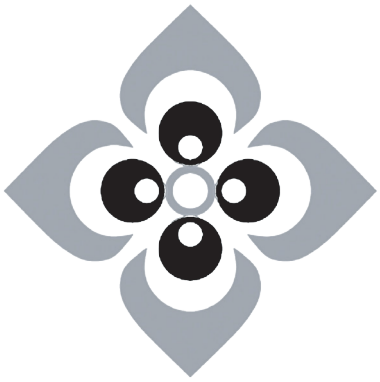

Consortium for Educational Communication

Module on

Epidemiology of Foodborne diseases II.

By

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Epidemiology

"Epidemiology is the study of the distribution and determinants of health related states and events in populations, and the application of this study to control health problems"
In the context of Health & Disease, Epidimiology deals with the following

- What causes disease?
- How does disease spread?
- What prevents disease?
- What works in controlling disease?

Milton Terris, a leading exponent of close interrelationships among epidemiology, public health, and policy, has summarized the functions of epidemiology as:
1. Discover the agent, host, and environmental factors that affect health, in order to provide the scientific basis for the prevention of disease and injury and the promotion of health.
2. Determine the relative importance of causes of illness, disability, and death, in order to establish priorities for research and action.
3. Identify those sections of the population which have the greatest risk from specific causes of ill health [and benefit from specific interventions], in order that the indicated action may be directed appropriately.
4. Evaluate the effectiveness of preventive and therapeutic health programs and services in improving the health of the population.

Food borne Disease
Foodborne disease is caused by consuming contaminated foods or beverages. Many different disease-causing microbes, or pathogens, can contaminate foods, so there are many different foodborne infections. In addition, poisonous chemicals, or other harmful substances can cause foodborne diseases if they are present in food.
Although majority of the foodborne illness cases are mild and self-limiting, severe cases can occur in high risk groups resulting in high mortality and morbidity. The high risk groups for foodborne

diseases include infants, young children, the elderly and the immunocompromised persons.

Foodborne disease outbreaks

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.

Food Borne Diseases: Areas of Occurrence

There are changes in the spectrum of foodborne illnesses along with demographic and epidemiologic changes in the population. A century ago, cholera and typhoid fever were prevalent foodborne illnesses, globally. During last few decades, other foodborne infections have emerged, such as diarrheal illness caused by the parasite Cyclospora, and the bacterium Vibrio parahemolyticus. The newly identified microbes pose a threat to public health as they can easily spread globally and can mutate to form new pathogens. In the United States, 31 different pathogens are known to cause foodborne illness, however, numerous episodes of foodborne illnesses and hospitalizations are caused by unspecified agents.

Symptoms of Foodborne Illness

•Common symptoms of foodborne illness are diarrhea and/or vomiting, typically lasting 1 to 7 days. Other symptoms might include abdominal cramps, nausea, fever, joint/back aches, and fatigue.

•What some people call the "stomach flu" may actually be a foodborne illness caused by a pathogen (i.e., virus, bacteria, or parasite) in contaminated food or drink.
•The incubation period (the time between exposure to the pathogen and onset of symptoms) can range from several hours to 1 week.

Causes of Foodborne Illness

Food & Drug Administration (FDA) 5 foodborne illness risk factors
- Improper hot and cold holding temperatures
- Improper cooking temperatures
- Dirty and/or contaminated utensils and equipment
- Poor health and personal hygiene
- Food from unsafe sources

A wide range of organisms including bacteria, parasites, viruses and their toxins can cause foodborne diseases. Because of the limited diagnostic capabilities less than 50% of all outbreak causes are identified. The most common cause of foodborne diseases are viruses but are not often investigated and confirmed because of the short duration and self-limited nature of the illness. In addition, the inherent difficulty of laboratory investigation and subsequent cost of viral studies lead to a lack of clinician investigation and therefore overall underreporting. Bacteria are the most common documented cause.

