IMPLICATIONS OF MICROBIOLOGY TO THE FOOD SERVICE INDUSTRY

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By

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INTRODUCTION

Progressive industrial development and socio-economic changes have provided employment for many people in many countries of the world. This has created the need for additional food service facilities in the form of industrial cafeterias, restaurants and lunch counters for employees in the labor force.

In the United States, increase of work demands and distance from job to home make it inconvenient for the employees to eat all of their meals at home. This situation is also true to the Philippines. Due to these changes that have brought people to eat outside the home, food sanitation has become a great concern. The Philippines has at the present time a major problem dealing with sanitation of restaurants and other quantity food operations. Vicente C. Buencamino, Sanitary Engineering Adviser of the Bureau of Health Services in Manila, stated that:

> . . . there are more health hazards in the capital, in chartered cities and municipal centers (called poblacions) than any other barrios of a municipality, especially with regard to food sanitation. . . . It is in these places where people concentrate to live and find opportunities in life that complex problems are created, not only concerning food, but also related to other factors of environment. It is

> in these places where most public eating and food processing and manufacturing establishments operate.[1]

Furthermore, Jose Tena, Manila Sanitary Inspector, writes about the public establishments in Manila:

> The restaurants in Manila are dirty! They pose a grave peril to public health. Day in and day out the people are exposed to food-borne diseases such as dysentery, cholera, diarrhea-enteritidis, and tuberculosis. The restaurants sell contaminated food swarming with microbes. Restaurant operators violate health and sanitary regulations with impunity.[2]

The United Nations Information Center in Manila reported that ". . . bacteria . . . thrive in the hot and humid conditions of the Philippine climate."[3]

The presence of pathogenic bacteria in food is due to the contamination of the food from an infected animal from which food is prepared, or from an infected person who has contact with food during preparation and/or service.

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[1]Vicente F. Buencamino, "Status of Food Sanitation in the Philippines," World Health Organization Western Pacific Region Seminar on Food Sanitation (Manila, Philippines, October 12, 1962), p. 1.

[2]Jose Tena, "Restaurants are Filthy," Weekly Graphic, Manila, Philippines, May 19, 1965, p. 87.

[3]United Nations' Food Technology Work in the Philippines (Manila, Philippines: United Nations Information Center), p. 1.

The following diseases may be spread by contaminated food:[4]

Amebiasis	Scarlet fever
Diptheria	Streptococcus sore throat
Diptheria, bacillary	Tuberculosis
Paratyphoid fever	Typhoid fever
Poliomyelitis	

These and many other diseases, including those listed below, may also spread indirectly or directly from food handlers to customers:[5]

Chicken pox	Pneumonia, broncho
Conjunctivitis, infectious	Pneumonia, lobar
Encephalitis, epidemic	Smallpox
Influenza	Syphilis (rarely)
Measles	Common cold
Meningococcus meningitis	Vincent's angina
Mumps	Whooping cough

In the control of disease there are three different methods of accomplishing results: sanitation, development of individual resistance and medical treatment. Medical treatment has been practiced since the days of Hippocrates, and although it is far from the superstitions of the healers of early times to the therapy of today, medical treatment has always had the same objective--the cure of disease.

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[4]K. Marden et al., "Administrative Control of Food Handlers and Place Dispensing Food and Drink," American Journal of Public Health, XXVIII (November, 1938), p. 1278.

[5]Ibid.

Today it is now realized that if prevention of disease is to be thorough it must go beyond the individual and must deal with the very habits of society. Concomitantly, food administrators and food handlers are instrumental in preventing disease through awareness of health hazards that are food oriented and sanitation education in the food service industry.

The writer's intent has been to review the principles of microbiology, to investigate the sanitation practices and procedures in the United States related to food handlers, and to summarize this information for use by food supervisors in the Philippines.

PRINCIPLES OF MICROBIOLOGY

Every year hundreds of diseases caused by food-borne microorganisms occur in the United States. Some of them are reported; many are not. According to the 1951-1960 reports (37) made to the United States Public Health Service, 7,000 to 12,000 people suffered annually from these diseases, and the total number of cases is estimated to be ten to twenty times as great as those recognized and reported (15). Despite precautions taken to protect food served to the public, prevalence of food-borne disease still presents a major problem.

Such occurrences need not happen, and yet, they do. Why do they happen and how do we prevent these from happening? Basic principles of microbiology can explain many causes of illness due to improper handling of food and also expand the knowledge of what occurs under given conditions.

Microorganisms - The Bacteria

Fossil records indicate that disease-producing organisms have plagued man since his first appearance on earth. Roman and Arabic writers speculated on the existence of non-visible forms of life. Some early philosophers even suggested that "germ" contagion passes from one person to

another causing disease. Needless to say, these theories remained mere speculations until man devised instruments for the observations of sub-visible organisms (50).

In 1590, Zacharias Janssen produced a compound microscope, but his lenses were too imperfect and his perseverance insufficient to permit him to see the microbes. Antonj van Leevenhoek of Holland is credited with the first recorded observation of the world of sub-visible life. During his leisure hours, this successful Dutch merchant produced a simple microscope consisting of home-ground convex lenses mounted in brass and silver. His lenses were so perfect that when Leeuvenhoek coupled them with keen eyesight and extreme patience he was able to observe the larger microorganisms in 1676 (6). Almost two hundred years later, in 1865, a trained scientist, Louis Pasteur worked in France on fermentations which led to an investigation of the "sick" wines of France. Pasteur showed that putrefaction was due to the presence of flavor-destroying bacteria (17).

