Vibrio cholerae

An introduction to FOODBORNE DISEASES & HACCP Systems

Watery diarrhoea

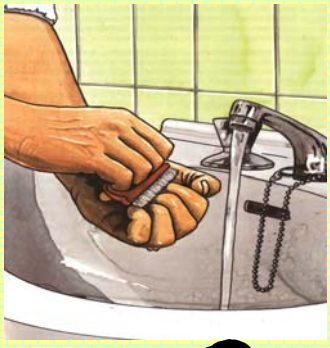
E.coli

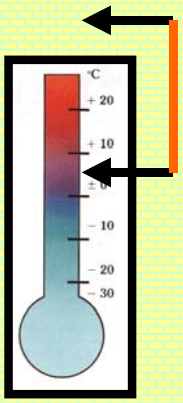
Fever, chills

Leptospirosis

with a practical guide for a Rapid Review of Different Infections and Intoxications

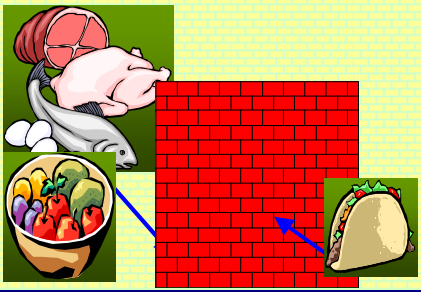
Listeriosis





Vitamin K

abdominal pain



Serum, biopsy specimens

Allergens

Milk and dairy product

- for Clinical Physicians, Veterinarians & Public Health Professionals -

Organic phosphorus poisoning

Atropine

Rotavirus enteritis

Fever, vomiting

nuts, fish

Bloody diarhoea

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ANNEXES

Foreword

Almost half of the world's population suffers from diseases associated with contaminated food and water. They are perhaps, the most widespread health problems in the contemporary world and important causes of low productivity. In 1995 diarrhoea diseases caused more than 3 million deaths worldwide. More than 80% among them were children under the age of five.

However, the importance of these diseases as a public health problem is often overlooked because their true incidence is difficult to be evaluated and the severity of their health and economic impact is often not fully understood. Moreover, there is scarcity of reliable information concerning the prevalence of these infections among the human and animal populations in most countries of the Mediterranean Region. Unawareness is probably responsible for the limited financial resources allocated to food safety in many countries.

For many years the World Health Organization (WHO), as well as other International Organizations, demonstrated particular concern to activities related to food safety and hygiene. Special attention was given to the developing countries, which pay the heaviest toll due to weak infrastructure, cultural constrains, social and economic changes, population resettlement, etc.

The Mediterranean Zoonoses Control Programme of the WHO includes, among its priorities the prevention and control of zoonotic foodborne diseases. Training Courses and laboratory training are included among its priority activities and adequate informative material is distributed.

Through the present edition the Mediterranean Zoonoses Control Centre (MZCC) aims at supplying clinical physicians/veterinarians and public health professionals with a technical "tool" of assistance in their task for a preliminary/introductory diagnosis and identification of most important sources contaminating food, as well as basic rules for the preparation of safe food.

The documents included in the lists of references and bibliography were valuable in the preparation of this publication.

Acknowledgments are addressed to Drs C. SAKAYANNI and C. VASSALOS for their contribution.

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Acronyms

CCP	=	Critical Control Point
DDT	=	1,1,1-trichloro-2,2-bis(p-chlorophenyl)-ethane
FAO	=	Food and Agriculture Organization of the United Nations
FBD(s)	=	Foodborne Diseases
HACCP	=	Hazard Analysis Critical Control Point
ICD	=	International Classification of Diseases
MR	=	Mediterranean Region
NPA	=	nitropropionic acid
ORS	=	oral rehydration salts
PCB(s)	=	polychlorinated biphenyles
TMP/SMX	=	trimethoprim/sulfamethoxazole
WHO	=	World Health Organization

Definitions[7, 8, 9, 16, 17, 18]

Attack rate	Proportion of people becoming ill after a specific exposure.
Carriers	Persons harboring specific infectious agents without visible clinical disease, but who can be reservoirs or sources of infection.
Case control studies	Studies comparing the exposure of cases (those with a specific disease) with that of controls (those without a disease).
Case fatality ratio	Number of people dying from a specific illness in a given period divided by the number of people being diagnosed with the disease in a given period.
Case of Foodborne disease	Any person who has become ill following consumption of food or water that is considered to be contaminated on the basis of epidemiological evidence or laboratory analysis.
Cohort studies	Studies comparing the incidence rate of disease in exposed populations with that in non exposed populations.
Contact	A person or animal that has been in an association with an infected person or animal or a contaminated environment that might provide an opportunity to acquire the infective agent.
Control (verb) in HACCP terminology	To take all necessary actions to ensure and maintain compliance with criteria established in the Hazard Analysis Critical Control Point (HACCP) plan.
Control measure in HACCP terminology	Any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.
Corrective action in HACCP terminology	Any action to be taken when the results of monitoring at the Critical Control Point (CCP) indicate a loss of control.
Critical Control Point (CCP) in HACCP terminology	A step where control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.
Critical Limit in HACCP terminology	The critical limit is a criterion, which separates acceptability from unacceptability.
Deviation	Failure to meat a critical limit.
Family outbreak	Episode in which two or more contacts or people who live under the same roof present the same disease after ingesting the same food and the epidemiological evidence indicates that such food was the origin of the disease.

Food	Any substance, whether processed, semi-processed, or raw, which is intended for human consumption, including drink, chewing gum, and any other substance which has been used in the manufacture, preparation, or treatment of "food"; does not include cosmetics, tobacco, or substances used only as drugs. Water in this manual is also considered as food because it may contain infectious agents from discharges of infected humans or animals. Ready-to-eat foods are usually contaminated by infected food handlers, contaminated eating utensils, food containers, work surfaces, rodents, or insects.
Foodborne disease (FBD)	Syndrome caused by the ingestion of food containing etiologic agents in such quantities that they affect the health of an individual or a group of individuals. These are usually classified as intoxications ("poisonings") or infections.
Foodborne disease(FBD) surveillance system	A simple, timely, and continuous information system covering specific diseases that are transmitted through the consumption of food. It includes investigation of the determining factors and causative agents of the disease, as well as analysis of the situation so as to formulate action strategies for prevention and control. The system should also be flexible, acceptable, responsive, and representative.
Foodborne infections	Are caused by ingesting food contaminated with specific infectious agents (such as bacteria, viruses, fungi, or parasites) that can multiply in the intestine, break down and produce toxins, or penetrate the intestinal wall and spread to other organs or systems.
Foodborne intoxications (poisonings)	Are caused by consuming toxicants which are found in tissues of certain plants and animals, metabolic products (toxins) formed and excreted by microorganisms (such as bacteria) while they multiply in foods, or poisonous substances which may be intentionally or incidentally added to foods as a result of producing, processing, transporting or storing.
HACCP	A system that identifies, evaluates, and controls hazards that are significant for food safety.
HACCP plan	A document prepared in accordance with the principles of HACCP to ensure control of hazards, which are significant for food safety in the segment of the food chain under consideration.
Hazard in HACCP terminology	A biological, chemical or physical agent in food, drinks, or water with the potential to cause an adverse health effect.
Hazard analysis	The process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for food safety and therefore should be addressed in the HACCP plan.
Host	A person or other living animal that affords subsistence or lodgement to an infectious agent under natural conditions. Hosts in which the parasite attains maturity or passes its sexual stage are primary or definitive hosts; those in which the parasite is in a larval or asexual state are secondary or intermediate hosts.
Immunization	Immunity is the power of living beings to resist infection. It varies in degree not only among persons but also in the same person, depending on his physical condition. It may be natural or acquired. Certain diseases give immunity against a second attack, and immunity can also be artificially obtained by the introduction of a serum, toxin or a vaccine (bacterial or viral; live or inactivated).

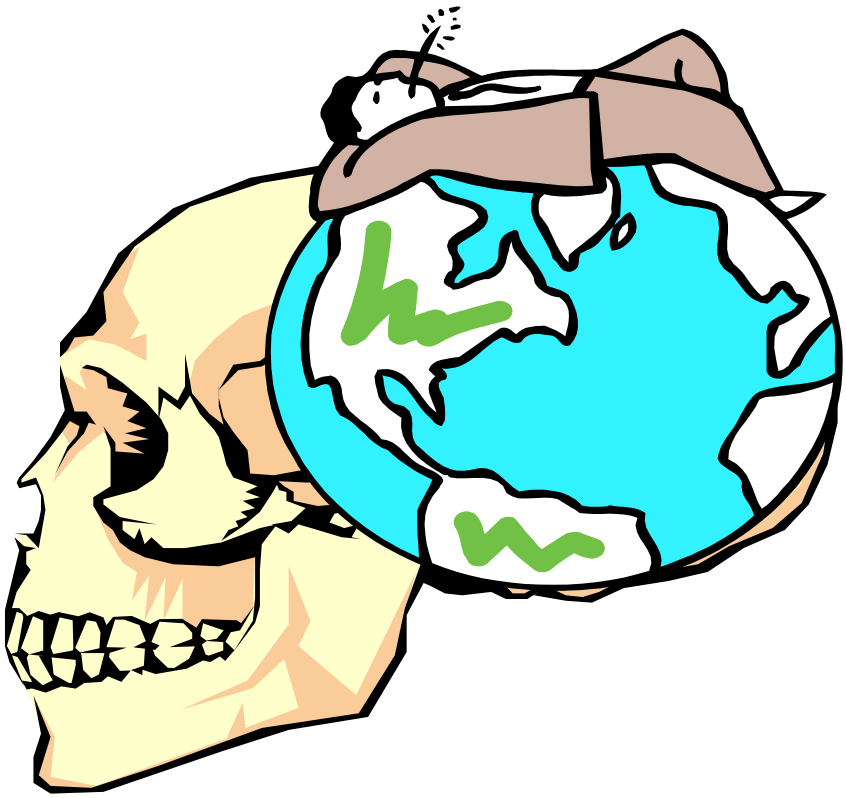
Incidence	Number of new cases in a given period in a specified population. The term incidence is sometimes used to denote incidence rate.
Incidence rate	Number of new cases in a given period in a specified population divided by the population at risk or person-time at risk.
Incubation period	Is the time elapsing between the entrance of an infectious or toxic agent into the body and the appearance of signs or symptoms of the disease.
Isolation	Involves the segregation of the patient. The degree of isolation depends on the nature of the disease.
Morbidity	Frequency of illness in a population, usually measured as incidence or prevalence.
Mortality	Frequency of death in a population, usually measured as crude or specific mortality rates. The crude mortality rate is the number of deaths in a specified period divided by the population at risk. If broken down by diagnosis this is a disease-specific mortality rate.
Odds ratio	In a case-control study the odds ratio is used as a measure of relative risk. It is calculated as the odds of exposure in cases divided by the odds of exposure in controls.
Outbreak of foodborne disease (FBD outbreak)	Episode in which two or more people present the same disease after ingesting food from the same origin and where the epidemiological evidence or laboratory tests indicate that such food was the vehicle of the said disease.
Predictive value positive	Proportion of people identified by a test or surveillance system as actually having the disease.
Prevalence	Number of cases in a given population at a specific point of time.
Prevalence rate	Prevalence divided by the population at risk.
Secular trends	Changes in the incidence rates occurring over a period of (many) years.
Sensitivity	Proportion of diseased persons detected by the test or surveillance system.
Reservoir (Source of contamination)	Any person, animal, arthropod, plant, soil or substance in which an infectious agent normally lives and multiplies, on which it depends mainly for survival, and where it reproduces itself in such a manner that it can be transmitted to a susceptible host.
Single case (sporadic case)	One case, as far as can be ascertained, unrelated to other cases with respect to consumption of food or water.

1. WORLD STATISTICS

DO YOU KNOW THAT

3.000.000 people around the World die every year because of diseases associated with food and water

Foodborne diseases are the major contributor to the estimated 1,5 billion annual episodes of diarrhoea in children under the age of five, which results in premature deaths.



CAN WE PRODUCE SAFE FOOD ?

YES !

IF WE ONLY FOLLOW THE RULES

All foods are liable to contamination by micro organisms. Therefore, the responsibility for supplying harmless food lies with the managers and food-handlers.

Table 1

MOST COMMON PLACES WHERE FOODS WERE MISHANDED	
PLACE	**PERCENT(%)**
Food service establishments	37
Homes	14
Food processing plants	6
Unknown	43
T O T A L	100

Most Common Foodborne Diseases

Staphylococcal intoxication

Clostridium perfringens gastroenteritis

Salmonellosis

Botulism

Bacillus cereus gastroenteritis

Shigellosis

Vibrio parahaemolyticus gastroenteritis

Escherichia coli gastroenteritis

50% of the World Population suffers from diseases associated with food or water.

Illness due to contaminated food is perhaps the most widespread health problem in the contemporary world and an important cause of reduced economic productivity.

(FAO/WHO Expert Committee on Food Safety, 1983).

The financial cost of foodborne diseases

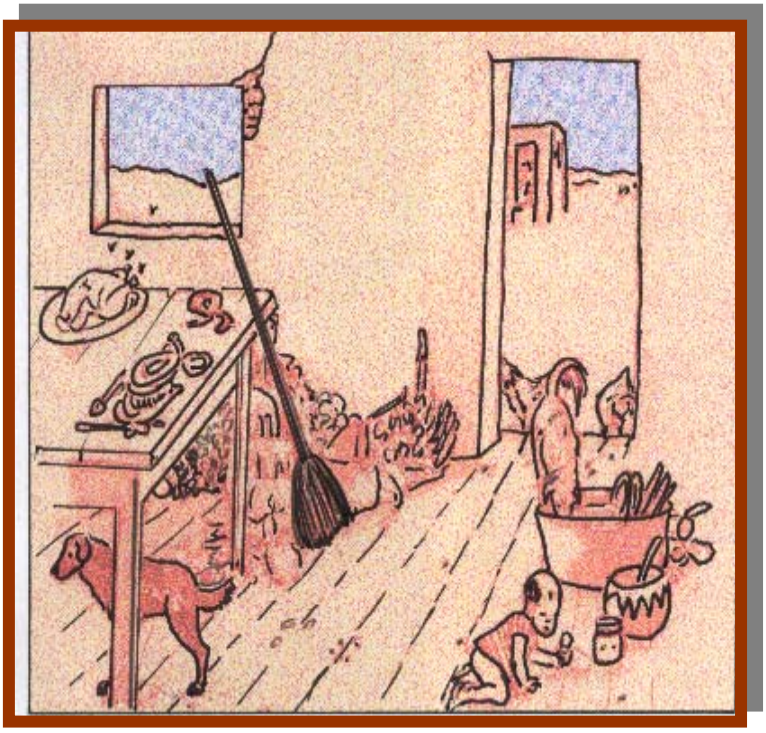
Each year in the United States of America, Foodborne diseases cost billions of dollars. Governmental sources estimate that the cost of human illnesses caused by the most common foodborne pathogens is around US$ 5.6 to 9.4 billions. Over 70% of costs were directly associated with treatment and investigation of cases, as well as with sickness-related absences from work.

Population at risk

Infants-Young children-Elderly-Immunocompromised

Causes potentially facilitating the transmission of zoonoses

- *close contact with sick pet, work, food or wild animals (veterinarians, technicians, Microbiologists, Farmers, Zoo personnel, personnel working in the forest)*
- *consumption of raw or insufficiently cocked food, especially milk and dairy products (General Population)*
- *changes in nutritional habits (eating outside), Travelers/Tourists/General Population*
- *increased trade of animals and their products*
- *increasing numbers of stray dogs, cats and rodents in urban areas*
- *illegal slaughtering*
- *poor environmental and personal hygiene*
- *mixing raw and coked food (use of dirty utensils) in houses and restaurants*
- *Use of unsafe raw material*
- *use of unsafe water*
- *insufficient cooking and long cooling (in houses, restaurants, plans)*
- *long storage in room temperatures before eating*
- *not reheating cooked food thoroughly*



2. FOODBORNE DISEASES

2.1. INTRODUCTION

Foodborne diseases (FBDs) continue to be a major public health problem and constitute an important cause of morbidity and mortality in both developed and developing countries.

The annual incidence of some 1.5 billion episodes of diarrhoea in children under 5 years of age, and the more than 3 million resultant deaths are an indication of the magnitude of the problem, as a significant proportion of the diarrhoeal disease cases are foodborne in origin. The 1992 FAO/WHO International Conference on Nutrition recognized that, hundreds of millions of people world-wide suffer from communicable and non-communicable diseases caused by contaminated food. These diseases take a heavy toll in human life and cause suffering, particularly among infants and children, the elderly and other susceptible persons. They also create an enormous social, cultural and economic burden on communities and their health systems (1).

As stated by the Constitution of World Health Organization (WHO), "the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition " (2).

Unfortunately, there are millions of people, especially in the developing countries, who live under extreme poverty with low health standards and inadequate health care. In these sectors of the population, FBDs appear more frequently and are considered to be more of a social than a communicable disease problem.

It is noteworthy that diseases like cholera, typhoid and paratyphoid fevers, various foodborne parasites and biotoxicoses, which have almost disappeared from the developed World, still exist in the developing countries (3). In addition to the physical suffering of people, FBDs have considerable economic consequences due to: food losses, decrease in food exports, loss of time at work, cost of hospitalization and rehabilitation and serious damages in the tourist industry.

It is, therefore, essential for every country to take adequate measures to prevent and control these diseases. The efficacy of these measures depends essentially on the availability of reliable information on foodborne diseases. Unfortunately this information is often collected by means of inadequately planned and imperfectly operated national surveillance programmes (4). In most countries existing programmes involve main urban settlements.

The prevalence of foodborne diseases tends to be underestimated by statistics, since a great number of cases are not reported to the appropriate health authority. In addition, some may not even be recognized as FBDs.

Traditionally, these diseases affect the gastrointestinal tract, with abdominal pain, diarrhoea, and vomiting as cardinal symptoms. These are usually mild, lasting only a few hours and not needing any treatment. Rarely, FBDs affect other systems too, as for example, the nervous system, and have a high mortality rate, unless early diagnosed and effectively treated (e.g. botulism).

During the last decade "new" etiologic agents have "emerged", such as *Listeria monocytogenes, Yersinia enterocolytica, Vibrio parahaemolyticus, Aeromonas hydrophila,* Norwalk virus*, Escherichia coli* O157:H7, domoic acid[i], cyclospora cayetanensis, campylobacter jejuni, Salmonella DT104, Salmonella newport, etc. They may constitute an additional concern for health authorities as they often cause serious and even fatal diseases in humans (5) (e.g. severe haemorrhagic colitis

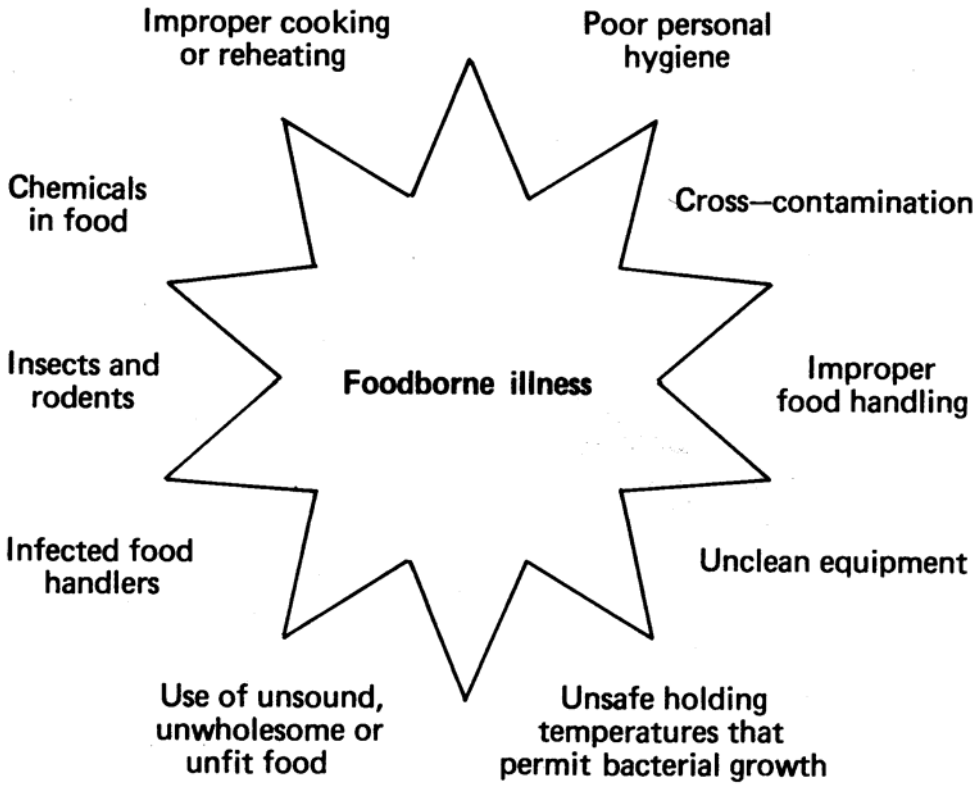
[i] *Also called amnesiotoxin because it produces irreversible loss of recent memory (5)*

caused by *E. coli* O157:H7, abortion or meningitis caused by *Listeria*), in contrast to the usually minor sequellae of the most commonly reported FBDs.

Noteworthy is also the fact that new foods or new forms of food processing or presentation have been recognized as "vehicles" for the transmission of certain FBDs, complicating more the epidemiology of these diseases. Such unusual vehicles might be bread, packed orange juice and frozen berries implicated in outbreaks of Hepatitis A and other viral diseases (5).

There are numerous factors contributing to foodborne diseases. Some important ones are summarized in the following figure. According to available data, a great number of cases world-wide, may be caused by poor food handling techniques, as well as by contaminated food served in food service establishments.

Graph 1: Summary of factors contributing to foodborne illness



Source:M Jacob. Safe Food Handling; A training guide for managers of food service establishments, WHO, Geneva, 1989

However, hygienic handling, processing, and appropriate storage of food can eliminate bacterial contamination. Sewage used for irrigation, pesticides used in agriculture and the indiscriminate use of insecticides as well as toxic metals and harmful natural toxins represent additional possible sources of food contamination (6).

The aim of this publication is to introduce food safety and HACCP issues for food inspectors and food handlers as well as to summarize and present in an easy-to-read way important data of foodborne diseases for physicians, such as:

- *international classification of diseases (ICD) codes*
- *causative agents, their nature and incubation times*
- *clinical features and duration of illness*
- *sources of contamination and important reservoirs*
- *foods frequently involved in outbreaks*
- *specimens collected for laboratory diagnosis treatments*
- *general comments on each disease*

All the above information is given in Table I which is organized in such a way that allows rapid review and comparison of relevant data concerning most of the foodborne diseases.

The diseases are classified according to the type of agent responsible for the illness, as follows:

- *bacterial*
- *viral and rickettsial*
- *fungal*
- *parasitic*
- *poisonous plants*
- *toxic animals*
- *toxic chemicals*

In each of the above categories the diseases most important for public health – transmitted mainly or exclusively by food or water have been included. Moreover, diseases in which foodborne transmission is either uncommon or inconclusive have also been mentioned. In addition, general principles of surveillance and control of outbreaks of foodborne diseases are included, as well as new worldwide developments in the Food Safety Sector. Among these developments the most important is the advent of the Hazard Analysis and Critical Control Point (HACCP) System, a method of food safety and assurance (see HACCP).

What can Governments do to prevent Foodborne Diseases?

Governments should plan and implement national food safety programmes, with the co-operation of food industry and the active participation of a well informed consumer. In order to succeed in this task, Governments should have an up-to-date food legislation and regulations. On the other hand, industry and trade have the responsibility for producing safe food, for adopting codes of hygienic practices and complying with regulation. However, government oversight is essential in promoting voluntary measures while making sure that unsafe food does not reach the consumer.

Moreover governments should undertake intensive efforts to educate food-handlers, and even CONSUMERS, because public education and community participation are, perhaps, the most important tools to improve food safety and prevent foodborne diseases!

2.2. FOOD-POISONINGS, INFECTIONS AND INTOXICATIONS

Sometimes even professionals familiar with Foodborne-Diseases terminology, find it rather difficult to classify a case according to its cause, in one among the following categories: "Poisonings, Infections, or Intoxications". This is due to the abundance of organic and inorganic pathogenic agents multiplied by their biochemical characteristics. For this reason it is considered necessary, not only to clarify the terminology but also to give examples confirming the rules, as well as examining some cases "in between", where no one can classify with certainty the pathogenic agent to a specific category. These exemptions may, or may not be of importance for the investigation of an outbreak but they can be crucial for the determination of Critical Control Points in a HACCP plan in Food Industry, Restaurants and Supermarkets.

The occurrence of a foodborne disease depends on the following factors:

1. the presence of causal agent in the environment (raw material, hands, equipment, utensils, insects, rodents etc),
2. the suitability of the specific food to favor the growth of the causal agent
3. the environmental favorable conditions (temperature, moisture)
4. the time
5. susceptible human or animal subjects

food-POISONING **VERSUS** food- INFECTION

FOOD **POISOINING** is resulting from the ingestion of food containing chemical or biological(=*toxins*) poisons:

[i] *Certain organisms (viruses, protozoa, Campylobacter) do not multiply in food even under favourable conditions and therefore a sufficient dose should be present in the food to cause illness. The same applies for chemicals and radioactivity.*

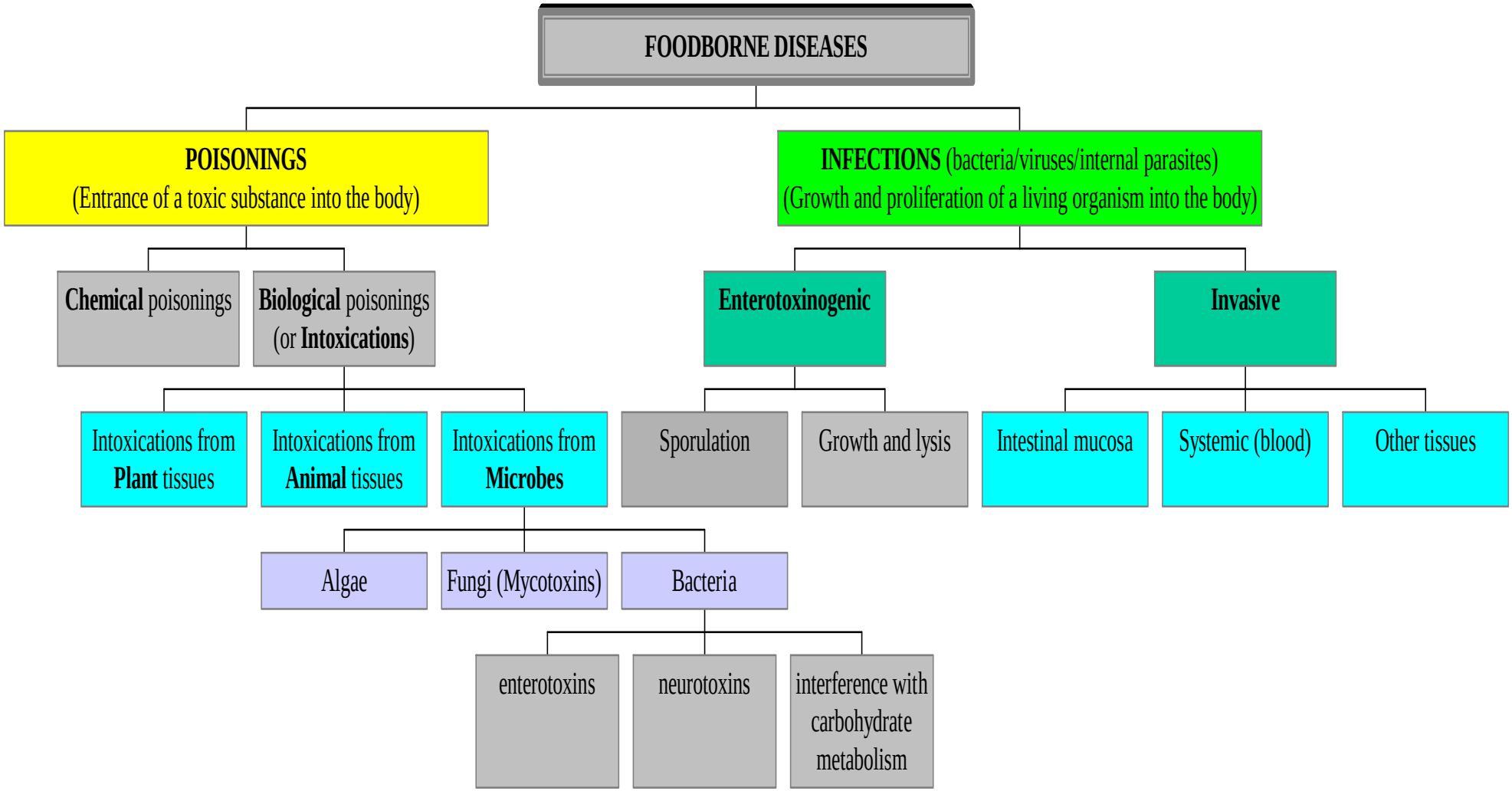
[ii] *Certain organisms (Salmonellae, Shigellae, C. Perfrigens and C. Botulinum multiply in food and even small quantities present in food may be hazardous for the health of the consumer.*

FOOD **INFECTION** is resulting from the ingestion of food containing a pathogen, which eventually will grow and/or proliferate into our body. (A pathogen can multiply in the intestine, break down and produce toxins, or penetrate the intestinal wall and spread to other organs or systems).

food-POISONING **VERSUS** food-INTOXICATION

The term FOOD **POISOINING** should be better used for Chemical substances whether the term FOOD **INTOXICATION** should be used for Biological substances of animal, plant or bacterial origin.