During recent decades there are major epidemiologic shifts in foodborne disease due to cultural and demographic factors, as well as increased mobility. The foodborne diseases of earlier times were smaller and limited in scope, more often originated in the home and were associated with Staphylococcus or Clostridium spp. The typical sources of outbreaks were family picnics or dinners and home-canned foods. Now a day's more than more than %80 of foodborne disease cases occur from exposures outside the home because many more people dine outside the home and travel more extensively.
Technology has provided the means for mass production and distribution of food. Therefore, foodborne disease often occurs on a massive scale, whereby hundreds or thousands are exposed and

may become ill. Mobility and travel have resulted in exposure to foods abroad, where regulation of food safety and food products for sale may vary. When traveling, the axiom "boil it, peel it, cook it, or forget it" remains true in many areas of the world. The family members and friends may be exposed to unexpected illness by eating unique foods as gifts brought by travellers. International ships discharging their bilge in ports are another possible means of disseminating pathogens.

Food importation has steadily increased to meet the demand for seasonal and nonseasonal foods. Conditions of production and harvest may be unsupervised or uncontrolled, with resultant importation of contaminated foods. The frequent use of raw manure as a fertilizer causes contamination of fresh produce. If improperly cleaned, the fertilized produce may cause illness when consumed.

Unique ethnic food preferences and preparation have been associated with several food-related illnesses. The outbreak of Yersinia enterocolitica infection in infants is associated by eating of chitterlings (cooked swine intestines) during the Christmas holiday season by Americans and Africans. The episodes of listeriosis in Hispanic neighborhoods have been associated with the use of fresh cheese made from unpasteurized milk.

The effects of foodborne disease are more likely on children and old age persons as well as immunocompromised patients and pregnant women. There is higher incidence, morbidity, and mortality among these groups. The effect of foodborne disease may extend beyond the immediate illness. This has been shown by a Danish study, which demonstrated a greater than threefold risk of dying in the year after contracting a foodborne illness.

Most foodborne disease has a short duration of illness and a self-limited course. Cryptosporidium and Cyclospora may cause a more protracted disease. However, some foodborne diseases are associated with long-term chronic sequelae.

Campylobacter spp., Salmonella spp., Shigella spp., and STEC O157:H7 are most commonly identified pathogens. One of the greatest attributes to these infection agents is that, they have developed extreme tolerance to cold, heat and acidic conditions. In addition they have developed multidrug resistance that has been

linked to prolonged illness and a greater risk of hospitalization.

Almost any food can be a source of foodborne disease. However different agents are associated with particular foods like Salmonella has traditionally been associated with poultry and eggs, Campylobacter with chicken and unpasteurized milk, and STEC O157:H7 with ground beef. An outbreak of STEC O157:H7 was associated with steak that had been needle-tenderized, thereby exposing the center of the meat to surface organisms. When the steak was not thoroughly cooked to an adequate internal temperature, the microorganisms survived and illness occurred after consumption.

Incubation periods of foodborne disease may offer clues to the cause. Four time frames may be envisioned: very brief, short, intermediate, and long durations of incubation. The very brief category (<8 hours) is generally caused by preformed toxins, which may be found in staphylococcal or bacillus-contaminated food. Short incubation periods (24-48 hours) are more typical of viral causes. Intermediate incubation periods (1-5 days) correlate with many bacterial pathogens. The long-duration incubation group (>5 days) approximates the time course of parasitic infections. These time frames are crude groupings and areas of overlap exist between them. In addition, the inoculum of organisms ingested may influence the incubation period and the rapidity of onset of illness—for example, a large inoculum may cause a shortened time to onset of illness.
Bloody diarrhea or a febrile illness is often associated with invasive organisms.

Impact of foodborne illness

- Public health impact

Foodborne illnesses are prevalent but the magnitude of illness and associated deaths are not accurately reflected by the data available in both developed and developing countries. To fill the current data gap, the World Health Organization (WHO) has taken initiative for estimation of the global burden of foodborne illnesses. World Health Organization and the US Centers for Disease Control