Another great figure, contemporary to Pasteur, was the German physician, Robert Koch who developed a liquefiable, solid culture medium for isolating pure strains of disease-producing microbes free from contamination by ordinary organisms of the dust and air. He was the first to prove the cause and effect relationship of bacteria to disease (38).

Shape and Size

Bacteria or their products, undoubtedly, are responsible for the majority of the outbreaks of food-borne diseases (2, 11, 35). These living organisms too small to be seen by the naked eye, are in three shapes: spheres, straight rods, or bent rods.

A spherical or ellipsoidal bacteria is usually termed a coccus. Considerable variation in shape is found among the cocci, although the cells are typically globular when two cocci lie side by side. The approximated side may be flattened, sometimes even concave.

The cells of many bacteria are rod-shaped and relatively straight. Such a rod-shaped organism may be called a bacillus. The rod may be long or short; it may have rounded ends, or it may be truncate, or even concave.

Some bacteria have the shape of a bent end; if the amount of bending is slight, the cell has the appearance of a short arc of a circle. The cell may be in the form of a spiral, in which case an organism is called a spirillum. The spirillum may show several or numerous complete turns of the spiral, or it may appear merely as a slightly bent rod.

Bacterial size is usually expressed in terms of a micron which is one-millionth of a meter or one-thousandth of a millimeter which is approximately 1/25,000 of an inch (6, 16). Such figures indicate how small these bacteria

really are. Because of their smallness, management is faced with not only a problem of contending with "invisible creatures," but also with convincing employees of the actual existence of these organisms and of dealing with them as a constant threat to public health.

Growth and Reproduction

All bacteria grow and reproduce very quickly, given favorable conditions (16). The significant growth factors are temperature, moisture, oxygen and hydrogen ion concentration.

For each microorganism the one temperature for the most rapid growth is called the optimum growth temperature. On the basis of optimum growth temperature bacteria can be grouped into three classes: psychrophiles, mesophiles, thermophiles. The psychrophiles or cold-loving microbes grow slowly at 32°F, and thrive at refrigerator temperatures below 68°F. The mesophiles, which have an optimum range between 68° and 104°F, are the largest bacterial group and include all animal pathogens. The thermophiles grow best at temperatures above 113°F and are of economic importance in the food processing industries since they survive the processing temperatures and grow rapidly during the period of cooling (50).

Microorganisms require a certain level of moisture for growth. The keeping quality of a foodstuff is therefore closely associated with its water content. Dehydration as means of food preservation is based on reducing the water content of the food below the level necessary for the growth of microorganisms.

Oxygen is a prime requisite for all bacterial growth. Depending on how they acquire oxygen, bacteria are either aerobic or anerobic. Aerobic bacteria obtain their oxygen from air just as animals do, and their growth is limited by the amount of oxygen available. Growing in liquid such as milk or broth, they depend on dissolved air. On the other hand, anerobic bacteria are unable to live in the presence of air; they obtain oxygen from compounds which are oxygen rich, such as sugar.

The acidity or basicity of the medium in which microorganisms grow is determined by the concentration of hydrogen ions. The pH scale, by which this property is measured, runs from 0 to 14; the low values indicating acid and the high values, alkaline. Most organisms have an optimum pH growth at or near neutrality pH 7.0. With few exceptions, the range for bacterial growth falls between pH 4 and pH 10. If the food is high in acid, pH 4.5 or less, virtually all bacteria will be inhibited since few can tolerate acid (50).

Multiplication of bacteria ordinarily takes place by the process of transverse binary fission. This is the simplest method of reproduction as it merely requires one cell to lengthen and then divide transversely into two individuals. In this respect bacteria are much like protozoa and the simplest algae (16).

A certain group of bacteria, the bacilli, produce spores. When bacteria produce spores, each individual bears but one spore and gives up its own existence in order to produce the spore. Such spores do not serve the purpose of multiplication, but enable the species to resist unfavorable environmental conditions. Bacterial spores can remain alive for long periods of time and can resist extremes of temperature, light, and chemical agents without being killed. This factor is particularly important in calculating time-temperature charts for the food processing industry (5).

Occurrence

Bacteria are ubiquitous wherever the temperature is not so high as to destroy life, or chemicals or other agencies do not interfere. Bacterial organisms are abundant in soil and air, in the depths of lakes and oceans, in certain foods, decaying organic matter of all kinds, on the skin, and within the intestines of man and animals (50). Bacteria will be found growing practically wherever there is assimilable food, and where suitable environment has enabled

them to produce spores, cells or cysts relatively resistant to drying, low temperature, and similar unfavorable conditions.

Bacteria are spread from two main sources; from man himself or from the animals with which he comes in close contact. Bacteria gain access to the body through the respiratory tract, the digestive tract or the skin. The mode of bacterial transmission comes under three main headings: direct transmission, indirect transmission and intermediate transmission (6).

