Environmental Quality

Air Pollution

Air pollution is a heterogeneous, complex mixture of gases, liquids, and particulate matter. Epidemiological studies have demonstrated a consistent increased risk for cardiovascular events in relation to both short- and long-term exposure to present-day concentrations of ambient particulate matter. Several plausible mechanistic pathways have been described, including enhanced coagulation/thrombosis, a propensity for arrhythmias, acute arterial vasoconstriction, systemic inflammatory responses, and the chronic promotion of atherosclerosis. The purpose of this statement is to provide healthcare professionals and regulatory agencies with a comprehensive review of the literature on air pollution and cardiovascular disease. In addition, the implications of these findings in relation to public health and regulatory policies are addressed. Practical recommendations for healthcare providers and their patients are outlined. In the final section, suggestions for future research are made to address a number of remaining scientific questions.

Cardiovascular disease:

Because of the enormous number of people affected, the impact of air pollution on cardiovascular disease represents a serious public health problem. Results from NIEHS-funded studies have demonstrated a strong relationship between levels of airborne particles, sulfur dioxide, and other fossil fuel emissions and risk of early death from heart disease. The data collected from these landmark studies has prompted federal regulatory agencies to revise existing air quality standards, yielded numerous studies on indoor pollution and respiratory health, and led to the development of air sampling techniques now used in a variety of research settings around the world.

In 1974, NIEHS-funded researchers at Harvard University began a long-term study on residents of six U.S. cities to assess the effects of common air pollutants on respiratory and cardiovascular health. Known as the Six Cities Study, it collected data on more than 8,000 subjects over a period of 14–16 years. The study focused on the health effects of gaseous pollutants such as sulfur dioxide, a colorless gas produced by coal-burning power plants, and fine particle air pollution, microscopic particles that come from motor vehicle exhaust and power plant emissions. The study results showed that subjects living in the more polluted cities had a higher risk of hospitalization and early death from pulmonary and heart diseases as compared to those living in the less polluted cities. The relationship between air pollution and mortality was much stronger for the fine particle component than for the gaseous pollutants.

Respiratory disease:

Asthma- Asthma is a serious environmental health threat, but it can be controlled by taking medication and by avoiding contact with environmental "triggers" such as dust mites, furry pets, mold, tobacco smoke, and certain chemicals.

Carbon Monoxide Poisoning- Carbon monoxide (CO), an odorless, colorless gas that can cause sudden illness and death, is found in combustion fumes produced by cars and trucks, generators, stoves, lanterns, burning charcoal and wood, gas ranges, and heating systems

Air Quality (fires/volcanic) - Volcanic emissions and smoke from wildfires are mixtures of gases and fine particles that can cause breathing difficulties or coughing and can harm your eyes.

Mold- Mold grows anywhere there is moisture but can be prevented. Exposure to damp and moldy environments may cause nasal stuffiness, throat irritation, coughing or wheezing, eye irritation, or skin irritation.

Water Quality

People are increasingly concerned about the safety of their drinking water. As improvements in analytical methods allow us to detect impurities at very low concentrations in water, water supplies once considered pure are found to have contaminants. We cannot expect pure water, but we want safe water.

The health effects of some contaminants in drinking water are not well understood, but the presence of contaminants does not mean that your health will be harmed. In North Carolina, drinking water is generally of high quality and free from significant contamination. Public water supplies are tested, and regulated to ensure that our water remains free from unsafe levels of contamination. Small private water supplies, including wells, are not regulated by drinking water standards, and the owner must take steps to test and treat the water as needed to avoid possible health risks.

What is in your drinking water? The only way to know is to have it tested.

Drinking water can become contaminated at the original water source, during treatment, or during distribution to the home.

- If your water comes from surface water (river or lake), it can be exposed to acid rain, storm water runoff, pesticide runoff, and industrial waste. This water is cleansed somewhat by exposure to sunlight, aeration, and micro-organisms in the water.
- If your water comes from groundwater (private wells and some public water supplies), it generally takes longer to become contaminated but the natural cleansing process also may take much longer. Groundwater moves slowly and is not exposed to sunlight, aeration, or aerobic (requiring oxygen) micro-organisms. Groundwater can be contaminated by disease-producing pathogens, leachate from landfills and septic systems, careless disposal of hazardous household products, agricultural chemicals, and leaking underground storage tanks.

Possible Health Effects

The levels of contaminants in drinking water are seldom high enough to cause acute (immediate) health effects. Examples of acute health effects are nausea, lung irritation, skin rash, vomiting, dizziness, and even death.

Contaminants are more likely to cause chronic health effects - effects that occur long after repeated exposure to small amounts of a chemical. Examples of chronic health effects include cancer, liver and kidney damage, disorders of the nervous system, damage to the immune system, and birth defects.

Evidence relating chronic health effects to specific drinking water contaminants is limited. In the absence of exact scientific information, scientists predict the likely adverse effects of chemicals in drinking water using human data from clinical reports and epidemiological studies, and laboratory animal studies.

Drinking Water Standards

The Safe Water Drinking Act of 1974 directed the U.S. Environmental Protection Agency (EPA) to ensure that public water systems (systems serving more than 25 people) and noncommunity water systems (hotels, campsites, restau- rants, migrant workers' encampments, and work sites) meet minimum standards for protecting public health. Its main provisions directed the EPA to establish minimum drinking water standards to limit the amounts of various contaminants found in drinking water. Because of growing concerns about the safety of the water supply, amendments were made to strengthen this law in 1986. These amendments required the EPA to do the following:

- Develop a maximum contaminant level goal (MCLG) and a maximum contarninant level (MCL) for all regulated contaminants. MCLGs are nonenforceable health-based goals and represent the maximum level of a contaminant that is expected not to cause any adverse health effects over a lifetime. MCLs are enforceable contaminant levels. They are set as close to the MCLG as possible and are based on protecting public health within economical and technical reason.
- Increase the number of regulated contaminants to a total of 83 by June, 1989. MCLs must be set for an additional 25 contaminants every 3 years thereafter.
- Set required schedules for water systems to monitor for contaminants in drinking water.
- Identify best available technologies (BATS) for removing excess contaminants from water, based on efficiency, availability, and cost.
- Issue variances and exceptions to systems that cannot comply with MCLs despite the application of BATS, unless an "unreasonable risk" to health exists. "Unreasonable risk" has not yet been defined.
- Provide for public notification when drinking water standards are violated.
- Ban the use of lead pipes, solder, fittings, and flux in public water systems.
- Bolster enforcement of penalties for violators of drinking water standards at the state and local level.
- Provide for protection of groundwater sources.