and Prevention (CDC) report every year a large number of people affected by foodborne illnesses. Globally, an estimated 2 million people died from diarrheal diseases in 2005; approximately 70% of diarrheal diseases are foodborne. It is estimated that up to 30% of the population suffer from foodborne illnesses each year in some industrialized countries. According to the estimation by CDC in 1999, around 76 million foodborne illnesses occur annually, resulting in 325,000 hospitalizations and 5200 deaths in the United States. However, a decrease in the incidence rates of notified foodborne illness was noticed from 1996 to 2005,but these rates have remained static since 2005. There is a 20% reduction in illnesses caused by the specific pathogens tracked by FoodNet system,over the past 10 years. There are many explanations for this decrease in foodborne illness. It may be due to improved food safety because of regulatory and industry efforts or because of better detection, prevention, education, and control efforts (CDC, 2011a). According to 2011
estimates of CDC, annually 48 million Americans get sick, there are 128,000 hospitalizations, and 3,000 deaths due to foodborne illnesses in the US. In Canada, an estimated 1.3 episodes per person-year of enteric disease occur. In New Zealand, there are an estimated 119,320 episodes of foodborne illnesses each year, accounting for a
rate of 3,241 per 100,000 population.
Foodborne-illness outbreaks are under-reported and it is estimated that 68% of foodborne illness outbreaks are notified to the Centers for Disease Control and Prevention. Even during foodborne illness outbreaks, only a small proportion of the total number of cases is reported. In the United States, during 1993–1997, an average of 550 foodborne illness outbreaks was reported annually. Each outbreak had an average of 31 cases.
Foodborne illnesses also play an important role in new and emerging infections. It is estimated that during past 60 years, an estimated 30% of all emerging infections comprised of pathogens transmitted through food leading to foodborne illness.

- Economic impact of foodborne illness

Every illness has an economic cost and same is the case with foodborne illness. However, the economic cost of health losses related to foodborne illnesses has not been extensively studied. There are few studies available which provide either incomplete cost estimates or
their estimates are based on limiting assumptions. In the United States, data from Foodborne Diseases Active Surveillance Network (FoodNet) and other related studies contributed to estimates of the economic cost of foodborne illness.The annual economic cost of foodborne illness is calculated by multiplying the cost per case with the expected annual number of foodborne illnesses experienced. It was estimated that in 1999, the US government spent $1 billion on food safety efforts at federal level, an additional $300 million were spent by state governments. Moreover, it is estimated that a total of $152 billion a year is spent on foodborne illness in the U.S. The foodborne illness also bears substantial economic burden at regional level. The annual estimated economic cost of foodborne illness for Ohio is between $1.0 and $7.1 billion i-e., cost of $91 to $624 per Ohio resident. A retrospective study performed in Uppsala, Sweden during 1998–99, estimated average costs per foodborne illness as $246 to society and $57 to the patient. An estimated $123 million was the annual cost of foodborne illnesses in Sweden . In New Zealand, the total cost of foodborne illness cases was estimated to be $55.1 million, accounting for $462 per case. The direct medical costs were calculated as $2.1 million while direct non-medical costs were $0.2 million. The estimated total costs were $161.9 million including government outlays of $16.4 million, industry costs of $12.3 million
and $133.2 million for incident case costs of disease associated with treatment, loss of output and residual lifestyle loss.

Monitoring And Surveillance of food borne disease

Any disease of an infectious or toxic nature caused by consumption of food is a food borne disease. In order to address and manage food safety, it is imperative to have cost-efficient monitoring of food contamination and surveillance of food-borne diseases. Monitoring is the performance and analysis of routine measure-

ments, aimed at detecting changes in the environment or health status of populations while as surveillance is the ongoing systematic collection, collation, analysis and interpretation of data, followed by the dissemination of information to all those involved so that the public health sector. To facilitate communication and coordination, establishment of a coordinating body with the participation of relevant stakeholders is recommended. Furthermore, directed actions may be taken (WHO/CDS/CSR). Both require coordinated multidisciplinary approach with the participation of stakeholders from all sectors of the "farm-to-fork" continuum including relevant surveillance data from all stages in the food production chain and from the surveillance of human disease should be continuously collected and analyzed to evaluate trends and sources of food-borne disease. The establishment of a dedicated multidisciplinary surveillance unit involving epidemiological and microbiological expertise from all sectors can facilitate this type of coherent data analysis and feedback. Systems such as these can be operated at the national regional, and global level.