Direct contact transmission may come from bacteria per se or from a carrier of bacteria. Contact may be actual such as a touching of the skin as in handshake, or by droplet transmission such as occurs in sneezing or coughing. Droplet infection is the usual mode of transmission of disease such as measles, common colds and whooping cough.

Through the consumption of tainted food or polluted water, bacteria are spread indirectly. In most cases of indirect infection, the bacteria are taken into the system through the mouth and discharged from the body through the feces.

Infections that are spread by intermediate hosts are the trichinosis from hogs and salmonella from rodents. Insects such as flies and roaches are also intermediate

hosts. These insects, besides being intermediate hosts themselves, also spread bacteria by purely mechanical transfer from one man to another (13).

Microbial Activities - Food Poisoning

Microorganisms may be grouped under the heading of useful, innocuous, and harmful. Certain microorganisms during food processing can cause undesirable changes in the food that might be dangerous to the health of the individual (6).

Microorganisms may affect the acceptability of food in several ways. Bacteria causing infectious disease may be present; toxin and poisonous products may develop by the growth of organisms; or changes affecting the palatability or nutritive value of the food may occur.

The most prevalent disease in the world next to the common colds and measles is food poisoning. Each year approximately three million Americans contract this disease (46). The term "food poisoning" as commonly understood includes any illness brought about by some injurious agent ingested in food which may be microbial or non-microbial in origin. Microbial poisoning may be due to the action of ingested toxins (food intoxication) or multiplication of ingested bacteria (food infection).

Smith (38) has classified food poisoning causes in four categories:

- Individual idiosyncrasies
- Chemical
  - Food that is naturally poisonous (toadstool, etc.)
  - Poison accidentally or purposely added (plant sprayed, etc.)
- Microbial
  - Food intoxication
  - Food infection
- Parasite infection (trichinosis, etc.)

The cases arising from individual idiosyncrasies and chemical poisoning have been excluded from this discussion as this paper is only concerned with microbial and parasite infection.

Food products responsible for the bacterial types of food poisoning either have become toxic because of bacteria growing in them before consumption or the food acts as a carrier of infection. Before the true relationship of bacteria to food poisoning was recognized, illness resulting from unwholesome food was attributed to basic nitrogenous products of protein breakdown known as ptomaines (40). Causes of food illness are now well documented, and the term "ptomaine poisoning" is recognized as a misnomer. Nevertheless, these compounds have achieved a bad reputation and to the popular

mind almost any form of digestive disturbance is automatically thought to be due to ptomaine poisoning.

Food Intoxication

Many pathogenic microorganisms produce a poisonous substance called toxin and hold this toxin within the cell until the cell wall is destroyed or until after death of the organism. Such toxin is known as intracellular toxin or endotoxin. Other bacterial products or toxins which are thrown from the cell into the surrounding environment are called extracellular toxins or exotoxins. Intracellular toxins are most frequently encountered in food-borne diseases (6).

Three microbial toxins are known to cause food intoxication: Clostridium botulinum toxin is the most fatal; Staphylococcus aureus toxin is the most common; and Clostridium perfringens toxin is the mildest.

Clostridium botulinum.--The disease botulism is caused by the toxin produced by the rod-shaped organisms called Clostridium botulinum and is usually fatal. This organism is widely distributed in the soils, and the spores may be found on the roots, leaves, and fruits of plants. Botulism organisms do not grow in acid foods, but they can poison non-acid foods. On this account, all canned foods of low acidity must be processed at 212^{o}F for at least six

hours to destroy the maximum number of spores of this organism likely to be present in a canned product and having maximum resistance to heat (8). Contaminated home-prepared foodstuffs which contributed to the 47 botulism cases reported in 1963 included chili peppers, green beans, corn, mushrooms, figs, beets, and home smoked fish; commercial products reported as sources of contamination in 1963 included liver paste, tuna fish, smoked white fish, and smoked white fish chubs (28).

The growth of Clostridium botulinum in canned food produces a very characteristic penetrating butyric odor, similar to that of rancid butter. This odor is very pronounced in meats and peas and least noticeable in canned string beans and fruits. Cases are on record, however, in which the spoiled product (home-canned string beans) did not have a very objectionable odor (8). Fortunately, the poisonous toxin produced by the botulinum organism can be destroyed by heating at 180°F or the boiling point for 10 to 15 minutes. If there is any doubt as to whether processed food is spoiled, the food should never be tasted until after it has been boiled for 10 minutes or longer (49).

First evidence of botulism is great muscular weakness, fatigue and dizziness. There is no fever. Nausea and vomiting may occur but are not pronounced nor lasting. Constipation and urine retention, not diarrhea, appear. One of the most characteristic symptoms is visual disturbance.

The eyes do not adjust to variations or degree of light intensity. The throat may have excessive salivation. There may be aphonia, a complete loss or partial loss of voice. There is no damage to the brain and the mind remains clear. If death occurs, it is from 4 to 8 days, as a rule, and is due to respiratory failure (6, 11).

Staphylococcus aureus.--Staphylococcus food poisoning is the most common type of food poisoning in the United States. The staphylococcus organism is found in the throats of individuals, on the skin as a causative agent of pimples, boils and carbuncles, and in great abundance in the post-nasal drip of patients recovering from colds. The organisms are, therefore, transmitted to food by food service workers who pick pimples, boils or other body infection, or who cough or sneeze into food.