Contaminants are regulated when they occur in drinking water supplies and are expected to threaten public health. Most levels established by the EPA allow a sufficient margin of safety, but acceptable contaminant levels vary widely among individuals and population groups. For example, high sodium levels, harmless for most people, can be dangerous for the elderly, people with high blood pressure, pregnant women, and people having difficulty in excreting sodium.

North Carolina has adopted EPA standards and the state has responsibility for enforcing drinking water standards.

Risk Assessment

Every day, you can be exposed to combinations of many toxic substances and these substances may interact.

What is in water may represent only a small part of your overall exposure to a specific contaminant. Scientists who investigate how contaminants affect human health get information in several ways. They may study how a toxic substance has affected people in a community over time. In some cases, this can show relationship between exposure to a contaminant and a health effect They may also use animal studies to collect information on the acute and chronic health effects.

Research helps scientists determine toxic doses and levels below which toxic effects are not observed. For noncancer-causing toxic substances, scientists use "acceptable daily intake" to estimate risk. The acceptable daily intake is the amount of a contaminant or toxic substance that humans can consume daily for a lifetime without any known ill effects. It includes a margin of safety. For a cancer-causing substance, no safe level has been set. Toxicity is estimated by calculating a risk estimate, or the concentration of a substance that presents the least acceptable risk. In the case of cancer-causing toxins, regulations are based on a level of risk that is acceptable, not a safe amount or concentration of a substance.

Four Groups of Contaminants

Microbial Pathogens. Pathogens in drinking water are serious health risks. Pathogens are disease-producing micro-organisms, which include bacteria (such as giardia lamblia), viruses, and parasites. They get into drinking water when the water source is contaminated by sewage and animal waste, or when wells are improperly sealed and constructed. They can cause gastroenteritis, salmonella infection, dysentery, shigellosis, hepatitis, and giardiasis (a gastrointestinal infection causing diarrhea, abdominal cramps, and gas). The presence of coliform bacteria, which is generally a harmless bacteria, may indicate other contamination to the drinking water system.

Organics. People worry the most about potentially toxic chemicals and metals in water. Only a few of the toxic organic chemicals that occur drinking water are regulated by drinking water standards. This group of contaminants includes:

- Trihalomthanes (THMs), which are formed when chlorine in treated drinking water combines with naturally occurring organic matter.
- Pesticides, including herbicides, insecticides, and fungicides.
- Volatile organic chemicals (VOCs), which include solvents, degreasers, adhesives, gasoline additives, and fuels additives. Some of the common VOCs are: benzene, trichloroethylene (TCE), styrene, toluene, and vinyl chloride. Possible chronic health effects include cancer, central nervous system disorders, liver and kidney damage, reproductive disorders, and birth defects.

Inorganics. These contaminants include toxic metals like arsenic, barium, chromium, lead, mercury, and silver. These metals can get into your drinking water from natural sources, industrial processes, and the materials used in your plumbing system. Toxic metals are regulated in public water supplies because they can cause acute poisoning, cancer, and other health effects.

Nitrate is another inorganic contaminant. The nitrate in mineral deposits, fertilizers, sewage, and animal wastes can contaminate water. Nitrate has been associated with "blue baby syndrome" in infants.

Radioactive Elements. Radon is a radioactive contaminant that results from the decay of uranium in soils and rocks. It is usually more of a health concern when it enters a home as a soil gas than when it occurs in water supplies. Radon in air is associated with lung cancer.

Food Borne Illness

An estimated 76 million cases of Foodborne Disease occur each year in the United States. The great majority of these cases are mild and cause symptoms for only a day or two. Some cases are more serious, and CDC estimates that there are 325,000 hospitalizations and 5,000 deaths related to Foodborne Diseases each year. The most severe cases tend to occur in the very old, the very young, those who have an illness already that reduces their immune system function, and in healthy people exposed to a very high dose of an organism.

Causes of Food Borne Illness:

- Bacteria
- Viruses
- Parasites
- Protozoa
- Natural toxins
- Other pathogenic agents as prions

Foods Most Associated with Food Borne Illness:

- Raw meat and poultry
- Raw eggs
- Unpasteurized milk
- Raw shellfish
- Raw fruits and vegetables
- Unpasteurized fruit juice

Food Processing Concerns:

- Foods that mingle the products of several individual animals
- A pathogen in one animal can contaminate may contaminate a whole batch of food mingling the products of several animals as bulk raw milk, pooled raw eggs or ground-beef
- A single hamburger may contain meat from hundreds of animals
- A glass of raw milk may contain milk from hundreds of cows
- A broiler chicken carcass can be exposed to the drippings and juices of many thousands of other birds that went through the same cold water tank after slaughter.
- Washing fruits and vegetables can decrease but not eliminate contamination
- Processing food under less than sanitary conditions can cause outbreaks

- Raw sprouts that are eaten without cooking may contain growing microbes
- Storage and transport methods for food

More Common in Food Borne Illness:

• Nausea • Vomiting • Diarrhea

Cooking meat and poultry to USDA recommended safe minimum temperatures makes them safe to eat:

• Beef, veal, lamb: steaks & roasts - 145°F • Beef, veal, lamb: ground - 160°F

• Fish - 145°F • Egg dishes - 160°F

• Pork - 160°F • Turkey, chicken & duck: whole, pieces & ground - 165°F

Reducing the Risk of Foodborne Illness:

- Cook meat, poultry, and eggs thoroughly
- Separate – don't cross-contaminate one food with another
- Chill – refrigerate leftovers promptly
- Clean – wash produce
- Report – suspected food borne illnesses to the local health department

To avoid Microbial Foodborne Illness:

- Clean hands, food contact surfaces, and fruits and vegetables. Meat and poultry should not be washed or rinsed.
- Separate raw, cooked, and ready-to-eat foods while shopping, preparing, or storing foods.
- Cook foods to a safe temperature to kill microorganisms.
- Chill (refrigerate) perishable food promptly and defrost foods properly.
- Avoid raw (unpasteurized) milk or any products made from unpasteurized milk, raw or partially cooked eggs or foods containing raw eggs, raw or undercooked meat and poultry, unpasteurized juices, and raw sprouts.