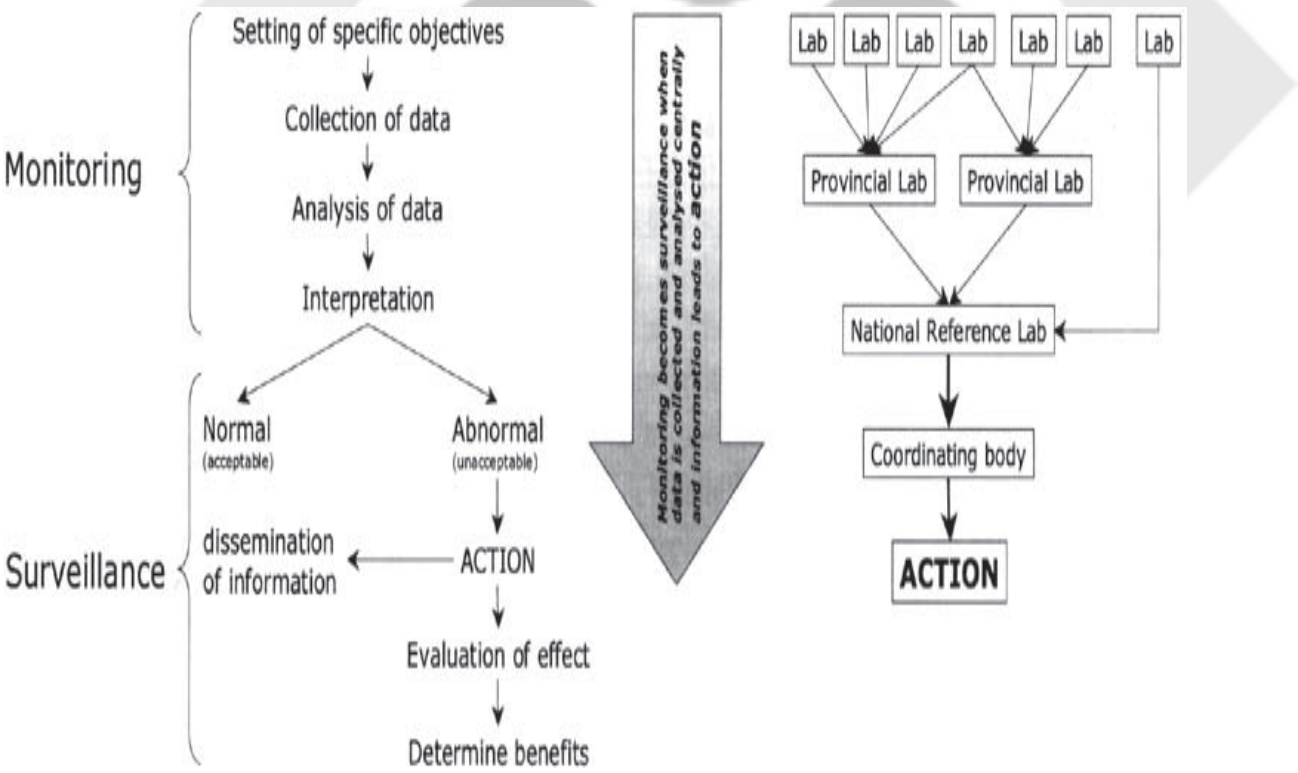

Figure 1. Graphic presentation illustrating the relation between monitoring and surveillance.

The Need for a National Approach

Pathogenic microorganisms can enter the food chain at any point, from livestock feed, via the on-farm production site, at the slaughterhouse or packing plant, in manufacturing, processing and retailing of food, through catering and home preparation. Since there are various possible routes for transmission of pathogens throughout production, isolated actions (e.g. decontamination of animal feed) cannot fully not ensure lasting consumer protection. In order to effectively manage the problem of food-borne disease, measures should be considered at all levels of production. This requires a coordinated surveillance and response effort from all major stakeholders in food safety.

The food industry is responsible for the quality and the safety of their products and is therefore a major stakeholder in food safety. Production may be monitored through, for example, certification programmes, process control schemes or HACCP (Hazard Analysis Critical Control Points) based control programmes. These control activities generate data that can constitute an important contribution to national surveillance programmes. Also, in an outbreak investigation, additional sampling may be required to trace-back human infection to the point of contamination in the food-production chain. Close cooperation between the private and public sector is therefore imperative.