The illness is manifested chiefly by nausea, vomiting, diarrhea and a moderate rise in temperature. The onset is sudden, the symptoms appearing a few hours after the ingestion of contaminated food and subsiding in a day or two. This type of food poisoning is seldom, if ever, severe enough to cause death.

The foods most commonly associated with staphylococcus food poisoning are cream-filled pastries, chocolate eclairs, cream puffs, cakes with cream fillings, salads, and, less commonly, meats (49). If staphylococcus are present in

food, they multiply at a tremendous rate and produce a toxic substance. The toxin produced is resistant to both heat and cold. However, the toxin can be made less toxic by heating to 375°F for 30 minutes. This is the basis for recommending the re-baking of cream-filled pastries (32).

The control of staphylococcus food poisoning depends upon proper care in preparation of and refrigeration of foods.

Clostridium perfringens.--The role of Clostridium perfringens (welchii) in food poisoning in the United States is just now being rediscovered. This type of food poisoning is relatively common in Great Britain and other European countries where home refrigeration ordinarily is lacking. Such illness results from growth of the anerobe in cooked meats which have been held at room temperatures overnight or longer.

The symptoms which appear some 10 to 18 hours after eating are those of an abdominal upset characterized by nausea, marked cramps and diarrhea, usually without fever or vomiting. Fatalities are rarely encountered and no immunity seems to result (12).

Food Infection

Infections caused by certain species of Salmonella and Streptococcus are frequently called food poisoning.

Salmonella.--Food poisoning of the infectious type is primarily due to organisms belonging to one of the fifty known types of Salmonella of which the three most common are Salmonella enteritidis (Gaetner's bacillus), Salmonella aertryche (typhimurium), and Salmonella suifestifer (Cholera suis) (6, 47).

Salmonella enteritidis was first isolated by Gaetner from the meat of diseased cow that had been responsible for a number of cases of food poisoning. Salmonella enteritidis is pathogenic for cattle and produces a dysentery in calves. Most outbreaks occur as a result of eating the meat of infected cattle.

Salmonella suifestifer or Cholera suis was thought to be the cause of hog cholera at one time and is often associated with the disease although it is not the cause. It is widespread in hogs and associated with food poisoning following the consumption of pork.

Salmonella aertryche or typhimurium is a natural parasite of rodents and is also pathogenic for cattle. It is usually associated with meats that have been contaminated by droppings of rodents.

Salmonella infections are usually associated with meats that have been processed, that is, made into patties

and meatballs. The extra handling increases the possibility of contamination. Improper refrigeration allows for rapid multiplication of the organism. The infections are most common in the summer months when warm weather increases the chance of bacterial growth in inadequately refrigerated food.

Salmonella food poisoning produces abdominal pains, diarrhea, fever, nausea and vomiting. Symptoms may appear from 6 to 48 hours after eating contaminated food and they originally persist from 24 to 72 hours. During this time and possibly for weeks later, a person is a carrier of the bacteria and can pass infection to others or contaminate food by handling unless strict personal sanitation is observed.

Salmonella organisms do not form spores and are destroyed by boiling. There is no practical method for detecting the presence of this organism in pork by inspection, so the only safeguard is to treat all pork as if it were infected and process it at 140^{o}F for an hour in order to destroy the organisms (46).

The rising incidence of Salmonella food poisoning in the home, at public functions, and in hospitals and institutions is of much concern among public health authorities. The cases reported annually increased from 504 in 1942 to 15,390 in 1963 (49). The Communicable Disease Center of the United States Public Health Service reported

an 11 per cent increase occurred in 1964 over the previous year. To safeguard the consumer, the government has established an inspection service which, although not perfect, goes a long way toward insuring the safety and high quality of the food reaching the customer (46).

Streptococcus.--These infections resemble those caused by Salmonella organisms in many ways. Streptococcus faecalis has been blamed, although another enterococcus, Streptococcus faecalis var. liquefaciens was held responsible for one outbreak (15).

Symptoms are nausea, somatic vomiting, colic-like pain and diarrhea. Mostly meat products have been involved thus far in Streptococcus faecalis infections like roast and barbecued beef, beef croquettes, Vienna sausage, ham, bologna, and turkey dressing. Other foods include cheese, cream pies, chocolate pudding, and canned evaporated milk.

Frazier (15) has listed the principles involved in the prevention of outbreaks of food-borne Streptococcus faecalis infections: (1) avoidance of contamination of the food with this organism, (2) prevention of growth of the organisms by adequate refrigeration, and (3) thorough cooking of the food. Eliminating infections from Streptococcus faecalis is difficult, for it is found commonly in milk and milk products, has been noted in dried eggs, and is present in fecal matter.

Parasitic Infection

In addition to the bacterial food-borne infection, there are a number of animal parasites that may attack man. This type of infection is usually discussed in conjunction with bacterial food poisoning and infection because all have similar symptoms and all are food-borne. While these infections are more properly considered in parasitology, a few of the more important will be reviewed in this section of the manuscript.