The following information was obtained from the CDC's frequently asked questions:

1. What are foodborne disease outbreaks and why do they occur?

An outbreak of foodborne illness occurs when a group of people consume the same contaminated food and two or more of them come down with the same illness. It may be a group that ate a meal together

somewhere, or it may be a group of people who do not know each other at all, but who all happened to buy and eat the same contaminated item from a grocery store or restaurant. For an outbreak to occur, something must have happened to contaminate a batch of food that was eaten by a the group of people.

Often, a combination of events contributes to the outbreak. A contaminated food may be left out a room temperature for many hours, allowing the bacteria to multiply to high numbers, and then be insufficiently cooked to kill the bacteria.

Many outbreaks are local in nature. They are recognized when a group of people realize that they all became ill after a common meal, and someone calls the local health department. This classic local outbreak might follow a catered meal at a reception, a pot-luck supper, or eating a meal at an understaffed restaurant on a particularly busy day. However, outbreaks are increasingly being recognized that are more widespread, that affect persons in many different places, and that are spread out over several weeks. For example, a recent outbreak of salmonellosis was traced to persons eating a breakfast cereal produced at a factory in Minnesota, and marketed under several different brand names in many different states. No one county or state had very many cases and the cases did not know each other. The outbreaks were recognized because it was caused by an unusual strain of Salmonella, and because state public health laboratories that type Salmonella strains noticed a sudden increase in this one rare strain. In another recent outbreak, a particular peanut snack food caused the same illness in Israel, Europe and North America. Again, this was recognized as an increase in infections caused by a rare strain of Salmonella.

2. How are Foodborne Illnesses diagnosed?

The infection is usually diagnosed by specific laboratory tests that identify the causative organism. Bacteria such as Campylobacter, Salmonella, E. coli O157 are found by culturing stool samples in the laboratory and identifying the bacteria that grow on the agar or other culture medium. Parasites can be identified by examining stools under the microscope. Viruses are more difficult to identify, as they are too small to see under a light microscope and are difficult to culture. Viruses are usually identified by testing stool samples for genetic markers that indicate a specific virus is present.

Many foodborne infections are not identified by routine laboratory procedures and require specialized, experimental, and/or expensive tests that are not generally available. If the diagnosis is to be made, the patient has to seek medical attention, the physician must decide to order diagnostic tests, and the laboratory must use the appropriate procedures. Because many ill persons to not seek attention, and of those that do, many are not tested, many cases of foodborne illness go undiagnosed. For example, CDC estimates that 38 cases of salmonellosis actually occur for every case that is actually diagnosed and reported to public health authorities.

3. How do public health departments track foodborne diseases?

Routine monitoring of important diseases by public health departments is called disease surveillance. Each state decides which diseases are to be under surveillance in that state. In most states, diagnosed

cases of salmonellosis, E. coli O157:H7 and other serious infections are routinely reported to the health department. The county reports them to the state health department, which reports them to CDC. Tens of thousands of cases of these "notifiable conditions" are reported every year. For example, nearly 35,000 cases of Salmonella infection were reported to CDC in 1998. However, most foodborne infections go undiagnosed and unreported, either because the ill person does not see a doctor, or the doctor does not make a specific diagnosis. Also, infections with some microbes are not reportable in the first place. To get more information about infections that might be diagnosed but not reported, CDC developed a special surveillance system called FoodNet. FoodNet provides the best available information about specific foodborne infections in the United States, and summarizes them in an annual report.

In addition to tracking the number of reported cases of individual infections, states also collect information about foodborne outbreaks, and report a summary of that information to CDC. About 400-500 foodborne outbreaks investigated by local and state health departments are reported each year. This includes information about many diseases that not under individual surveillance, so it provides some useful general information about foodborne diseases.

Vocab

A

Absolute risk difference: The difference in the risk for disease or death between an exposed population and an unexposed population. (*Harm/Etiology*)
Absolute risk reduction (ARR): the difference in the absolute risk (rates of adverse events) between study and control populations. (*Therapy*) To Calculation

Absolute risk: The observed or calculated probability of an event in the population under study. (*Harm/Etiology, Therapy*)

Adjustment: A summarizing procedure in which the effects of differences in composition of the populations being compared have been minimized by statistical methods. See Confounding variable(*Harm/Etiology*)
Association: Statistical dependence between two or more events, characteristics, or other variables. An association may be fortuitous or may be produced by various other circumstances; the presence of an association does not necessarily imply a causal relationship. (*Harm/Etiology)*

B

Bias (systematic error): Deviation of results or inferences from the truth, or processes leading to such deviation.
Biological transmission--when the agent undergoes changes within the vector, and the vector serves as both an intermediate host and a mode of transmission
Blind assessment: The evaluation of an outcome is made without the evaluator knowing which results are from the test under study and which are from the control or “gold standard”.
(*Diagnosis*)
Blind(ed) study (masked study): A study in which observer(s) and/or subjects are kept ignorant of the group to which the subjects are assigned, as in an experimental study, or of the population from which

the subjects come, as in a nonexperimental or observational study. Where both observer and subjects are kept ignorant, the study is termed a **double-blind study**. If the statistical analysis is also done in ignorance of the group to which subjects belong, the study is sometimes described as **triple blind**. The purpose of "blinding" is to eliminate sources of bias. (*Diagnosis, Harm/Etiology, Therapy*)

C

Case definition--establish with the 4 components or standard criteria for determining who has the disease or condition (1) Clinical information – about the disease or condition (2) Characteristics- of the affected people (3) Location or place- as specific as possible as restaurant, county, or several specific areas (4) Time sequence- specific time during which the outbreak or condition occurred
Case report/case series--case report = detail report of a single patient from one or more doctors while case series = characteristics of several patients
Case-control study: Retrospective comparison of exposures of persons with disease (cases) with those of persons without the disease (controls) (*Harm/Etiology*). See Retrospective study.
Case-control study--Works backward from effect or illness to suspected cause. also: retrospective comparison of exposures of persons with a disease with those of persons without a disease. Uses odds ratio.
Case-series: Report of a number of cases of disease. *(Harm/Etiology*)
Causality: The relating of causes to the effects they produce. Most of epidemiology concerns causality and several types of causes can be distinguished. It must be emphasized, however, that epidemiological evidence by itself is insufficient to establish causality, although it can provide powerful circumstantial evidence. (*Harm/Etiology)*
Classical epidemiology--population oriented, studies community origins of health problems related to nutrition, environment, human behavior, and the psychological, social, and spiritual state of a population. The event is more aimed towards this type of epidemiology.
Clinical epidemiology--studies patients in health care settings in order to improve the diagnosis and treatment of various diseases and the prognosis for patients already affected by a disease.
Clinical outcome: Measures patient health or well being. Ideally it should be credible, comprehensive, sensitive to change, accurate, sensible, and biologically sensible. Compare with Surrogate outcome. (*Diagnosis, Harm/Etiology, Prognosis, Therapy*)
Cluster--an aggregation of cases over a particular period esp. cancer & birth defects closely grouped in time and space regardless of whether the number is more than the expected number. (often the expected number of cases is not known.)
Cohort study: A study that begins with the gathering of two matched groups (the cohorts), one which has been exposed to a prognostic factor,risk factor or intervention and one which has not. The groups are then followed forward in time (prospective) to measure the development of different outcomes. In a retrospective cohort study**,** cohorts are identified at a point of time in the past and information is collected on their subsequent outcomes.
(*Diagnosis, Harm/Etiology, Prognosis, Therapy*)