Graph 2:


FOODBORNE DISEASES
POISONINGS
(Entrance of a toxic substance into the body)
INFECTIONS (bacteria/viruses/internal parasites)
(Growth and proliferation of a living organism into the body)
Chemical poisonings
Biological poisonings
(or Intoxications)
Enterotoxinogenic
Invasive
Intoxications from Plant tissues
Intoxications from Animal tissues
Intoxications from Microbes
Sporulation
Growth and lysis
Intestinal mucosa
Systemic (blood)
Other tissues
Algae
Fungi (Mycotoxins)
Bacteria
enterotoxins
neurotoxins
interference with carbohydrate metabolism

2.3. EXAMPLES NOT FOLLOWING THE RULES!

1st Example

Clostridium perfrigens is listed as an INFECTION because the spores are producing toxins inside the body. However, although it is not growing or proliferating in the food, is sporulating in it (depending on environmental conditions). Therefore the spores are present in the food when it enters the body and accordingly they produce toxins and they are giving symptoms in very short time.

2nd Example

Bacillus cereus gastroenteritis is also listed as an INFECTION because toxins are released in the organism after consumption of contaminated food.

However, the bacterial cells might be autolysed in the food and produce toxin there. Therefore, in this case it should be classified as Intoxication

BUT

In both cases must be consumed a large amount of viable cells to produce illness, meaning that the large amount of toxin needed to cause illness is produced rather in vivo than in the food.

Conclusion

The abovementioned diseases can't be listed to a specific category before the examination of the environmental conditions under which the suspected food was kept.

3. OUTBREAK OF FOODBORNE DISEASE (FBD OUTBREAK)

An outbreak of Foodborne disease is an episode in which two ore more people present the same disease after ingesting food from the same origin and where the epidemiological evidence or laboratory tests indicate that such food was the vehicle of the said disease.

3.1. OUTBREAK DETECTION

Outbreaks are detected by various means. **Health workers**, including **medical practitioners**, may note a shared exposure among self-reporting cases and report the cluster of cases to public health authorities, or they may routinely report selected conditions voluntarily or as required by law (e.g. botulism, cholera, haemolytic uraemic syndrome, bloody diarrhoea, listeriosis).

Members of the general public institutions such as schools, universities or places of work may detect an outbreak, for instance after a shared meal at a restaurant, canteen, party reception, field day or conference.

3.2. OUTBREAK INVESTIGATION

The Detection of an outbreak is followed by its investigation. But, who is responsible for the investigation and what is the role of each profession?

Epidemiologist

Health worker

Doctor

Microbiologist

i. *Health inspectors are interviewing the ill persons and the persons at risk*[i] *and collect samples for the Laboratories;*

ii. *The microbiologists in State hospitals or clinics isolate the causative agent from stools, vomit or suspected food and identify it, thus confirming officially the presence of a Foodborne disease outbreak. Then, they immediately report to the Health authorities by telephone, FAX or e-mail, the presence of the pathogenic agent (an official letter should follow);*

iii. *The epidemiologists of Health authorities are processing and analyzing the data, formulating epidemiological associations from initial information;*

iv. *Then, Epidemiologists, Veterinarians and Physicians work together in order to formulate a 'hypothesis*[ii]*.*

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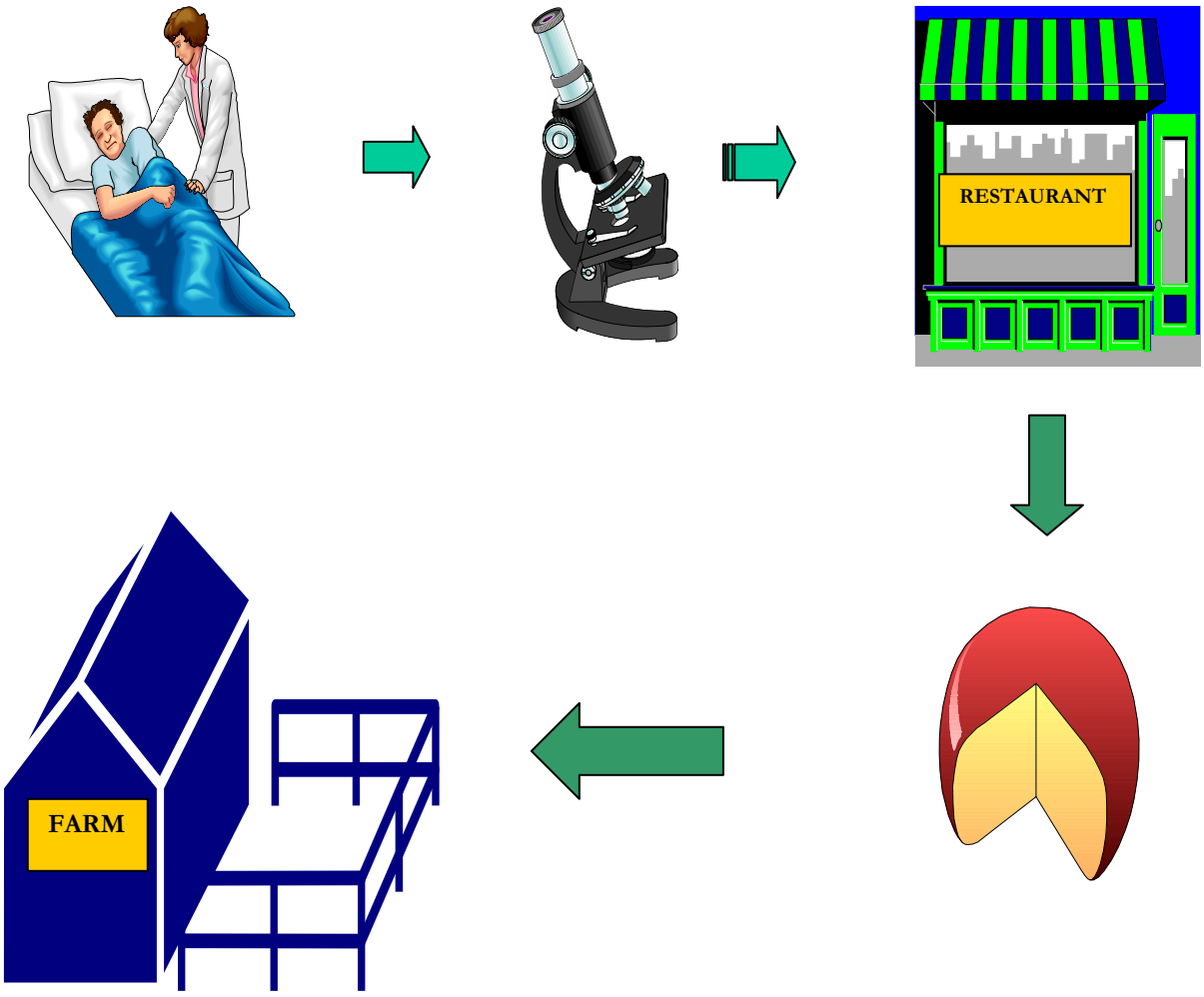
[i] *What food did the patients eat? What food did the people who remained healthy eat?*

[ii] *Formulation of hypotheses such as: (Who are considered ill and who healthy), or (Will – eventually – all people who eat contaminated food, be ill or not?)*

An outbreak investigation may be easy (if patients are known, i.e. school children, or prisoners), or, **very difficult** (foodborne diseases at home and diseases due to street vendors).

Quick outbreak notification leads to a quick investigation and increases the possibilities of isolation of the causal agent in stool, vomit specimens, even leftovers of food. This can lead the investigator back to the restaurant, or supermarket and eventually to the factory or even the farm where the raw material came from. In the following pictures you can see in a schematic way the pathways of an investigation.



Population Under Surveillance

The population under surveillance includes those of been at risk and involved in outbreaks, provided they are accessible to investigating officers. They are likely to include people attending large functions *(weddings, funerals),* those eating in restaurants and obtaining food from take-away or street vendors, and those obtaining pre-cooked or ready-to-eat foods from food industries. Those consuming food prepared at home are usually under-represented in outbreak surveillance as the size of the outbreak is smaller and people are less likely to report it to public health officials.

Reporting Results

Outbreak investigation is carried out by various disciplines, including public health physicians, epidemiologists, food safety officers, environmental health officers and microbiologists. Outbreak investigators should analyze and report as soon as possible to prevent additional cases. National and international compilation of reported outbreaks may be done annually or once every few years for monitoring trends.

Methods of Outbreak Investigation

As mentioned before the investigations may use epidemiological or microbiological methods, or both. In the epidemiological approach a case-control or cohort design may be used.

In a case-control study, cases with foodborne disease are compared with controls regarding their food intake, food preparation practices, and other possible risk factors in a given period of exposure. Controls should be representative for the population from which cases were drawn but should not have a foodborne disease in the relevant period of time. The main outcome of a case-control study is an estimate of the relative risk of illness after various exposures. This is estimated by the odds ratio.

A cohort study compares attack rates of an illness in those who have eaten certain food items and those who have not. The ratio of these two attack rates is expressed as a relative risk. Cohort studies are used somewhat less often than case-control studies but may be convenient and powerful tool if those at risk are easily listed, such as passengers on a cruise or guests party. Its advantage over a case-control study is that absolute risks *(attack rates)* can be obtained *(see following example).*

EXAMPLE of outbreak investigations using a cohort study design

A large outbreak of gastro-enteritis caused by diarrhoea toxin producing *Bacillus cereus*

Cohort: Those attending a university field day

Case definition: Diarrhoea (three or more loose stools in a 24-hour period) within five days after the field day

Data collection method: Postal questionnaire

Results:

Table 2

Consumption of Pork	Total	Number of Cases	Attack Rate	Relative Risk
YES	523	137	26%	5.4(1.4-21)
NO	41	2	5%	

Conclusion: Those eating pork were five times more likely to become ill than those not eating pork.

UTILIZATION OF RESULTS

Results of an outbreak investigation should be analyzed immediately as the basis for taking rational measures is to control the outbreak itself, such as withdrawal of the implicated product or adjustment of the production process. Publication of results is very useful for health policy-makers and for the producers, distributors, handlers and consumers of the food concerned.

Outbreak investigation is useful in that it responds to public demand and can provide timely information to prevent further cases of foodborne disease. It may also be a unique source of information on routes of transmission of specific pathogens and for the identification of high-risk environments and high-risk foodhandling practices. Its major limitations are the high resource requirements in terms of skilled manpower and laboratory facilities, and a strong selection bias towards large or serious outbreaks and against small clusters and mild disease.

Outbreak investigation is particularly useful in achieving the second and the third objectives of surveillance of foodborne diseases: *"take remedial action to limit the size of outbreaks, determine to what extent food acts as transmission routes of specific pathogens, and identify high risk food handling practices and high risk population"*.

Table 3 *Examples of recently published results from outbreak investigations of foodborne diseases*[i]

Microbiological Agent	Food Implicated	Factors Contributing to Outbreak	Action Taken
Bacillus cereus	Fried rice	Keeping cooked rice at room temperature	Education of day care stuff
Cryptosporidium	Apple cider	Apples harvested from pastures where cattle grazed, insufficient washing of apples before use	Guidelines for cider production
Escherichia coli 0157:H7	Hamburgers in chain fast-food restaurants	Errors in meat processing and cooking	Recall of hamburgers
Salmonella enterica serotype paratyphi B	Goats-milk cheese	Use of unpasteurized milk; insufficient microbiological monitoring of milk and cheese.	Recommendations on cheese production and education of public.
Salmonella typhimurium	Roast pork	Keeping meat unrefrigerated; reheating briefly in microwave	Recommendations on health education
Shigella sonnei	Iceberg lettuce	Faecal contamination of lettuce	Withdrawal of lettuce, support for restriction, public health warning
Vibrio cholerae	Various street-vended foods	Food preparation (contaminated raw products and water, cross-contamination, time-temperature abuse)	Recommendations on licensing street vendors and health education

[i] *Source:* Surveillance of foodborne diseases: What are the options? Food Safety Issues, *Food Safety Unit, World Health Organization, Geneva, 1997 (Doc. WHO/FSF/FOS/97.3)*

Outbreak Surveillance Programmes

The objectives of a surveillance programme are the following:

i. *Promotion of reporting and investigation of FBD outbreaks.*

ii. *Collection, compilation and analysis of relevant and up-to-date information on reported cases of FBDs.*

iii. *Analysis and interpretation of data in order to determine the number, distribution, and severity of cases; identification of food responsible for transmission of the causative agents; detection of the sources of contamination, the population groups at risk, critical control points and any other contributing factors.*

iv. *Dissemination of the information obtained to other competent authorities.*

v. *Recommendation of prevention and control measures for Authorities and General Public.*

vi. *Investigation of new problems or prediction of changes in FBD trends.*

Control Measures

The primary goal of outbreak investigation is to control ongoing and to prevent future outbreaks. Ideally, control measures are guided by the results of the ongoing outbreak investigation, but as this may delay the prevention of further cases is often unacceptable from a public health perspective. At the same time, specific interventions such as recalling a food product or closing a food premise can have serious economic and legal sequences and must be based on correct information. Thus implementing control measures is often a balancing act between the responsibility to prevent further cases and the need to protect the credibility of an institution.

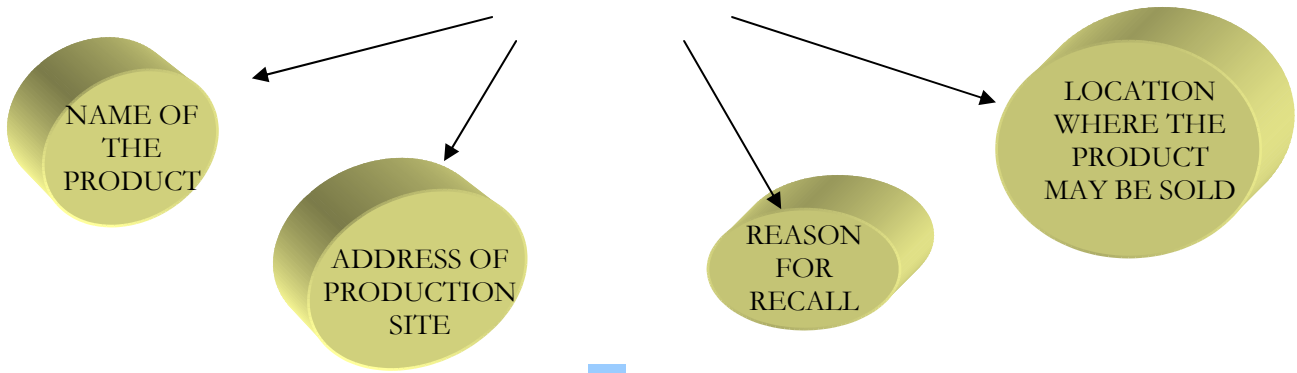
Once the investigations have identified that a food or a food premise is associated with transmission of the suspected pathogen, measures should be taken to control the source. The steps may include: removing implicated foods from the market (food recall, food seizure), modifying a food production or preparation process and closing food premises or prohibiting the sale or use of foods.

A food recall is undertaken by any business that manufactures, wholesales, distributes or retails the suspect food, for example large corporations, partnerships, or family owned business. It may be initiated by the business itself or on request of an appropriate health authority.

A food seizure is the process by which an appropriate authority removes a food product from the market if the business does not comply with recall. In most cases, business will comply with a request for food recall to protect themselves from private lawsuits and a damaged reputation.

Graph 3: Food Recalling

Before recalling the public should be informed for the:



Although recalling is the duty of the manufacturer or distributor, the authorities should notify the public preferably at the same day when the decision is taken to recall the food product. The information to the public should include: 1) The reason for recall, 2) The name of the product, 3) The name of the producing establishment and its address, 4) The location where the product may be found and sold.

At the same time the Ministry of Health should make an announcement in the Mass Media (Radio, TV, Press) giving the symptoms of illness associated with the suspected pathogen, or toxin or chemical involved, the way of prevention and basic rules of hygiene.

Sometimes important new information becomes available after the initial release is published. This may require a "Correction" or "update" or a complete revision and at the same time removal of the first release from circulation.

Closing Food Premises

If on site inspection reveals a situation that poses a continuing health risk to consumers, it may be advisable to close the premises until the problem has been solved. This may occur with the agreement of the business or be enforced by law (closing order). Once the premise has been closed the responsible authorities should monitor the premises and ensure that they remain closed.

Control of Transmission

Public Advice

If a contaminated food product cannot be controlled at source, steps need to be taken to eliminate or minimize the opportunities for further transmission of the pathogen. Depending on the situation appropriate public advice can be issued during a period of hazard, for example during an earthquake, which damaged the water reservoirs or a traffic accident involving leakage of chemicals to the water beds. In the case of microbial contamination boiling of the water is recommended. In case of chemical contamination the water should be rejected. Advice also should be given on the proper preparation of foods in case of electricity failures in warm seasons, when at the same time it should be emphasized the personal hygiene measures, as well as the regular controls and inspections in food manufacturing plants.

Exclusion of Infected Persons from Work and School

The risk of spreading infection by infected persons depends on their clinical picture and their standards of hygiene. Persons with diarrhoea present a far greater risk of spreading infection than asymptomatic persons with a sub-clinical illness. All of the following persons with diarrhoea or vomiting should remain off work or school for 48 hours after recovery:

- *Food handlers whose work involves touching unwrapped foods to be consumed raw or without further cooking or other forms of treatment*
- *Persons with direct contact to highly susceptible patients or persons in whom gastrointestinal infection would have particularly serious consequences (e.g. the young, the old, the ill)*
- *Children aged less than 5 years*
- *Older children and adults with doubtful personal hygiene or with unsatisfactory toilet, handle-washing or hand-drying facilities at home, work or school*

Even if clinically well, no person should handle unpacked food when is an excretor of any of the following conditions are present:

- *Salmonella typhi* or *Salmonella paratyphi;*
- the etiological agents of cholera, amoebic dysentery or bacillary dysentery;
- hepatitis A or hepatitis E and all other forms of acute hepatitis until diagnosed not to be hepatitis A or hepatitis E;
- *Taenia solium* (pork tapeworm) infection;
- tuberculosis (in the infectious state).

Advice on Personal Hygiene

Avoid preparing food for other people until free from diarrhoea or vomiting

Wash hands thoroughly after defecation, urination and before meals

Use your own separate towels to dry hands (liquid soap and disposable towels are indicated for institutions and schools)

Clean toilet seats, flush handles, wash hand basin taps and toilet door handles with disinfectant after use

Table 4 *List of the Most Important Measures applied for Prevention and Control of Foodborne Diseases*

Prevention and control of foodborne diseases should include the following measures *(see also hygiene in Mass Catering)*:

Food processing and storage	Chill foods rapidly in small quantities Cook or re-heat all foods thoroughly Hold hot foods at 60° C or above Re-heat leftover foods to at least 70° C Pasteurize milk and egg products Avoid cross contamination from raw to cooked foods Heat-treat feed and feed ingredients Protect food and feed from animal, human, bird, insect, rodent excreta Process meat and poultry in sanitary manner Heat cans at predetermined temperatures and pressures for sufficient time Cook home-canned foods thoroughly (boil and stir for 15 minutes), acidify adequately Keep perishable foods under refrigeration Cure in recommended concentration of curing salts Control moisture during storage
Sanitation rules	Clean home and work environments(sanitation) Wash hands after touching raw meat Sanitize equipment Practice personal hygiene. Supervise carriers and restrict them from handling food Exclude the ill (with diarrhoea, skin lesions, respiratory infection), from food handling
Water	Protect and disinfect water supplies Dispose of sewage in sanitary manner Avoid using sea water for rinsing foods to be eaten raw or for cleaning eating utensils
Cheese	Age cheese for at least 90 days
Insects –rodents	Control of flies, insects and rodents
Farms	Eliminate major zoonoses from livestock Incinerate or deeply bury dead animals (cover with lime) Maintain farm sanitation
Fertilizer-dirt	Avoid using human excreta for fertilizer (night soil) Prevent children from eating dirt
Dog control	Control slaughtering so that dogs do not have access to scraps Control stray dogs De-worm domestic dogs
Dangerous plants, vegetables, fish, molluscs	Eat only mushrooms known to be of non-poisonous species Control industrial waste Ban fishing in polluted waters Avoid eating shellfish from polluted waters
Education	Public health education Education of abattoirs workers, food handlers and consumers Community participation

4. THE HAZARDS IN FOODS

Foodborne disease caused by microbiological and chemical hazards is a large and growing public health problem. Most countries with well functioning systems for reporting cases of foodborne diseases have documented significant increases over the past few decades in the incidence of these diseases.

Chemicals are a significant source of foodborne diseases, although effects are often difficult to link with a particular food. Environmental or man-made chemical contaminants in food include among others, dioxins, mercury, lead, and radionuclides. Food additives, pesticide and veterinary drugs are widely used too and it is essential to assure that these uses are safe.

Surveillance of foodborne diseases and food contamination monitoring are essential tools for risk assessment. For this reason main efforts are directed to the development of adequate methods of surveillance of foodborne diseases and food contamination monitoring to provide the necessary data for quantitative microbiological and chemical risk assessment.

This section presents information on chemical contaminants, additives and residues in foods that may have an adverse impact in health.

Microbiological Hazards

The incidence rates of foodborne diseases, due to *Salmonella* spp., *Campylobacter jejuni, Listeria monocytogenes, E. coli 0157* and other, are not comparable because national reporting, definitions and diagnostic methods are different among different countries. This is aggravated by the level of under-reporting; only 1-10% of cases comes to the knowledge of the official agencies and the extent of under-reporting varies from country to country.

Salmonellosis is still the most frequently reported foodborne disease in the Mediterranean region, and in most countries notification of this disease is reliable. Incidences of salmonellosis in the Mediterranean region have not shown a clear geographical pattern, however, there are some temporal trends.

Mycotoxins[i]

Mycotoxicoses are diseases caused by mycotoxins(*organic compounds of low molecular mass*) which are the toxic secondary metabolites of some moulds. They are responsible for some disorders ranging from gastroenteritis to cancer. The severity depends on the toxicity of the mycotoxin, the extent of exposure, the age and the nutritional status of the individual as well as the possible synergistic effects of different chemicals present in the food or the environment.

Mycotoxins occur more frequently in areas with a hot and humid climate, favourable for the growth of moulds. However they can be found also in temperate zones. Exposure to mycotoxins is performed mostly by ingestion, but also occurs by the dermal and inhalation routes. Mycotoxins are often unrecognised by medical professionals, unless when large number of people are involved. The most widespread mycotoxin is *aflatoxin*, produced by the mould *Aspergillus flavus*, flourishing in areas of high humidity and temperature.

In the Middle ages, outbreaks of ergotism (caused by the ergot alkaloid *Claviceps purpurea*), reached epidemic proportions in Europe. A recent interest in mycotoxins was stimulated in 1960s after

[i] *Adapted from Petaica M., Radic B., Lucic A. & Pavlovic M.:* Toxic Effects of Mycotoxins in Humans*, Bulletin of the World Health Organization, 11(9) 711-786, 1999.*

the appearance of a feed-related mycotoxicosis in farm animals in England(*turkey¨X¨ disease*). The Food and Agriculture Organization has estimated that up to 25% of the world's foods are significantly contaminated with mycotoxins.

From long time ago, certain moulds were used for the production of cheese and salami as well as in the fermentation of beer and wine. Accordingly in the pharmacopoeia the moulds are used in the production of antibiotics, although the classification of mould metabolites as antibiotics or mycotoxins is based on their beneficial effect in treating diseases or their toxicity on humans and animals. Ergot alkaloids are still used in the treatment of parkisonism, as prolactin inhibitors, for the migraine treatment, for venous insufficiency, thrombosis and embolisms, for the stimulation of cerebral and peripheral metabolism, in uterine stimulation, as a dopaminergic agonist. The toxic effects of mycotoxins were mostly known from veterinary practice. However, due to the modern trade patterns mycotoxicoses resulting from contaminated food, could occur in developing and developed countries alike.

Ergot

Ergot is the common name of fungal species within the genus *Claviseps*, which produces ergot alkaloids. These alkaloids are also secondary metabolites of some strains of *Penicillium*, *Aspergillus* and *Rhizopus* spp. The source of the ergot strongly influences the type of alkaloids present, as well as the clinical picture of ergotism. Ergotism is extremely rare today, primarily because the normal grain cleaning and milling process remove most of the ergot so that only low levels of alkaloids remain in the flours. Furthermore, these alkaloids are usually destroyed during baking and cooking.

Aflatoxins

They are found in nuts, cereals and rice under conditions of high humidity and temperature and present a serious risk to human health.

The two major species are *A. flavus*, (producing only B aflatoxins) and *A. parasiticus*, (producing B and G aflatoxins).

Aflatoxins are either acutely toxic or mutagenic, teratogenic and carcinogenic compounds.

3-Nitropropionic acid

3-Nitropropionic acid (3-NPA) is a secondary metabolite of *Arthrinium* spp., considered to cause a form of acute food-poisoning called *¨mouldy sugarcane poisoning¨*. The incubation period is generally 2-3 hours following the ingestion of the mouldy sougarcane, and the main clinical symptoms are vomiting, dystonia, staring to one side, convulsions, carpopedal spasm and coma.

Ochratoxins

Ochratoxins are secondary metabolites of *Aspergillus* and *Penicillium* strains. They are found on cereals, coffee and bread, as well as on all kinds of food commodities of animal origin in many countries. The most frequent is *ochratoxin A*, which is the most toxic. Ochratoxin A is nephrotoxic, carcinogenic, and teratogenic toxin in all experimental animals tested so far.

Trichothecenes

Trichothecenes are mycotoxins mostly produced by the members of the *Fusarium* genus. To date, 148 trichothecenes have been isolated, but only a few of them have been found to contaminate human food and animal feed.

Zearaleone

Zearaleone, which was previously known as F-2, is produced mainly by *Fusarium graminearum*, in wheat, maize, sorghum, barley and compounded feeds.

Fumonisins

Fumonisins are mycotoxins produced throughout the world by *Fusarium moniliforme* and related species when they grow in maize. Only the Fumonisins B_1 and B_2 are of toxicological significance.