Any parasite which is embedded in food contents as well as adhering to surface of hands and utensils used in preparation of food may enter the human body. In some instances parasites inhabiting the intestinal tract of man or other animals may be simply transferred by contamination of food or water or by direct contamination of the hands to the alimentary tract of a new individual (16). A certain stage of the parasite is passed in the body of one species of animal; but in order to attain complete development and rounding out of the life cycle, transfer to another host must take place. In some cases, man functions as the intermediate host, but most commonly as final host of the parasite. For example, the larval stage of the pork tapeworm occurs in hogs; the adult stage in man. The parasites of man that cause food-borne infections are practically limited to two groups, the protozoa and the helminths (15).

Protozoa.--Protozoa sometimes found in the human intestine include the parasite of amoebic dysentery, Endamaoeba histolytica, which is a tissue feeding parasite and makes its primary invasion into the wall of the large intestines. This invasion results in a more or less extensive ulceration; and although the majority of persons infected do not exhibit marked symptoms, others show every gradation of intestinal upset from slight diarrhea to a debilitating and often fatal dysentery. Furthermore, in infected persons the amoeba are carried to the liver and in a small percentage of cases give rise to serious hepatitis abscesses. From this site they may also break over into the lungs or be carried to other organs such as the brain and spleen, where they produce abscesses similar to those in the liver. The parasites complete their life history only in carriers who are not suffering from marked symptoms. In the individual, certain amoeba secrete thin wall producing cysts. The cysts pass out of the body with the feces and find their way back to man always by means of various types of fecal contamination.

Human beings are infected by Endamaoeba histolytica from swallowing cysts of the parasite derived from carriers passing these in their feces. The contamination of food and drink is mainly brought about by the presence of infected food handlers, by the use of night soil as fertilizer for

garden vegetables, and by allowing flies free access to infected feces and food (22).

Helminth Parasites.--The helminth parasite or worms which produce disease in man are divided into two large groups, the flat worm and the round worm.

The flat worm comprises the flukes and the tapeworm. The flukes are trematode worms, mostly flattened leaf-like form, which live in such localities as the intestines, bile, ducts, lungs, and portal veins, and produce diseases characteristic of these specific localizations. The tapeworms in their adult stage form long tapelike ribbons which are essentially colony form, instead of occurring as single individuals.

The eggs of the tapeworm, which are laid in the intestine, pass out of the body with the feces. Fish represent a potential source of infection to man or animals. In the majority of cases intestinal infection with the adult worm produce no clinical symptoms. In a certain number of cases, however, a pronounced anemia resembling pernicious anemia develops of which the symptoms readily disappear with the removal of the infective parasite (21).

For both of these worms, insufficiently cooked food is the principal means of human infection.

The round worm parasite that infects man shows a wide diversity in life cycles. Likewise, the method of transmission also varies. Some complete their entire life

cycle in a single host, and others an alternate of hosts. Some are transferred from man to man by various blood-sucking insects. In others, the infectious forms pass out of the body with the feces and infect human beings by contamination of food and drink. Still others live in the muscles of certain animals and are transmitted by eating the flesh of these animals (6).

The most dreaded of these parasites is Trichinella spiralis which causes the infection trichinosis. The usual hosts for the parasite are hogs and rats, but man is highly susceptible and can be infected by eating insufficiently cooked pork. Trichinosis is a disease characterized by fever, muscular pain, or an enormous increase in the number of eosinophil corpuscles. As a disease trichinosis wears many disguises and is frequently diagnosed as a number of other diseases and disorders, as an upper respiratory infection, acute nephritis or rheumatic fever. Trichinosis may present a complicated clinical picture, and an accurate diagnosis on the basis of symptoms is not easy. Evidence that food containing pork such as pork sausage and ham loaf has been consumed may be a valuable clue to diagnosis. Trichinosis can be prevented by thorough cooking at not lower than 137^{o}F so as to destroy the trichinae larvae (22).

Generally, the prevention against any parasitic infection consists largely of general hygiene measures--personal cleanliness and treatment of infected individuals (15).

FOOD SANITATION PRACTICES AND PROCEDURES

The basic principles of food establishment sanitary regulations require that the customer's health be protected against contaminated food and communicable disease organisms (6). In order to understand what measures might be taken to protect the customer's health, it is important to examine the "chain of disease transmission" or the "infectious process." For any disease to occur, six conditions must be met and all of them must occur in a set and logical sequence. These six steps or links in the chain of transmission are (39):

- Etiologic agent, that is, the causative organisms, pathogen, or infective agent or material
- Reservoir of infection or habitat that permits the survival of the etiologic agent
- Escape of the etiologic agent from the reservoir to the next prospective host
- Transmission from the reservoir to the next prospective host
- Entry into the prospective host
- Susceptible host.

To protect the customer, a means of eliminating or modifying one of the links in the chain of transmission must be devised. This will disrupt the infectious process and prevent disease from occurring. Prevention of disease or sanitation measures will be augmented by the assumption that all food is contaminated and, therefore, precautions must be taken. The aim is to eliminate or modify one of the links in the chain of transmission.

How well the patrons of public food and drink establishments of all types are protected depends upon how well an establishment, whatever its size, conforms to the sanitary points enumerated below:

- Safety of the food and drink served
- Personal hygiene and food handling practice of the food workers
- Safety of the water supply
- Sanitary disposal of sewage and water-carried wastes
- Protection of food from contamination during processing, display and storage
- Washing, sanitizing and storing of utensils and equipment
- Sanitary maintenance of the premises including general arrangements and upkeep, refrigeration, light, ventilation, toilet and hand washing facilities, housekeeping practices and the disposal of garbage and refuse.