In general, the main stakeholders in food safety representing the government are the Ministries of Health and the Ministries of Agriculture/Food. Under them are agencies that are responsible for the legislative, technical and practical implementation of food safety programmes, and each agency often has a dedicated reference laboratory associated with it. The access to surveillance data often goes through these laboratories. These two or possibly three organizational structures often run independent of each other. In order to get a comprehensive view of the national food safety status, the two Ministries and their respective agencies and reference laboratories should work closely together.

Surveillance to detect foodborne disease

Surveillance refers to a specific extension of monitoring where obtained information is utilized and measures are taken if certain threshold values related to disease status have been passed. The main objectives of surveillance are outbreak detection, monitoring trends in endemic disease, evaluating interventions, and monitoring programme performance and progress towards a predetermined control objective. However, surveillance is not merely a routine measure of the current situation (as opposed to monitoring), but a basis for giving qualified feed-back to producers, tracing back contamination to its origin, pin-pointing critical (control) points during production and initializing targeted action.
There are various levels of intensity and coordination in surveillance systems. Surveillance can be active or passive, general or sentinel, continuous or intermittent, disjointed or integrated. In general, the intensity of surveillance is a product of social (i.e. priority of disease, societal impact), practical (i.e. availability of epidemiological knowledge) and financial parameters.

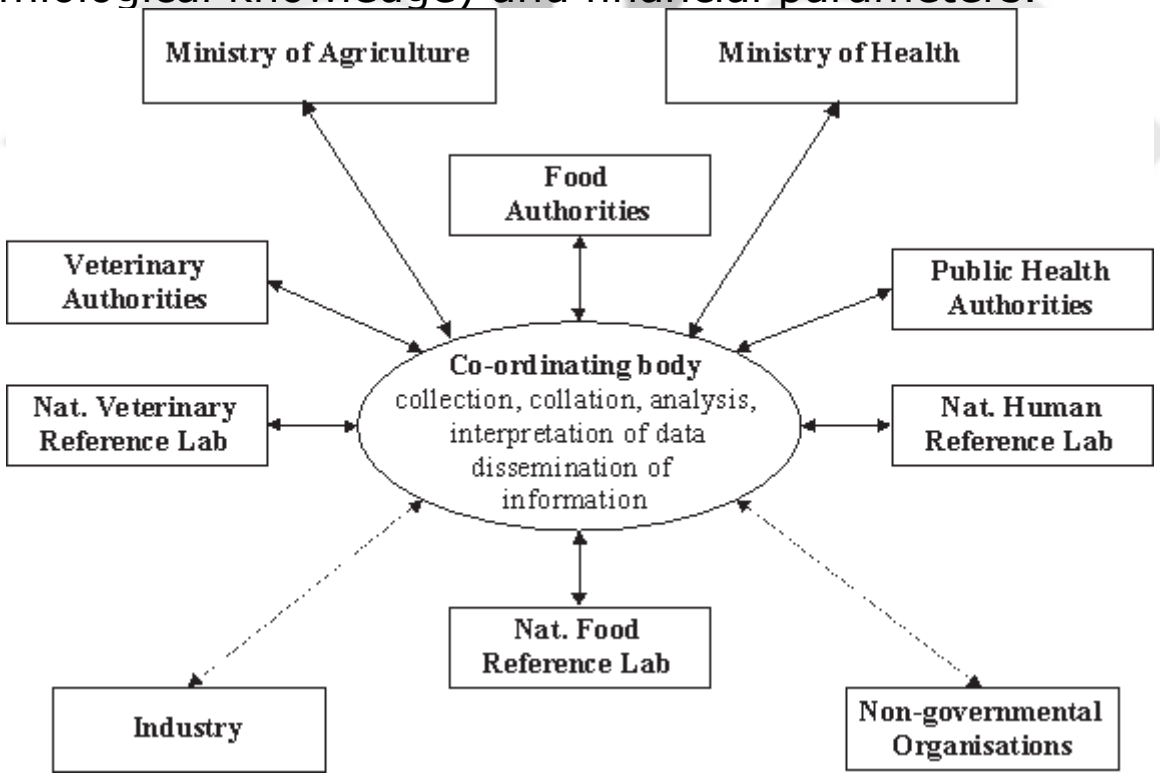

Figure 2. Schematic presentation of the collection, collation, analysis and interpretation of surveillance data and the subsequent dissemination of information to all the major stakeholders in food safety