Other unidentified mycotoxins

The impact of other mycotoxins on human health was reported in persons occupationally exposed to large amounts of different mycotoxin-producing fungi *(farmers, workers in silos etc.)*. In these cases exposure to spores via the respiratory tract seems to be of considerable importance.

Table 5 *Toxicity and Biological Effects of Some Major Mycotoxins Found in Foods*

Mycotoxin	Major foods	Common producing spp.	Biological activity	**LD_{50}** (mg kg^{-1})
Aflatoxins	Maize,groundnuts, figs, tree nuts, (Aflatoxin M_1 (secreated by cow after metabolism of Afl B_1) Milk, milk products)	*Aspergillus flavus* *Aspergillus parasiticus*	Hepatotoxic, carcinogenic	0.5(**dog**) 9.0(**mouse**)
Cyclopiazonic acid	Cheese, maize, groundnuts, Rodomillet	*Aspergillus flavus* *Penicillium aurantiogriseum*	Convulsions	36(**rat**)
Deoxy-nivalenol	Cereals	*Fusarium graminearum* *Fusarium culmorum*	Vomiting, feed refusal	70(mouse)
T-2 toxin	Cereals	*Fusarium sporotrichioides*	Alimentary toxic aleukia	4(**rat**)
Ergotamine	Rye	*Claviceps purpurea*	Neurotoxin	
Fumonisin	Maize	*Fusarium moniliforme*	**Equine:** encephalomalacia pulmonary oedema **Pigs:** oesophageal carcinoma	
Ochratoxin	Maize, cereals, coffee beans	*Penicillium verrucosum* *Aspergillus ochraceus*	Nephrotoxic	20-30(**rat**)
Patulin	Apple juice, dammaged pomme fruits	*Penicillium expansum*	Oedema, haemorrhage (possibly carcinogenic)	35(**mouse**)
Penitrem A	Walnuts	*Penicillium aurantiogriseum*	Tremorgenic	1.05(**mouse**)
Sterigmatocystin	Cereals, coffee beans, cheese	*Aspergillus versicolor*	Hepatotoxic, carcinogenic	166(**rat**)
Tenuazonic acid	Tomato paste	*Alternaria tenuis*	Convalsions, haemorrhage	81(**female mouse**) 186(**male mouse**)
Zearaleone	Maize, barley, wheat	*Fusarium graminearum*	Estrogenic	not acutely toxic

Marine Biotoxins

Intoxication by marine biotoxins is another problem of concern. In many areas of the world this type of poisoning is a major public health problem, affecting many thousands of people. The most common type is ciguatera, which is associated with the consumption of a variety of tropical and subtropical fish, mainly coral fish, feeding on toxin-producing dinoflagellates, or predatory fish consuming such coral fish. Another group of marine biotoxins produces acute intoxication after consumption of contaminated shellfish. Known for centuries, this intoxication occurs throughout the world. Toxins causing shellfish poisoning are produced by various species of dinoflagellates. Shellfish feeding on these algae accumulate the toxins, without being affected. The shellfish most often implicated are clams, mussels, and occasionally scallops and oysters. Depending on the symptoms, different types of intoxications have been described as a result of the consumption of contaminated shellfish. These include paralytic shellfish poisoning (PSP), diarrhoeal shellfish poisoning (DSP), neurotoxic shellfish poisoning (NSP), amnesic shellfish poisoning (ASP) and azaspiracid poisoning (AZP). Recent evidence suggests that the warming of the world's oceans has altered the distribution and range of the dinoflagellates.

Plant Toxicants

Toxicants in edible plants and poisonous plants that resemble edible plants are important causes of ill health in many areas of the world. Green potatoes and tomatoes contain naturally occurring toxins and insufficiently cooked legumes may contain toxic substances.

Bacterial toxins

Several toxins are produced in food as the result of contamination and growth of bacteria. These bacteria include *Staphylococcus aureus*, *Bacillus cereus* and *Clostridium botulinum*. Intoxications caused by toxins of Staphylococcus aureus and Bacillus cereus are not uncommon, but are usually self-limiting. However, botulism is serious and often fatal and specific control measures for this hazard are in place in most countries in the world. Another group of bacterial toxins are the biogenic amines, which are formed during fermentation (e.g. cheese ripening, wine fermentation) and decomposition of protein. They include histamine, tyramine, cadaverine, putrecine and others. The main significant food safety hazard related to this is the formation of histamine in a number of fish species *post mortem* by bacterial activity.

Chemical Hazards

The contamination of food by chemical hazards is a major public health concern both for developed and developing countries. The use of various chemicals, such as food additives, pesticides, veterinary drugs and other agro-chemicals can also pose hazards if such chemicals are not properly regulated or appropriately used.

Information on chemical food contamination even in developed countries is variable and usually not recorded in monitoring programmes. Food contamination arises largely from industrial contamination of air, soil and water – whether from mining and smelting activities, the energy sector, the agricultural industry or dispersal of hazardous and municipal waste. Contamination of food items usually occurs in these "hot spots" rather then contamination of food items throughout the whole Mediterranean region.

Over the past 50 years, the widespread introduction of chemicals in agriculture and in food processing has resulted in a more abundant and arguably safer food supply. To protect

consumers, most governments have adopted a risk assessment paradigm to scientifically estimate the potential risk to human health posed by chemicals in food. While risk assessment methods have been to a great extent harmonized, risk management approaches will necessarily vary depending on whether the chemical is intentionally added to the food supply or is present as the result of inadvertent or unavoidable contamination. In addition, the choice of a risk management option may vary among countries depending on their desired level of health protection and technical, economic, socio-cultural and other factors. In a number of cases, these differences have resulted in disruption of international food trade. Chemical contaminants can cause a variety of acute and chronic diseases in humans. Cancer, neurological diseases and developmental deficiencies are some of the most serious adverse health effects posed by chemicals.

In order to assess the potential health risks of chemicals, risk assessment methods have been developed to predict possible harm to the human population and to provide guidance on safe levels in food.

The chemical hazards are classified into one of the following categories:

1. FOOD ADDITIVES

Food additives comprise a large and varied group of chemicals, which have a long history of use or are thoroughly tested to assure their safety. They are added to food to improve keeping quality, safety, nutritional quality, sensory qualities (taste, appearance, texture etc.), and certain other properties required for processing and/or storage. Food additives are evaluated to assure that these substances are used safely, which includes the precaution that a food additive should be used at the minimum level to achieve its technological effect.

2. VETERINARY DRUG RESIDUES

Veterinary pharmaceuticals have been a key element in increasing the production of animal derived foods. Vaccines and therapeutic drugs are essential to protect the health of confined animals, which are under more stress and are more at risk for communicable diseases. Antibacterial drugs are also given to animals in less than therapeutic doses to promote weight gain and to improve feed efficiency. Again, conditions for their safe use must be established before these substances are marketed. It should be noted that the use of antibiotics in this way has contributed to problems with antibiotic-resistant micro-organisms in humans. Therefore, some countries are now banning in animal production the use of certain class of antimicrobials that are essential for human use. Furthermore, the use of hormonal anabolic agents in meat production has proven controversial and an international consensus on these uses is currently lacking.

3. PESTICIDE RESIDUES

Like other intentionally added substances, pesticides are evaluated and conditions for safe use, including maximum residue limits, are established before they are introduced in agriculture. Because of their inherent toxicity, the application of good agricultural practices is extremely important when pesticides are employed. In a number of situations, foods have been found to contain high levels of pesticide residues, for example, when the crops had been harvested too soon after applications of pesticides or when excessive amounts of pesticides had been applied.

While this increasing trend in the number of violative samples is worrisome, the more significant public health concern is for high residues of certain pesticides, which may produce acute adverse health effects. In particular, developmental and reproductive effects are of concern because these can be caused by single exposures to high levels of pesticides.

Chemical Contamination of Food Through the Polluted Environment[i]

A number of chemical substances may occur in the food supply as a result of environmental contamination. Their effects on health may be extremely serious and have caused great concern in past years. Serious consequences have been reported when foods contaminated with toxic metals such as lead, cadmium, or mercury have been ingested. For chemicals such as lead, human exposure is truly through multimedia, including air, water, soil and food. Consequently, significant reductions in such exposures will require the coordinated efforts a several government agencies and sectors.

Dioxins as well as polychlorinated biphenyls (PCBs) are among a group of toxic chemicals known as persistent organic pollutants (POPs). In the environment, dioxins tend to bioaccumulate in the food chain. (see: Dioxin and Health)

Heavy metals and Polychlorinated biphenyls (PCBs) are taking a great toll among wild life and children when their concentrations increase during industrial accidents and physical disasters.

Among the metals, mercury, is produced in a vast number of industrial sites finding its way to the environment and reaching through the food chain some food intended for human consumption, especially fish. In the organism mercury causes serious damages to the central nervous system and is especially dangerous in children and pregnant women. Another dangerous metal transmitted through food and affecting the nervous and renal system of children is lead. In large towns lead is produced mainly from the exhaustion pipes of those cars, which are burning leaded fuel.

Consumption of edible oil contaminated with PCBs has resulted in many cases of serious illness and deaths in different places of the world. PCBs were produced in large quantities many years ago for hydraulic systems, transformers and heat exchangers, but their use has been reduced drastically in many countries during the last decades. PCBs are mostly contained in fish than other types of food. Organochlorine pesticides such as DDT, identified in animal and human fat during 1970 in increased concentrations alarmed the scientists who saw that the pesticides do not disappear in the environment but do persist by hiding in the fatty tissues of animals and people. Actually chemicals like DDT cannot be considered as factors contributing to the Food Poisoning in a short sense, since their side effects such as the potential cancerogenicity, are long termed and not clearly defined.

Today, the organochlorine pesticides have increasingly been replaced by organoposphorous compounds which do not persist in the environment therefore do not invade animals and human tissues because rarely are present in food. However when they accidentally infest sugar or flower during transportation or storage, they pose serious threat to public health.

On the other side residues of veterinary drugs such antibodies, can find their way to the table through milk, meat or their products. Usually they do not cause immediate effects and they are not posing considerable threat to anybody. They, however, may provoke allergic reactions to sensitive people. In generally they are responsible for the development of resistance of certain bacteria to the specific antibiotics, rendering this antibiotic useless in case of treatment against these strains. For this reason has been recommended that antibiotics used in human medicine should not be used by veterinary pharmaceutical industries.

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[i] *Adapted from Petaica M., Radic B., Lucic A. & Pavlovic M.:* Toxic Effects of Mycotoxins in Humans*, Bulletin of the World Health Organization, 11(9) 711-786, 1999.*

Radio-Polutants

Among the broad sense of inorganic environmental pollutants can be considered the radionuclides, although emission of these substances is largely limited to industrial accidents. The Chernobyl accident provoked great concern about the health risks to people, but these were mainly limited to people living in the vicinity of the accident and in parts of Europe where deposition occurred. In other parts of Europe and elsewhere, concern focused on contaminated foods from these areas as main source of exposure. In most cases, the estimated average dose acquired from eating contaminated foods only amounted to a fraction of the dose normally received from background radiation. At the present time, food contaminated by radionuclides with long half-lives, such as caesium 137, is the major source of exposure for people living in the Ukraine.

Unsanitary Practices in Agriculture

Pollution of the environment with animal or human wastes such as sewage can be a serious threat to food safety. Human excrement can contain a wide range of pathogens transmitted by the faecal-oral route including bacteria such as *Vibrio cholerae, Salmonella typhi*, viruses such Hepatitis A virus, and parasites. These can be transferred to foods if raw sewage is used to fertilize fields or if the water used to irrigate, wash, cool or transport food is contaminated with sewage.

Filter-feeding shellfish will filter large volumes of water to extract nutrients. If this water is polluted with sewage they will also concentrate pathogenic bacteria and viruses in their tissues. Polluted water used in aquaculture can also lead to the carriage of pathogens such as *Vibrio cholerae* by farmed fish and shellfish.

Hygienic Production of Food Sources

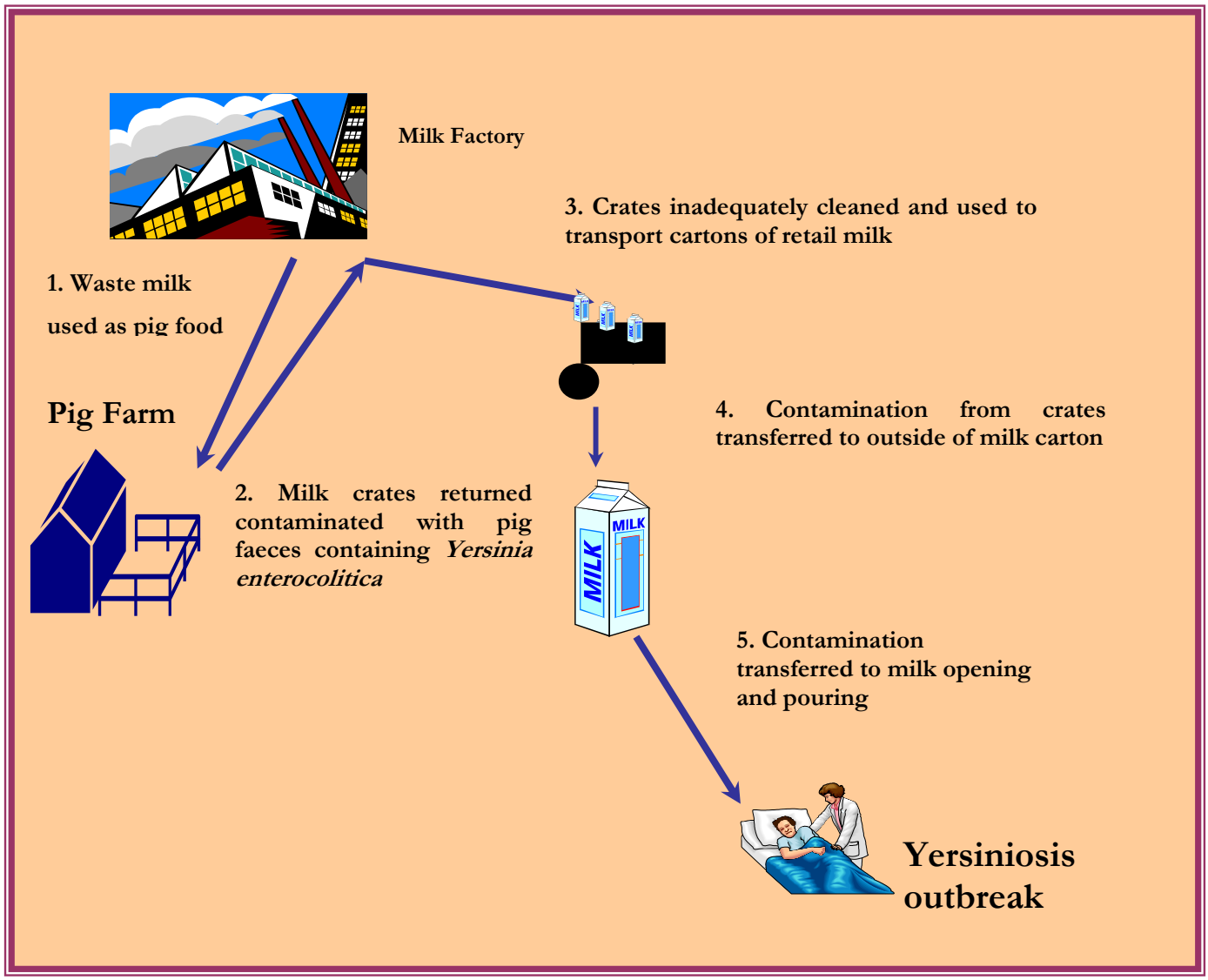
The potential effects of primary production activities on the safety and suitability of food should be considered at all times. This includes identifying any specific points in such activities where a high probability of contamination may exist and taking specific measures to minimize that probability. Producers should as far as practicable, implement measures to:

- *Control contamination from air, soil, water, foodstuffs, fertilizers (including natural fertilizers), pesticides, veterinary drugs or any other agent used in primary production;*
- *Control plant and animal diseases so that they do not pose a threat to human health through food consumption, or adversely affect the suitability of the food product; and*
- *Protect food sources from fecal and other contamination.*

In particular, care should be taken to manage wastes, and store harmful substances appropriately. On-farm programs with specific food safety goals are becoming an important part of primary production and should be encouraged.

Hazards associated with primary production may or may not be eliminated or reduced to acceptable levels, depending on the subsequent processing and handling of the primary food products.

Possible health risks to consumers may arise from primary products which are excessively contaminated with microorganisms or toxins. An understanding of how pathogens are introduced during primary production is essential to the development of appropriate interventions and effective control mechanisms. In many cases, however, primary production control measures that will provide a means to control certain hazards have not yet been defined. More research is needed to establish the ecology of pathogenic microorganism so that appropriate intervention strategies can be devised for the reduction of pathogens at the beginning of the food chain.



Faecal contamination leading to an outbreak of yersiniosis.

Adapted from: M. Adams, Y. Motarjemi, *Basic Food Safety for Health Workers*, World Health Organization, Geneva, 1999, (Doc.WHO/SDE/PHE/FOS/99.1)

Animal excrement poses equally serious problems. For example, a large outbreak of listeriosis was caused by the contamination of cabbages with sheep manure.

Chicken faeces adhering to the outside of egg shells can contaminate the contents when the egg is broken and this has been the cause of numerous outbreaks of salmonellosis. Sometimes the link between the food and faecal contamination can be quite complex, as it is illustrated by an outbreak of yersiniosis. In this case, crates used to transport waste milk to the farm where it was used as animal feed were contaminated with pig excrement. Back at the dairy, the crates were insufficiently washed and disinfected before being used to transport retail milk to the shops. During this process the outside of the milk cartons were contaminated with *Yersinia enterocolitica* which was, in turn, transferred to the milk when the cartons were opened and the milk poured.

Nutritional hazards

While some nutrients can pose a hazard by being present in excessive amounts, e.g. Vitamin A, most nutrients are of concern when they are not present in sufficient amounts in the diet. For foods that are fortified, the proper addition of the nutritional supplement becomes a critical issue for health. For example, if iodine was not present or was insufficient in iodised salt, mental retardation and other adverse effects could result in populations living in areas of endemic iodine deficiency. In addition to iodine, other deficiencies involving several other micronutrients, such as iron, niacin, vitamin A and folic acid, pose serious public health concerns and fortification of foods with these micronutrients is being used in many countries to assure sufficient intakes. Similarly, foods for infants that comprise a significant portion of the diet must be produced with special care to assure that inadvertent deficiencies do not occur. Under these situations, the monitoring of fortified food is an important food safety activity that should be integrated into the existing food control infrastructure.

Dioxin and Health[i]

Dioxin[ii], the most toxic chemical ever known, belongs to the group of chlorinated hydrocarbons. It is a manmade chemical not occurring or found in nature before the twentieth[iii] century; an unwanted by-product of many chemical, manufacturing, and combustion processes. During 1930-1940, chlorinated hydrocarbons proved to be a mixed blessing for humanity because on one hand made possible the production of many modern solvents, pesticides, plastics etc., but on the other hand they release dioxin when processed in chemical plants or burned in incinerators. Therefore, for sixty years now dioxin is released into the natural environment by chemical plants, pesticide factories, metal smelters, paper mils, incinerators and especially the factories producing PVC (polyvinyl chloride).

Production and dissemination of dioxins.

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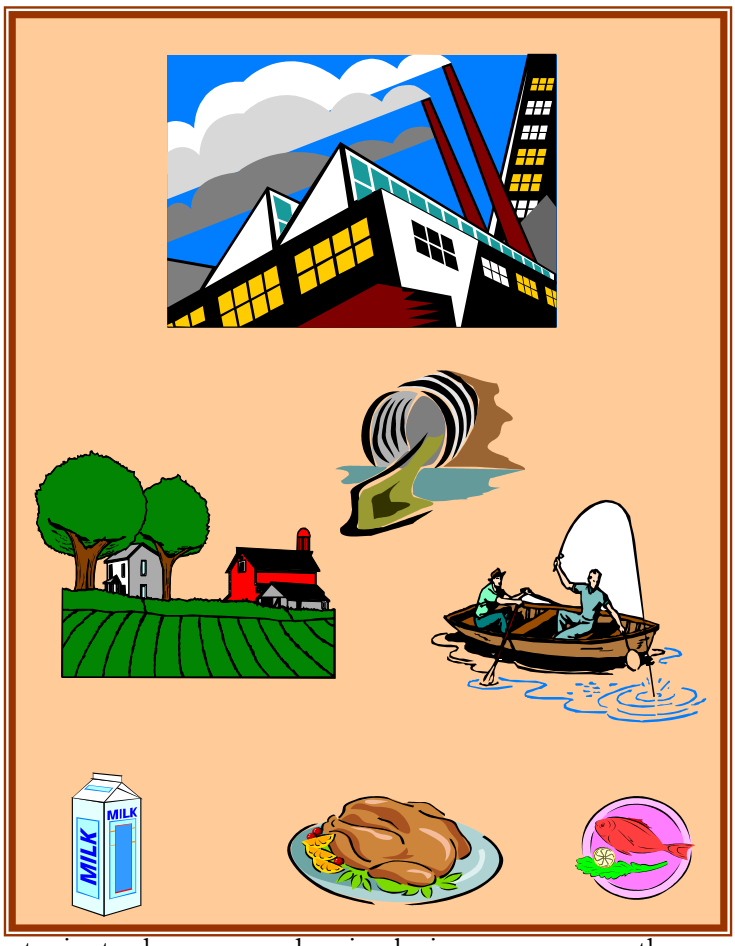
[i] *Source: Environmental Protection Agency, May 25, 2001 Update..*

[ii] *Dioxin [2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD)], is a general term that describes a group of hundreds chemicals highly persistent in the environment.*

[iii] *Dioxin was first created by Dow Chemical in Midland, Michigan around 1900.*



Although dioxin is toxic to humans and animals in many ways, the general public is not adequately protected from ill effects by a traditional "margin of safety[i]". Therefore, health reports throughout the industrialized world reveal that adults are already carrying such a high dioxin levels[ii] in their bodies that are capable to produce illness. These dioxin levels are due mostly to the consumption of food. Since dioxin is fat-soluble, it bioaccumulates up the food chain and it is mainly found in *meat, fish* and *dairy products*. In fish alone the dioxin levels are 100 000 times that of the surrounding environment. Now, new evidence suggests that absorption through the skin, especially for babies and children, may be an important way for dioxin to enter the body.

The first disease associated with exposure to dioxin was Chloracne[iii], which appeared in 1930s as an occupational problem among workers in factories manufacturing PCBs[iv]. Today studies show that the danger of cancer in humans is evident when dioxin body burden reaches a point 8 times as high as the average dioxin burden. The International Agency for Research on Cancer (IARC), which is part of the World Health Organization announced in February 14, 1977, that the most

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[i] *As margin is considered an amount of poisons of at least 100 times below levels known to humans and animals.*

[ii] *About 13 nanograms of dioxin/ kg of body weight (1 nanogram is a billionth of a gram).*

[iii] *Chloracne produces skin eruptions, cysts and pustules with sores occurring all over the body, lasting in some cases for years.*

[iv] *Polychlorinated biphenyls.*

potent dioxin, 2,3,7,8,-TCDD, is now considered a Class 1 carcinogen, meaning a "known human carcinogen[iii]".

Furthermore, laboratory experiments on monkeys (marmosets) reveal learning disorders in young monkeys with dioxin body burden 3.2 times as high as that of an average inhabitant of an industrialized country. This means that there is not even a factor of 10 separating the average person from the possibility of a dioxin detrimental effect on the central nervous system.

A major incident involving elevated levels of dioxins and PCBs in animal derived foods occurred in Belgium as a result of a contaminated ingredient (recycled edible oil) in animal feed. Epidemiological investigation following an industrial accident in Seveso, Italy indicates that acute effects of exposure to high levels of dioxins include skin lesions, such as chloracne, altered liver function and a curious shift in the sex ratio of progeny to favour girls. Long-term exposure is linked to impairment of the immune system, the nervous system, the endocrine system and reproductive functions.

Other effects of dioxin are: diabetes, changes in white blood cells, sperm loss[iii] and endometriosis[iv]. Dioxin is present in the fatty breast milk. Fetuses, infants, and children may be more sensitive to dioxin exposure because of their rapid growth and development. Data on risks to children are limited, however, and it is not known if children in the general population are experiencing adverse effects from dioxin. Although breast milk appears to be a significant source of dioxin exposure for nursing infants, the overwhelming body of evidence supports the health benefits of breastfeeding despite the potential presence of dioxin.

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[i] *The incidence of testicular cancer has tripled in the last 50 years, and prostrate cancer has doubled.*

[ii] *In 1960, a woman's chance of developing breast cancer during her lifetime was one in 20. Today the chances are one in eight.*

[iii] *Sperm count in men worldwide has dropped to 50% of what it was 50 years ago.*

[iv] *Endometriosis, which was formerly a rare condition, now afflicts 5 million American women.*

How to Stop Dioxin Dissemination in the Environment?

The ways of dissemination of this chemical threat into the environment and the ways of the exposure of the population to dioxin should be analysed more carefully in order to comprehend the difficulties of minimizing or even control dioxin.

As mentioned above, the chlorine content in the waste stream, which is burned in medical and garbage incinerators, generates dioxin. Chlorine is present in various plastics, mostly PVCs. When these plastics are burned, chlorine is released, and quickly reacts with available phenol compounds, which are present in wood and paper products, to form dioxin. Eventually dioxins are released to the air, ending up in fields, rivers and oceans. Therefore, the major source of dioxin is the chemical industry especially the field that uses chlorine in the production of pesticides, pharmaceuticals, cosmetics, detergents, solvents, and dyes. Herbicides are made by adding chlorine to phenoxy compounds. Dioxin is formed as a by-product and ends up in the formulated end product (i.e. herbicide Agent Orange).

Another major source of dioxin emission are pulp and paper mills. Dioxin is formed in the pulp and paper industry when chlorine or chlorine dioxide is used to bleach pulp and paper. Naturally occurring phenol compounds found in wood pulp react with chlorine to form dioxin. This results in dioxin in paper products, paper mill sludge, and in the wastes from these plants. Dioxin, like DDT, does not break down easily in the environment. As a sequel, the body accumulates any dioxin to which it is exposed through the years, until adverse health effects begin to occur. Animals are exposed primarily to dioxin emissions that settle onto soil, water and plant surfaces. Soil deposits enter the food chain by ingestion by grazing animals. People then ingest dioxin through the meat, dairy products, fish and eggs they consume. This means that, as a society, we have been accumulating dioxin and dioxin-like chemicals in our body for many years and it may take a small additional exposure to "'push" us over the edge and trigger adverse health effects. For some individuals, any exposure to dioxin, no matter how small, may lead to some adverse health effects. In this aspect limiting further exposure of the population cannot be accomplished through lifestyle or dietary changes. **Therefore the most sensible way to limit further exposure is to shut down the sources of dioxin contamination in order to protect the coming generations.**

The measures to be applied are the following:

prohibiting the incineration of municipal, medical, military and radioactive waste;

commencing of a phase-out of the industrial production and use of chlorinated organic compounds (including plastic, PVC);

eliminating of chlorine and chlorine based bleaches in the paper industry.

Global confrontation of Chemical Hazards

Chemical hazards are usually controlled successfully due to the mobilization of resources available to Governments and International Organizations. However, it is also clear that constant vigilance is essential to maintain this high standard, particularly in regard to sporadic outbreaks caused by illegal activities. The periodic failings of food safety systems to control chemical hazards, point to the need for more effective approaches for ensuring that such events do not occur. Furthermore, when such incidents occur, action must be promptly taken, including rapid and accurate communication with the international community. This has become more important given the increased awareness that terrorist threats to the food supply must be countered by efforts to strengthen prevention and response infrastructure.

With the incorporation of risk analysis principles into the development of international standards, foodborne risks must be characterized more precisely and transparently than it has been done in the past. This includes strengthening of the scientific database to evaluate toxic effects, caused by both long- and short-term exposures. Endocrine disruption, neurotoxicity and immunotoxicity are three areas of growing concern. The growing rates of breast cancer in women, testicular cancer in men and brain cancer in children all suggest that further research is needed to rule out the possible contribution of chemicals in food to these diseases.