Mallman (24) has stated that food service personnel make up 99.99 per cent of the problem of food care and sanitation. Although it has been pointed out that the source of contamination may be in the food supply, more commonly it originates with food service personnel. The workers are, in most outbreaks of food poisoning and food-borne diseases, the source of disease either directly or indirectly.

This section of the manuscript will deal with personal hygiene and food handling practices of food workers and point out ways of lessening the possible passage of microbial disease organisms from the worker to the food.

Role of Management

Any business or profession carries with it certain obligations and responsibilities; food service operators have a personal responsibility not only to keep restaurants clean but to prevent food-borne illness and to maintain the highest possible standards of customer protection. Every person working where food and drink are prepared should be responsible for the safe service of good food. His own health as well as that of his customers is at stake; his practices and habits have a direct influence upon public health.

Food sanitation begins at the top (9). This is a responsibility which must be shared by top administrators

and housekeeping, engineering, purchasing, and food service. These are the members of the team that must function together if food-borne disease is to be prevented. Local health department officials should be invited to assist in planning new food services, remodeling old ones, or to make a periodic inspection of the day-by-day operation from a sanitary viewpoint. State health departments should also be consulted as they are always ready to help in specialized problems. All these groups work for the best in food service sanitation and are thus "guardians" of the public health.

Food sanitation is a team problem and should be solved by a team approach (39). The National Industrial Conference Board listed five major areas where this team could work together. They are planning, organizing, coordinating, motivating, and controlling (18). Let us look at these five areas of management and see how they relate to the achievement of food service sanitation.

Planning

Plan what to do and how to do it, realizing that planning is necessary to good sanitation. Every person involved "in the doing" must also be able to participate "in the planning." Food service managers, restaurant operators, and dietitians must cooperate with the sanitarians

and sanitary industry in planning the "what" and the "how." Sanitarians must be regarded not as policemen but allies in planning good sanitation.

Employees at all possible levels must know not only the objective but also understand how they are going to carry out the program to meet the objective and the reasons why they are doing it. Employee's involvement may be in the form of film showing and follow-up discussions, demonstrations, and other aids which are readily available through governmental and industrial organizations (39).

Organizing

This area embraces definition of functions, arranging of facilities, division of tasks and assigning tasks to individuals or groups. Organizing will vary greatly according to the type and size of operation. Here, the element of supervision becomes apparent. If the organization is small, the manager's supervision extends to detailed operation. As complexity and diversity of an operation require division of work, the manager relies more and more on supervisors whom he expects to understand "how" they are going to meet the objective, the reason "why" they are doing it, and to have the ability to interpret the objectives to the lowest level worker (48).

Most important of all, good organizing implies the delegation of responsibility for sanitation standards. This

responsibility includes continuous interpretation to people actually doing the job. Responsibility must be accompanied by authority to deal with those who cannot be motivated to do the job properly.

Coordinating

Coordination implies good communication. Here again, good supervision is imperative. Communicated information on what is to be done and how it is to be done is essential, but failure can never be detected without adequate supervision.

Communication is often accomplished well verbally, but written procedures are essential as a beginning point. Without initial interpretation, understanding and constant follow-up, they are soon forgotten.

Motivating

This term means getting a person to do something because he wants to do it. The food service operator must be properly motivated himself so as to motivate employees to do the job properly. The motivation of the manager, while much the same as that of employees--namely, the satisfaction of basic needs--is often stimulated by the profit element (30).

The employee in food service is faced with a relatively repetitious job, somewhat lacking in stimulation. In many cases, he or she is not nearly as interested in a

fastidious job of serving food and personal cleanliness as is the proprietor, sanitarian or patron.

Material rewards alone do not satisfy human needs. The average person will do what is right if he knows it is best for him and for other persons. He will do it much more willingly if he gains recognition as a worthwhile person and for work well done.

Many studies in industry have shown that recognition for work well done, a feeling of belonging to the organization, and a sense of being appreciated rate well above wage levels and fringe benefits as reasons for why people work (33).

Controlling

This means working with facts, the detection of strengths and weaknesses, and the instigation of steps to make use of strength and correct weakness. Control is accomplished primarily through personal supervision and reports. In the case of food service sanitation, personal cleanliness is extremely important. Man with his eyes alone cannot analyze the results of sanitizing process or detect the presence or spread of dangerous bacteria. Scientific testing is essential.

We see in all these five areas that management is responsible legally and morally for establishing a quality sanitation program within an institution (36, 40). A practical and comprehensive sanitation program entails informed

supervision, trained employees, clearly outlined methods and follow-up inspection. However, the foremost consideration in a training program for employees requires that management must be made aware of the role of public health practices in a food processing and/or serving program.

Technological advances, up-to-date equipment and better training are too often counterbalanced by carelessness and indifference. Progress in food hygiene has been most evident where the management has been cooperative and where regular inspection and close supervision have been possible (9). Management must provide the facilities which enable the employee to do his task easily and properly. Proper facilities should be provided near working areas to provide adequate cleaning and washing of hands and utensils. Adequate handwashing lavatories should also be provided in the vicinity of the kitchen. If management has done its part by providing these facilities, it is in a much better position to require high standards of cleanliness from its employees.