An **inception cohort** is a group identified at the onset of a disorder or a first exposure to a potential risk factor, and followed forward in time. (*Harm/Etiology, Prognosis*)
Cohort study--A follow-up of exposed and non-exposed groups, with a comparison of disease rates during the time covered. Uses relative risk
Co-interventions: Interventions other than the treatment under study that may have been applied differently to the study and control groups. Co-intervention is a serious problem when double-blinding is absent or when the use of very effective non-study treatments is permitted. (*Therapy*)

Co-morbidity: Coexistence of a disease or diseases in a study participant in addition to the index condition that is the subject of study. (*Harm/Etiology*, *Prognosis, Therapy*)
Comparison group: Any group to which the index group is compared. Usually synonymous with control group. (*Harm/Etiology, Therapy*)
Confidence interval (CI): "The CI gives a measure of the precision (or uncertainty) of study results for making inferences about the population of all such patients". (Strauss, 2005 p. 263) The 95% CI is the range of values within which we can be 95% sure that the true value lies for the whole population of patients from whom the study patients were selected. Wide confidence intervals indicate less precise estimates of effect. CI is affected by sample size and by variability among subjects. The larger the trial's sample size is, the larger the number of outcome events and the greater the confidence that the true relative risk reduction is close to the value stated: the confidence intervals narrow and "precision" is increased.
(*Harm/Etiology, Therapy*) To Calculation
Confounding variable (confounder): A characteristic that may be distributed differently between the study and control groups and that can effect the outcome being assessed. Confounding may be due to chance or bias. See Adjustment, Selection bias
(*Harm/Etiology, Therapy*)
Continuous Common Source Epidemic--occurs when the exposure to the source is prolonged over an extended period of time
Control event rate (CER): The percentage of the control/nonexposed group who experience outcome. (*Harm/Etiology, Therapy*)
To Calculation
Correlative studies--correlates general characteristics of the population with health problem frequency with several groups during the same period of time
Cross sectional--a survey of a population where participants are selected irrespective of exposure or disease status

D

Determinant: Any definable factor that effects a change in a health condition or other characteristic. (*Harm/Etiology*)
Direct contact--occurs through kissing, skin-to-skin contact, and sexual activity
Direct transmission--immediate transfer of agent from a reservoir to a susceptible host by direct contact or droplet spread.
Dose-response relationship: A relationship in which change in amount, intensity, or duration of exposure is associated with a change--either an increase or decrease--in frequency or intensity of a specified outcome. (*Harm/Etiology*)
Droplet spread--direct transmission by direct spray over a few feet, before droplets fall to ground

E

Ecologic relations--correlate relative to specific ecologic factors as diet
Effectiveness: A measure of the benefit resulting from an intervention administered under usual conditions of clinical care for a particular group of patients. See Intention to treat**.** (*Therapy*)
Efficacy: A measure of the benefit resulting from an intervention for a given health problem administered to patients under ideal conditions (i.e., perfect compliance). (*Therapy*)
Epi curve--a histogram showing the course of the disease or outbreak to identify the source of the exposure. Must compare number of cases to time

Epidemic--large numbers of people over a wide geographic area affected.
Epidemiology Triad--1.Host - person getting disease and factors of him 2.Agent - what caused the condition 3.Environment - where it occurred and how it related to spread of disease 4. Vector - transmitter of disease (Vectors aren't always considered part of the triad.)
Epidemiology--the study of distribution and determinants of health-related states in specified populations, and the application of this to control health problems
Etiology: The study of the cause or origin of a disease.
Exclusion criteria: Stated conditions which preclude entrance of candidates into an investigation even if they meet the inclusion criteria. (*Diagnosis, Harm/Etiology, Prognosis, Therapy*)
Experimental event rate (EER): The percentage of intervention/exposed group who experience outcome in question.
To Calculation

F

Follow-up: Observation over a period of time of an individual, group, or initially defined population whose relevant characteristics have been assessed in order to observe changes in health status or health-related variables. (*Harm/Etiology, Prognosis*, *Therapy*)
Fomite--a physical object that serves to transmit an infectious agent from person to person. A comb infested with one or more head lice would be a fomite or the dust particles containing infectious cold virus that remain after droplets of infected saliva are coughed into the air

G

Gold standard (also Reference standard): Ideally, the criterion used to unequivocally define the presence of a condition; or practically, the method, procedure or measurement that is widely accepted as being the best available to detect the presence of a condition. (*Diagnosis*)

I

Incidence: The rate of new cases of illness commencing during a specified time period in a given population See also Prevalence. (*Harm/Etiology*)
Incidence--The number of new cases of illness commencing, or of persons falling ill, during a specified time period in a given population.
Incubation period--time elapsed between exposure to a pathogenic organism, or chemical or radiation, and when symptoms and signs are first apparent. Range of minutes to 30 years
Index test: The test whose diagnostic accuracy is being measured against the reference or gold standard. (*Diagnosis*)
Indirect transmission--agent is carried from reservoir to a susceptible host by suspended air particles, vectors, or vehicles
Infectivity--capacity to cause infection in a susceptible host
Intention to treat analysis: Individual outcomes in a clinical trial are analyzed according to the group to which they have been randomized, regardless of whether they dropped out, fully complied with the intervention or crossed over to the other treatment. By simulating practical experience intention to treat analysis provides a better measure of effectiveness (as opposed to efficacy). (*Therapy*)
Interviewer bias: Systematic error due to interviewer's subconscious or conscious gathering of selective data. (*Harm/Etiology*)
Koch's Postulates--1. The microorganism must be found in all cases of the disease. 2. It must be isolated from the host and grown in pure culture. 3. It must reproduce the original disease when introduced into a susceptible host. 4. It must be found in the experimental host so infected

L

Lead-time bias: Overestimation of survival because of earlier diagnosis—time of death does not change, just time of diagnosis. (*Harm/Etiology, Prognosis*)
Likelihood ratio of a positive test: Ratio of the probability of a true positive result if the disease is present to a false positive result if the disease is absent.(*Diagnosis*)
To Calculation
Likelihood ratio: The likelihood ratio for a test result compares the likelihood of that result in patients with disease to the likelihood of that result in patients without disease.