Research into the potential adverse health effects of chemicals should be accompanied by refinements of knowledge about exposure assessment in order to provide the most precise and accurate assessments of the risks posed by chemical hazards. This also serves to provide the basis for international harmonization under the World Trade Organization's Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). Key to this is the strengthening of national capacities to conduct health-oriented, population-based monitoring programmes to assess exposure of populations to chemicals in food and the total diet.

Less developed countries must develop risk assessment and management capabilities to effectively deal with chemical hazards in food. In some countries, existing infrastructures need to be streamlined and strengthened to achieve a higher level of protection. Some countries still do not have detailed legislation to control chemicals in food or lack food control capacities to enforce such legislation. Most of these countries have no monitoring capabilities and little information about the dietary exposure of their populations to chemicals in food, such as total diet studies, is available. Therefore developed countries should offer technical and financial assistance in establishing and strengthening basic chemical assessment capabilities in the developing countries in collaboration with international organizations.

5. PREVENTION OR CURE?

Different approaches may be used to try to ensure that the levels of contaminants in foods are as low as reasonably achievable and never above the maximum levels considered to be acceptable or tolerable from the health point of view. Essentially, these approaches consist of:

- *measures to eliminate or control the source of contamination*
- *processing to reduce contaminant levels and to avoid recontamination*
- *measures to identify and separate contaminated food from food fit for human consumption - contaminated food should then be rejected.*

Previously, most systems for regulating food safety were based on legal definitions of unsafe food, enforcement programmes - to remove such food from the market, and the application of sanctions on those held responsible for contravening the regulations. Such systems have not been successful in dealing with previous or current problems and are unlikely to be able to deal with emerging risks.

In some cases, a combination of the above approaches is used, for example, when emissions from previously uncontrolled sources have resulted in environmental pollution with persistent chemicals that have then entered the food chain. Control of final products can never be extensive enough to guarantee contaminant levels below established maximum levels and safety, and other aspects of food quality cannot be 'inspected into' food at the end of the production chain. In most cases, chemical contaminants cannot be removed from foodstuffs and there is no feasible way in which a batch of contaminated foodstuffs can be made fit for human consumption.

The advantage of eliminating or controlling food contamination at source, i.e. *a preventive approach*, is that this is usually more effective in reducing or eliminating the risk of untoward health effects. Smaller resources for food control are required with this approach and the rejection of foodstuffs and resulting economic and other losses is avoided. It also decreases the spread of the contaminant in the production chain. The BSE case illustrates what happens if these approaches are not effective and contamination spreads: the effects can be devastating and long-lasting for human health, control and enforcement measures, food policy, legislation, trade and economics.

The use of a preventive and integrated approach to the management of food safety through out the food chain is illustrated in the following examples.

5.1. CONTROL OF PATHOGENS IN POULTRY

The overall goal to control *Salmonella* in poultry, covering the different parts of the feed-food chain is to ensure that less than 1% of animals sent for slaughter are contaminated with *Salmonella*, thereby ensuring that poultry-meat will be free from *Salmonella*. Consistent application of this strategy has resulted in a prevalence of *Salmonella* in poultry (at slaughter) of less than 1%. The strategies to reach this goal are as follows:

- *Prevent* Salmonella *contamination in all parts of the production chain.*
- *Monitor the whole production chain: surveillance programmes for feed, live animals, carcasses, meat and other foods of animal origin are in place.*
- *If* Salmonella *is found, action is taken to eliminate the infection/contamination. Any food item contaminated with* Salmonella *is deemed to be unfit for human consumption.*

All isolations of *Salmonella* in humans, animals and food of animal origin are notifiable. In addition, findings of *Salmonella* in official samples of food of any origin are notifiable. Primary isolates of *Salmonella* are characterized by sero- and phage-typing the strains and isolates of animal origin are also tested for antibiotic resistance. In order to illustrate how the system works, some details of the measures taken in the poultry area are given below.

Since the frequency of *Salmonella* isolation in a country's poultry flocks is very low, most of the measures in the current control programmes are of a preventive nature. Four factors are of major importance to maintain this favorable situation.

- *The breeding pyramid is kept free from* Salmonella *by regular sampling of flocks and hatcheries, as well as by slaughtering a breeder flock where* Salmonella *is detected. No* Salmonella *vaccination is applied. All grandparent animals are imported from countries free of* Salmonella *and are quarantined and repeatedly tested negative for* Salmonella *before they can be used for production.*
- *Feed is maintained free from* Salmonella. *The control consists of three parts: import control of feed raw materials, mandatory heat-treatment of compound feedingstuffs for poultry and an HACCP-based* Salmonella *control in the feed industry.*
- *Strict hygiene and biosecurity standards are in place, preventing the introduction of* Salmonella.
- *Measures are always taken in case of* Salmonella *infection in poultry. If a breeder flock is detected to be* Salmonella *positive at any time of its life, it will be slaughtered. All meat obtained from these flocks, as well as from production flocks is heat-treated. The poultry house is cleaned, disinfected and tested for* Salmonella. *Negative* Salmonella *results must be obtained before the next flock can be re-introduced.*

An extensive sampling programme continuously monitors the *Salmonella* situation in poultry. In addition to sampling at the flock level, samples are also collected at all poultry slaughterhouses to monitor the end product.

5.2. MINIMIZING PESTICIDES IN NATURE[i]

In order to minimize the risk of high residue levels in food and also to avoid environmental pollution and occupational health risks, pesticides should be used according to the principles of Good Agricultural Practice and, only by persons who have received adequate training. Pesticide residue levels should be monitored in food (including drinking water and sources thereof) and animal feed to ensure that they do not exceed established MRLs. The results of such monitoring should be made public. The fact that information about products containing levels above the MRLs is public encourages producers and traders to ensure that their products are in compliance. When residue levels above the MRLs are found in foodstuffs, this triggers increased control of products from the same producer/supplier and remedial action to prevent any repetition.

[i] *Maximum Residue Levels*

5.3. REDUCING VETERINARY DRUGS

In the EU, veterinary drugs, including antimicrobial drugs, are subjected to thorough investigation and assessment prior to approval for use. In many countries the use of antimicrobial drugs is not limited to therapeutic uses. However, in order to limit the development of antibiotic-resistance, the EC has prohibited the use of four main drugs in feed for growth-promotion purposes. In some EU countries such as Sweden and Finland the availability of drugs is limited to veterinary professionals. The levels of residues of veterinary drugs in foods of animal origin are monitored annually and the results made public. When residue levels exceeding the MRLs are found, this leads to a thorough investigation of the source of the problem, which is usually traced to the primary producer. Such strict control measures are essential to manage the risk of development of antimicrobial resistance in food-producing animals and humans with the consequent health implications.

5.4. CONTROL OF MYCOTOXINS AND MARINE BIOTOXINS

The problem of contamination of feed and foodstuffs with mycotoxins, such as aflatoxins, ochratoxin A, patulin and fusarium toxins, is best tackled by a systematic examination of the whole production, processing and distribution chain in order to discover the points at which contamination is likely to occur. In this way appropriate preventive and control measures can be taken. Mycotoxin levels in primary products can vary widely from year to year, depending on, among other things, climatic conditions during harvesting. Thus there is a need for constant vigilance and co-operation between agricultural advisory and control services, the food control authorities and food and feed producers. The Codex Committee on Food Additives and Contaminants (CCFAC) has developed and is developing codes of practice to reduce contamination of food and animal feed with mycotoxins. Such codes of practice can form the basis of advice at the national level on preventive measures. Through the control of aflatoxins in animal feed components and routine monitoring of aflatoxin M1 in milk back to the individual farmer it is possible to ensure that aflatoxin levels in milk are kept below the current maximum limits. Although a considerable amount of work has been done, there is a need for much more research on mycotoxins in order to provide a sound scientific basis for recommendations for both pre- and post-harvest measures.

It is very difficult to tackle the problem of contamination of shellfish with certain marine biotoxins, such as DSP and PSP, at source. Control efforts are therefore mainly directed towards trying to predict and detect relevant algal blooming, and to pre-harvest examination of shellfish for toxins in order to prevent contaminated products reaching the consumer.

5.5. CONFRONTING PERSISTENT ENVIRONMENTAL POLLUTANTS

Earlier emissions of persistent chemicals, such as PCBs, dioxins and mercury have led to contamination of foodstuffs, especially foods of animal origin (particularly fish). There is an on-going need for monitoring and control of some products to ensure that they do not contain levels above safe limits. In order to protect public health it may also be advisable to issue recommendations to susceptible population groups, for example, women of childbearing age, advising them to restrict their consumption of certain fish species, or fish from contaminated waters.

The most effective way to reduce the levels of environmental contaminants in food (and thus human exposure) is to take measures to reduce emissions from industry and other sources. The levels of methylmercury in fish from some oceans is unfortunately due to volcanic activity and

therefore not amenable to control. In recent decades the introduction of such measures has resulted in a number of success stories. For example, the levels of lead in human blood have dropped quite dramatically in countries where lead is no longer added to petrol. Likewise, measures to control pollution with dioxins and PCBs, and a ban on the use of persistent pesticides, such as DDT, has led to a marked reduction in the levels of these substances in food and in human exposure, as measured by the levels in human milk. This is an example of an area where co-operation between the authorities responsible for food safety and environmental protection has borne fruit. Although the levels of PCBs have decreased, it is important that control on the disposal of PCB-containing materials is continued, otherwise there is a risk that environmental pollution and levels in food will start to increase again.

6. HYGIENE IN MASS CATERING: IMPORTANT RULES TO PREVENT FOODBORNE DISEASES[i]

6.1. PERSONAL HYGIENE

- **Wear clean clothes!**

To avoid contaminating food with microorganisms and any foreign objects. The cleaner the clothes, the smaller the risk of contamination.

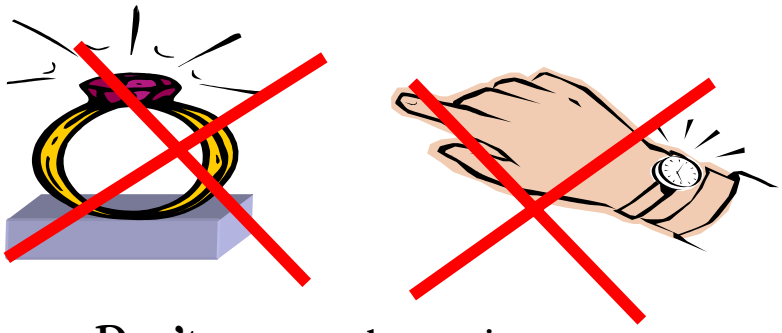
When working with food wear always clean clothes.

Always cover your hair while working in the kitchen!

Use headgear provided, because this prevent hair from falling into food.

- **Remove jewellery (rings, watches) before starting to work!**

Jewellery makes hand-washing less effective



Don't wear watches or rings

Jewellery makes hand-washing less effective

- **Refrain from smoking!**

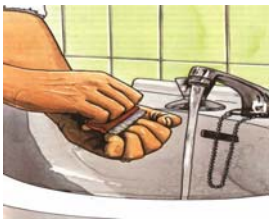
Cigarette ash and butts can fall into food.

Don't smoke, drink or eat when working with food (chefs are excluded, but forks or spoons should be discarded afterwards)

[i] *Adapted from: "HYGIENE IN MASS CATERING" brochure produced jointly by the Food Safety Unit, WHO, Geneva, Switzerland and the FAO/WHO Collaborating Centre for Research and Training in Food Hygiene and Zoonoses at the BgVV, Berlin, Germany*

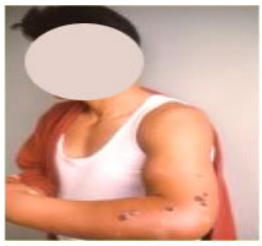
■ **Hands should always be washed before work and especially after visiting the toilet!**

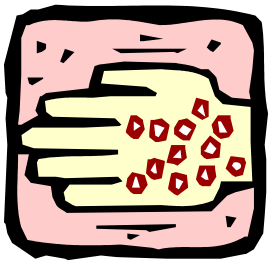
Hands can be contaminated with disease-causing microorganisms, particularly after visiting the toilet. In some cases, use of gloves is advisable.

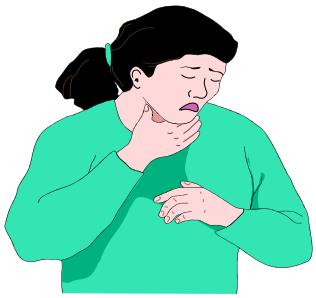


■ **If suffering from an illness involving any of the following, report to the employer before commencing work! It may be necessary to be temporarily assigned to another task.**

Jaundice, diarrhoea, vomiting, fever, sore throat, skin rash or other shin lesions (boils, cuts, etc. however small)







■ **Wounds on hands and arms should be carefully bandaged with impermeable material!**

Wounds may be infected with microorganisms, which cause diseases.

- **Cover your nose and mouth when sneezing/coughing!**

Even healthy people have microorganisms in their nose and throat. Use a paper handkerchief which should then be thrown away. Hands should be washed afterwards.

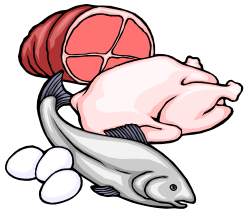
Cover your nose and mouth when sneezing/coughing, and than wash hands.

Even healthy people have microorganinsms in their nose and throat. About 40% of healthy adults have *Staphylococcus aureus* in their nose.

6.2. HYGIENIC HANDLING OF FOOD

- **Perishable food should be refrigerated!**

Multiplication of most microorganisms is reduced by chilling to a temperature of 5^0C, preferably lower. Refrigerator temperature should be checked 3 times per day.



- **Never place hot food immediately in the refrigerator. Let them cool down for one hour at least in a cool, clean place, covered with clean towels if possible. When their temperature drops under 10^0C, put them in the refrigerator in 1-5^0C.**

- **Thoroughly defrost frozen meat and poultry before cooking!**

If all parts are not completely defrosted, the temperature increase in some thicker parts, e.g. chicken breast, may not be sufficient to kill all micro organisms during cooking.

Defrost deeply frozen foods in environmental temperature of 2^0-5^0C or under running water of 20^0C (in this case make sure that the water is safe or the food is packed in waterproof containers.

- **Discard all liquid accumulated during defrosting of meat and poultry, and if refrigerator** shelves, table tops or utensils are soiled with it, they should be thoroughly washed!

These liquids may contain disease-causing microorganisms.

- **Cook food thoroughly!**

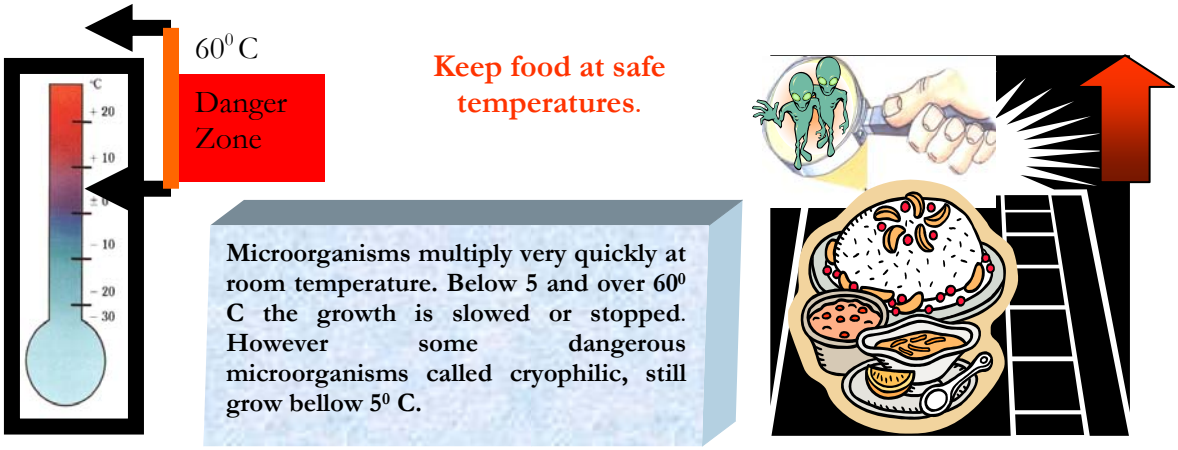
Thorough cooking will kill micro organisms. But remember that thorough cooking also means that all parts of the food must reach a temperature of at least 70^0C for at least 2 minutes. (Use special thermometers if in doubt). Large parts of meat should be chopped up in small pieces.

Cook and reheat cooked food thoroughly (especially meat, poultry, eggs, and seafood). Make sure with a thermometer that the temperature has reached the 70^0 C in the middle of the food (especially large joints of meat and whole poultry).

Fats and oils used and reused for cooking should be filtered first (if used once) and heated in temperatures not exceeding 180^0 C.

- **Keep cooked food hot – at temperature of at least 60^0C!**

Microorganisms multiply at temperatures below 60^0C. Therefore, food, which is ready for consumption should be kept either, hot or be cooled quickly.



- **Reheat cooked food to at least 70^0C!**

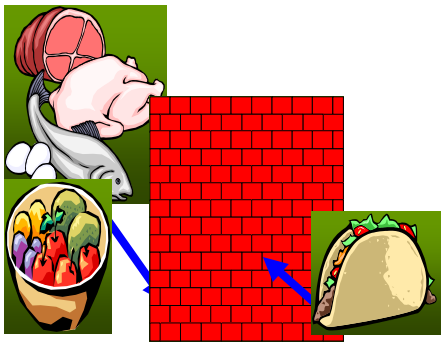
Proper reheating kills microorganisms, which may have developed during storage. This rule also applies when freshly cooked food is added to leftovers.

- **Perishable food should not be stored too long, even at refrigeration temperature!**

Chilling prevents the growth of many microorganisms. For others chilling only slows down the growth and some microorganisms may even multiply at low temperatures. Refrigerated food indented to be consumed cold should not be stored for more than 24 hours. If it is to be consumed hot, then it may be refrigerated for 48 hours.

- **Keep cooked food separate from raw food!**

This reduces the risk of cross-contamination.



Separate raw food, fruits and vegetables from cooked food. Do not handle both at the same time, or if you handle raw food, wash your hands before you touch the cooked food. Use separate equipment and utensils (knives, cutting boards) for raw food. Do not store raw and cooked food in the same container..

Raw food contains dangerous microorganisms that are transferred to the cooked food where no microorganisms have survived the temperature of cooking. These are proliferating very fast due to the lack of competition by others and the favorable temperature and the cooked food becomes more dangerous than the raw.

- **Cooked food should not be touched by hand!**

Microorganisms are present even on a clean hand and may be transferred to food.

6.3. PREMISES AND KITCHEN UTENSILS

- **Keep kitchen area and adjoining rooms clean!**

Every food scrap, crumb or spot is a potential reservoir of germs.

Clean (wash and dry) floor, kitchens, equipment, containers, dishes and boxes keeping food.

Disinfect with a light disinfectant (detergent or bactericidal solution) when necessary.

- **Frequent cleaning up as you go along ensures hygienic kitchens!**

Dried and encrusted leftovers are hard to remove from surfaces and utensils. The working area must therefore be cleaned thoroughly after each process of production.

- **Clothes and drying towels that come into contact with dishes and utensils should be changed every day!**

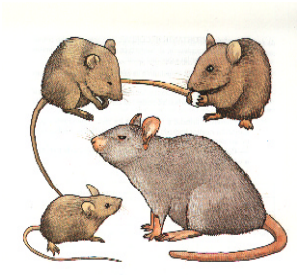
Thorough washing at higher temperatures removes dirt and kills microorganisms. Separate cloths should be used for cleaning the floors, and these also require frequent washing.

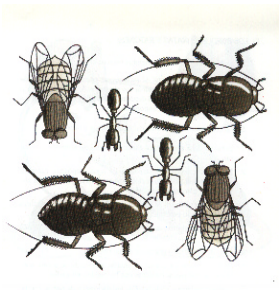
- **Keep kitchens tidy!**

Tidy kitchens are more easily kept hygienically clean. Personal belongings, for example, should be left in the cloakrooms provided.

- **Protect kitchen and storage area from insects and other vermin!**

These pests may carry disease-causing organisms.





Protect food from insects (flies, cockroaches, ants, spiders)**, animals** (rodents, pets) **and birds because they are always carrying disease-causing microorganisms.**

All windows, doors and other openings should be protected with insect nets.

Insecticides and poisons should be applied regularly in food establishments but

ONLY UNDER THE SUPPERVISION AND RESPONSIBILITY OF SPECIALLY TRAINED PERSONS.

■ **Keep dangerous/poisonous substances, e.g. detergents, disinfectants and insecticides, outside the kitchen area in labelled and closed containers !**

Accidents can easily occur when food and poisonous substances are confused.

Don' t store food and chemicals in the same place.

■ **When preparing mixed dishes, e.g. potato or noodle salads, always cool the cooked component before adding other ingredients!**

Large amounts of hot food cool down very slowly, and during that period microorganisms from other components may multiply.

■ **Avoid overcharging the cold-storage equipment!**

This leads to a slow and ineffective chilling of the food, which may promote an increase of microorganisms.

■ **Refrigerate cooked food in shallow containers!**

Shallow containers allow faster cooling than do deeper pans.

■ **All work with perishable food must be carried out quickly !**

The longer the food is exposed to the warmth of the kitchen, the higher the risk of an increase of microorganisms to disease-causing levels.

- **Do not change dishwasher timings / techniques / temperatures!**

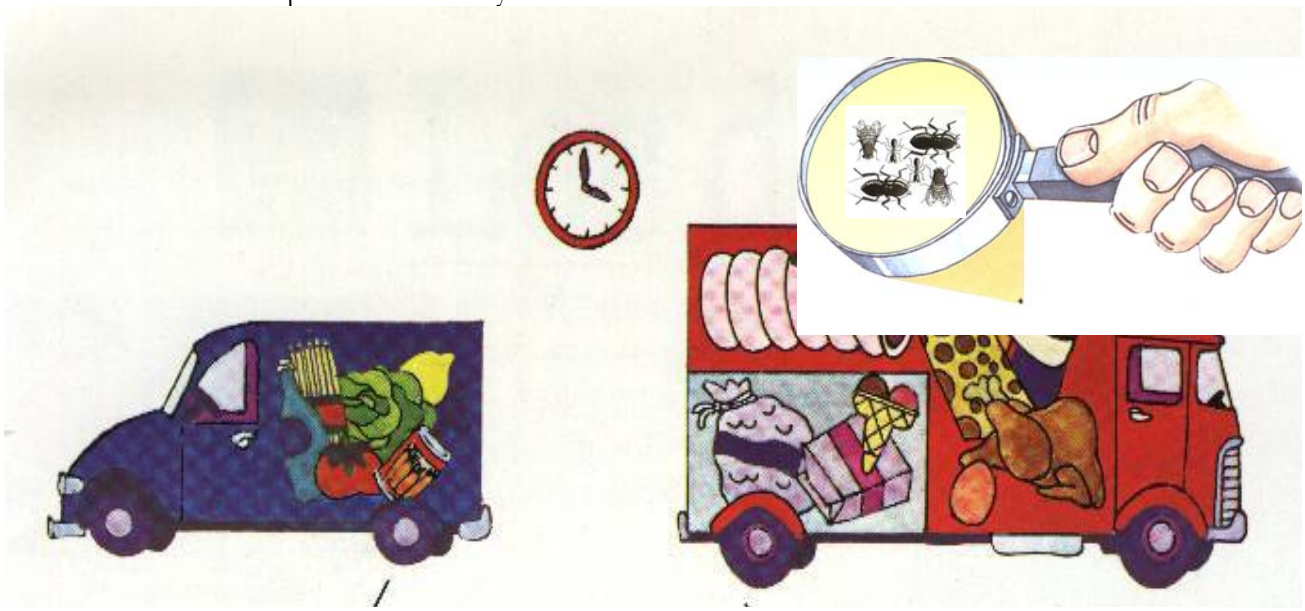
Food particles may stick to objects in dishwashers, and bacteria may survive if the temperature is not correct or the specified amount of detergent is not used or the timing is inadequate. The manufacturers' guidelines must be followed when using equipment.

WHEN RECEIVING FOOD make sure that you check for the following:

- Expiry date of the products.
- The temperature of the transportation vehicle, especially during warm whether and cleanliness of the vehicle, especially when food is not wrapped or in containers.
- The external damages in containers or wrapping material.
- The presence of insect, rodents.
- General diffusive strong odors from detergents or petroleum.
- The organoleptic characteristics (color, odor, appearance, and taste – if possible)

HANDLING AND STORING FOOD is a very serious job.

- Handle gently all food. Rough handling will damage it causing faster detrioration.
- Store immediately all perishable food in a refrigerator.
- Non-perishable food can be stored in dry, well ventilated and cool storage areas on top of shelves (never store food on the floor). Storage areas should be insect and rodent proof.
- Use clean and dry containers for not packaged substances (flour, sugar, nuts, etc)
- Use the concept of **first-in first-out**. That means that we should remove from the storage area or the refrigerator the food that has been placed there before and leave inside the food placed there lately.



Always check the transportation vehicle for cleanliness, correct temperature, odors and presence of insects or rodents – The transportation vehicle is a very good indicator of food safety assurance.

7. HAZARD ANALYSIS AND CRITICAL CONTROL POINTS (HACCP)

7.1. HISTORICAL OVERVIEW

The concept of pre-HACCP is attributed to W.E. Deming, who among others developed in 1950s the leading theory of a Total Quality Management system (TQM). First the Japanese tested this system with great success, thus improving greatly their efficiency and productivity. In between, the TQM system paved and prepared the way for the appearance of an almost full-developed HACCP system in 1960s. But let's see in more details, what exactly happened at that time.

In 1973, the Pillsbury Company published *Food Safety through the Hazard Analysis and Critical Control Point System*, which was the first document on HACCP concepts and techniques. Twenty years later, this system was internationally recognised and accepted for food safety assurance, including, not only microbiological safety of foodstuffs but also chemical and physical hazards. Since then and for many years HACCP system has been applied on a voluntary basis in many food industries.

Systematic implementation of a HACCP system-based approach to food safety assurance throughout the developing world cannot be expected for some years to come, because of the lack of expertise and training on the subject. However, meeting food export requirements has always been a strong motivation to introduce HACCP system

Until 1995, it was used originally throughout the industry the term: HAZARD ANALYSIS CRITICAL CONTROL POINT. This was changed after a proposal from WHO/Geneva Consultation in 1995 to: **HAZARD ANALYSIS AND CRITICAL CONTROL POINT** system. In 1997, the *Codex Alimentarius* Commission adopted officially the proposed term in order to ease its translation into other languages:

The original acronym HACCP was conceived in 1959 and developed by the Pillsbury Company together with the National Aeronautics and Space administration (NASA) and the U.S. Army Laboratories at Natick, in order to ensure the safety of astronauts' food.

7.2. CONCEPT

The hazard analysis critical control point **concept** is a systematic approach to the identification, assessment and control of hazards. It is very simple because it only identifies potential food safety problems and determines how and where they can be controlled and prevented. At first it was a management tool used in food industry to keep the processing line under control. Experience from the canning industry demonstrated that keeping control over processing conditions was much more efficient and reliable than end product testing. The time and temperature employed guaranteed safety of the product (*even significant under-processing can seldom be detected by end product testing*).

