Epidemiology and Disease

Specialist epidemiologists are normally called upon to assess the health issues in complex disasters with large numbers of displaced persons. The following health information on epidemiology and disease gives a general overview of what the epidemiologist will take into account as he or she assesses the epidemiological condition of a displaced population.

1. Epidemiology Concepts

Epidemiology is the study of the occurrence, distribution, and determinants of diseases and injuries in human populations. An epidemiologist is concerned with the types and frequencies of illnesses, injuries, and other health-related conditions or problems in groups of people and with the factors that influence their distribution. The overall goal of the epidemiologist is to discover the factors essential for diseases to occur within groups and then to find the best methods to reduce or prevent those factors and other conditions detrimental to the health of communities.

a. The Epidemiologic Triangle. The epidemiologic triangle consists of three components, with the **Host** at the top point and the **Agent** and the **Environment** at the other two points of an equilateral triangle. Each component must be analyzed and understood to comprehend and predict patterns of disease. Changes in any component will alter the existing equilibrium to increase or decrease the frequency of a disease. In a steady state of the triangle, each leg of the component is affecting and being affected by the other components. If a change occurs in any of the components sufficient to affect the steady state, changes will occur in one or both of the other components.

b. Epidemiologic Definitions

Agents. Specific living or inanimate objects that can cause health problems to hosts. Examples of living agents are microbes (bacteria, viruses) and certain plants (poison ivy, plants that are poisonous when eaten). Examples of inanimate agents are poisons, pesticides, and severe heat or cold.

Clinical Infection. The state in which the host has symptoms, feels ill, or dies. ***Clinical infection*** and ***disease*** are terms often used as synonyms.

Contamination. The state of things in the environment (like water, air, or food) when the agent is found to exist in a state capable of reproducing (for a living agent) or in a state capable of causing symptoms in hosts if they are exposed (for a toxin or poison).

Disease. This is the point at which an abnormal condition within the host impairs normal physiologic functioning.

Disease Cycles. Cycles are named for each specific condition under study. For example, there are diarrhea cycles, typhoid fever cycles, malaria cycles, etc. Each cycle is made up of specific factors in hosts and agents within a specific environment such that if all the factors are present, then diseases or conditions of poor health will occur. Notice that the definition of hosts and agents include some common terms. For example, animals can be hosts agents. However, for a specific disease cycle, animals must be defined either as hosts, agents, or part of the environment through which the agent is transmitted. Describing specific disease cycles can help epidemiologists solve problems related to the health and well-being of displaced populations. The disease cycle helps explain how people get ill and suggests ways to prevent illness in a specific population. It does not matter whether a disease cycle is constructed with animals as host or as agent, as long as the result of the study is a better understanding of how the health problem occurs and how it might be prevented.

Endemic. The disease or condition of ill health that is always present in about the same percent of the population (hosts). See *epidemic.*

Epidemic. This is a very general and somewhat vague expression that means a greater number of hosts have been found to be ill than one would expect to find during a period of time within a certain population. An epidemic is any unusual excess amount of disease or injuries within a population. This idea is most useful when contrasted with the term *endemic*.

These same terms, *epidemic* and *endemic,* are also used to classify agents as either endemic or epidemic. Whether an agent is classified as endemic or epidemic does not consider the seriousness of the condition to the hosts. Conditions can be epidemic in one population while they are endemic in another. An endemic illness can become epidemic under certain conditions where there is a change in the behavior or immunity of the host population. The reverse situation also occurs.

Environment. The physical surroundings of the hosts and agents such as altitude, climate, geography, dust, amount of sunlight, etc. Time can also be considered as an environmental factor, including season of the year or the time of day, week, or month that illnesses or deaths occur.

Hosts. Groups of living organisms (people, animals, and plants) that, under certain circumstances, may become unhealthy.

Incidence. The probability that healthy people will develop a disease during a specified period of time (that is, the number of new cases of a disease in a population over a period of time). Incidence measures the rapidity with which a disease occurs or the frequency of addition of new cases of a disease. These new cases of disease occur either through onset of the disease in current

members of the population or by immigration into the population of persons already ill. The formula for determining incidence rates is:

$$\text{Incidence rate} = \frac{\text{No. of new cases during a given period}}{\text{Population at risk during the same period}} \times 10^n$$

Prevalence. The number of people in a population who have a given disease at a given period of time.

The formula for determining prevalence rates is:

$$\text{Prevalence rate} = \frac{\text{All new and preexisting cases during a given time period}}{\text{Population at risk during the same time period}} \times 10^n$$

Note: It is important to remember that the rates for both incidence and prevalence include a factor of 10 such as per 100 or per 1,000. (Rate is usually expressed per 1,000.) The value of n depends on the relative frequency of a given disease.

The major distinction between prevalence and incidence is that prevalence includes both *old* and *new* cases.

For prevalence and incidence to be useful in the evaluation of the effects of control programs, they must be precisely defined and the time periods clearly designated. Incidence is the preferred count for disease such as measles, mumps, rubella, and conditions such as poisonings.

Both incidence and prevalence counts are important for the control of malaria and tuberculosis. Prevalence counts are important for planning services for the treatment of disease.