Likelihood ratio of a negative test: Ratio of the probability of a false negative result if the disease is present to the probability of a true negative result if the disease is absent.

M

Meta-analysis: Statistical synthesis of the results from several studies that address the same question.

N

Negative predictive value: The proportion of people who receive a negative test result who are truly free of the target disorder.

Number needed to harm (NNH): The number of patients for whom there is one additional patient who experiences a harmful outcome. Calculated the same way as NNT.

Number needed to treat (NNT): The number of patients with a particular condition who must receive an intervention to prevent the occurrence of one adverse outcome.
*(Therapy)*To Calculation

O

Observational study (non-experiemental study): Changes or differences in one characteristic (e.g. whether or not people received a specific treatment or intervention) are studied in relation to changes or differences in other(s) (e.g. whether or not they died), without the intervention of the investigator. Examples are case control and cohort studies.
Odds ratio (OR): The odds of the experimental group showing positive (or negative) effects of an intervention or exposure, in comparison to the control group. (*Etiology/Harm, Therapy*)
To Calculation
Odds ratio--is calculated to evaluate the possible agents & vehicles of transmission. Used in case control ad/bc
Odds: A ratio between two probabilities—the probability of an event to a non-event. (*Etiology/Harm, Therapy*)
Outbreak—(localized epidemic) – more cases of a particular disease than expected in a given area or among a specialized group of people over a particular period of time.

P

P value: The possibility that any particular outcome would have occurred by chance. Statistical significance is usually p<0.05. Considered to be inferior to confidence intervals in determining significance of studies.
Pandemic--An epidemic occurring over a very wide area (several countries or continents) and usually affecting a large proportion of the population
Pathogenicity--capacity to cause disease in a host
Point Source Epidemic--occurs over limited, well-defined period of time. Shape of curve rises rapidly and contains definite peak followed by gradual decline
Power:The ability of a study to demonstrate an association or causal relationship between two variables, given that an association exists. For example, 80% power in a clinical trial means that the study has a 80% chance of showing a statistically significant treatment effect if there really was an important difference between outcomes. If the statistical power of a study is low, the study results will be questionable (the study might have been too small to detect any differences).
By convention, 80% is an acceptable level of power. (Bandolier; April 1, 2008. http://www.jr2.ox.ac.uk/bandolier/booth/glossary/statpow.html)
Precision (statistical precision): The range in which the best estimates of a true value approximate the true value.
(*Diagnosis, Harm/Etiology, Prognosis, Therapy*)
See Confidence interval.
Predictive value: In screening and diagnostic tests, the probability that a person with a positive test is a true positive (i.e., does have the target disease), or that a person with a negative test truly does not have the disease. The predictive value of a screening test is determined by the sensitivity and specificity of the test, and by the prevalence of the condition for which the test is used.
(*Diagnosis*) To Calculation
Prevalence: The proportion of persons with a particular disease within a given population at a given time. (*Diagnosis)*
Prevalence--the proportion of persons with a particular disease within a given population at a given time.
Primary Prevention--early intervention to avoid initial exposure to agent of disease preventing the process from starting
Primary research: Individual studies such as randomized controlled trials, cohort studies, case-control studies, cross-sectional studies, etc.
Prognosis: the possible outcomes of a disease or condition and the likelihood that each one will occur. (*Prognosis*)
Prognostic factor: A factor or indicator (such as age or gender) related to an individual's probability of developing a disease or other outcome. Compare with risk factors. Neither prognostic nor risk factorsnecessarily imply a cause and effect relationship. *(Prognosis)*
Propagated (progressive source) epidemic-- occur when a case of diseases serve later as a source of infection for subsequent cases. shape of curve is successively larger peaks
Prospective study: Study design where one or more groups (cohorts) of individuals who have not yet experienced the outcome event in question are followed forward in time and monitored for the number of such events which occur (*Diagnosis, Harm/Etiology, Prognosis, Therapy*)
Prospective study--A study design in which one or more groups (cohorts) of individuals who have not had the outcome event in question are monitored for the number of such events which occur over time
P-value--Tells whether the results of the study can be used. measures how confident you are that your findings are correct. You can only trust your findings to be correct if the p-value is less than .05. Also: p-value is the probability that your sample could have been drawn fromt he populations being tested

R

Randomized controlled trial: An experimental comparison study in which participants are allocated via a randomization mechanism to either an intervention/treatment group or a control /placebo group, then followed over time and assessed for the outcomes of interest. Participants have an equal chance of being allocated to either group. (*Therapy*)
Recall bias: Systematic error due to the differences in accuracy or completeness of recall to memory of past events or experiences. (*Harm/Etiology*)
Reference standard: See Gold standard.
Referral bias: The sequence of referrals that may lead patients from primary to tertiary centers raises the proportion of more severe or unusual cases, thus increasing the likelihood of adverse or unfavorable outcomes. Physicians and medical centers may attract individuals with specific disorders or exposures. (*Prognosis*)
Relative risk (RR): The ratio of the probability of developing, in a specified period of time, an outcome among those receiving the treatment of interest or exposed to a risk factor, compared with the probability of developing the outcome if the risk factor or intervention is not present. (*Therapy, Harm/Etiology*)
To Calculation
Relative risk reduction (RRR): The extent to which a treatment reduces a risk, in comparison with patients not receiving the treatment of interest. *(Therapy)* To Calculation
Relative Risk--the ratio of the probability of developing, in a specified period of time, an outcome among those exposed to a risk factor compared to the probability of developing the outcome if the risk factor is not present. Used in cohort study. (a/(a+b))/(c/(c+d))
Reproducibility (repeatability, reliability): The results of a test or measure are identical or closely similar each time it is conducted. *(Diagnosis)*
Retrospective study: Study design in which cases where individuals who had an outcome event in question are collected and analyzed after the outcomes have occurred. (*Harm/Etiology*)
See also Case-control study.
Retrospective study—a study design in which cases where individuals who had an outcome event in question are collected and analyzed after the outcomes have occurred.
Risk factor: Patient characteristics or factors associated with an increased probability of developing a condition or disease in the first place. Compare with prognostic factors. Neither risk nor prognostic factors necessarily imply a cause and effect relationship. (*Harm/Etiology*)
Risk--The probability that an individual will be affected by, or die from, an illness or injury within a stated time or age span.