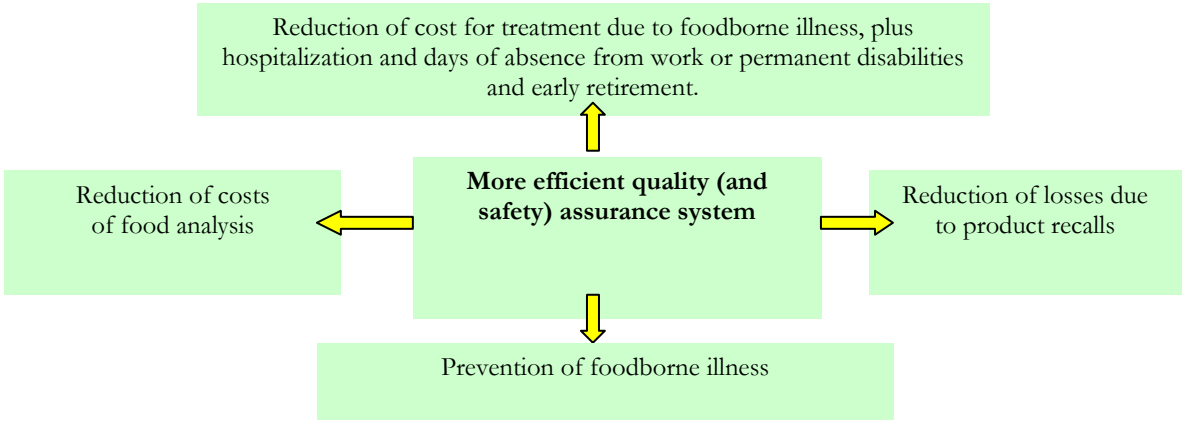
To assure that measures are carried out as determined, all-important actions are described and personnel is trained to carry them out. Actions have to be implemented without exception. To ensure that they are carried out correctly and to provide evidence of this, the results have to be recorded. At the same time those records also provide a basis for improvement.

7.3. OBJECTIVES

No matter the role and the importance of Governments in the implementation of HACCP, it should not be overlooked that HACCP was introduced by the food industries to obtain greater assurance for food safety.

It becomes clear that it is in industry's best interest to produce safe food. If people become ill after eating a company's product, it may lose its customers and its good reputation as well as large amounts of money. So the HACCP system is not meant to be an additional regulatory burden, but (rather), a tool for ensuring safety and preventing foodborne illnesses.

Graph 4: Objectives of application of the HACCP system



Therefore, HACCP objective is to enhance assurance in the food safety in order to prevent foodborne illnesses more efficiently. Additionally it will reduce the costs of control and wasted food and it will protect the reputation of the food processor and its entire industry.

7.4. AREAS OF APPLICATION

Application of the seven HACCP principles[i] means in practice that a HACCP team performs a HACCP study. Originally HACCP was a tool used in food industries on a voluntary basis. However, over the years it has been proved to have many applications. In addition to its

[i] *see HACCP System Principles*

application in food industries and food service establishments, the system has also been used in health education, and in food safety programme management. The areas of application are as following:

i. *In **food production**, processing, manufacturing and preparation it is applied as a method of food safety assurance.*

ii. *In **food control** it is used as an inspection tool to channel the resources to critical issues. Moreover the assessment of the HACCP plan in a food-producing unit automatically confirms that this unit is properly designed and effectively operated and conclusively there is no need to exercise any food control on the final product.*

iii. *In **education** it is used to study food preparation practices and to identify hazardous behaviour.*

iv. *In the **investigation of foodborne disease outbreaks** it may helps in identifying the cause of the outbreak.*

v. *In the **management of food safety programmes** it may identify those problems, which are of the greatest risk for the public health and prioritise interventions, which may have the greatest impact on the prevention of the problem.*

The *Codex Alimentarius* Commission has accepted the HACCP system as a primary tool to ensure the safety of foods.

7.5. DEVELOPMENT AND IMPLEMENTATION

Naturally before attempting to do HACCP, management support and commitment are needed. In addition to the final costs necessary for training, there may be also additional costs for acquiring necessary expertise, equipment and material. The stages in developing and implementing HACCP are:

i. *Perform a HACCP **study** during which the elements of the HACCP system in line with the 7 principles of HACCP are established.*

ii. *Develop a HACCP **plan**. This is a document that reflects the results of the study.*

iii. ***Train** personnel in their functions as determined by the HACCP plan.*

iv. ***Implement**[i] (=*To carry into effect*) the HACCP plan i.e. monitoring, taking corrective actions and verification.*

v. ***Verify** the HACCP plan.*

The *Codex Alimentarius* Commission guidelines describe how a HACCP study could be performed. These guidelines give a certain universal structure to a study, which will make it more likely to be accepted by other parties (food inspectors and trade partners). However, 7 principles should be applied taking into account specific conditions of size, sophistication of the process and the level of the food safety management system. These 7 principles are the minimum mandatory requirements in the application of the HACCP system. But before reporting the 7

[i] *The* Codex Alimentarius *Commission text does not give guidance on how to put the results of the HACCP study into practice. Therefore some industrial practices are provided.*

principles[i], all steps leading to the Hazard Analysis should first be analysed, which is the first principle of HACCP. **Appointment of the HACCP team** will go ahead with the appropriate activities. One of the first activities of this team is to **describe the product** (i.e. raw materials used, suppliers, parameters influencing safety, processing conditions, packaging performance, characteristics of the packaging materials.). Next, the **intended use** of the product should be defined (i.e. for caterings, hospitals, general population, exportation specific groups of the population etc.).

To understand how a product is manufactured, and to have a disciplinary approach in the study, it is important to construct a **flow diagram** covering all steps where product safety could be affected. In many food production and preparation establishments, different areas or rooms have different hygiene levels, and barriers, such as walls or air curtains separating them.

It is important to inspect the site and the practices applied during all hours of operation (even night shifts, weekends etc) as well as the cleaning procedures and validate their efficacy. During this inspection all potential hazards should be listed and a Hazard Analysis of the production and process should be performed by establishing Critical Limits for each Critical Control Point.

Let's now suppose that a specific plant is working under strict HACCP, conditions. In that case of course there is no need to perform microbiological examinations (for example) in any stage of production in order to verify that the product is free from pathogens. Still, pathogens may enter the premises on the raw material or in the potable water. It is therefore important for the manufacturer of the final product to make sure that every raw material or substance entering his plant is safe in any sense and meaning. In order to achieve this, the manufacturer of the final product should ask from the supplier of raw materials (especially for the edible ones), to provide written specifications for any ingredient they contain. Furthermore the manufacturer may conduct audits to validate the status of the vendor certification program. This activity certifies that every substance entering the plant has been manufactured/and or produced/and or transported under strict regulations and there is no need to proceed with microbiological or other tests in order to use it for the manufacturing of the final product. In any case that the manufacturer of the final product can't audit the supplier's plant (i.e. because of the distance-some exotic material may come from aboard), he always can ask the supplier to provide an assurance that the ingredients meet the specifications of the international standards. In this case the supplier should accompany his product with a GMP certificate attesting not only the concerned product but also the particular batch that has been manufactured and dispatched. This certificate should accompany the batch upon arrival in the plant or entry into the country.

Under the circumstances, one may say that even the potable water used for the manufacturing of the products should have a GMP certificate. This is not absolutely necessary because it is generally expected that, public water typically, maintain high quality standards for chemical and microbiological content. Considering, however, that water is used both in many food processes, such as to wash foods, to clean and sanitise facilities, utensils and equipment, to make ice as well as food ingredient, food processors should perform monitoring analyses to confirm the quality and store the results in their periodic control records.

7.6. BENEFITS

The HACCP system is a scientific, rational and systematic approach to identification, assessment and control of hazards during production, processing, manufacturing, distribution, preparation

[i] *The Seven Principles of HACCP are: (1) conduct of Hazard analysis; (2) Determine the Critical Control Points; (3) Establish critical limits; (4) establish a system to monitor control of the CCP; (5) Establish the corrective actions to be taken when monitoring indicates that a particular CCP is not under control; (6) Establish verification procedures; (7) Establish documentation concerning all procedures and records relevant to the HACCP principles and their application.*

and use of food to ensure that food is safe when consumed. With the HACCP system, food safety control, presently based on end product testing, is integrated into the design of the process. In general the HACCP system benefits can be described as follows:

- It is applicable to the whole food chain, from production of raw materials to the end product (e.g. growing, harvesting, processing, manufacturing, transport and distribution, preparation and consumption)
- It has few of the limitations of traditional approaches to food safety control[i].
- It has the potential to identify all conceivable, reasonably to be expected hazards, even when failures have not previously been experienced. It is therefore particularly useful for new operations.
- It is capable of accommodating changes introduced, such as progress in equipment design, improvements in processing procedures, and technological developments related to the product.
- It helps to target or manage resources at the most critical part of the food operation.
- It aids the relationships between food processors, inspectors and consumers.
- It promotes international trade by providing for equitable food safety control systems everywhere in the world.
- It increases confidence in food safety as it reduces detention, confiscation, and destruction of contaminated food shipments and
- It can be easily integrated into quality management systems such as ISO 9000.

Therefore, HACCP provides a foodborne disease prevention system and a cost-effective approach to food safety[ii].

Except for the general benefits of HACCP system that are referred above, one may focus to its specific benefits for the consumers, the industry and the governments.

a. Benefits to consumers

- Reduced risk of foodborne diseases
- Increased awareness of basic hygiene
- Increased confidence in the food supply and
- Improved quality of life (health and socio-economic)

b. Benefits to industry

- Increased consumer and/or government confidence

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[i] *Collecting and examining sufficient number of samples, high cost, time, identification of problems without understanding the causes, limitations of snapshot inspection.*

[ii] *Experiences gained in some countries indicate that application of HACCP systems leads to more efficient prevention of foodborne diseases. In the U.S.A, only, application of HACCP by the fish processors alone is estimated to avert some 20-60% of cases of sea-foodborne illnesses.*

- Reduced legal and insurance costs
- Increased market access
- Reduced production costs (reduced recall/waste of food)

- Improved product consistency
- Improved management commitment to food safety and
- Decreased business risk and liability

c. Benefits to governments

- Improved public health
- More efficient and targeted food control
- Reduced public health costs
- Trade facilitation (import/export)
- Increased confidence of the community in the food supply

7.7. DIFFICULTIES AND BARRIERS IN THE IMPLEMENTATION

There are barriers that impede HACCP's implementation at the national, business, and consumer level in each country. At the national level, legislative approval is required for mandatory implementation. At the business level, training and technology must be funded. At the consumer level, buyers may be resistant to necessary changes in national customs and habits. Once governments, businesses and consumers understand what is needed to assure food safety, each can then be a supporter of the HACCP system. The following points address the objections and barriers to the implementation of HACCP.

Government commitment is the most important factor in the development and the implementation of HACCP. Government awareness may be influenced by epidemiological data on foodborne diseases and food contamination and especially by the need for food safety and HACCP in order to export foods to other countries. Advocacy by international organizations, e.g. *Codex Alimentarius* Commission, WHO, FAO and World Trade Organization (WTO) may also help a government to commit.

Government intervention and an active help network to provide technical, scientific and educational support is necessary for success. Legal requirements vary from country to country. Large food industries in places other than the United States and the European Union, for example, may introduce HACCP without any legal coercion. Small businesses may need an active government intervention in order to promote and facilitate the change to a food safety management system. The government and the trade associations should provide help. This help and support may include education for the managers and staff, and/or scientific support. Whether HACCP is implemented under voluntary or mandatory schemes, the government should train regulatory authorities in HACCP for proper third party auditing.

Experts and technical support are necessary in the food industry. The most important human barrier for the implementation of HACCP is the lack of management commitment and understanding of HACCP systems. Therefore during the early stages of the HACCP plan development, businesses need to commit additional staff time and resources, for experts and technical support. Moreover the new food safety roles and responsibilities need to be explicitly identified and handled. For guidance on training and model curricula, reference is made to the WHO document entitled "*Training Aspects of the Hazard Analysis Critical Control Point System*[i]".

Appropriate infrastructure and facilities within the business itself and within the community are necessary for the implementation of HACCP. It is clear that no HACCP or GHP/GMP system can ever be implemented without roads, electricity and a safe water supply. It is the role of government to ensure that the appropriate infrastructure is in place before issuing a licence for a food business operation. Likewise business should ensure that premises, work surfaces and equipment are designed, constructed and maintained to facilitate cleaning and to minimise any possibility of cross contamination. In functioning, GHP is a precondition for an effective HACCP system implementation.

Customer and business demand: is a very important force for encouraging businesses to implement the HACCP system. Customers purchase food from reliable suppliers, transporters and retailers who have a food safety management system in place. As customers become better informed with regard to food safety, it can be expected that HACCP will be applied, or businesses will loose their customers to others who can answer the demands of the well-informed buyer. Therefore, businesses should ensure that they purchase food from appropriate suppliers, transporters and retailers who implement food safety management systems. This, together with a better-informed consumer creates a **demand** for the application of HACCP systems.

Costs versus benefits: Although the economic constraints are a serious barrier for the implementation of HACCP systems, the government and especially the industry, should take under consideration the long term savings from reduced public health costs, litigation due to food safety failures, and spoilage due to improved handling, storage etc. Therefore the costs to business to implement HACCP must be weighed against the possible losses due to food safety failures when HACCP is not in place. Management must be prepared for the initial costs and for the day-to-day operations of the HACCP plan for that particular industry. A team of experts will be acquired to make the plan and train the employees. There may be expenses in purchasing equipment and material, and making changes throughout as necessary. Both government and business will appreciate the long-term savings from reduced public health costs.

In small or less developed businesses, the government and the trade associations should provide expertise and technical support. This support may include education for the managers and staff, and/or scientific support where appropriate.

[i] Training Aspects of the Hazard Analysis Critical Control Point System (HACCP). Report of a WHO Workshop on training in HACCP. WHO/FNU/FOS/96.3. WHO doc, Geneva, 1999.

8. HAZARDS ANALYSIS, CRITICAL CONTROL POINTS AND CONTROL MEASURES

Hazard is a biological, chemical or physical agent, or a condition of food with the potential to cause an adverse health effect when present at an unacceptable level.

Hazard analysis[i] is the process of collecting and interpreting information on hazards and conditions leading to their presence to deciding which are significant for food safety and should be addressed in that particular industry's HACCP plan.

Hazards to food safety can originate from the raw materials, the line environment, and the personnel handling the food, but even if they enter the final product, this does not mean that their levels are always dangerous. Therefore, hazard analysis is a process of deciding whether potential hazards are significant and if they need to be controlled. During this process the hazard will be determined to be significant depending upon the levels present, the sizes or the doses of the hazardous agent. Furthermore, the effect of the agent varies with the food in which it is found and the susceptibility of the person ingesting it. Some agents, for example, are more dangerous than others and there is a great variety in the severity of the effect. However there is always a level below which the presence of an agent is considered to be acceptable. For most chemicals, a maximum residue level (MRL) has been established. For the establishment of acceptable levels for chemicals, risk assessment protocols have already been in use; for microbes these protocols are under development.

Biological agents include bacteria, viruses, moulds, parasites and toxin, whereas chemical agents may be various paints, or poisons used as pesticides or insecticides or the inner coating of cooking utensils. Foreign material such as pieces of glass, cork, wire, or clothes may be considered hazards, which escaped into the food during the processing, or packaging and they may cause perforation of the guts or suffocation in babies and children.

Potentially harmful agents are present in many raw materials, usually in very low levels. They become dangerous when their level, or the level of the toxins they produce, increases to a point where they may cause disease. Viruses and parasites do not multiply in food; the same is true for many natural toxins and chemicals. However there are also situations where chemical reactions may continue to occur; for example nitrosamine formation, which could present a hazard. To prevent this, the conditions leading to increase would be kept under control. If an agent is at a high level and processing is meant to decrease the level to an acceptable one, the conditions during processing should assure that the acceptable level is actually reached.

The HACCP system is very dynamic. During a HACCP study, only the existing situation, or the situation as it is expected to exist can be taken into account. Every change can introduce the hazard; thus, every change has to induce the hazard analysis reflex. It should be understood that once a HACCP plan has been established, it needs continuous "maintenance". Every new raw material may bring a new hazard. Therefore potential new hazards have to be analysed during and directly after industrialisation.

Hazard analysis determines which agents could be present in the food study. Epidemiological data have linked foods with particular foodborne pathogens, chemical or physical hazards, (for example, canned food and *Clostridium botulinum*, eggs and *Salmonella*, milk and the *Mycobacterium bovis* responsible for tuberculosis). These agents may be present in the raw material, but their levels may not be high enough to cause disease. To decide whether the presence of an agent in the raw material is a significant hazard, we have to know the levels at which it may cause disease.

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[i] Codex Alimentarius *Commission definition of Hazard Analysis (1997)*

We also have to know which conditions can cause a pathogen to increase to an unacceptable level, the severity or magnitude of a health effect caused by this pathogen, and, finally the likelihood of its occurrence.

Potential hazards can be present in raw materials and in ingredients, or may be introduced or increase during processing. A product formulation may allow a pathogen to multiply to unacceptable levels, i.e. to become a significant hazard. Packaging may prevent a food from recontamination but may also create conditions favouring pathogen growth. Storage and distribution of perishable foods may create hazards. The growth of pathogens increases significantly at temperatures above 5-60^0 C. Foodborne illness sometimes results from improper preparation and use. Finally the consumer's susceptibility influences the severity and the probability of occurrence of a foodborne disease. When a food product is targeted at the very young, the very old or people with certain diseases, potential hazards often become significant hazards. For instance, a healthy person normally can consume low levels of *Listeria monocytogenes* without becoming ill; for immuno-suppressed person, these doses may be dangerous.

8.1. CLASSIFICATION OF HAZARD ACCORDING TO THE RISK AND SEVERITY (HAZARD INDEX)

Priorities must be assigned to address contaminants in a rational and cost-effective way. These criteria can be used to establish priorities for food safety control activities. Although food safety emergencies always have highest priority, sound public health planning must rest on science and on objective assessments of risks and cost-effective possibilities for their reduction.

One of these criteria, and perhaps the most important from the public health point of view, is the severity of potential effects of a contaminant on health. Therefore in order to classify a hazard we should take under consideration its Risk and Severity according to the following table.

Table 6.: A Hazard Index according to the risk and severity

Risk (R)	**Severity (S)**	**Hazard Index (HI)**
Maximum likelihood = 5	Lethal hazard = 5	Maximum value = 25
Medium likelihood = 3-4	Severe hazard = 3-4	Medium value = 9-16
Minimum likelihood = 1-2	Minimum hazard = 1-2	Minimum value = 1-4

Hazard Index = risk x severity

8.2. ASSESSMENT OF RISK IN HAZARD ANALYSIS

Evaluating the *likelihood of occurrence* of the hazard is the most difficult aspect of Hazard Analysis.

It is possible for instance, that *Salmonella* is present in any number of raw materials; but is its presence probable or likely or reasonably expected to occur?

The choice of descriptive wards reflects an assessment of the likelihood of occurrence, which is one of the elements of the assessment of risks. Another part is the assessment of whether the reduction of a hazard is adequate, acceptable or unacceptable.

The table below shows some of the contaminants listed on the basis of risk severity.

Table 7.: Contaminants listed on the basis of severity of risk

MICROORGANISMS AND PARASITES	CHEMICALS
Severe hazards	***Naturally occurring chemicals***
Clostridium botulinum types A,B,E and F	*Mycotoxins (e.g. aflatoxin)*
Shigella dysenteriae	*Scombrotoxin (histamine)*
Salmonella typhi; paratyphi A, B	*Ciguatoxin*
Hepatitis A, E	*Mushroom toxins*
Brucella abortus; suis	*Shellfish toxins* *Paralytic shellfish poisoning (PSP)* *Diarrheic shellfish poisoning (DSP)* *Neurotoxic shellfish poisoning (NSP)*
Vibrio cholerae 01	*Amnesic shellfish poisoning*
Vibrio vulnificus	*Pyrrolizidine alkaloids*
Taenia solium	*Phytohemagglutinin*
Trichinella spiralis	*Polychlorinated biphenyls (PCBs)*
Moderate hazards (Extensive spread)	***Added chemicals***
Listeria monocytogenes	*Agricultural chemical*
Salmonella spp.	*Pesticides, fungicides, fertilisers, insecticides, antibiotics, heavy metals, ink from seals and labels, PCG's, packaging materials, pigments, disinfectants, cleaners, growth hormones etc.*
Shigella spp.	*Prohibited substances (21 CFR)* *Direct* *Indirect*
Enteovirulent E. coli (EEC)	*Toxin elements and compounds* *Lead, zinc, arseni, mercury and cyanide*
Streptococcus pyogenes	*Food additives* *Direct – allowable limits under GMPs legal restrictions* *Preservatives (nitrite and sulphating agents)* *Flavour enhancers (monodium glutamate)* *Nutritional additives (niacin)* *Colour additives*
RotavirusNorwalk virus group	*Secondary direct and indirect* *Plan chemicals (e.g. lubricants, cleaners, sanitises, cleaning compounds, coating and paint)*
Entamoeba histolytica	*Maintenance materials* *……surface paints* *……machine lubricants*
Diphylobothrium latum	
Ascaris lubricoides	*Chemicals intentionally added (sabotage)*
Cryptosporidium parvum	
Moderate hazards (Limited spread)	
Bacilus cereus	
Campylobacter jejuni	
Clostridium perfrigens	
Staphylococcus aureus	
Vibrio cholerae, non-01	
Vibrio parahaemolyticus	
Yersinia enterocolitica	
Giardia lablia	
Taenia saginata	

8.3. PHYSICAL HAZARDS

As physical hazards are considered all foreign material slipping accidentally into the food, such as metal, glass, bone, feathers, teeth, hair, nails, nut-shell, eggshell, rodents dead bodies, insects, parasite eggs, grit, sand, and rarely medical or cleaning equipment needles, wire, thermometers, bottles, or even personal equipment (rings, hairpins).

In order to protect the product from the above hazards entering the premises through the raw material, one should take different steps for each hazard. For chemical and biological hazards a GMP certificate should accompany if possible all products and raw material entering the plant. This way we can be sure that everything entering the plant is safe and it should remain safe during the process. In order to verify that all raw materials are safe we may perform a formal inspection in the source of every raw material and check the implementation of the HACCP. For physical hazards beyond the GMP certificate, a visual inspection upon the entrance, metal detectors, magnets and filters depending on the substance may be of great help. However from the point of entrance and after, the responsibility lies on the owner of the plant who should insure that there is a creditable HACCP system working 24 hours per day.

Example: Raw meat

Meat is subject of contamination at the moment of slaughter and evisceration. It is well known that the digestive tract of all animals and birds as well as their skin and feathers are the major source of contamination for meat and poultry. This usually happens when the evisceration is not performed properly and the contents of the digestive tract are poured on the surface of the carcass. Further washing of the carcass only helps in the spreading of the contamination to other parts of the carcass or to adjacent carcasses. Salmonella among a large variety of pathogens is transmitted through evisceration. Therefore the implementation of HACCP in the slaughterhouses is a matter of paramount importance[i]. However it is very difficult to restrain the spread of pathogens in the slaughterhouse especially in case that, most of the slaughtered animals are loaded with pathogens! For this reason HACCP is starting at the farm level - and even before (production of feedstuff, control of water sources etc). In England, Denmark, and other EU countries are still implemented programs for the control of Salmonellosis in poultry farms.

These programs are considered as a part of the HACCP system on farm level, which actually starts with the entrance of foodstuff in the farm (checking of GMP certificates of the producer) and ends with the serological examinations of animals, little before they will live the farm for the slaughterhouse (including transportation).

This practice can reduce the initial load of pathogens and consequently help in the control of salmonella in the slaughterhouse and beyond. In practice, control of salmonellosis usually means control of many other pathogens (such as *Campylobacter jejuni*) causing foodborne diseases, since Salmonella is often used as an indicator for the confirmation of the effectiveness of HACCP systems.

Let's suppose that the entering raw product is raw meat (beef, swine or poultry) arriving either directly from the slaughterhouse or from a storehouse. The responsible person should check the new batch upon arrival in the plant. First he can perform a visual inspection of the truck/containers. During this inspection he may "feel" or even count with a thermometer the temperature of the truck and see with his own eyes the conditions (cleanliness) during the

i Other pathogens transmitted from the digestive tract to the surface of meat are: Listeria monocytogenes, Clostridium botulinum, Staphylococcus aureus, Bacillus cereus, E. coli 0157:H7 etc.

transportation. In this way he may assure that the raw material has been transported under the proper conditions and theoretically has not been contaminated with microorganisms or foreign material. He can also be sure that the temperature at the arrival was the proper and therefore the existing microorganisms have not multiplied during the transportation. Then he should check all papers (GMP certificates) and make sure that this is the proper lot. Finally he can supervise for the proper transportation and storage of the meat into the plant making sure that the product is stored in the correct temperature and position according to his HACCP system papers.

By the end of this procedure, the first step has been successfully completed – the raw material is clean, safe, and properly stored. The second step is the process of the product until the attainment of the final product. The third step is the proper marking of each batch, the proper storage and finally the transportation to the final point (whether this is a supermarket or a restaurant). Unloading and signing the papers of acceptance conclude the HACCP system of the Plant. From now on the responsibility of the safety lies on the Super market or the Restaurant or farther more the final consumer who is responsible for the storage, handling and cooking of the product according to directions on the label.

Usually hazards exercise slight and undetected adverse health effects to the consumers, but sometimes they may cause serious health problems or even death to individuals or to a large number of people, depending on the case. In general we may list these adverse health effects as following:

Acute illness: Choking
Vomiting
Abdominal cramps
Diarrhoea
Nausea
Fever

Chronic illness: Chronic infections
Damage of various organs
Some Cancers

Death

Factors contributing to foodborne illness

There is a vast number of factors contributing to foodborne illness. In brief we mention below only a few of them, such as the factors depending on the pathogen (*e.g. infective dose, virulence of strain, vegetative spores or cells*), or the host *(e.g. age, immune status, gastric acidity, Immuno-competence, nature of gut flora, pregnancy*), or the nature of the food itself (*acidity, presence of fat, etc*).

In the first category there are some other sub-classifications affecting the pathogenic agent such as the temperature and time of cooking or preserving, the pH, the water activity, the oxygen tension, the preservatives, or even the microbial interactions.

Unclean equipment is often a source of foodborne pathogens. Raw materials that are eaten fresh or insufficiently cooked are another source. In other cases pathogens find their way into food through insects, rodents or other pests. Aerosols from cleaning dirty surfaces with jet sprays carry pathogens from unclean areas into foods. Condensation droplets falling down from cold overhead pipes do the same. Infected food handlers infect food with their hands. Foods that are

often insufficiently cooled or not held at hot enough temperatures, so the pathogens are allowed to multiply, are the sources of many epidemics of foodborne diseases as well.

Some factors contributing to foodborne illness, in industry and at home.

A large number of foodborne diseases outbreaks are due to mishandling both in the production sites and the consumer's home. If we know why these incidents occur, we can apply control measures.

In industrialised countries, most outbreaks can be traced to food service establishments (restaurants, institutions) and to the home. Industrially processed foods and retail foods are less likely to be involved in outbreaks, but when they occur they often involve a large number of cases.

In developing countries, a significant proportion of cases occur in homes or after eating food purchased from street vendors. There are of course many outbreaks of undetermined origin.

Controlling growth of microbes – Control Measures

Various biological and chemical agents are usually and even normally present in the food without causing adverse reactions to health. This happens because they may be in such a small quantity that can be easily confronted by the biological or mechanical defences of the host. Therefore if the agent is present in a food at a low, acceptable level[i] the concern of the HACCP plan is to keep it under this level preventing its increase. If unlikely, the agent present in the food is over the harmless level, then the HACCP plan should propose a way to assure its reduction to/or beyond the acceptable level. This "way" is generally called "Control Measures".

Therefore, "Control Measures" are the actions or activities that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level. At this point it is very useful to specify the word "Control" when used isolated in a HACCP system.

Table 8 - Need for the growth of pathogens and Control measures.