Finally, other stakeholders of food safety are the non-governmental organizations. They may represent consumers, food industry workers or the environmentalists. Although these organizations seldom are directly involved in the generation of data, they can influence the launching of food safety initiatives and serve as a driving force behind initiation of surveillance efforts. The biggest challenge is to develop structures that ensure the systematic collection, collation, analysis and interpretation of surveillance data and communication to all public and private stakeholders involved (Fig. 2). For this purpose, one or more coordinating bodies or steering committees with representatives of all stakeholders may be formed. The integration of all surveillance data from farm-to-fork in a coherent analysis and subsequent interpretation may be the task of a specialized multidisciplinary research unit, which reports to the relevant coordinating bodies or steering committees. The evaluation by these committees can then lead to a coordinated response.

Integration of surveillance activities to the national level facilitates optimization and cost efficiency in the generation and utilization of surveillance data. The challenge is to optimize the sensitivity of the surveillance system while minimizing the costs. For example:

- Integration of surveillance components within and between links of a production chain, e.g. to investigate possible associations between the levels of food-borne pathogens in food animals and in food products at retail;
- Integration of different surveillance programmes of the same production animal, e.g. using the same serum samples for the detection of antibodies against both Salmonella and PRRS;
- Integration of different surveillance programmes for different production animals, e.g. to estimate the relative contribution of the main reservoirs to the total number of human cases of food-borne illness;
- Integration of national surveillance programmes to rapidly recognize and report international outbreaks, e.g. EnterNet, OzFoodNet and Global SalmSurv.

The integration of food-borne disease surveillance activities can be achieved through:

1) Communication : Communication between major stakehold-

ers can be maintained during regular meetings and direct, informal contact between veterinary and public health workers in key-positions.

2) Collaboration: Collaboration consists mainly of the routine exchange of data and participation in outbreak investigation and response.

3) Coordination: Control activities and the sharing of information need to be coordinated, within and between programmes

4) Central storage of data : Managing a central database containing all surveillance data allows for coherent analyses of the relation between food-borne-pathogen reservoirs and disease in time and space.

These four components ensure the optimal use of data that already is being generated.

Worldwide, there are various surveillance systems to monitor, investigate, control and prevent illness. To assess and monitor morbidity and mortality in the United States, surveillance activities are conducted by several systems in collaboration with federal agencies and health departments . Some surveillance systems are specific for foodborne illnesses. In addition to monitoring the foodborne illness, these surveillance activities also help in evaluating the safety of the food supply . Some of these surveillance systems are discussed below:

• FoodNet (Foodborne disease active surveillance network): FoodNet is the surveillance system in the United States. For Foodnet, CDC has collaborated with ten Emerging Infections Program (EIP) sites (California, Colorado, Connecticut,Georgia, New York, Maryland, Minnesota, Oregon, Tennessee and New Mexico), the US Department of Agriculture, and the Food and Drug Administration. It performs active surveillance for foodborne illnesses and also conducts epidemiologic studies to determine the changing epidemiology of foodborne illnesses. It responds to new and emerging foodborne illnesses, monitors the burden of foodborne illnesses, and identifies their sources. It helps in understanding foodborne disease reporting in FoodNet surveillance system. It shows steps involved in the registration of an episode of foodborne illness in the population.