S

Sample size: Is the size of the sample. Larger samples usually mean more precise results. Sample size usually depends on the purpose of the study, the population size from which the sample the sample will be pulled, as well as the level of precision and the level of confidence or risk that is acceptable, and the degree of variability in the attributes being measured.
Secondary Prevention--during the latent stage (when the disease has just begun), process of screening and instituting treatment may prevent progression to symptomatic disease
See also Referral bias, Selection bias, Verification bias.
(*Harm/Etiology, Therapy*)
Selection bias: A bias in assignment or a confounding variable that arises from study design rather than by chance. These can occur when the study and control groups are chosen so that they differ from each other by one or more factors that may affect the outcome of the study. (*Harm/Etiology, Therapy*)

Sensitivity (of a diagnostic test): The proportion of truly diseased persons, as measured by the gold standard, who are identified as diseased by the test under study. (*Diagnosis*)
To Calculation
Sensitivity Analysis (economic studies): A technique for testing the robustness of a decision analysis by repeating the analysis with a range of probability and utility estimates.
Specificity (of a diagnostic test): The proportion of truly non-diseased persons, as measured by the gold standard, who are so identified by the diagnostic test under study. (*Diagnosis*)
To Calculation
Statistical significance: How likely the result is due to chance. The probability that an event or difference occurred by chance alone.
Stratification: Division into groups. Stratification may also refer to a process to control for differences in confounding variables, by making separate estimates for groups of individuals who have the same values for the confounding variable. (*Therapy*)
Strength of inference: The likelihood that an observed difference between groups within a study represents a real difference rather than mere chance or the influence of confounding factors, based on both p values and confidence intervals. Strength of inference is weakened by various forms of bias and by small sample sizes. (*Harm/Etiology, Therapy*)
Surrogate outcome/endpoint: Intended to capture the treatment effect of an important clinical endpoint but does not directly measure the clinical benefit of the intervention, substitutes something we can measure for something we want to measure. Compare with clinical outcome. (*Diagnosis, Harm/Etiology, Prognosis, Therapy*)
Surveillance--The systematic, ongoing collection, analysis, interpretation, and dissemination of health data. The purpose of public health surveillance is to gain knowledge of the patterns of disease, injury, and other health problems in a community so that we can work toward controlling and preventing them
Survival curve: A graph of the number of events occurring over time or the chance of being free of these events over time. The events must be discrete and the time at which they occur must be precisely known. In most clinical situations, the chance of an outcome changes with time. In most survival curves the earlier follow-up periods usually include results from more patients than the later periods and are therefore more precise. (*Prognosis*)

T

Tertiary prevention--during the symptomatic stage (when the patient shows symptoms), intervention may arrest, slow, or reverse the progression of disease
Test/treatment thresholds: The probability of disease above which we treat for the disease and below which we do not treat. The treatment threshold is determined by the costs and benefits of the treatment.

The **external validity** of a study refers to the appropriateness by which its results can be applied to non-study patients or populations.

The **internal validity** of a study refers to the integrity of the experimental design.
The probability at which one should be indifferent between testing and treating.
Time series analysis--correlate within the same population at different point in time

V

Validity: The degree to which the results of a study are likely to be true, believable and free of **bias**. This is entirely independent of the precision of the results and does not predict the results to your patients. (*Diagnosis, Harm, Prognosis, Therapy*)

Values can be assigned to these thresholds from data on the reliability and potential risks of the diagnostic test and the benefits and risks of the diagnostic test and the benefits and risks of a specific treatment. Treatment should be withheld if the probability of disease is smaller than the testing threshold, and treatment should be given without further testing if the probability of the disease is greater than the test-treatment threshold. The test should be performed (with treatment depending on the test outcome) only if the probability of disease is between the two thresholds. The method exposes important principles of decision making and helps the clinician develop a rational, quantitative approach to the use of diagnostic tests.
Vector--an animate intermediary in the indirect transmission of an agent that carries the agent from a reservoir to a susceptible host. An organism that transmits the infection as a mosquito transmits the malaria protozoan
Vehicles--inanimate intermediaries (objects) that carry agent. aka fomite
Verification bias (work-up bias): Occurs when patients with negative test results are not evaluated with the gold standard test.
Virulence--severity of disease that the agent causes to host
What is needed to determine the cause/effect relationship??-- 1.Strength of association - relationship must be clear 2.Consistency - observations must be repeatable in different populations at different times 3.Temporality - the cause must precede the effect 4.Plausibility - the explanation must make sense biologically 5.Biological gradient - there must be a dose-response relationship
Zoonosis--An infectious disease that is transmissible from animals to humans.

Studies
Case-control study: Retrospective comparison of exposures of persons with disease (cases) with those of persons without the disease (controls) (*Harm/Etiology*). See Retrospective study.
Case-control study--Works backward from effect or illness to suspected cause. also: retrospective comparison of exposures of persons with a disease with those of persons without a disease. Uses odds ratio.
Cohort study: A study that begins with the gathering of two matched groups (the cohorts), one which has been exposed to a prognostic factor,risk factor or intervention and one which has not. The groups are then followed forward in time (prospective) to measure the development of different outcomes. In a retrospective cohort study**,** cohorts are identified at a point of time in the past and information is collected on their subsequent outcomes.
(*Diagnosis, Harm/Etiology, Prognosis, Therapy*)
Cohort study--A follow-up of exposed and non-exposed groups, with a comparison of disease rates during the time covered. Uses relative risk
Prospective study: Study design where one or more groups (cohorts) of individuals who have not yet experienced the outcome event in question are followed forward in time and monitored for the number of such events which occur (*Diagnosis, Harm/Etiology, Prognosis, Therapy*)
Prospective study--A study design in which one or more groups (cohorts) of individuals who have not had the outcome event in question are monitored for the number of such events which occur over time
Retrospective study: Study design in which cases where individuals who had an outcome event in question are collected and analyzed after the outcomes have occurred. (*Harm/Etiology*)
See also Case-control study.
Retrospective study—a study design in which cases where individuals who had an outcome event in question are collected and analyzed after the outcomes have occurred.