Need for the growth	**Control measures**
Nutrients	Clean surfaces
Water	Dry surfaces
Temperature	Food kept hot or cold
Time	Short holding time

When using the **verb** control[ii], we mean to take actions (direct, regulate, command), in order to ensure and maintain compliance with the criteria established by the specific HACCP plan. When we use the **noun** control, we mean that we have the things under control (because the correct procedures are being followed and criteria set by the HACCP plan are being met). Accordingly we can use the word control (noun or verb) in order to specify the "**Hazard Control**" that has

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[i] *Some agents are more dangerous than others, and there is a great variety in the severity of the effect. To this concept, not all levels (or sizes) of all agents are harmful to all individuals under all conditions. Therefore agents (contaminants) are acceptable as long as their levels remain below a certain maximum.*

[ii] *In HACCP, the word "control" does not mean in any way: to check or to test!*

been taken already (noun) or are been taken now (verb) in order to prevent or eliminate a food hazard or reduce it to an acceptable level (*i.e. prevent the product from contamination, prevent the increase of the hazard over the acceptable level, decrease the hazard to/or beyond the acceptable level, prevent from recontamination, prevent of dissemination of the hazard to adjacent or other working grounds*).

In order to achieve the "control of a hazard", one should perform a "**Hazard Analysis**" which is the process of collecting and interpreting information on hazards and conditions leading to their presence. Under this process, one may decide which hazards or conditions leading to specific hazards are significant and therefore should be addressed in the HACCP plan.

A Hazard Analysis should be performed during:

- product development
- industrialisation of a new product
- when specific hazards emerge
- when new raw material are used
- when formulation or use is changed
- when equipment is changed
- when a new production area is used

Points that should be considered while performing a hazard analysis include:

- The likely occurrence of hazards and the severity of their adverse health effects
- The qualitative and/or quantitative evaluation of the presence of hazards
- Survival or multiplication of microorganisms of concern
- Production or persistence in foods of toxins, chemicals or physical agents
- Quality of raw materials
- Conditions leading to the above and identification of control measures

Questions to be considered in a Hazard Analysis

The hazard analysis consists of a series of questions, which are appropriate to each step in a HACCP plan. It is not possible in these recommendations to provide a list of all the questions, which may be pertinent to a specific food or process. The hazard analysis should question the effect of a variety of factors upon the safety of the food.

a. ***Ingredients***

- *Does the food contain any sensitive ingredients that may present microbiological hazards (e.g. Salmonellae, Staphylococcus aureus), or chemical hazards (e.g. aflatoxin, antibiotic or pesticide residues) or physical hazards (e.g. stones, glass, metal)?*
- *Is potable water used in formulating or in handling in food?*

b. ***Intrinsic Factors***

- *What are the physical characteristics and composition (e.g. pH, type of acidulents, fermentable carbohydrate, water activity[i], preservatives) of the food during and after processing?*
- *Which intrinsic factor of the food must be controlled in order to assure food safety?*
- *Does the food permit survival or multiplication of pathogens and/or toxin formation in the food during processing?*
- *Will the food permit survival or multiplication of pathogens and/or toxin formation during subsequent steps in the food chain?*
- *Are there other similar products in the market place? What has been the safety record for these products?*

c. ***Procedure used for processing***

- *Does the process include steps destroying pathogens both vegetative cells and spores?*
- *Is the product subject to recontamination between processing (e.g. cooking, pasteurising) and packaging*

d. ***Microbial content of the food***

- *Is the food commercially sterile (e.g. low acid canned food)?*
- *Is it likely that the food will contain viable sporeforming or non-sporeforming pathogens?*
- *What is the normal microbial count of the food?*
- *Does the microbial population change during the normal time the food is stored prior to consumption?*
- *Does the subsequent change in microbial population alter the safety of the food, pro or con?*

e. ***Facility design***

- *Does the layout of the facility provide an adequate separation of raw materials from ready-to-eat foods if this is important to food safety?*
- *Is positive air pressure maintained in packaging areas? Is this essential for product safety?*
- *Is the traffic pattern for people and moving equipment a significant source of contamination?*

f. ***Equipment design***

- *Will the equipment provide the time-temperature control that is necessary for safe food?*
- *Is the equipment properly sized for the volume of food that will be processed?*
- *Can the equipment be sufficiently controlled so that the variation in performance will be within the tolerances required to produce a safe food?*
- *Is the equipment reliable or it is prone to frequent breakdowns?*
- *Is the equipment designed so that it can be cleaned and sanitised?*

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[i] *Microorganisms need available water to grow, which is not bound with other molecules in the food. The term water activity (A_w) describes the available water needed for the microbial growth and ranges between 0 – 1.0. The lowest A_w at which a harmful bacteria can grow is 0.85 (the most favour A_w is between 0.97 and 0.99).*

- *Is there a chance of product contamination with hazardous substances (e.g. glass)?*
- *What product safety devices are used to enhance consumer safety? (metal detectors, sifters, filters, screens, thermometers, de-boners, dud detectors)*

g. ***Packaging***

- *Does the method of packaging affect the multiplication of microbial pathogens and/or the formation of toxins?*
- *Is the package clearly labelled "Keep refrigerated" if this is required for safety?*
- *Does the package include instructions for the safe handling and preparation of the food by the end user?*
- *Is the packaging material resistant to damage thereby preventing the entrance of microbial contamination?*
- *Does each package and case contain the proper label and code?*

h. ***Sanitation***

- *Can sanitation impact upon the safety of the food that is being processed?*
- *Can the facility and equipment be cleaned and sanitised to permit the safe handling of food?*
- *Is it possible to provide sanitary conditions consistently and adequately to assure safe foods?*

i. ***Employee health, hygiene, education***

- *Can employee health or personnel hygiene practices impact upon safety of the foods being processed?*
- *Do the employees understand the process and the factors they must control to assure the preparation of safe foods?*
- *Will employees inform management of a problem, which could impact upon safety of the food?*

j. ***Conditions of storage between packaging and the end user.***

- *What is the likelihood that the food will be improperly stored at the wrong temperature?*
- *Would an error in improper storage lead to a microbiologically unsafe food?*

k. ***Intended use***

- *Will the food be heated by the consumer?*
- *Will there likely be leftovers?*

l. ***Intended consumer***

- *Is the food intended for the general public?*
- *Is the food intended for consumption by a population with increased susceptibility to illness (e.g. infants, the aged, the informed, immunocompromised individuals)?*

Critical Control Points (CCPs)

The Hazard Analysis will determine the Critical Control Points (CCPs[i]) of raw materials in different locations of the process no matter what the practice or the procedures used for the development of the product are. A **Critical Control Point** is a step[ii] in the food chain where activities are carried out, or conditions prevail, which can have an influence on the safety of the product, and where control can be exercised over one or more factors to prevent or eliminate a food safety hazard or reduce it to an acceptable level. Therefore the Hazard Analysis by determining the CCPs in the food chain helps the team to establish **Critical Limits** for each CCP, or in other words, to establish criteria, which separate acceptability of the product from unacceptability. The CCPs are usually standard procedures (such as pH, a_w, temperature, time), Maximum Levels (of contaminants), Limits in microbial criteria, Levels of cleanliness, Levels of chlorine, pressure etc.

Then the team establishes a **Monitoring system** for each CCP in order to observe and/or measure its functions and parameters and assess whether the specific CCP is under control.

Monitoring

Monitoring should aim to detect any deviation from the established criteria. It usually depends on observations, or physical or chemical measurements (e.g. temperature, pH, concentration of salt).

Monitoring is an essential element of "controlling hazards" and it has to be carried out by the person (operator) in charge of the control measure at the CCP. In other words monitoring means the regular measuring and recording of values at predetermined intervals. These values are the parameters used to assure that a situation is under control. As a consequence the hazard is reduced to an acceptable level where no unacceptable growth occurs and therefore, every unacceptable contamination is prevented.

Monitoring of critical control points is essential to ensure that specific criteria are being met. Foods can be monitored in many ways depending on the type of control point and the instruments and equipment available.

Monitor is the act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control

In order to monitor, we need to set critical limits and determine which methods can be used to check whether a CCP is under control. When critical limits are exceeded, then corrective actions have to be taken; these actions must be described in the HACCP plan.

Through the monitoring system the team establishes the method or the equipment to be used in this CCP, the intervals or the frequency of checking, and finally the interpretation of the results and the actions to be taken.

Continuous monitoring

Ideally, measurement and testing should be done continuously. An example is the continuous measurement and recording of the acidity or pH obtained during fermentation. Such a recording shows that small fluctuations always occur. This reflects the normal treatment variations. In process control terminology, we call the arithmetic mean of the values the "target level" and two

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[i] *The difference between CCP_1 or $CCP_{e\ (=elimination)}$,$CCP_{p\ (=prevention)}$, $CCP_{r\ (=reduction)}$ does no longer exist.*

[ii] *Step in HACCP is a point, procedure, operation or stage in the food chain, including raw materials, from primary production to final consumption.*

or more standard deviations determine the upper and lower control level. Under optimal conditions, there should be sufficient distance between the upper (or lower) control level and the critical limit, to ensure that the critical limit is not surpassed in normal operational conditions.

Critical limit

The critical limit should not be exceeded; otherwise the safety of the product cannot be assured. By definition, the critical limit separates acceptability from unacceptability in terms of risks for the consumer wherever possible.

Critical limits can be all kind of parameters. Physical parameters such as pH, a_w, temperature and time are usually preferred as they can be measured continuously and "in line". Critical limits may also be established for other process parameters such as absorbed radiation dose, level of disinfectant or antimicrobial agents, over-pressure in heat exchanger, or over-pressure of air in a clean room. However, critical limits can also be Maximum Residue Levels for pesticides or Maximum Levels of chemicals set by Public Health Authorities and *Codex Alimentarius*. Also, limits in microbiological criteria of pathogens or indicators may be taken as critical limit, although they are often of little practical use.

The selection of parameters for which critical limits have to be established requires an in-depth understanding of the technologies used for controlling the hazards and the processing. For instance, for chlorination of water, it is important to monitor not only the residual chlorine but also the contact time, pH and turbidity of the water.

In order to determine the Critical Limits, let us take the example of pasteurisation of milk.

Normally, the milk is heated at 73°C for 15 seconds. This temperature treatment assures that levels of pathogens such as *Mycobacterium bovis, Salmonella, Listeria monocytogenes* and *Campylobacter* are reduced sufficiently to guarantee that the product is safe. When the temperature drops a few tenths of a degree, the number of microorganisms will still be reduced sufficiently; there is a safety margin. But at a certain point, the deviation becomes too large and safety is not assured. This unacceptable deviation determines the critical limit. Milk produced with a temperature lower than the critical limit should not reach the consumer. This is an easy example because it deals with thermal treatments of known bacteria in an easy-to-control situation. Many other situations are less easy to control (for instance re-contamination) and determining a deviation from "normality" is much more difficult.

Microbiological process control

HACCP was developed in the food processing industry because it was known that controlling processing conditions gives a better assurance of the product's safety than testing the final product. For example, it is more effective to control retorting time and temperature in canning, because even serious under-processing cannot normally be detected by microbiologically testing of the end-product. Microbiological process control means having control over conditions, which may lead to unacceptable events. Such events are unacceptable growth, survival, and spread or contamination of/with undesirable microorganisms. The word "unacceptable" is important because some growth, survival and even spread or contamination can always occur.

Table 9.: Examples of Preventive Measures for Biological Hazards

Pathogen	Preventive Measure or Control
Bacillus cereus	Proper holding and cooling temperatures of foods. Thermal processing of shelf-stable canned food
Campylobacter jejuni	Proper pasteurisation or cooking; avoiding cross contamination of utensils, equipment, freezing, atmospheric packaging
Clostridium botulinum	Thermal processing of shelf-stable canned food; addition of nitrite and salt to cured processed meats; Refrigeration of perishable vacuum packaged meats; Acidification below pH 4.6; reduction of moisture below water activity of 0.93
Clostridium perfrigens	Proper holding and cooling temperatures of foods; Proper cooking times and temperatures
Escherichia coli 0157:H7	Proper holding and cooling temperatures of foods; Proper cooking times and temperatures
Listeria monocytogenes	Proper heat treatments; rigid environmental sanitation programmes; separation of raw and ready-to-eat production areas and/or product. This may be included in the sanitation SOPs.
Salmonells spp.	Proper heat treatment; separation of raw and cooked product; fermentation controls; decreased water activity; withdrawing feed from animals before slaughter; avoiding exterior of hide contacting carcass during skinning; antimicrobial rinses; proper scaling procedures; disinfecting knives
Staphylococcus aureus	Proper fermentation and pH control; proper heat treatment and post-process product handling practices; reduced water activity
Yersinia enterocolytica	Proper refrigeration; heat treatments; control of salt and acidity, prevention of cross-contamination.

Deviation

A deviation is a failure to meet a critical limit. According to the *Codex Alimentarius* terminology, deviation means a loss of control. For the purposes of this lecture however, the word deviation will be used for any situation, which is not "normal".

The last question to be asked for each CCP and each hazard is "what the appropriate reaction to a deviation should be"? This will help to define corrective actions.

Corrective actions

When a deviation occurs, corrective actions have to be taken. In the latest text of *Codex Alimentarius*, corrective actions are only those actions, which are taken when a CCP is out of control; thus, when a critical limit is exceeded. However here we will use the term "corrective action" to apply also to situations where critical limits were not exceeded, and where the corrective action was used only to make minor readjustments.

Specific corrective actions must be developed for each CCP in the HACCP system in order to deal with deviations when they occur. The actions must ensure that the CCP has been brought under control. Actions taken must also include proper disposition of the affected product.

Deviation and product disposition procedures must be documented in the HACCP record keeping.

Corrective actions should ensure that only safe products reach the consumer.

Various corrective actions may be necessary. There is still some ambiguity in the use of the terminology "corrective actions", but the final result should be that safe products reach the consumer.

Ideally, corrective actions should readjust deviations before they become unacceptable. They should ensure that the product produced during a situation that is out of control does not reach the consumer, and they should also prevent reoccurrence of the event. This may mean that the process has to be redesigned, or that a monitoring frequency method or a target level has to be changed; in other words, the HACCP plan should be improved.

HACCP Plan

Is a document prepared in accordance with the principles of HACCP to ensure control over hazards, which are significant for food safety in a segment of the food chain under consideration. The goal of this activity is to assess the compliance with product/process description, to process flow diagram, to assess and identify the most significant hazards, to correct identification of all hazard sources, to identify all Critical Control Points, to monitor the programme (frequency, methods, equipment etc), and evaluate the quality of information gathered through records.

The term "HACCP plan" has been used several times. The *Codex Alimentarius* definition describes what a HACCP plan is. It indicates what needs to be done, when and where. It is the basis of documentation, which can be shown to food inspectors and auditors. Normally, a flow chart with CCPs is attached. It is the result of a HACCP study; it is specific to a production site and product, and must be rigorously implemented. Since the HACCP plan is specific, each change and its potential impact on safety, should be studied and the HACCP plan should be modified when necessary. The results of a HACCP study are also presented in a condensed form in a HACCP data sheet. (see below)

Table 10.: a HACCP data sheet

Raw Materials	Hazards	Control Measures	CCP Parameters	Critical limits	Target Values	Monitoring Procedures	Corrective Actions
Process step	Hazards	Control measures	CCP Parameters	Critical Limits	Target Values	Monitoring Procedures	Corrective Actions

This sheet lists all CCPs and their associated hazards, the control measures, the parameters assuring the control, the critical limits and target values which need to be monitored, as well as the monitoring procedures and the corrective actions. Therefore it gives auditors and inspectors a quick insight into the decisions made during the HACCP study.

In order to collect objective evidence, it is necessary to proceed to Record review. This activity is consisted in the examination of records maintained by the undertaking. The information achieved will be useful for the auditor to determine if the HACCP system is being implemented as described and is effective on a continuous basis.

In a HACCP plan we should establish a record[i] keeping and documentation concerning:

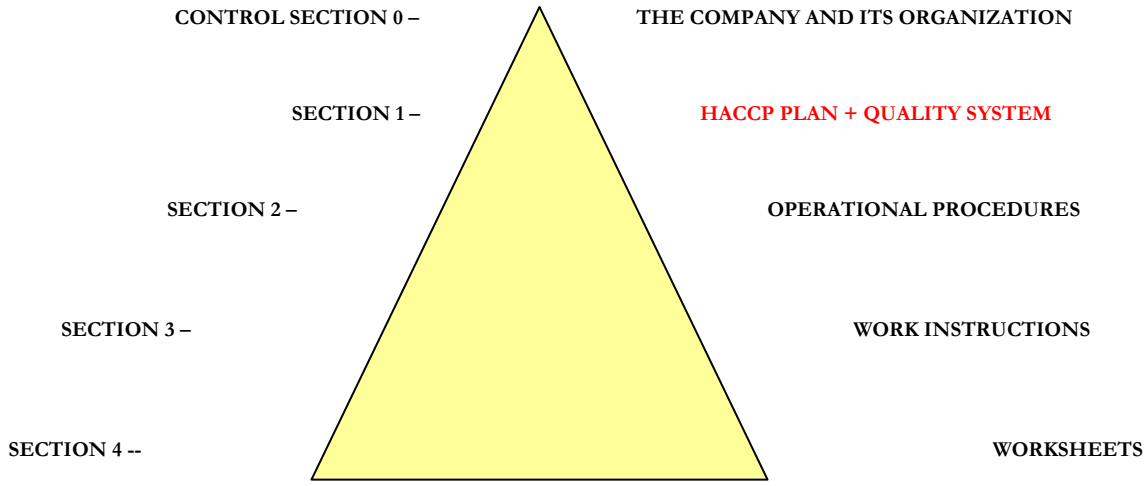
- Minutes of HACCP study meetings, (decisions made and their reasons)
- Records of monitoring
- Records of verification
- Records of deviations and corrective actions
- Records of modifications to the HACCP plan

In other words, issuing a HACCP plan (documenting the analysis of risks, defining control points and relevant control methods, etc) is not enough; a description of the firm's organisation and its basic "working rules" connected to the production process control is also necessary. The structure of system documentation must be chosen on a "case by case" basis, according to the firm's real needs. Main criteria used are:

- *Company Complexity and Number of Products: The HACCP Control System must suit the firm's dimensions and guarantee its effectiveness in all cases (system's documentation needed for a small firm producing only one type of product will be minimal, while, for a large industrial Company, documentation will be more complete and detailed for the various products/process.*
- *Existence of the quality system: A quality system developed according to ISO 9000 standards includes a complete documentation, structured on 4 levels: a) Quality system manual, b) Operational procedures, c) Work instructions, d) Worksheets for quality records. Such documentation already covers some elements of the HACCP Control System. Therefore the problem is to integrate the HACCP control System into the Quality System. This applies especially to medium and large firms wanting to develop a complete Quality System according to ISO 9000 Standards and wanting to integrate the HACCP Control System into this Quality System.*

[i] *Records are operative sheets regarding: Incoming materials (raw material, ingredients), Process parameters (temperature, time), Finished product, Cleaning and sanitising, Pest control, Employee Training as well as Other record-keeping document such as microbiological/chemical test results, calibration certificate, complaints documents, finished products rejected, hours for equipment maintenance and results of internal/external audits*

Graph 5.: Point of integration of a HACCP Plan and a Quality system



The operational procedures of a HACCP plan

They describe the rules and responsibilities of an operational process. The procedures are generally interfunctional (they often involve more than one organisational function). The choice of "which" and "how many" procedures to develop depends on the company's complexity and size. The following is a possible list of Procedures:

Table 11.: Possible list of Procedures of a HACCP plan

1	Document issuing and control
2	**Purchasing control**: All purchased products, significant from the quality point of view, must be under control. This control must include: suppliers' evaluation and selection, clear definition of suppliers' requirements, and verification of purchased product.
3	**Sanitising** = control and improvement of working environment conditions (e.g. cleaning, disinfecting, pest control, improvement of temperature, humidity, light, noise etc.) Premises, equipment and tools should be cleaned and disinfested: All facilities, equipment and tools involved in the production process must be cleaned and disinfected. These activities should be proved and documented. **Cleaning** = removal of dust, undesired materials or dirt from surfaces, objects, defined surfaces and their surrounding areas. **Disinfecting** = destroying or inactivating pathogen microorganisms from defined surfaces and their surrounding areas.
4	**Rat and pest control**: The aim of this procedure is to guarantee that all pest and rat control activities carried out on the Firm's premises are performed according to specific given indications. The procedure guarantees that all production steps, all storing activities of food and packaging materials, are performed in a clean working environment, using clean equipment and tools; the procedure also identifies operators responsible of such activities.

5	**Personal hygiene**: This instruction applies to all personnel directly involved in production as well as all management staff occasionally in contact with products being processed. All personnel should have a "health register" recording all sanitary data, which has to be renewed every year. Health registers are kept in administration in order to keep track of documents, which have to be renewed. In case of illness (respiratory problems, skin diseases, etc,..) employees are suspended from work until recovery. Among others, personnel should not be eating, smoking, spitting, or chewing in the working areas; Overalls or other clothes must not be reused once they have been thrown into dirty clothes bins. Before starting work, after any interruption and whenever necessary, operators must accurately wash their hands using hot water and liquid antiseptic soap and then dry them accurately with paper towels.
6	**Personal training** involves specific technical and technological knowledge relevant to the operators' tasks. This education is aimed at the development of capabilities coherent with the assigned position. Personnel have to be trained on activities performing procedures and modalities in compliance with proper hygienic sanitary procedures.
7	**Machinery and equipment maintenance**: All machinery involved in the production process must be efficient. It is required to: Identify, register and list all equipment and machines. Define specific maintenance requirements to each equipment or tool. Define responsibilities. Prepare a form to each equipment in which to register every preventive and corrective maintenance performed
8	**Calibration of measuring equipment**: It is essential to guarantee the proper control of the product.
9	**Product identification and traceability** To IDENTIFY means to associate to a member of a population a series of Identification Data, which allow to distinguish it from the other members of the population (*if for example we like to identify a live bovine animal then the identification data should be its European Union identification number which identifies nationality, origin, breed, etc*). To TRACE means to reconstruct the product's history, identifying all its components and the relevant suppliers, the processes and the operators involved, the customers, which have bought it.
10	**Water supplies**: Aim of this procedure is to guarantee that the water used in the firm does not compromise the product's hygienic and sanitary aspects. It is applied to all activities relevant to water supplies used in all processing steps and in cleaning and sanitising activities. The results must be available for audits/inspections by the competent authority and filed for 2 years period in the Firm's archives.
11	**Processing residues and garbage**: All waste produced during processing steps and empty containers of cleaning products will not become a contamination source for environment and foods. People responsible for these activities are also identified. This procedure applies to all reception, preparation, service, cleaning, sanitising, pest control activities performed in the firm, which will produce waste. Waste disposal is managed according to the type of waste/garbage and the requirements of legislation in force.
12	**Control of "non-conforming" product and procedures**: Processes and products can sow "non-conformities". In such cases we should prevent unwanted use of non-conforming product and trace back and/or recall the product already distributed. We also should notify non-conformity cases
13	**Corrective and preventive actions**
14	**Internal system audits**

HACCP System (preliminary phases)

A HACCP system is a scientific and systematic method aimed to assure food safety. This method is based on "prevention" from the stage of primary production to the final consumer and it is

performed through identification assessment and control of hazards significant for food safety. Otherwise, HACCP is an internationally accepted instrument that allows obtaining the hygienic aspects of food quality.

According to another relative definition, HACCP system is a scientific, rational and systematic approach to ensure food safety through identification, assessment and control of the hazards, significant for food safety, from primary producer to final consumer.

However, prior the application of HACCP to any sector of the food chain, that sector should be operating according to the *Codex Alimentarius* General Principles of Food Hygiene, the appropriate Codex Codes of Practice, and appropriate food safety legislation. In the development of a HACCP plan, five preliminary steps need to be accomplished before applying the HACCP principles to a specific product and process. These tasks are as follows:

i. *Assemble the HACCP team*

ii. *Describe the row material*

iii. *Describe the food*

iv. *Describe the intended use and consumers of the food*

v. *Develop a flow diagram which describes the progress*

vi. *Verify the flow diagram*

Assembling the HACCP team, is the first and most important phase for the implementation of a HACCP system. Although it is not the intention of this document to analyze the preliminary phases of HACCP, we feel that we should introduce the reader to, at least, the organization and activities of a typical HACCP team.

HACCP Team

In order to work out with a HACCP system we should assemble a HACCP team. The team should be familiar with overall food operation and the specific production process to be included in the plan. Therefore the team's goal and each member's responsibilities in reaching that goal must be clearly defined. The first duty of the team is to gather the information essential to the HACCP plan construction. This information starts with the products' description and the identification of its intended use. Then the team should develop a flow diagram and a plant layout and confirm it on site.

Team competencies and professional figure of the team

The team must have specific knowledge referring to:

- *characteristics and intended use of examined product*
- *phases of productive process*
- *equipment characteristics*
- *technological aspects*
- *practical aspects of productive activities*
- *microbiological principles of examined product*
- *HACCP principles.*
- *Therefore the team should be constituted by a Veterinarian specialized in food safety aspects and/or an Agronomist, a Biologist, a Chemist, an Engineer, a Physician, a person responsible of research and development section and a person responsible of production.*

Team's activities

The activities of the team should focus on Hazard identification in every possible point of the production, the determination and monitoring of the CCPs and the auditing of the actions implemented at CCP level. Therefore the HACCP team, after studying the whole operation, should describe the product (*identifying potential food safety problems*), identify the products' intended use, construct a flow diagram specific for each processing step, list all potential hazards, conduct a hazard analysis (*determining how and where hazards can be controlled or presented*), consider control measures, lay down the means for the provision of resources, equipment, etc., describe what to do for the training of the personnel, and finally, be responsible for the proper implementation, verification and improvement – in other words - be responsible for the follow-up of the whole plan. It is considered very important at this point that the team should succeed in the commitment of the management and shall issue documents (fill-out forms) specific for each step of the food processing chain. These forms or records should be easy for the personnel to understand and to complete in a given time (daily or weekly depending on the case), because this is the only way to follow-up the success of the HACCP system implementation in the plan.

Size and composition of the team

The number of people composing the team is dependent on the kind of examined activity, nature of the hazards to be prevented, and complexity of the control measure to be arranged. It also depends on the size of the plant and its' different departments involved in the production process as well as of the raw materials and the ingredients used. For instance, in a vegetable processing plant an agronomist is required, whereas in a meat processing plant a veterinarian should be used. Accordingly in a mixed plant both professionals should be part of the team. The HACCP team should be composed by:

- **in general:** *personnel which is directly involved in daily activities of the enterprise, and outside expertise, where the enterprise doesn't have the required competent personnel. In order to be qualified as competent personnel, the team's components must have specific knowledge referring to characteristics and intended use of examined product, the phases of productive process, equipment characteristics, technological aspects, practical aspects of productive activities, microbiological principles of examined product, HACCP principles.*
- **in particular:** *a top manager of the factory, a secretary, and private experts in microbiology, chemistry and food technology. They should be familiar with overall food operation and the specific production process to be included in the plan. Therefore the team's goal and each member's responsibilities in reaching that goal must be clearly defined.*

External duties of a team

Furthermore the team should assure co-operation with other experts on every field of food production and processing. In the very beginning the members of the team define the scope of the study and set priorities according to the intended use of the product[i]. Afterwards they study the formulation and the composition of raw materials and ingredients taking into consideration all parameters influencing their safety during processing, packaging and distribution. Now having

[i] *Whether it is a Food Service Establishment, Caterers, Hospitals, Preparation practices etc.*

full knowledge of the characteristics of the product they are ready to construct a flow diagram[i] covering all steps, which might have an influence on the safety of the product. Then the team lists the hazards associated with each step, conducts a Hazard Analysis and considers any measures to control identified hazards.

Duty and responsibilities of the team's co-ordinator, the technical secretary and of the management

The team co-ordinator should assure that the team composition fits the study needs. He/she should also assure that the working plan is correctly realised, divide work and responsibilities, ensure that the study goal is reached, chair the team meeting, resolve possible conflicts between group members, assure communication of defined decisions, and act as a link between team and management.

The technical secretary should organise meetings and record the decisions defined during the meetings.

The management should provide the resources necessary for the study; in particular should provide time for the meetings, money for training, documents essential for the working group, admittance to the labs as well as admittance to all information sources.

1st Example

HACCP plan of refrigerated meats in an enterprise, which has implemented regulations of ISO 9000 series.