- PulseNet (The molecular subtyping network for foodborne bacterial disease surveillance): In the United States, PulseNet has created a national framework for pathogen-specific surveillance . PulseNet is responsible for molecular subtyping of foodborne illness surveillance. It helps in detecting widespread foodborne outbreaks by comparing strains of bacterial pathogens from all over the United States. It performs DNA "fingerprinting" on foodborne bacteria by pulsed-field gel electrophoresis. By identifying and labeling each "fingerprint" pattern, it is possible to rapidly compare these patterns through an electronic database at the CDC, thus identifying related strains

- Electronic Foodborne Outbreak Reporting System (eFORS): The Electronic Foodborne Outbreak Reporting System's (eFORS) database is a surveillance system that collects reports on foodborne outbreaks. It requires specialized knowledge and,expertise to appropriately analyze and interpret the data Various studies are conducted by analyzing the data collected within the Electronic Foodborne Outbreak Reporting System (eFORS) in various settings, such as schools in order to examine the magnitude of foodborne illness, their etiologies and to provide recommendations for prevention of foodborne illness

Strategies for control of foodborne illness

The contamination of food is influenced by multiple factors and may occur anywhere in the food production process. However, most of the foodborne illnesses can be traced back to infected food handlers. Therefore, it is important that strict personal hygiene measures should be adopted during food preparation. To prevent foodborne infections in children, educational measures are needed for parents and care-takers.
Good agriculture practice and good manufacturing practice should be adopted to prevent introduction of pathogens into food products. In order to control foodborne viral infections, it is important

to increase awareness of food handlers regarding the presence and spread of these viruses. In addition, standardized methods for the detection of foodborne viruses should be utilized and laboratory-based surveillance should be established for early detection of outbreaks. To prevent food-related zoonotic diseases, collaboration between public health, veterinary and food safety experts should be established. This collaboration will help in monitoring trends in the existing diseases and in detecting emerging pathogens. It will help in developing effective prevention and control strategies . The control strategies should be based on creating awareness among the consumers, farmers and those raising farm animals. The improvement of farming conditions, the development of more sensitive methods for detection of pathogens in slaughtered animals and in food products, and proper sewage disposal are other intervention strategies . Hygienic measures are required throughout the continuum from "farm to fork". Further research is also required to explore pathways of the foodborne illness and to determine the vehicles of the greatest importance. In a study conducted in Turkey, knowledge, attitudes, and practices about food safety among food handlers, were explored. The study revealed that food handlers in Turkish food industry often lacked knowledge regarding basic food hygiene. The authors concluded that the food handlers must be educated regarding safe food handling practices. For the prevention of foodborne outbreaks, training of food handlers, regarding appropriate preparation and storage of food is required. In addition, effective environmental cleaning and disinfection, excluding infected staff, implementing hand hygiene principles, and preventing cross-contamination are recommended .Proper processing of food is necessary to ensure the reduction or elimination of the growth of harmful microorganisms. Pasteurization of milk and dairy products and hygienic manufacturing processes for canned foods will help reduce the cases of food-borne illnesses. Food irradiation is a recent technology for prevention of food-borne illnesses. The food irradiation methods include Gamma irradiation, Electron beam irradiation, and X-ray irradiation. Irradiation destroys the organism's DNA and prevents DNA replication. Food irradiation could eliminate E. coli in ground beef, Campylobacter in poultry, Listeria in food and dairy products, and Toxoplasma gondii in meat. However, all food products cannot be irradiated .The consumers should also take precautions

to prevent foodborne illnesses. These include cooking meat, poultry, and eggs at appropriate temperatures; proper refrigeration and storage of foods at recommended temperatures; prevention of cross-contamination of food; use of clean slicing boards and utensils while cooking; and washing hands often while preparing food.

Detection of Food borne illness outbreaks

The primary goal of surveillance for foodborne disease outbreaks is the prompt identification of any unusual clusters of disease potentially transmitted through food, which might require a public health investigation or response. Detecting outbreaks requires efficient mechanisms to capture and respond to a variety of data sources. In most countries, the main data sources for detecting foodborne disease outbreaks are:

- The public: Members of the public are often the first to provide information about foodborne disease outbreaks, particularly when they occur in well-defined populations or at local level. Public health authorities should have guidelines on how to deal with and respond to such information and outbreak reports received by the public should never be dismissed without consideration. When reports of an outbreak are received, the following information should be gathered:- the person(s) reporting the outbreak; characteristics of the suspected outbreak (clinical information, suspected etiologies,suspected foods); persons directly affected by the outbreak (epidemiological information). The challenge in dealing with these reports is to follow up on all relevant information without wasting resources in investigating a large number of non-outbreaks. The initial response can be facilitated if one individual is designated as the focal point for the event. This person should receive all additional information that is obtained from other sources, maintain contact with the person(s) reporting the outbreak, contact additional cases as appropriate and ensure that staff members of different departments (e.g. epidemiology, food inspection) do not contact cases independently or without each other's knowledge. Standardized forms should be used to collect information about such events.