Role of Food Service Personnel

Restaurant sanitation rests directly upon every individual working in the establishment. Because personnel form a vital link in the chain of sanitary food service, the personal habits of food handlers have been stressed. In spite of the wide application of ordinances and codes and

the employment of many sanitary and food inspectors, the increase of food poisoning and food-borne diseases continues undiminished (24).

Basic Considerations

The employer has to be reminded that before employing new staff he should be satisfied that they know and understand the basic principles of food hygiene and that their medical history is satisfactory.

At one time health authorities felt secure in mandatory physical examination for employees, but these have proved to be of relatively little value in reducing incidence of food-borne diseases. These examinations are often not sufficient to detect a typhoid carrier and frequently fail to restrict respiratory disease patients from employment (39). The cost of these examinations is not commensurate with public health benefits obtained. This has been demonstrated in recent years by many health departments replacing physical examinations with educational programs. The day-to-day health of employees is the most important consideration in protecting the public. Exclusion of sick persons or persons suffering from infected wounds from all food handling operation is the best control method.

An initial medical examination upon employment is advantageous if it includes a morbidity history of the patient (35). When examination discloses a history of

typhoid fever, diptheria, acute tuberculosis, or any illness initiating infection that can be transmitted through food or drink, freedom from pathogenic infection should be confirmed by laboratory test before the person is employed. Persons with discharging infected wounds or lesions should not be permitted to handle food, utensils, or equipment. Infections from these sources are often the cause of the staphylococci type of food poisoning (42).

The protection of the food from contamination by workers is possible only by good personal hygiene. The principles of food personnel hygiene are well established and there is little controversy about their application to food sanitation; but there still remains the problem of getting food handlers to practice them conscientiously. At least three factors operate against careful handling of food: first, just as those familiar with food sanitation can attest, there are certain individuals who are by nature or temperament unfit to handle food; second, there is a rapid turnover in personnel causing unstable employment and insufficient training; and third, the food handler is under stress particularly at meal time in his attempt to give quick service. This situation often contributes to carelessness. Although these conditions must be faced realistically, they are not insuperable. The food handlers must be counseled to plan ahead and taught good food handling methods.

The following approach to the problem will be helpful (10):

- Be sure that the employees really understand the danger of noncompliance by telling them actual cases where carelessness caused disaster.
- Give them a feeling of responsibility by explaining how the health--perhaps even the lives of customers and fellow employees--depends on them.
- Appeal to their personal pride in appearance and good manners.

This entire phase of food sanitation must be approached with a sympathetic attitude. Many persons handling food have meager educational backgrounds, and long technical explanations will be of little value to them. A common sense approach on the basis of decency and practical application will generally obtain results more effectively than a long dissertation on the etiology of microorganic diseases.

In order to make a health sanitation program workable, food handlers must be enlightened and urged to cooperate. Control on this administrative level can by far bring the best results. Rigid application of rules must be stressed.

Rules for Food Handlers

The primary objective of sanitary supervision is to prepare and serve food to the public and to prevent illness or death from spoiled or contaminated food (39). Most states, cities, and towns have laws governing the sanitation of eating and drinking establishments. Regulating control may be based on grading, system, permit revocation or other measures. For the guidance and assistance of those responsible for sanitation of eating places, the United States Public Health Service has developed recommended standards of sanitation practices which are now the basis of most state and local codes (40). Those parts of the Food Hygiene Regulation which relate to personnel are clearly of great importance in food service establishments.

Health and Disease Control.--Section C, number 1 of the 1962 Ordinance and Code Regulating Eating and Drinking Establishments prepared by the United States Public Health Service states:

> No person while affected with any disease in communicable form or while a carrier of such disease, or while afflicted with boils, infected wounds or sores, or an acute respiratory infection shall work in any area of a food-service establishment in any capacity in which there is likelihood of such a person contaminating food or food-contact surfaces with pathogenic organisms, or transmitting disease to other individuals; and

> no person known or suspected of being affected with any such disease or condition shall be employed in such an area or capacity.[6]

This regulation definitely spells out that persons with colds, sore throats, nausea, vomiting, abdominal pain, and diarrhea should not work around food. Also, persons with skin eruptions such as boils or infected cuts should not work with food; however, if this measure is too drastic, the policy should be flexible enough so that the worker can at least be transferred to some duty not involving direct handling, provided that sores are properly bandaged and completely protected from contact with food or utensils (10). Employees should never pick noses or pimples, boils or blackheads. If this should be done inadvertently, they should immediately wash their hands with soap and water before resuming work. Any skin eruption containing even minute quantities of pus can subject foods, particularly custard, baked hams and cold pressed meats, to infection. An acute cold with attendant coughing and sneezing can expose food to droplet and hand contamination; sneezes must be caught in a handkerchief or better yet a disposable tissue, or directed away from food. Observance of good manners will be

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[6]Ordinance and Code Regulating Eating and Drinking Establishments, Public Health Service Publication No. 37 (Washington, D. C.: U. S. Government Printing Office, 1962), p. 47.

appreciated by fellow employees who will in turn show the same considerations. Close observation of food handlers is recommended. Any person with even suspected symptoms of disease should be questioned and temporarily suspended from work, at least until he has been given a "clean bill of health" by the health officer or by a physician designated by him when such legal authority can be applied.

