lawn mowers following a series of accidents when they first came on the market; the installation of safety releases inside refrigerators following a series of suffocation deaths by children who used them for hiding places.

The most neglected area of research on accident prevention is man himself. Very little is known about his physical, physiological or psychological make-up, particularly as he relates to his environ-

ment. What are the physical boundaries of man's control and how do they relate to the positioning of controls? What are the limitations to man's sensory and motor systems and how do they relate to the demands for action which he encounters?

A technician can handle with utmost dexterity, radioactive substances housed within a nuclear reactor by means of a mechanism operated through the shielding --- using the same hand and arm movements he would use if he were handling the material with his own hands. Such an instrument can actually be considered an extension of his nervous system and appendages. Can similar equipment be adopted in other areas of control?

What are the psychological variables involved in accidents? Can they be pre-determined? Can controls or warning systems be contrived for personality deviations that may lead to accidents? Dr. Morris S. Schulzinger in his book --- The Accident Syndrome --- lists the main psychological or physiological elements that increase the probability of accidents in maladjusted persons as: anxiety, fear, worry, guilt, hostilities, emotional and psychosexual conflicts, early exposure to aggression, overauthoritative parents or parent figures, broken homes, frustration, inadequacies of youth, rejection and fatigue.

Accident research encompasses a larger area than the study of energy exchange patterns within the host-agent-environment framework. The factors that determine the subsequent results of accidents include a) quality and quantity of available first aid, b) emergency transportation, c) medical care and d) rehabilitation. These

areas are, of course, the primary concern of the medical profession. Physicians represent a small contingent of professionals engaged in accident research, and in general, there are few well-trained groups of investigators in this field.

Since government support of research is a generally reliable index of activity in an area of investigation, it is of interest that the Chief of the Research Grants Section, Div. of Accident Prevention, USPHS, estimates "that more than 300 times as much money is currently being spent in the U.S. on medical research as on accident prevention research, despite the fact that accidents are the 4th leading cause of death and account for more than 45 million injuries annually."

As Dr. Haddon points out, "valid accident research involves an interdisciplinary approach --- a difficult task for many who are committed to traditional methods, as time, knowledge and finances allow. In addition, the field at present promises little in the way of monetary or social regard and is widely assumed to be uninteresting intellectually and productive of little in the way of human progress. As a result of the personnel shortage; accident research remains in a primitive state of methodology and much of the work currently being published is inadequate because the investigator's training was either too narrow to encompass certain significant variables or inadequate for the proper interpretation of the data.

The lack of adequate professionalism in the accident field has frequently led to the adoption of countermeasures on the basis of "common sense" without evidence of their effectiveness or provision for their evaluation after being adopted. Examples in the traffic

field are: motor vehicle inspections, speed laws, operator license requirements and public information programs. Little attempt has been made to measure either the magnitude of the specific accident problem they are supposed to reduce, or the effectiveness in reducing the problem.

"While these unevaluated accident prevention measures may do no harm, they dissipate money, time and public concern, that might be applied to more effective measures, and the public and its government may conclude that everything that can be done is being done."(2)

These difficulties in developing adequate accident research are actually manifestations of deeper causes - for history has shown that a society can mount any sort of research program that it regards sufficiently important. The man in space program matches or exceeds in complexity, manpower problems, cost, and sheer technical difficulty, the development of a broad scientific program in accident research.

Ironically, the unfortunate deaths of three astronauts in terrestial accidents not directly related to their space missions give witness to the present situation.

The space program has gone ahead swiftly because our society regards it as worthwhile, not only giving it financial support but also in modifying the educational program and manipulating the system of social regards in order to provide adequately trained manpower.

There are many reasons why accidents have remained largely outside the sphere of social concern and why the reduction of accidents has not become a strong social value. Dr. William Haddon(2) lists the following:

FOLKLORE

Many people believe that accidents mysteriously defy any kind of systematic study beyond mere tabulation --- that they "just happen," are "acts of God," punishment for misdeeds," and "unwarranted blows delivered by a capricious fate."

Accidents are commonly regarded by the general public and even by many research workers to result from causal sequences that are somehow intrinsically different from those that lead to disease and to other everyday events.

Luck, chance, and acts of God are all culturally acceptable explanations of accidents although such concepts have gradually fallen into disuse in explaining the causation of disease. Even current accident research literature makes reference to "natural" disasters and other accidents whose outcomes appear to be well beyond human control and influence.

Accidents in which no man played any causative role are rare. In the last 50 years, the average annual number of deaths from tornadoes in the U.S. has been 195 --- about half the number now killed daily by accidents. Deaths caused by lightning are even fewer, and some of them would not have occurred if proper precautions had been taken. Many people are terrified by electrical storms when their chance of being killed by other accidental means, which they customarily ignore, is 700 times greater.

REMOTENESS

People are obviously more attentive and responsive to actions that are immediate, close at hand and dramatic. Thus, an airplane

crash that takes the lives of 100 persons may produce an outcry for flight safety legislation, but the fact that the same number of persons are killed on the same day on American highways produces no such outcry, perhaps because it is largely unrecognized and perhaps because the public has yet to be taught the horror of the split-second crushing involved in virtually every motor vehicle death.

Firearms accidents account for 2,300 deaths each year. Motor vehicle accidents total 4,800,000 but neither of these categories have resulted in legislative restrictions. Apparently these victims are psychologically more "remote" than children who were trapped and slowly suffocated in the refrigerator instances.

Another aspect of remoteness is the belief that accidents happen to "the other fellow." Also, many people have not been personally acquainted with the victim of a fatal accident.