- The media: The media are usually very interested in foodborne outbreak reports and may devote considerable resources to detecting and reporting them. A local journalist may be the first to report an outbreak of which the community has known for some time. Public health authorities may first learn of a possible outbreak through media reports. Journalists may detect outbreaks that have been hidden from the health authorities because of their sensitive nature or because of legal consequences. Internet editions of regional or national newspapers and web-based discussion groups may provide a timely and accurate picture of ongoing outbreaks throughout the country or the region. However, media reports will inevitably be inaccurate at times and should always be followed up and verified. This will also help public health authorities in controlling public anxiety caused by outbreak rumours in the media.
- Reports of clinical cases from health care providers: Health care providers may report clinical cases or unusual health events directly to the public health authorities. These reports may come from such sources as a doctor working in the emergency department of a large hospital, a general practitioner, a public health nurse with knowledge of the community, or the medical department of a large company. Information sharing of this kind is common and often enables faster and more efficient detection of foodborne outbreaks than legally mandated reporting channels (e.g. statutory disease notification). Information received by astute or concerned health care providers should always be followed up unless there are very good reasons not to do so. The rationale for not acting on such information should always be explained to the health care provider in order to maintain credibility.
- Surveillance data: Surveillance activities are conducted at local, regional and national levels through a variety of systems, organizations and pathway. Among the many surveillance methods for foodborne disease, laboratory reporting and disease notification may contribute importantly to outbreak detection. Other types of surveillance that may be of value in detecting foodborne disease outbreaks are hospital-based surveillance, sentinel site surveillance, and reports of death registration. Generally, however, these are not primary data sources for detecting outbreaks

and their usefulness will depend on the inherent quality of the systems and the circumstances in which they are employed.

- Laboratory-based surveillance: Laboratories receive and test clinical specimens from patients with suspected foodborne disease (e.g. faecal samples from patients with diarrhoea). Often, positive microbiological findings from these specimens are also sent by laboratories to the relevant public health authorities. In addition, some laboratories send patient material or isolates to a central reference laboratory for confirmation, typing or determination of resistance patterns. The collation of these reports and their systematic and timely analysis can provide useful information for detecting outbreaks, particularly when cases are geographically scattered or clinical symptoms are nonspecific. Detecting outbreaks is facilitated by early typing of isolates of foodborne pathogens. Routine typing may detect a surge of a particular subtype and link apparently unrelated infections. Interviewing affected individuals about their food consumption may then identify contaminated foods that may have not been recognized otherwise. Other factors that determine the usefulness of laboratory reporting in the detection of outbreaks include the proportion of cases from whom specimens are taken for laboratory examination, how often laboratories send their reports, how complete these reports are, how many laboratories participate in the reporting and whether the tests employed allow direct comparison of results. Traditional laboratory-based surveillance is "passive", i.e. dependent on laboratories to report cases to public health authorities. In some situations, such as when a potential problem is suspected, "active" surveillance may be warranted for a period of time: laboratories may then be actively and regularly contacted by food safety or public health authorities to enquire about recent positive tests indicative of potential foodborne diseases.
- Disease notification: In most countries medical practitioners are required to notify public health authorities of all cases of certain specified diseases. Notification of cases is usually based on clinical judgement and may not require confirmation by other diagnostic means. It is widely recognized that most statutory disease notification systems suffer from substantial under-reporting of diagnosed cases and long delays in notification. Moreover, many

people with foodborne disease do not seek medical advice or will not be diagnosed as suffering from a foodborne disease because of the nonspecific nature of their symptoms. Medical practitioners who become aware of unusual clusters of diarrhoeal disease or other syndromes that may indicate foodborne disease should also be urged to report these promptly to public health authorities.