- Responsible of quality assurance (co-ordinator)
- HACCP responsible (technical secretary)
- Responsible of meat division
- Expert veterinarian (external expertise)
- Expert of quality system (external expertise)
- Official authority

2nd Example

HACCP plan of cheese in a small and/or less developed dairy.

- Owner
- Expert veterinarian (external expertise – co-ordinator)
- Expert of quality system (external expertise)
- Official authority

[i] *This diagram should include important data such as time and temperature and indicate the specific hygienic level for each working area or even setting barriers between working areas of different hygienic importance. The flow diagram should be checked for its correctness of information, and whether this information is important or overlooked. These checks are performed during all periods of operation (during working hours) and during idle hours (cleaning, maintaining of equipment etc). At this point the person responsible for the flow of diagram may discuss with operators, train them theoretically on GHP, GMP and HACCP rules and help them practically to fill out the given forms.*

HACCP System Principles

It is unanimously accepted that responsibility for producing safe food is in the hands of producers or providers. It is thus the responsibility of industry to ensure proper application of the seven HACCP principles and implementation of the HACCP plan. The *Codex Alimentarius* text distinguishes principles (which are essential), from guidelines for their application (which are advisory). Application may differ according to the product, the size and sophistication of the industry, the country etc., but it is the responsibility of the industry to ensure that the essentials of HACCP are put into practice and, when requested, to provide evidence that this was done.

One very important aspect of HACCP has to be repeated here. Each step of the food chain has its own responsibility. HACCP is effective at ensuring safety only when it is applied at all steps, from farm to fork. Food safety is a shared responsibility of farmers, manufacturers and consumers.

HACCP consists of 7 principles, which are the minimum requirements in the mandatory application of the HACCP system. These principles are the following:

Principle 1: Conduct a hazard analysis

Principle 2: Determine the Critical Control Point (CCP)

Principle 3: Establish critical limits

Principle 4: Establish a system to monitor control of the CCP

Principle 5: Establish the corrective actions to be taken when monitoring indicates that a particular CCP in not under control

Principle 6: Establish procedures for verification to confirm that the HACCP system is working effectively

Principle 7: Establish documentation concerning all procedures and records appropriate to these principles and their application

<u>Principle 1</u>: Conduct a Hazard analysis

The team should examine the problems caused by the foodborne diseases in the specific region or country where the product is produced (or raw materials are coming from) and identify the hazards to occur at any step of the process. These can be of microbiological or chemical or even physical nature. Within a HACCP system, there is a distinction between biological, chemical and physical hazards. In case of physical hazards (splinters of metal, glass or other foreign material), is required logical thinking and the knowledge of the technological production procedures. Here, the expertise lies with the technical staff of the food company. In contrast, the assessment of chemical and biological hazards requires special expertise for the pathogenesis of human diseases, which are caused by such hazards. Therefore the development of effective preventive measures requires comprehensive knowledge of the epidemiological factors, which threaten the health of the consumer. A hazard analysis carried out for a product or process should be reviewed if any changes are made in the product or the process (new raw material, changes in the method of preparation, processing or packaging etc)

Hazards of low probability of occurrence and of a low severity should not be addressed under the HACCP system but may be addressed through Good Manufacturing Practice (GMP)[i].

[i] *PAHO/INPAZ 2001/HACCP Essential Tool for Food Safety*

Points that should be considered while performing a hazard analysis include:

- *The likely occurrence of hazards and the severity of their adverse effects.*
- *The qualitative and quantitative evaluation of hazards*
- *The survival or multiplication of microorganisms in concern*
- *The production or persistence in foods with toxins, chemicals or physical agents*
- *The quality of raw material*
- *The conditions leading to the above and identification of control measures.*

Hazard analysis is a key element in developing a HACCP plan. It is essential that this process be conducted in an appropriate manner, which utilize the results of the hazard analysis. Thus, hazard analysis represents the foundation for building a HACCP plan.

To exemplify the term "hazards and conditions leading to their presence", the enterotoxin of *Staphylococcus aureus* is an example of a hazard, whereas "a condition leading to the presence of this hazard" would be the exposure during production or storage of a product to a temperature at which *Staphylococcus* can grow and produce enterotoxins.

For simplicity, the hazard analysis procedure is divided into the following activities[i]:

- *Review incoming material for potential hazards*
- *Evaluate processing operations for hazards*
- *Observe actual operating practices*
- *Take measurements*
- *Analyse the measurements*

Principle 2. Determine the Critical Control Points (CCPs)

A CCP is a step in the food chain where activities are carried out, or conditions prevail which can have an influence on the safety of the product, and where control can be exercised over one or more factors to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Critical Control Points are crucial to ensuring product safety. A CCP can be related to raw materials, processes and practices applied along the food chain. CCPs govern all factors, which are basic to the prevention of foodborne diseases.

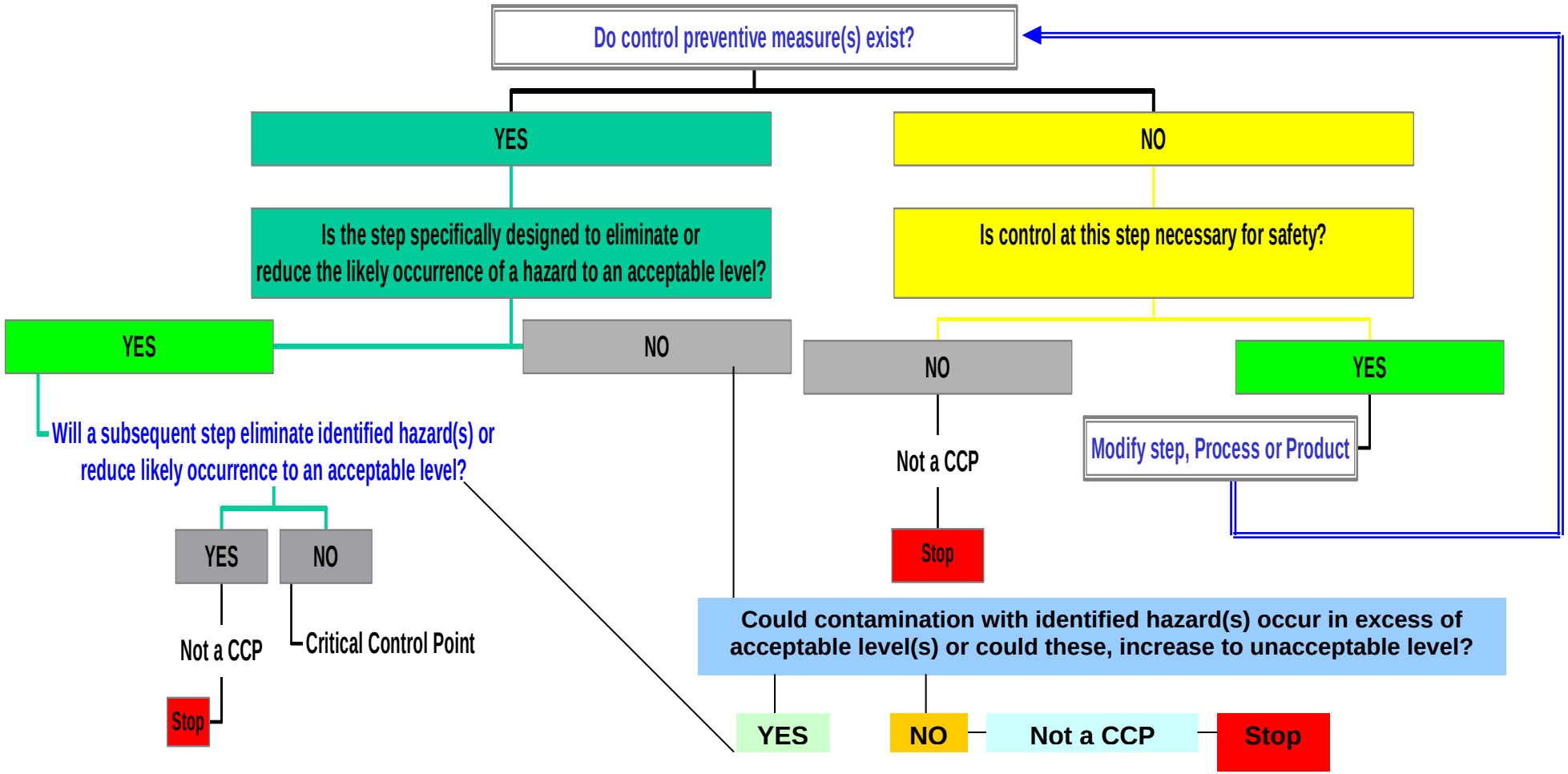
If a hazard has been identified at a step where is necessary for safety and if no control measure exists at that point or at any other, then the product or process should be modified at that step, or at any earlier or later stage, to include a control measure for this hazard.

Determination of critical control points (CCPs) must follow a logical consideration of all steps where hazards can be controlled. There may be one or more CCPs at which control can be applied to address the same hazard.

The determination of a CCP in the HACCP system can be facilitated by the application of a flexible, decision tree according to the type of operation, which indicates a logical reasoning approach. (e.g. production, slaughter, processing, storage, distribution or other). The next figure represents a decision tree such as that included in the *Codex Alimentarius, Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application.*

[i] *PAHO/INPAZ 2001/HACCP Essential Tool for Food Safety*

Graph 6.: Decision Tree[i]



[i] *PAHO/INPAZ 2001/HACCP Essential Tool for Food Safety.*

Principle 3. Establish Critical Limits

Critical limits are defined as criteria that separate acceptability from unacceptability. A critical limit represents the boundaries that are used to judge whether an operation is producing safe products.

Critical limits must be specified for each critical control point for safety. The critical limits of each CCP must be realistic, and sufficient to provide the necessary food safety assurances. Measurable and observable criteria used to set critical limits may include measurements of temperature, pH, time, or available chlorine.

The critical limits should meet requirements set out by government regulations and/or company standards and/or be supported by other scientific data. In some case, food control regulatory authorities provide information on which to establish the critical limits based on known food hazards and the results of risk analysis (e.g. the time/temperature requirements for thermal processes such as pasteurisation, cooking, retorting, maximum number and size of physical contaminants, chemical residues). It is essential that the person responsible for establishing critical limits have knowledge of the process and of the legal and commercial standards required for the product.

Sources of information on critical limits include:

- Scientific publications/research data
- Regulatory requirements and guidelines
- Experts studies (e.g. thermal process authorities, consultants, food scientists, microbiologists, equipment manufacturers, sanitation specialists, academics)
- Experimental studies (e.g. in-house experiments, contract laboratory studies).

If the information needed to establish critical limits is not available, a conservative value should be selected or regulatory limits used. Once the critical limits are established, they are recorded in the proper form together with the description of the process step, CCP number and hazard description.

Examples of critical versus operating limits are given in the Table below[i] :

Table 12. Critical and Operating Limits

Hazard	*CCP*	*Critical Limit*
Bacterial pathogens	*(non sporulating)*	*Pasteurisation 72^0 C (161.5^0 F) for at least 15 seconds*
Metal fragments	*Metal detector*	*Metal fragments larger than 0.5 mm*
Bacterial pathogens	*Drying oven*	*A_w < 0.84 -0.85 for controlling growth in drying food products*
Excessive nitrite	*Brining*	*Maximum 200 ppm sodium nitrite in finished product*
Bacterial pathogens	*Acidification step*	*Maximum pH of 4.6 to control Clostridium botulinum in acidified food*
Food allergens	*Labelling*	*Label that is legible and contains a listing of correct ingredients*
Histamine	*Receiving*	*Maximum of 25 ppm histamine levels in evaluation of tuna for histamine[ii].*

[i] *PAHO/INPAZ 2001/HACCP Essential Tool for Food Safety.*

[ii] *US regulatory action level is 50 ppm, but histamine levels may increase during processing. Therefore, industry may want to set lower histamine critical limits at receiving*

Operating limits

If monitoring shows a trend towards lack of control at a CCP, operators can take action to prevent loss of control of the CCP before the critical limit is exceeded. The point at which operators take such action is called "the operating limit". Operating limits should not be confused with critical limits because they may be almost similar and yet they are quite different to each other. The explanation is because the operating limit is more restrictive and it will be reached before the critical limit is violated (e.g. the operating limit for drying oven in the above table = 0.80 A_w and the Acidification is pH 4.3).

<u>Principle 4:</u> Establish a system to monitor control of the CCP

The *Codex Alimentarius Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application*, defines monitoring as the act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control.

"Monitoring" is checking by testing, measuring, observing etc., whether a Critical Control Point is under control. It is the tool that will confirm if the HACCP plan is being followed. It is essential in making sure that critical steps are under control. It will identify where a loss of control has occurred or if there is a trend towards a loss of control. It will also identify the corrective actions to the processes to restore or maintain control. The monitoring procedures must be able to detect loss of control at the CCP. The monitoring system will be effective only if the owner of the establishment, the manager and employees are given the knowledge, skills and the responsibility for preparing safe food.

There are many ways to monitor the critical limits of a CCP. Monitoring can be done on a continuous base (100 percent monitoring) or in a batch analysis base. Continuous monitoring is preferred, where feasible because is more reliable. The higher the frequency of monitoring (i.e. the less time between each instance of monitoring), the less product will be affected when there is a loss of control at the CCP.

Sampling and microbiological testing are usually not adequate by themselves to ensure food safety. Microbiological testing is seldom effective for monitoring CCP and cannot be used as a means of process control because of the lengthiness of analytical procedures and the inability to provide results in real time. In addition, detection of pathogenic microorganisms can be difficult if contamination of the product at the CCP is at a low level or is unevenly distributed in the food sample, necessitating large and numerous samples. Microbiological testing does have a role in HACCP verification, however. When critical limits are established for the elimination of pathogens or their reduction to an acceptable level, microbiological testing can be used to verify the HACCP plan's effectiveness and to ensure that the identified microbiological limits have not been exceeded. In this instance, the length of time involved in the analytical procedures does not create operational difficulties[i].

Target values are used in monitoring. Even if the value is slightly higher or lower than the target value, it is still acceptable as long as it remains within the critical limits; otherwise, the product is considered unacceptable and cannot be released.

Monitoring procedures need to be rapid, as they relate to on line processes, which in general do not leave time for lengthy analytical testing. For this reason, physical and chemical measurements (temperature, time, pH, moisture level and water activity) or visual observations, which may be done rapidly, are often preferred to microbial testing.

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[i] *PAHO/INPAZ 2001/HACCP Essential Tool for Food Safety.*

The purposes of monitoring include the following:

i. *To measure the performance level of the operation at the CCP (trend analysis)*

ii. *To determine when the performance level of the system results in a loss of control at the CCP, e.g. when there is deviation from a critical limit; and*

iii. *To establish records that reflect the performance level of the system's operation at the CCP, to comply with HACCP plan.*

Accurate monitoring procedures and associated records provide information to the operator and allow for decisions to be made on the acceptability of the lot at a particular stage in the process. For the monitoring procedures it is essential that all monitoring equipment is always properly calibrated for accuracy.

Responsibilities for monitoring should be clearly defined, and individuals must be adequately trained in the monitoring procedures for the CCP for which they are responsible.

The monitoring specifications for each CCP should be written on the proper form. They should give information on:

- *What will be monitored (i.e. measurement of the cold-storage temperature, of the pH, of the A_w etc)*
- *How critical limits and preventive measures will be monitored (i.e. physical or chemical measurements instead of microbiological testing)*
- *Who will monitor (individuals assigned to monitor CCP's may include line personnel, equipment operators, supervisors, maintenance personnel and quality assurance personnel).*

<u>Principle 5.</u> Establish the corrective actions to be taken when monitoring indicates that a particular CCP is not under control.

Specific corrective actions must be developed for each CCP. Corrective actions must specify what needs to be done to bring the CCP under control and ensure that potentially unsafe products are not marketed. Corrective actions include steps to correct the problem and steps to deal with the affected product.

The *Codex Alimentarious Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application* defines corrective action as "any action to be taken when the results of monitoring at the CCP indicate a loss of control". In this concept, loss of control is considered a deviation from the critical limit of a CCP and deviation is a "failure to meet a critical limit".

Any corrective measures undertaken with regard to a specific step should be easily implemented and understood by the employee performing the activities. Any corrective action taken should be documented and communicated to management in order for the system to be modified, if necessary, and reoccurrence of the problem prevented. The diversity of possible deviations at each CCP means that more than one corrective action may be necessary at each CCP. When a deviation occurs, it will most likely be noticed during the routine monitoring of the CCP.

The producer should control the deviations as follow:

- *He should have a specific -for each product- mechanism in place, to identify deviations as soon as possible*
- *He must be able to spot and isolate all affected products manufactured during this deviation*
- *He should cooperate with experts (or reference centres) on different fields in order to evaluate a specific deviation (e.g. with a microbiologist to examine and evaluate a deviation from microbiological standards in order to detect if this deviation is a possible source of a hazard).*

After the evaluation of a deviation a corrective action should be taken in order to prevent the production of unsafe products. Corrective action procedures are necessary to determine the cause of the problem, to prevent recurrence and to follow up with monitoring and reassessment to ensure that the action taken is effective. The producer's corrective action programme should include (1) investigation to determine the cause of the deviation, (2) effective measures to prevent recurrence of the deviation and (3) verification of the effectiveness of the corrective action taken.

Examples of deviation procedures for different product[i].

Canned Vegetables: *"The scheduled thermal process is not met because of a loss in steam pressure"!*

- *The operator notices the deviation before the product is released and refers immediately to the written deviation procedures*
- *According to the deviation procedures the operator adds an additional processing time*
- *However the problem is not completely over! The operator following the instructions reports the incident to his superior and they mark the affected(?) lot for further inspection by the experts, leading to its authorisation or final condemnation.*

In case that the same problem persists, beyond the above-mentioned detention of the product for inspection, the processor should examine the underline cause of the deviation, i.e. he should determine the reason for the loss in steam pressure and the actions that should be taken to prevent recurrence of the problem.

Milk: *"Antibiotics are detected by a rapid screening test"*

- *The operator notices the deviation before the product is unloaded from the truck and refers immediately to the written deviation procedures*
- *According to the deviation procedure the operator/manager should follow up with the milk supplier involved,….*
- *All corrective actions are recorded.*

Cooked sausages: *"Sausages are sliced with equipment that has not been cleaned at specific frequency."*

- *The operator notices the deviation and believes that the product has an excessive bacterial contamination*
- *He informs the supervisor according to the deviation procedure and the suspected product is withheld and subjected to microbial testing.*
- *The employee responsible for equipment cleaning is questioned according to the written procedures and is retrained if necessary.*

[i] *PAHO/INPAZ 2001/HACCP Essential Tool for Food Safety.*

<u>Principle 6.</u> Verification/Establish verification procedures

The *Codex Alimentarius* guidelines define verification as "the application of methods, procedures, tests and other evaluations, in addition to monitoring, to determine compliance with the HACCP plan".

In other words verification refers to all these activities undertaken to check compliance with the plan and its implementation. These activities should be planned ahead, because they should be approved by the responsible person in the establishment, at the same time as all other activities of the HACCP study.

Originally, the producer did verification in order to check out the effectiveness of the HACCP system. For this reason he used a qualified individual or individuals who were capable of detecting deficiencies in the plan or its implementation. However, since HACCP has been incorporated into legislation and recommended by *Codex Alimentarius*, State regulators have seen verification as their task.

Taking under consideration that internationally accepted definitions of the tasks of regulators or law enforcement officers have not been established yet, here we will use the word verification to refer to an activity performed by the food handler, in accordance with the HACCP plan. Therefore, in this document the food handler should perform the verification in order to determine conformity[i] with the HACCP plan.

When regulatory agencies test samples of the end products, this could be seen as verification if the results are also used by the industry. When during a regulatory assessment books and records are reviewed, this again can be seen as verification, as long as the results are used by the industry. If results of assessment activities by regulatory authorities are not communicated to and used by the industry these activities should not be called verification.

The word **conformity**[ii] is used in reference to industrial activities; the word "**confirmation**" refers to a regulatory situation, or in other words, it means compliance. In definitions both of **conformity** and **compliance**, it is mentioned that they refer not only to HACCP, but also to its prerequisites[iii]. Foods in international trade have to be produced according to General Principles of Hygiene and HACCP. Even for foods, which are intended for domestic use, GHP should be the basis whereas HACCP is complementary to the system, but cannot stand-alone. For this reason the word "prerequisites" has been introduced.

Although there is not yet international agreement on what verification should encompass, it means *"checking the implementation and effectiveness of the HACCP system"*. Therefore it is carried out to determine if the HACCP system is working correctly and eventually to highlight deficiencies that need to be rectified. Verification may also be initiated for other reasons, e.g. changes in the process with potential safety consequences.

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[i] *PAHO/INPAZ 2001/HACCP Essential Tool for Food Safety.*

[ii] *System **conformity** means that the seven principles have been correctly applied and that the HACCP plan is correctly and consistently implemented. It is not an approval of the system, i.e. that all the hazards have been correctly identified, that critical limits have been correctly chosen etc. <u>It only means that the system was understood and the resulting activities put into action.(for distinction between conformity and confirmation see par. 20.7)</u>*

[iii] *Prerequisites of HACCP are practices and conditions needed prior to and during the implementation of HACCP and which are essential for food safety, as described in the Codex General Principles of Food Hygiene and other Codes of Practice.*

Although verification is performed by the plant personnel in a scheduled basis, it may also be performed by someone other than the person who is responsible for performing the activities specified in the plan, such as:

- *Government inspection services,*
- *Private organizations, expert teams,*
- *Quality control laboratories,*
- *Trade associations, expert teams*
- *Consumer associations, expert teams*
- *Buyers, expert teams*
- *Importing country authority inspection services*

The verification may be done: (a) After each HACCP plan elaboration, (b) As part of a continuous revision, established by the program, to demonstrate that the HACCP plan is efficient, (c) When there is any change that affects hazard analysis or changes HACCP in any way.

It can be applied in each step of the HACCP plan, in the HACCP plan of each product (including each step) and when there is any change in the process or materials used, affecting hazard analysis.

Verification comprises checking system **conformity** and confirmation of **effectiveness**[i] of the system.

Verification activities

Verification is an ongoing activity. A new hazard analysis is necessary after changes in raw materials, processing conditions, line layout, distribution conditions, preparation and use etc. The outcome of such an analysis may need to be validated and verified. As a consequence of trends detected in monitoring results, or results of raw material and end product testing, changes may be made which need to be verified. The verification activities are mentioned in the *Codex Alimentarius* text as examples of verification. External auditors or government inspectors should keep records of all these verification activities for examination. The verification activities are mentioned more detailed and "again" in brief below:

- *Analyse the HACCP plan documents and its registers,*
- *Scientifically evaluate all hazards,*
- *Analyse deviations of critical limits,*
- *Analyse corrective actions taken for each deviation in the past,*
- *Guarantee that all CCP are under control,*
- *Guarantee -through calibration- that all measuring equipment are working properly*
- *Perform laboratory analysis to guarantee that the critical limits are well established, and*
- *Evaluate suppliers for quality assurance.*

[i] *Confirmation of Effectiveness means that evidence is sought to confirm that the system delivers what is expected.*

Review

Review means a retrospective view or survey of past events, experiences etc. A review should show whether unacceptable deviations were followed up and/or whether CCPs were kept under control. The review of consumer complaints can demonstrate that deviations were not detected, and thus some things have to be changed because the system did not deliver what was expected. If the review shows that CCPs were not always monitored as foreseen, or that instruments used for monitoring were not accurate, the system or its implementation has to be improved.

End product testing may provide some evidence that the plan was effective, and that objectives were achieved, but especially as regards to the control of pathogens it is a poor verification tool.

Principle 7. Establish documentation concerning all procedures and records relevant to the HACCP principles and their application.

Records are written evidence through which an action is documented. A record shows the process history, the monitoring, the deviations and the corrective actions that occurred in the past. Accurate documentation and record keeping is essential to the application of a HACCP system. They should be appropriate to the nature and size of the operation. They should also be sufficient to enable the business to be confident that controls are in place and being maintained. Records document that the critical limits at each CCP were met or that appropriate corrective actions were taken when the limits were not met. They can also record that the actions performed were verified. Therefore it is imperative that the producer maintains complete, current, properly filed and accurate records.

Four types of records should be used in the HACCP plan:

- *Basic Support Documentation (bibliographical or other data used for the establishment of control measures, shelf life, critical limits)*
- *Records generated by the HACCP system (all activities and documentation required to prove adherence of a HACCP system to the originally designed HACCP plan)*
- *Documentation of methods and procedures used (since they clearly relate to the safety of the product they should be maintained for possible auditing by the regulatory authorities).*
- *Records of employee training programs (employees are trained to understand the appropriate procedures/methods and actions in order to intervene when critical control limits are threatened).*

Verification is one of the seven principles of HACCP, and the associated activities are established during the HACCP study.

9. A GUIDE ON SAFE FOOD FOR TRAVELLERS[i]

Foodborne and waterborne diseases affecting travelers

Depending on the geographical area, travelers may be exposed to a number of foodborne or waterborne diseases, present in this area. The risk of becoming ill will varies according to the luck, to the length of time the traveler remains in the foreign place, the local standards of accommodation, the behavior of the traveler and its precautions taken before the travel. General precautions can greatly reduce the risk of exposure to infectious agents and should always be taken for visits to any destination where there is a significant risk of exposure.

We know that a great number of foodborne[ii] and waterborne diseases are transmitted only through the consumption of contaminated material and therefore, it is easy to avoid them or reduce the risk of been contaminated by following some old and well known rules.

Some of the most important foodborne diseases are brucellosis, cholera, cryptosporidiosis, giardiasis, hepatitis A, leptospirosis, etc. However, for travelers, the main health problem is "Diarrhoea" due to contaminated food or water. Besides diarrhoea, it may be present vomiting, fever, dizziness, nausea and other symptoms, depending on the species and amount of the pathogenic agent, as well as the sensitivity of the individual.

Beyond the biological hazards in food and water, there may be present chemical poisons such as pesticides, herbicides, dioxins, PCPs etc. These late intoxications however, are mostly dependant on a long time of exposure to the pathogenic agent and they do not influence that much the health of travelers.

The safety of food and water depend on the standards of hygiene applied in their preparation, which are mostly inadequate in developing countries. However, while the risk is greater in developing countries, locations with poor hygiene are be present even in the most developed country of the world.

Another source of waterborne infections is sewage polluted seawater or fresh water in lakes and rivers, as well as swimming pools. Bathing in contaminated waters may result in ingestion of diarrhoea producing microorganisms.

How to avoid illnesses caused by unsafe food and drink and what to do if you get diarrhoea

☞ BEFORE LEAVING HOME

Consult your physician for advice on the various diseases to which you may be exposed, and the need for vaccinations or other preventive measures.

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[i] *Prepared by the Programmes on Food Safety and Diarrhoeal Diseases Control of the World Health Organization, Geneva, 1997 (Doc.WHO/FOS/97.4)*

[ii] *over 200 – see Tables at the end of the Document.*

Make sure your medical kit contains Oral Rehydration Salts (ORS)

☞ EATING SAFELY

The following recommendations apply to all situations, from food vendors on the street to expensive hotel restaurants:

- *Cooked food that has been held at room temperature for several hours constitutes one of the greatest risks of foodborne illness.* ***Make sure your food has been thoroughly cooked and is still hot when served.***
- *Avoid any uncooked food, apart from fruits and vegetables that can be peeled or shelled. Avoid fruits with damaged skin. Remember the dictum "Cook it, peel it or leave it"*
- *Dishes containing raw or undercooked eggs, such as home-made mayonnaise, some sauces (e.g. hollandaise sauce) and some desserts (e.g. mousses) may be dangerous*
- *Ice cream from unreliable sources is frequently contaminated and can cause illness. If in doubt, avoid it.*
- *In some countries, certain species of fish and shellfish may contain poisonous bio-toxins even when they are well-cooked. Local people can advise you about this.*
- *Unpasteurized milk should be boiled before consumption.*
- *When the safety of drinking-water is doubtful, bring it to a vigorous boil. In situations where boiling water is not possible, a combination of a well maintained filtering device and a slow release disinfectant agent might be considered.*
- *Avoid ice unless you are sure that is made from safe water.*

Beverages such as hot tea or coffee, wine, beer, and carbonated soft drinks or fruit juices which are either bottled or otherwise packaged are usually safe to drink

☞ WHAT TO DO IF YOU GET DIARRHOEA

Most diarrhoeal attacks are self-limiting and clear up in a few days. The important thing is to avoid becoming dehydrated

As soon as diarrhoea starts, **drink more fluids**, such as bottled, boiled or treated water, or weak tea. Fruit juice (diluted with safe water) or soup may also be taken. If diarrhoea continues for more than one day, prepare and drink ORS solution[i] and continue to eat normally.