Often, real and visualized threats are unknown. With changes in technology, causative factors become increasingly remote from the injury produced. For example, man-made radiation may be noted only after a considerable time past exposure. Similar accidental ingestion of toxic agents --- pesticides, paints, industrial processes --- may occur years after the agent is introduced into the environment. The difficulty in connecting cause with effect may make preventive action more difficult than it was when it involved installing gates at a railroad crossing.

APATHY IN PUBLIC RESPONSE

The public as a whole is usually unwilling to assume the cost of countermeasures when the lives to be saved or lost are the cumulative

result of many accidents widely distributed in time and location.

Accidents are not unique in this respect. Many current health problems are similar, such as radioactive fallout, air and water pollution, and smoking. They involve the problem of mobilizing public response to events which are not readily or immediately apparent to an individual.

DIFFERENCES WITH CULTURAL BEHAVIOR

Some accident prevention measures are not accepted because they deprive an individual the gratification gained from behavior that is culturally valued.

The American culture is built upon the stories of men who took risks and who have heroic qualities, even when his risk-taking is unsuccessful and he is maimed or killed. The explorer, prizefighter, sports-car racer, mountain climber, test-pilot, and even medical researchers who use themselves as human guinea pigs, are examples of men who are idolized in our culture.

Even socially disapproved risk-takers, such as the Western gunman, the confidence man, and the stock-market speculator are admired for their "guts" or nerve. Paladin in "Have Gun - Will Travel" and "The Fugative" are TV shows which present characters with these desirable traits.

In more mundane terms, the highway speedor, skier, skin diver, and sky diver might lose considerable psychic reward if his activities were curtailed by enforced accident prevention measures.

In a related manner, certain accident preventative measures can be regarded as a threat to their roles in society. At present, there

is a certain reluctance on the part of hockey players to wear protective helmets and face masks probably because these articles, in their minds, distract from the image of "manliness" which they must present to be successful in the sport. The same type of reaction came in the 1920's from baseball players when protective paraphernalia for catchers was introduced.

ACCEPTANCE OF VIOLENCE BY SOCIETY

Just as risk-taking provides a psychic reward in our culture, accidents may conceivably provide our society with satisfactions related to those derived from human sacrifice. One only has to read the newspaper headlines for examples of such activities:

A witness at the Sebring race, where a run-away sports car rammed the grandstand and killed four spectators, admits that "such events make the race more exciting" (and therefore, perhaps more enjoyable).

A ring of people involved in the medieval and outlawed sport of cockfights is uncovered, and one of the promoters of the fights defends his action by saying, "We take better care of our chickens than you do of your children."

Boxing, football and sadistic motion pictures and TV programs are socially condoned forms of public violence. Support for accident research and prevention may be hindered until the role of violence in human behavior with regard to accidents is understood.

INCONVENIENCE AND ACTIVE COOPERATION

People are lazy. The most successful accident control measures --- e.g. sprinkler systems and electrical insulation ---

do not require cooperation or involve inconvenience. They are completely passive in their operation.

RESTRICTS PERSONAL FREEDOM

Many other accident control measures involve the restriction or prohibition of behavior that the individual enjoys or that the culture honors. A restriction on firearms would be regarded by many individuals as an infringement of their constitutional rights. Likewise, a driver's license is widely regarded as a civil right as well as an economic necessity.

THREATS TO SPECIFIC INDUSTRIES

Accident prevention methods can be a "bone in the throat" for many manufacturers and industries for a number of reasons. To rid this "bone," they may have to "cough up" considerable amounts of money for modifications or additional features deemed necessary to insure the safety of their product. Such changes may run counter to advertising campaigns which appeal to the daring or the status-enhancing features of design.

The "bone" can also be a "lump in the throat" or an object of embarrassment, for any changes that are made serve as a reminder to both manufacturer and buyer that the particular product may be dangerous.

The history of safety legislation, however, has shown that costly safety devices or regulations can be swiftly and effectively forced upon a specific industry by a public that has been outraged by a specific disaster, such as the suffocation of a dozen children in discarded refrigerators.

TIME INVOLVED FOR CHANGE

Many institutions and organizations are slow to respond to new concepts and findings, particularly when they involve qualitative and quantitative shifts in the emphasis of programs or the redesign of products, services or laws.

Building codes and the standards of various trade or professional organizations have been given legal standing by legislative act or administrative decision. Any changes to be made must be done through the appropriate, time consuming, and often complex channels.

As simple a change-over as the substitution of mouth-to-mouth resuscitation for the less successful prone pressure method has required years of education and thousands of revisions in textbooks.

COMPLEXITY AS A SUBSTITUTE FOR EFFICIENCY

The existence of a complex of accident-related special interests often forms the basis in the public's mind that society is adequately meeting and solving the problems of accidents. If a community acquires a new ambulance and establishes facilities for first aid and emergency treatment, citizens in the community may be convinced that everything possible is being done for their protection. A program of safety education introduced into the public schools may likewise reassure citizens that their children are being protected, regardless of the actual efficiency of the program itself.

Seen in another light, people with lower levels of intelligence and education appear to believe that an insurance policy protects its holder against the occurrence of an accident rather than alleviating its consequences. On the other hand, people at higher levels, believe

that existing legislation designed to reduce accidents necessarily embody the ultimate in both knowledge and practice.

THE FUTURE

Despite the many obstacles, a number of forces have been at work to stimulate and facilitate accident research. New concepts and knowledge in medicine, statistics, psychology and sociology have provided impetus for work on accidents. Computors have provided new methods of data processing and new developments, such as systems analysis and information theory now provide the accident researcher with insights, tools and techniques. Accomplishments in military and space programs have shown that something can be done to lessen the chance of accidents.

In the past few years there has been mounting public concern over the increase in highway death and injury toll and the increase in certain types of "modern" accidents in areas of Westernization or urbanization. In general, as more accidents are affecting more of the population, there will inevitably be more public involvement.

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