The Basics

Epidemiology

Epidemiology is the study of distribution and determinants of health-related states in specified populations, and the application of this to control health problems. There are four basic reasons for why disease detectives study and research outbreaks and epidemics. These reasons are: Control and Prevention, Research Opportunities, Training, and Legal Concerns.

Two Basic Types of Epidemiology

1. Classical Epidemiology - population oriented, studies community origins of health problems related to nutrition, environment, human behavior, and the psychological, social, and spiritual state of a population. The event is more aimed towards this type of epidemiology.
2. Clinical Epidemiology - studies patients in health care settings in order to improve the diagnosis and treatment of various diseases and the prognosis for patients already affected by a disease. These can be further divided into:

- Infectious Disease Epidemiology - heavily dependent on laboratory support
- Chronic Disease Epidemiology - dependent on complex sampling and statistical methods

Basic Epidemiology Terms

Cluster - an aggregation of cases over a particular period closely grouped in time and space, *regardless of whether the number is more than the expected number*
Outbreak - more cases of a particular disease than expected in a given area or among a specialized group of people over a particular period of time
Epidemic - large numbers of people over a wide geographical area affected
Pandemic - an *epidemic* occurring over several countries or continents and affected a large *proportion* of the population
Surveillance - The systematic and ongoing collection, analysis, interpretation, and dissemination of health data. The purpose of public health surveillance is to gain knowledge of the patterns of disease, injury, and other health problems in a community so that we can work towards their prevention and control.

Plague - A serious, potentially life-threatening infectious disease that is usually transmitted to humans by the bites of rodent fleas. It was one of the scourges of our early history. There are three major forms of the disease: bubonic, septicemic, and pneumonic.

How to prove x caused y, or Causation

Hill's Criteria for Causation

Nine criteria must be met to establish a cause-and-effect relationship. This is commonly known as *Hill's Criteria for Causation*:

1. Strength of Association - relationship is clear and risk estimate is high
2. Consistency - observation of association must be repeatable in different populations at different times
3. Specificity - a single cause produces a specific effect
4. Alternative Explanations - consideration of multiple hypotheses before making conclusions about whether an association is causal or not
5. Temporality - cause/exposure must precede the effect/outcome
6. Dose-Response Relationship - an increasing amount of exposure increases the risk
7. Biological Plausibility - the association agrees with currently accepted understanding of biological and pathological processes
8. Experimental Evidence - the condition can be altered, either prevented or accelerated, by an appropriate experimental process
9. Coherence - the association should be compatible with existing theory and knowledge, including knowledge of past cases and epidemiological studies

Hill's Criteria for Causation Explanations and History

Epidemiological Triad

The traditional model of infectious disease **causation**. It is commonly known as the *agent/host/environment triad*. Includes three components:

1. an external agent
2. a susceptible host
3. an environment that brings the host and agent together, so that disease occurs.
4. Vector - transmitter of disease (Vectors aren't always considered part of the triad.)

Epidemiological Study Designs

Basic Studies

1. Ecological- comparisons of geographical locations
2. Cross Sectional - a survey, "snapshot in time"
3. Case-control - compare people with and without disease to find common exposures
4. Cohort - compare people with and without exposures to see what happens to each
5. Randomized controlled trial - human experiment

Advantages and Disadvantages to Study Designs

Study Designs	Advantages	Disadvantages
Trial	Most Scientifically Sound Best Measure of Exposure	Time Consuming Unethical for Harmful Exposures Most Expensive
Cohort Study	Most Accurate Observational Study Good Measure of Exposure	Time Consuming Expensive
Case-Control Study	Can Study Rare Diseases Relatively Less Expensive and Relatively Fast	Possible Time-Order Confusion Possible Error in Recalling Past Exposures
Cross-Sectional Study	Fastest Least Expensive	Possible Time-Order Confusion Least Confidence in Findings

2*2 Table

Table which has two columns and rows for people with or without exposure and with or without disease; shows amount of people with each characteristic.

	Disease	No Disease
Exposure	a	b
No Exposure	c	d

Using the 2*2 Table, we can calculate odds ratio and relative risk. These calculations allow comparisons between the control group and the group afflicted with the condition. One is the neutral value and means that there is no difference between the groups compared; when the value is greater than one it means that there has been some difference between the two groups, whether it was caused by bias, chance, or an actual relationship between the exposure and outcome is yet to be seen. The P-value tells us whether the results of the study can be used. The P-value is the measure of how confident you are that your findings are correct. You can only trust your findings to be correct if the P-value is less than .05.

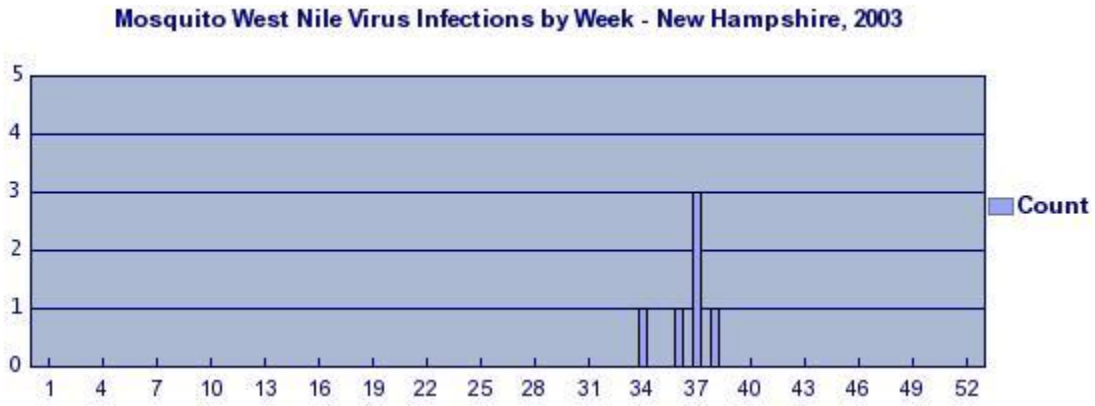
Odds Ratio - used in case-control study, ad/bc **Relative Risk** - used in cohort study, (a/(a+b))/(c/(c+d))