Incubation Period. The time from first contact with an infectious agent until symptoms appear in the host. This is an important fact to consider when a group is ill. Epidemiologists often calculate the average incubation period for the group and then look back in time to see when exposure could have occurred.

Infection. This occurs only when a living agent causes any observed effect in a host. The concept of infection implies that the agent has invaded the host tissues and has reproduced to a point where tests or symptoms reveal its presence. Such agents are called pathogenic for the hosts.

Infectiousness or Communicability. The ability of the infected host to interact with the agent so that the agent is transmitted to another host and causes infection. By definition, the contaminated host-agent states are not infectious. However, contaminated articles in the environment can be infectious.

Latent Period. The time from first contact with nonliving agent until symptoms appear (cold, heat, irradiation, poisons, toxins, etc.).

2. Definitions of Environmental Characteristics

Environmental factors can influence the relative strength (resistance and immunity) of the host or the relative strength of the pathogenic organisms (pathogenicity and virulence) so that either the host or the pathogen is favored. When the pathogen benefits from environmental conditions, disease spread is more likely. Likewise, when conditions benefit the host, disease is less likely. Environmental conditions may include many things, such as overcrowded living conditions, presence or absence of pathogens, food supplies, and air quality.

Contamination. The state of things in the environment like food, water, or air, when the agent is found to exist in a state capable of reproducing (for a living agent) or in a state capable of causing symptoms in hosts if they are exposed (for a toxin or poison).

Fomite. An inanimate object that is contaminated with infectious agents.

Epizootic. An condition of outbreak of disease in animals. Environmental health specialists and epidemiologists watch carefully for epizootic conditions that may be transmitted to humans so they can take early action to prevent human disease. Examples include rabies in wildlife, encephalitis in birds or horses, and plague in rodents.

Pollution. The existence of certain abnormal amounts of toxic chemicals or dust within an environmental category such as air, water, food, or soil.

Reservoir. Living organisms or inanimate matter (such as soil) in which an infectious agent usually lives and multiplies. Reservoirs of infection consist of human beings, animals, and environmental sources.

Routes of Transmission. Some agents are transmitted through the environment or through society by many different ways. Others can be transmitted by only one method. Listed below are some ways to describe methods by which an agent can be passed to another host.

- **Direct person-to-person contact** with the skin or bodily fluids of a diseased person. Examples are dysentery, boils, and several airborne diseases (see below).
- **Fecal-oral transmission** is the usual route of transmission of **enteric diseases**. Enteric diseases are diseases that affect the gut and other abdominal organs such as the liver. Infectious agents present in stools of infected persons are transmitted to uninfected persons through contaminated food or water that is ingested by mouth. Examples are cholera, typhoid, dysentery, botulism, staphylococcal food poisoning, polio, hepatitis A and E, polio, and amebiasis.
- **Mucus-to-mucus** contact by kissing or sexual intercourse. Examples include sexually transmitted diseases (STDs), infectious mononucleosis, and hepatitis B.

- **Direct contact with the skin, flesh (raw or not thoroughly cooked), saliva, or other bodily fluids of domestic or wild animals.** Examples are rabies, plague, anthrax, tularemia, and trichinosis.
- **Indirectly through inanimate fomites (objects).** Examples are staphylococcal infection, streptococcal infection, colds, hospital-acquired wound infections through use of improperly sterilized items.
- **Indirectly through the air** (sneezes, tobacco smoke, coughs, dust). Examples are colds, influenza, measles, mumps, chicken pox, and pneumonia.
- **Blood contamination indirectly by arthropod vectors.** Examples are malaria, typhus, plague, African sleeping sickness, encephalitis, yellow fever, and dengue fever.

Vector. An arthropod or other invertebrate organism that conveys the agent from a person or an animal to another person or animal.

Vehicle of Transmission. The matter, usually inanimate, in which pathogenic agents are present and survive until there is physical contact (including ingestion) with susceptible persons (hosts). Bodily discharges including blood, pus, saliva, urine, and feces may contain such agents. Hands, eating utensils, toilet articles, water, air, sewage, clothing, or milk and other foods may be the vehicle of transmission.

3. Disease Cycle Intervention

The interaction of host, agent, and environment makes up the disease cycle. Although the agent must be present for a disease to occur, it alone is not a sufficient cause. The cycle must be completed for the disease to occur or conversely, the cycle must be broken to control the disease. Listed below are some intervention concepts used for disease control programs.

- **Surveillance programs** are designed to detect early cases of disease among hosts.
- **Monitoring programs** are like surveillance activities but are for hosts known to be infected with agents transmissible to others. The same term is used for routine testing of the environment for pollution.
- **Eradication programs** are aimed at the reservoir of infection for the purpose of completely removing the agent. Eradication programs, when applied to certain small niches in a controlled environment, are often successful. An example would be an effort to eradicate a reservoir of an agent in a community water supply.
- **Immunization programs** are directed toward the host to provide specific antibodies against agents. They are usually directed at those individuals at the highest risk from the agent.
- **Behavior modification programs** are aimed at changing the actions of the host that add to the level of risk of disease, allowing the host to enter environments where the agent is located. Health education is a method often tried in displaced persons camps.