Personal Hygiene.--Section C, number 2 of the same ordinance states:

> All employees shall wear clean outer garments, maintain a high degree of personal cleanliness, and conform to hygiene practices while on duty. They shall wash their hands thoroughly in an approved hand-washing facility before starting work, and as often as may be necessary to remove soil and contamination. No employee shall resume work after visiting the toilet room without first washing his hands.[7]

Personal cleanliness is one of the fundamental principles of food handling. The food handler must be taught to keep his hands clean. Proper washing of the hands before coming to or returning from work with food, after using the toilet, whenever soiled, and after contamination from coughing or sneezing is of utmost importance. This is essential to avoid contamination of food. Hands contaminated with discharges of the mouth, nose, throat, and the gastro-intestinal tract can be a menace to the public health. The

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[7] Ibid., p. 48.

fingernails must be kept neatly trimmed and free from dirt at all times. Staphylococcus germs have frequently been found in cultures taken from under fingernails. Clean fingernails are indispensable to good appearance. Nail polish, if used, should be colorless or natural in shade. The nails and cuticles should receive frequent care to avoid hangnails. To wash hands thoroughly, hot running water, soap, a nail brush and individual towels are necessary, and the management must be able to provide these. Handwashing signs should be conspicuously displayed in toilet rooms and in work rooms (1).

Daily bathing is advisable. It stimulates circulation, helps the skin eliminate body wastes, massages the muscles, rids that tense tired feeling, and altogether gives pep. To be of real benefit, the body should be cleaned with warm water, a suitable soap and scrubbing. Use a deoderant to combat body odors. Frequent shampoos are also advisable. Dirty hair in a food establishment is as offensive as an unclean body (31).

Brushing the teeth must be often and thorough. Brushing the teeth not only removes food particles, thus warding off decay, but discourages film from accumulating and stimulates circulation of blood through the gums. Because restaurant workers are in fairly close contact with each other and their customers, they need to avoid unpleasant

body odors and bad breath. It also ensures that the individual worker is personable and attractive at all times.

Clean, washable, light-colored outer garments should be worn by food workers. All workers, including dishwashers, bus boys, and kitchen help should wear a clean apron, coat, frock, or uniform. Street clothing is unsuitable because it may serve as a source of contamination to food, dishes, and utensils; besides, it often can not easily be laundered. If uniforms are not clean, all other possible means of prevention are diminished or complicated since hands and sometimes food are in contact with outer garments. Clean uniforms should be easily accessible to food handlers at all times (10).

Underclothing must be fresh and clean daily. Perspiration and food odors penetrate underclothes and can be instantly detected.

Hair is another source of contamination (15). It should be covered so that there is no temptation to brush the hair from the face with the hands. Hair nets, caps, or bands designed to keep hair in place should be worn by food handlers. This is, of course, primarily a guard against falling hair. It also improves the personal appearance of the employees.

Posture is not directly involved in food-borne diseases. Nevertheless, the more tired an employee is, the more

he is apt to relax defenses on sanitation procedures. Posture improves appearance and is less tiring. Whether standing or walking, one should keep shoulders erect, chest up, abdomen flat, and hips drawn back. The feet should be placed close together and pointed straight ahead. Body should be balanced on both feet. Do not slouch against the counter or lean against the wall. To save both strength and disposition, restaurant workers need to stand correctly; that requires sensible shoes. They give more mileage with less complaint (2).

Smoking should not be permitted in a room where food is being prepared. Ashes tend to get in the food; smoking constitutes a fire hazard; it is unpleasant for fellow employees who are non-smokers. Moreover, it is almost impossible to smoke without fingering the lips. If disease organisms are present in the mouth or throat, they are sure to be mixed with the saliva that gets on the finger. Smoking may also promote spitting, affording transmission of disease organisms present in the saliva to food or food contact surfaces (29).

Locker rooms should be kept neat, emptied and cleaned frequently with all waste materials deposited in a covered receptacle provided. Old, soiled or unused clothing should not be permitted to accumulate in lockers. Street clothing when not in use should be kept in lockers, not

laying around. Food should not be brought into the locker rooms. Meals should be eaten in the dining rooms provided. The accumulation of unused material in lockers forms an excellent harborage for roaches. They also make locker facilities unsightly and unpleasant for an individual's comfort and his fellow employees (10).

Food serving practices involve a large variety of common and improper handling methods, several of which may be cited here: handling food with fingers rather than with appropriate utensils--butter patties without a butter fork, chipped ice or cubes without a scoop, pastries without tongs; holding glasses by the rim instead of the bottom or side; holding knives by the sharpened end; holding clean containers with fingers inserted inside; wiping cutting knives on a soiled apron; licking fingers and then handling food; using a side towel to wipe away perspiration (32).

General Observations

High standards of hygiene in restaurants cannot be achieved without cost and, indeed, these costs are obvious. The price which has to be paid for dirty food in terms of sickness, loss of working time and general inconvenience is not obvious but it is real.

Food poisoning outbreaks may be prevented by sanitation education at all levels. Providing instruction to food service personnel followed by continuous observance of the regulations taught will accomplish much in minimizing these unfortunate occurrences.

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