Using Epi-Curves

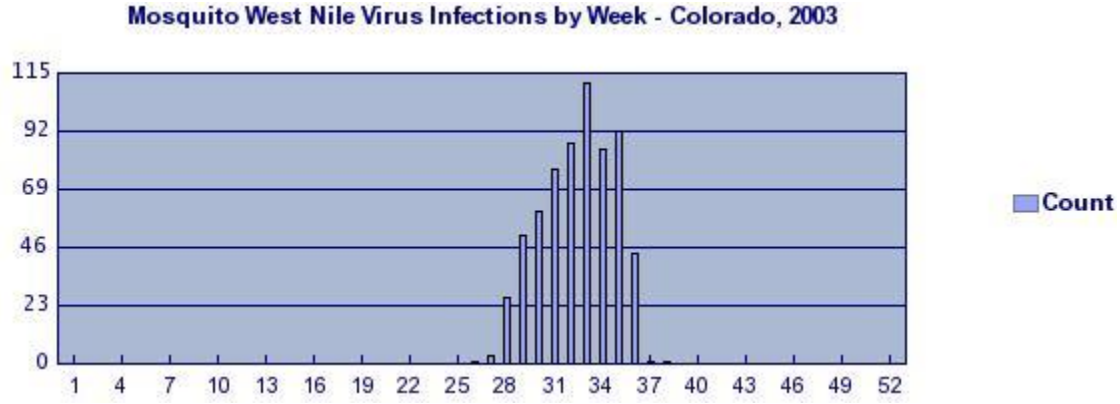
An epi-curve is a histogram that shows the course of an outbreak by plotting the number of cases of a condition according to the time of onset.

Epi-Curves fall into three classifications:

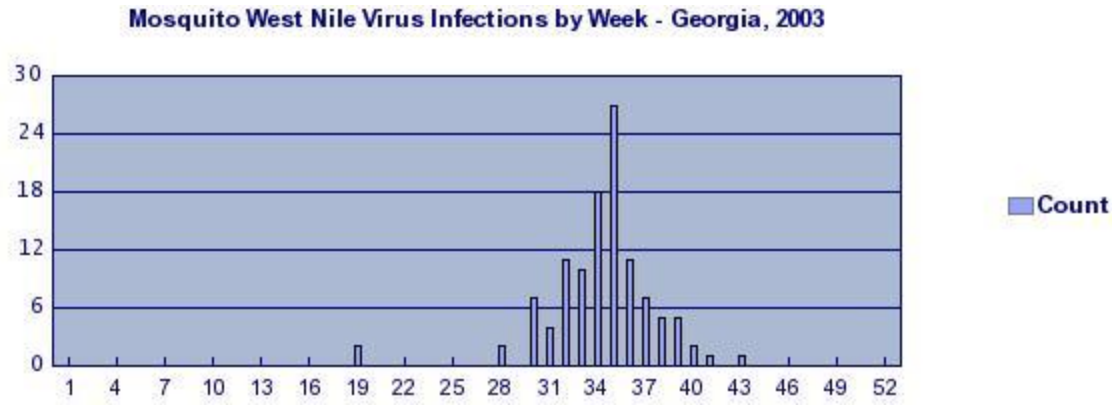
Point source epidemics occur when persons are exposed to the same exposure over a limited, well define period of time. The shape of the curve commonly rises rapidly and contains a definite peak, followed by a gradual decline.



Continuous common source epidemics occur when the exposure to the source is prolonged over an extended period of time and may occur over more than one incubation period. The down slope of the curve may be very sharp if the common source is removed or gradual if the outbreak is allowed to exhaust itself.



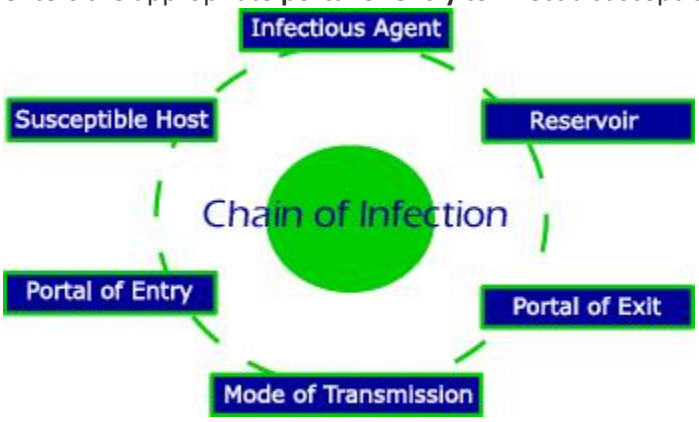
Propagated (progressive source) epidemics occur when a case of disease serves later as a source of infection for subsequent cases and those subsequent cases, in turn, serve as sources for later cases. The shape of this curve usually contains a series of successively larger peaks, reflective of the increasing number of cases caused by person-to-person contact, until the pool of those susceptible is exhausted or control measures are implemented.



Disease and Disease Transmission

Chain of Infection

Agent leaves **reservoir** through **portal of exit**, and is conveyed by some **mode of transmission**, and enters the appropriate **portal of entry** to infect a susceptible **host**.



- Agent - A microbial organism with the ability to cause disease.
- Reservoir - A place where agents can thrive and reproduce.
- Portal of Exit - A place of exit providing a way for an agent to leave the reservoir.
- Mode of Transmission - Method of transfer by which the organism moves or is carried from one place to another.
- Portal of Entry - An opening allowing the microorganism to enter the host.
- Susceptible Host - A person who cannot resist a microorganism invading the body, multiplying, and resulting in infection.

Chain of Infection: Diagram and Explanation

Characteristics of Agents

1. *Infectivity* - capacity to cause infection in a susceptible host
2. *Pathogenicity* - capacity to cause disease in a host
3. *Virulence* - severity of disease that the agent causes to host

Modes of Disease Transmission

- Direct transmission - immediate transfer of agent from a reservoir to a susceptible host by direct contact or droplet spread.
  - Direct contact - occurs through kissing, skin-to-skin contact, and sexual activity.
  - Droplet spread - direct transmission by direct spray over a few feet, before droplets fall to ground.
- Indirect transmission - agent is carried from reservoir to a susceptible host by suspended air particles, vectors, or vehicles.
  - Vectors - animate intermediaries (such as fleas, flies, and mosquitoes) which carry the agent through mechanical means.
  - Vehicles/Fomites - inanimate intermediaries (objects) that carry agent

- Mechanical transmission - no multiplication or change of the agent within the vector
- Biological transmission - when the agent undergoes changes within the vector, and the vector serves as both an intermediate host and a mode of transmission

Disease Prevention

- Primary prevention - early intervention to avoid initial exposure to agent of disease preventing the process from starting
- Secondary prevention - during the latent stage (when the disease has just begun), process of screening and instituting treatment may prevent progression to symptomatic disease

Tertiary prevention - during the symptomatic stage (when the patient shows symptoms), intervention may arrest, slow, or reverse the progression of disease