Table 13

Amounts of fluid or ORS to drink	
Children less than 2 years	1/4 – 1/2 cup (50 – 100 ml) after each loose stool
Children from 2 years to 10 years	1/2 – 1 cup (100 – 200 ml) after each loose stool
Older children and adults	unlimited amount

[i] *If ORS are not available, mix 6 level teaspoons of sugar plus 1 level teaspoon of salt in one litre of safe water. Drink this as indicated above for ORS.*

Seek medical help if :

Diarrhoea lasts for more than 3 days and/or there are very frequent watery bowel movements, blood in the stools, repeated vomiting or fever.

When there is no medical help available and there is blood in the stools a course (5 days) of trimethoprim/sulfamethoxazole (TMP/SMX) may be taken[i].

Prophylactic use of antibiotics is not recommended. Antidiarrhoeals (e.g. loperamide) are not recommended but may be used in addition to fluids, **by adults only**, for symptomatic relief. They should never be used for children.

If there are other symptoms, seek medical advice.

[i] *Dosage for trimethoprim/sulfamethoxazole:*

For adults : *160 mg of trimethoprim and 800 mg of sulfamethoxazole, twice a day, for 5 days*

For children: *5 mg of trimethoprim and 25 mg of sulfamethoxazole per kg of body weight, twice a day, for 5 days*

10. WHO RECOMMENDED SURVEILLANCE STANDARDS[i]

In 1999 the World Health Organization published, as a 2nd edition, the *"WHO Recommended Surveillance Standards"*. This document serves only as a guide to good practice and may help to harmonize surveillance activities. It is intended to be a handy reference for key elements and contact information for communicable diseases/syndromes associated with current WHO control programmes.

Example on Salmonellosis[ii]

Rationale for Surveillance

Salmonellosis has emerged as one of the greatest causes of foodborne diseases. The detection and control of outbreaks associated with this organism is complicated by the fact that there are over 2,200 serotypes of *Salmonella* spp., several of which have multiple phage types. Laboratory-based surveillance of salmonellosIs with definite typing and antibiograms allow for rapid identification of clusters of cases. Investigations can then concentrate on case with the *"epidemic"* strain leading to better identification of risk factors and implicated food items. Utilisation of molecular methods can lead to even more accurate identification of "epidemic' strains.

The most important criterion for the «confirmation» of Salmonellosis is the isolation of *Salmonella* s.p.p. from the stools or the blood of a patient. Only then we can say with certainty that the «case» has been confirmed.

An incident of Salmonellosis in which two or more persons experience the same illness after they have been exposed to the same agent (ingestion of the same, or deriving from a common source food, or water), is called an outbreak.

The surveillance of salmonellosis is a laboratory-based exercise. However, the samples examined by laboratories must be generated from cases presenting at health centres, private practitioners and hospitals. To this end practitioners must be aware of the importance of requesting examination of stool specimens for public health purposes, especially in cases where food or water borne transmission is suspected.

Surveillance of salmonellosis should be based on a network of laboratories that routinely report data on isolation of *Salmonella* spp. to more central levels. In addition, isolates of *Salmonella* spp. may be sent to a reference laboratory for more definitive typing. At more central levels, definitive-typing data can be analysed on a broader geographical basis allowing for the detection of outbreaks that may not otherwise be detected.

All suspected outbreaks of salmonellosis should be reported to the central level and investigated. A minimum data set should be collected on each outbreak at intermediate and central level. This should be done after the outbreak investigation and should include key variables describing the nature and extent of the outbreak.

Note: The laboratory network for surveillance of salmonellosis should be as wide and complete as possible. The concentration of facilities for definitive typing in reference laboratories is useful in order to maintain quality. However, care must be taken in relying on the samples processed in such laboratories as they may not always be representative in terms of clinical spectrum or geography.

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i *Document WHO/CDS/CSR/ISR/99.2*

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ENTER-NET ***(previously SALM-NET)*** is an intentional network of information on laboratory isolations of salmonellosis and *Escherichia coli* O:157 is shared between countries in the network on much the same basis as within countries. This allows for the detection of outbreaks of international significance and the early warning of countries about to be contaminated in the near future.

Recommended Minimum Data Elements

The recommended Min. Dat. Elem. are:

Case-based data from laboratory, such as the following:

- *Unique identifier, age, sex, geographical information*
- *Date of onset, date of specimen*
- *Specimen type, organism(s) identified*

As aggregated data from laboratory can be considered the

- *Number of cases by Salmonella spp., the geographical area, the age of patients, etc.*

Outbreaks aggregated data are:

- *Specific Salmonella species and phage type identified*
- *Number of people at risk/ill/hospitalized/dead*
- *Geographical information, outbreak setting (e.g. restaurant, hospital, school)*
- *Date of first and last case*
- *Food or constituent implicated and evidence for implication (e.g. epidemiological study, isolation in food)*
- *The most important factors contributing to the outbreak are (e.g. inadequate storage, inadequate heating, cross-contamination, infected food handler, environmental factors)*

Recommended Data Analyses, Presentation, Reports

Surveillance data

Frequent review of laboratory data looking for clusters of case in time, place or person. All suspected clusters should be investigated to establish whether an outbreak has occurred. Incidence of laboratory identifications by week, geographical area, organism, age group and sex *(map incidence by geographical area if possible).*

Outbreak investigation data

Incidence of outbreaks by species, phage type, month, geographical area, setting of outbreak, attack-rate, duration of outbreak, foods implicated and factors contributing to the outbreak.

Principal Uses of Data for Decision Making

Determine the magnitude of the public health problem

Timely detection of clusters/outbreaks

Track trends in salmonellosis over time

Identify high-risk food, high-risk food practices and high-risk populations for specific pathogens

Identify emergence of new species and phage types

Guide the formation of food policy and monitor the impact of control measures

Risk assessment and standard setting

Special Aspects

Human surveillance should be linked with food safety and control authorities.

11. CONTAMINATION OF FOOD THROUGH FOOD-HANDLING PERSONNEL

The term "Food-handling personnel" includes all people who come into contact with edible end-product at any stage of production (i.e. from the farm to the consumer)

In a 1988 Report of a WHO consultation it was emphasized the role of the food-handling personnel in the contamination of the food. After examining the situation, the Report concluded that on the first place it has not been proven the importance and the extend of transmitting diseases trough food-handling personnel and secondary it is not so easy as it seems to maintain control over the food-handlers. Medical examinations are costly and for many reasons, can't guarantee the detection of all carriers of pathogenic microorganisms.

It is understood today that most of the infections among the food-handlers occur after the medical examinations render them thus, useless as a preventive measure. Screening for pathogens in stool specimens of personnel is very expensive and is not recommended any more except in specific cases. Therefore the most effective preventive measure remains the education and the devotion of the food-handling personnel.

The ability of food-handling personnel to transmit disease is related to the degree of contact that they are likely to have with particular shorts of food, which in most modern, robotized and computerized plans is almost minimal. However, lets first examine the variety of human sources introducing pathogens into the food.

Gastrointestinal pathogens come through food of animal origin and rarely through human sources. Row food of animal origin is in many cases loaded with pathogens, and the attempts to reduce microbial loads at various stages of production, are mostly unsuccessful. Therefore the protection of the consumer depends largely on the correct application of modern processing technologies, such as pasteurization, irradiation, cooking, freezing and pickling in the industrial, retail and domestic levels. Beyond these techniques it is absolutely necessary to store sensitive food in the correct temperatures and avoid cross-contamination of raw and cooked food.

According to the definition of a "Food-handler", there are many people working in farms and food-processing industries who come in contact with the edible product but not necessarily with the final "end-product" which has a long way of sanitization before it reaches the consumer. Therefore these people even if they are in the position to transfer some pathogens to the product, it is expected that the final product which derives after the chain of sanitization (e.g. pasteurization or cooking in high temperatures), will eventually be free from pathogens.

Those who present a risk of transmitting pathogens are the persons who touch foods to be consumed raw or without further cooking or other forms of treatment, such as salads, sandwiches, cooked meets, fresh cream or egg-based products etc. In this category should be included the street vendors as well as the workers in water treatment plants. Mishandling or disregard of hygienic measures on their part may enable pathogens to come into contact with food, and some cases to multiply and cause illness to the consumer.

The roads of contamination are the following:

Pathogens are shed by hands that came in contact with nose, feces, urine, skin, mouth, ears. (Epidemiological studies have shown that *Salmonella typhi, Campylobacter* and *Escherichia coli* that these pathogens can survive on fingers for a period of time even after hand-washing. Especially Staphylococci may not be removed from hand by washing when the form part of the resident flora, because are hiding in deeper layers of skin and hair follicles, and arise in warm and humid environmental conditions, mostly resembling with those of a kitchen).

Pathogens are also spread through coughing or sneezing.

However the presence of some pathogens in the food is not always the critical factor for producing a foodborne illness. There are other vital preconditions, such as the number of microorganisms introduced, the storage temperature, the time from inoculation to consumption, the type of pathogen or the type and quantity of toxin etc. For example, gastrointestinal pathogens are excreted in large numbers in the acute phase of disease, but the excretion of the virus in hepatitis A starts in the incubation period and stops when the clinical manifestations become apparent.

However in general the stools from people acutely ill from a gastrointestinal infection are characteristically loose and frequent with large numbers of pathogens, easily disseminated to the environment. Carriers on the other hand have normally-formed stools and excrete diminished numbers of pathogens as time passes.

Infections and Intoxications potentially transmitted by food-handlers.

Staphylococcus aureus infection: Is found frequently in small numbers in the nose and skin of clinically healthy people and in very large numbers in pus, eczema, psoriasis and otitis lesions.

Typhoid and paratyphoid fevers: *Salmonella typhi and S. paratyphi* is transmitted usually from symptomless faecal and urinary carriers, but not always!

Non-typhi salmonellosis: Are mostly transmitted through raw poultry, meat and vegetables. Thus food-handlers may be transmitters when clinically ill, rather dificault because they will be absent from their work –except perhaps the cases of housewifes.

Escherichia coli enteritidis: give a variety of clinical symptoms some of which include gastroenteritis.

Shigellosis: Is caused by poor personal hygiene on the part of the food-handlers(usually suffering from diarrhea at the time of food preparation). Food-handlers constitute a risk only in the acute face of illness. (Carriage of *Shigella* spp rarely lasts longer than a month).

Cholera: Food-handlers constitute a risk only in the acute face of illness.

Viral hepatitis A: Asymptomatic(pre-icteric) food-handlers are contaminating raw foods (salads, sandwiches, shellfish, cold meats, fruit juices). Food-handlers constitute a risk only in the acute face of illness.

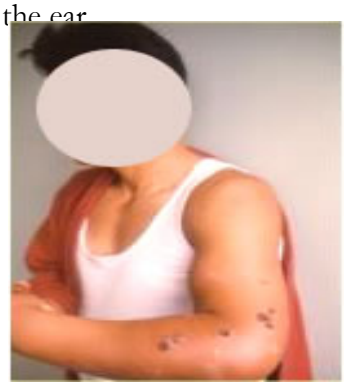
Amoebiasis: Most infections are symptomless. Therefore the only measure for prevention the transmittion trhough food is the practice of personal hygiene among the food handlers.

Who can play a role in the ensuring that food-handlers are fit to work with food?

Taking under consideration that the information taken by a medical examination or a microbiological examination of specimens is rather expensive and valid only for the time at which is carried out, we can't advise it as a regular practice in food-processing plants. However it is obvious that a tool of investigation and method of prevention is needed in order to ensure food-safety and decrease the incidence of food-borne diseases. For this, a non-medical-qualified personnel, such managers or supervisors together with an occupational nurse and scarcely a physician, can play an important role.

Specifically, in Gastroitestinal diseases such as, non-typhoid salmonellae, shigellae and campylobacter, physical examinations or microbiological tests won't reveal the carriers. In these cases only questioning may reveal a history of disease.

In the opposite, in staphylococcal and streptococcal infections non-medical qualified persons can identify the skin lesions. However only physicians and occupational nurses may detect chronic suppurative conditions of the ear.



Pulmonary tuberculosis is usually detected by chest radiography but human tuberculosis is not transmitted by food.

Viral hepatitis A sufferers are transmitters of the illness almost two weeks before the onset of jaundice. Therefore the only preventive measure left is the exclusion of the carriers for one week after the onset of jaundice.

Protozoal and helmithes can be only prevented from contaminating food by the practice of personal hygiene by the food-handlers.

Sexually transmitted diseases are not transmitted through food.

AIDS is not transmitted through food. However the disease is usually associated with other transmissible infections, such as salmonellosis.

Routine medical or laboratory examinations of Food-handling personel.

In some countries, the legislation requires some medical examinations of the food-handlers. These examinations can be one or more of the following:

Brief physical examination by a physician, trained nurse, or manager (This examination may reveal pustular lesions on skin surface or jaundice).

Taking the medical history by a physician. (It can be performed also by a short questionnaire, but it depends largely on the honesty and the understanding of the prospective employee).

Taking of a throat swab for isolation of streptococci (it is justified only in the case of clinical symptoms)

Collection and testing of blood specimen for sexually transmitted diseases (since sexually transmitted diseases are not transmitted through foods, no use for this test).

Taking an X-ray for evidence of tuberculosis (since Mycobacterium tuberculosis is not transmitted through food, they are of no value).

Examination of faeces for parasites, salmonelallae, shigellae and other microorganisms. The value of these examination depends on:

- *the number of specimens examined (a large number of specimens increases the possibility of finding the microorganism),*
- *the intervals between successive examinations (for example the excretion of salmonella is intermittent, the chances of detecting it through a single specimen are low)*
- *the cost of the examinations compared with the benefits.*
- *the honesty of the prospective employee (some are taking for examination stools of people known that had already passed the test)*

The major disadvantage of the test is the false security created in case of a negative result. Then the strict hygienic measures may relax and the contamination of food continues.

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ANNEX I

Five keys to safer food

Keep clean

- Wash your hands before handling food and often during food preparation
- Wash your hands after going to the toilet
- Wash and sanitize all surfaces and equipment used for food preparation
- Protect kitchen areas and food from insects, pests and other animals

Why?

While most microorganisms do not cause disease, dangerous microorganisms are widely found in soil, water, animals and people. These microorganisms are carried on hands, wiping cloths and utensils, especially cutting boards and the slightest contact can transfer them to food and cause foodborne diseases.

Separate raw and cooked

- Separate raw meat, poultry and seafood from other foods
- Use separate equipment and utensils such as knives and cutting boards for handling raw foods
- Store food in containers to avoid contact between raw and prepared foods

Why?

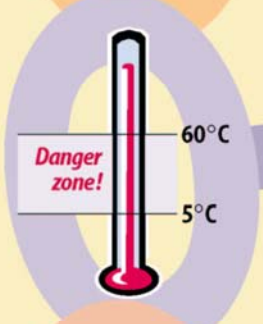
Raw food, expecially meat, poultry and seafood, and their juices, can contain dangerous microorganisms which may be transferred onto other foods during food preparation and storage.

Cook thoroughly

- Cook food thoroughly, especially meat, poultry, eggs and seafood
- Bring foods like soups and stews to boiling to make sure that they have reached 70°C. For meat and poultry, make sure that juices are clear, not pink. Ideally, use a thermometer
- Reheat cooked food thoroughly

Why?

Proper cooking kills almost all dangerous microorganisms. Studies have shown that cooking food to a temperature of 70°C can help ensure it is safe for consumption. Foods that require special attention include minced meats, rolled roasts, large joints of meat and whole poultry.



Keep food at safe temperatures

- Do not leave cooked food at room temperature for more than 2 hours
- Refrigerate promptly all cooked and perishable food (preferably below 5°C)
- Keep cooked food piping hot (more than 60°C) prior to serving
- Do not store food too long even in the refrigerator
- Do not thaw frozen food at room temperature

Why?

Microorganisms can multiply very quickly if food is stored at room temperature. By holding at temperatures below 5°C or above 60°C, the growth of microorganisms is slowed down or stopped. Some dangerous microorganisms still grow below 5°C.

Use safe water and raw materials

- Use safe water or treat it to make it safe
- Select fresh and wholesome foods
- Choose foods processed for safety, such as pasteurized milk
- Wash fruits and vegetables, especially if eaten raw
- Do not use food beyond its expiry date

Why?

Raw materials, including water and ice, may be contaminated with dangerous microorganisms and chemicals. Toxic chemicals may be formed in damaged and mouldy foods. Care in selection of raw materials and simple measures such as washing and peeling may reduce the risk.

Design: Marilyn Langfeld; Illustration: Janet Pridgeon

Food Safety
World Health Organization

Knowledge = Prevention

WHO/SDE/PHE/FOS/01.1
Distribution: General
Original: English

ANNEX II

INCIDENTS OF FOODBORNE ILLNESS

The following are examples of incidents of foodborne illness, giving the faults in food handling that lead to outbreaks. The case studies illustrate, among other things, the role of cross-contamination.

Salmonellosis

Example 1

An outbreak of salmonellosis occurred affecting 19 people, 18 of whom had eaten at one restaurant; the 19th was a cook at the restaurant. Symptoms were diarrhoea (in 100% of cases), abdominal cramps (in 100% of cases), fever and vomiting starting between 8 and 39 hours (with an average of 17 hours) after eating. The illness lasted from 1 to 17 days. Salmonellae were isolated from 10 of 11 stool specimens submitted by people with symptoms, and from the cook who had had diarrhoeal illness during the same 3-day period.

All 18 customers had eaten cold turkey in either sandwiches or turkey salad. Investigation revealed that all the turkey served in the restaurant was cooked on the premises by roasting to an internal temperature of 57-60 ^{0}C rather that the 74 ^{0}C required by local regulations. Cooked turkeys were then refrigerated until served in sandwiches or salad. Hot turkey dishes were prepared by reheating sliced meat to a temperature of over 74 ^{0}C. In this case, reheating apparently provided sufficient additional cooking since only cold turkey dishes were implicated in the outbreak. The cook, although producing positive stool specimens, was probably not the source of the outbreak. He ate at the restaurant and probably became infected there.

FAULTS

- Inadequate initial cooking temperature, insufficient to destroy salmonellae.
- Possibly storage for too long after cooking, in changing temperatures favourable to multiplication of bacteria.

Example 2

Four people ate a late-night meal of curried chicken and chips bought at a cafeteria. All became ill 24-36 hours later, with vomiting and diarrhoea. Faecal samples were taken from all those affected. Salmonellae were isolated from three of them as well as from the remnants of the food retrieved from the dustbin. A search for other cases revealed that 15 more people were ill. They had all bought similar meals from the same cafeteria. Onset of symptoms was 16-96 hours after eating the curry, and salmonellae were isolated from all 15 people.

Investigation revealed that food handling techniques and cleaning arrangements at the cafeteria were highly unsatisfactory. Raw, frozen chickens were delivered and allowed to defrost in cardboard boxes and plastic containers. After thawing they were spit-roasted, cooled, and put back into the cardboard boxes used for the raw chicken. After refrigeration, some cooked chickens were jointed and sold. For use in curries the flesh was removed from the chickens, cut into pieces and deep-frozen until needed. When needed, several portions would be taken from the deep-freeze and warmed by steam injection in stainless steel bowls. When warm, portions

were removed as required, and served in curry sauce. The remaining portions were allowed to cool at room temperature, and rewarmed as required.

Salmonellae were isolated from chickens in the cardboard boxes and in the deep-freeze, from the stainless steel bowls and from trays in the shop. Wipe swabs from the cardboard boxes and cutting table also yielded salmonellae, and two of the five staff members tested were found to be excreting salmonellae.

The likely sequence of events was that the cooked chickens were contaminated from the cardboard boxes that had contained them when raw. Then the repeated steaming and cooling prior to consumption allowed the salmonellae to multiply. The infected food handlers were clearly infected by the food.

FAULTS

- Cross contamination allowed by placing cooked chicken in containers that had held raw food.
- Storing and handling chicken in changing temperatures allowing bacteria to multiply. Rewarming is particularly dangerous.

Staphylococcal illness

Example 1

A sandwich shop was involved in a series of complaints of staphylococcal illness. In the shop, large quantities of baked ham were sliced at one time, and the slices kept without refrigeration on the back bar of the serving area. The outbreaks were traced to the days when the owner of the establishment sliced the ham. Her hands were found to be contaminated with enormous numbers of staphylococci and her nasal secretions were also heavily contaminated.

FAULTS

- Direct contamination of cooked food by staphylococci from a food handler's hands (or when sneezing, or blowing the nose).
- Storage of ham at room temperature for several hours, allowing bacterial multiplication.

Example 2

A cafeteria was involved in seven cases of staphylococcal illness, resulting from contaminated corned beef sandwiches. Laboratory tests revealed that two employees who handled the corned beef had positive nasal cultures. One was the waitress who served the sandwiches. The other had a habit of coughing and putting his hand to his mouth while handling the corned beef.

FAULT

- Bad hygiene by the food handler allowed his hands, contaminated by staphylococci, to touch the food.

Example 3

A barbecue was involved in a number of cases of staphylococcal foodborne illness. One of the food handlers had injured his hand by sticking a skewer into it while preparing pork. He was working wearing a hand bandage. Three days after his injury he had prepared and cut most of

the cooked meat portions which were stored at ambient temperature until sold directly to the public. The food handler passed on staphylococci to the cooked meat from his injured hand.

FAULTS

- Staphylococci were passed to food because the handler was not wearing a protective waterproof bandage.
- Cooked meat was stored at room temperature for several hours, allowing bacteria to multiply.

Example 4

Of 110 people on a coach outing, 61 developed illness two hours after eating cold ham at a cafe. Staphylococci isolated from stools and vomit from some patients corresponded in type with those isolated from the ham slicer, the chef's hands, and other food in the cafe.

FAULT

- Poor food hygiene standards. The ham slicer was not effectively cleaned, allowing proliferation of staphylococci in the café at room temperature.

Clostridium perfringens

Example 1

Abdominal pain and diarrhoea were reported in a large number of children in a school. The school kitchen was visited the day after the outbreak. The suspected meal, eaten 9 to 12 hours before the symptoms started, consisted of cold boiled salt beef, salad, and boiled potatoes, followed by pudding and jam.

The beef had been delivered to the kitchen on the previous afternoon in joints each weighing, 1.8-2.7 kg. The meat was immediately cooked in large boilers for 2 hours and left in its own liquor all night to cool. The following day the meat was taken from the liquor, drained, sliced and served cold for lunch. A portion of this meat left over from the meal and kept in a refrigerator was examined in the laboratory. Several types of bacteria were found, including *Clostridium perfringens*.

FAULT

- Leaving the meat in its own liquor all night at room temperature allowed the spores that survived the preliminary heat treatment to produce bacteria which multiplied vigorously.

Example 2

Boiled chickens in liquor were transferred to open vessels, left all night to cool, and eaten cold. Illness followed the day after the chickens were eaten. *Clostridium perfringens* was found in a high proportion of dust samples from the kitchen. The organism may have been on the chickens before they were cooked or on the vessels where the cooked chickens were left to cool.

FAULT

- Whatever the source of contamination, the long, slow cooling encouraged multiplication of *Clostridium perfringens*

Example 3

Four large groups of people at a wedding party had dinners provided by a catering service. The total number of people served was 1100, and 320 became ill. Investigation revealed that the main item served was sliced roast beef and gravy. The gravy was prepared three days before the meals were to be served. The roast beef was reheated just before serving.

The gravy had been prepared in a large, single container, properly cooked and then placed, uncovered, in a refrigerator to cool. Steam from the gravy condensed on teh bottom of pots and pans on the shelf above and dripped back into the gravy. The large amount of gravy in the container maintained its warmth for a long time, and provided an environment with a lack of air. This combination was ideal for the growth of *Clostridium perfringens*. On examination the gravy was found to be teeming with this organism.

FAULT

- The gravy was held, uncovered, in a large container for an excessively long time (3 days) before the meal was consumed.

Example 4

After eating a meal of roast beef and gravy, 150 people became ill, with severe diarrhoea and stomach pains. The beef and gravy had been prepared the day before, and allowed to cool in open trays without refrigeration for 22 hours. *Clostridium perfringens* organisms were found in both beef and gravy.

FAULT

- Storage of beef and gravy in open trays at ambient temperature provided ideal conditions for the growth of *Clostridium perfringens*.

Clostridium botulinum

Example 1

An outbreak of botulism was reported in the owner of a restaurant, and two of his employees. The owner arrived at a hospital emergency room with symptoms of botulism. He died of pneumonia two days later.

The patient had eaten marinated fish prepared by his wife 15 days prior to his illness. She had stored the fish in three large, narrow-mouthed, glass jars with screw caps, and left them to cure under a table. When the investigators found the jars, a thick layer of oil had formed between the fish mixture and the air remaining in each jar.

The investigators attempted to find out who else might have eaten the fish and two more cases were identified. The second patient was a 24-year-old restaurant employee who had developed weakness six days before his employer, after eating portions of fish over a period of 3 days. He

had shown symptoms of botulism but had recovered. Another employee, a 16-year-old boy, was found at home with severe weakness and some symptoms of botulism. He had also eaten small amounts of fish. Following therapy his condition improved slowly.

Clostridium botulinum type A toxin was found in serum from patients, and in the contents of the three jars of marinated fish.

The thick top layer of oil prevented the passage of oxygen to the fish. Anaerobic conditions, favourable to the multiplication of *Clostridium botulinum*, were created.

FAULT

- Curing, bottling or canning of food that may contain botulinum organisms can be very hazardous. In this case, marination did not destroy the botulinum organisms present.
- Apparently the pH of 4.6 was not low enough to inhibit spore germination and the growth of pathogens. The creation of an anaerobic condition in the jars allowed the formation of fatal botulinum toxin.

Example 2

Nine people ate hamburgers in a restaurant in a small town. Seven of them ate sliced dill pickle on the hamburger, and two did not. All seven who ate the pickle became ill after returning home. Five, were taken to hospital, and one died. Tests indicated *Clostridium botulinum* as the causative agent. The pickles had been canned by the restaurant proprietor.

FAULT

- The temperature achieved in the cooking and canning process was not high enough to destroy the *Clostridium botulinum* organisms present.

Bacillus cereus

Example 1

An outbreak of foodborne illness occurred affecting eight people who had eaten in a restaurant. They all had a meal of soup, rice, prawns and bean shoots followed by ice cream, and were taken ill with vomiting 1½-2 hours later. *Bacillus cereus* was isolated from seven people who submitted specimens of faeces, the count in one instance being 2½ million *Bacillus cereus* cells per gram of faeces. None of the suspect rice was available but subsequent samples, prepared as usual, yielded over 30 million *Bacillus cereus* per gram.

Example 2

A series of five small episodes of foodborne illness over a period of 2½ months affected customers eating meals in a restaurant. Thirteen people who ate fried rice with their meals became ill, whereas seven of their companions who did not eat the rice remained well. Illness was characterized by nausea and vomiting 1-6 hours after the meal, in all those affected, and diarrhoea after 2-5 hours in 8 people, *Bacillus cereus* was isolated in large numbers in stool specimens from the patients, in samples of fried rice and from boiled rice ready for frying. Left-over fried rice produced a count of 350 million *Bacillus cereus* per gram, and small numbers of the same organism were found in samples of uncooked rice.

FAULT

- In some restaurants rice intended for frying is boiled the evening before it is needed, and allowed to dry off overnight at room temperature. This gives spores that survive the boiling process ideal conditions to germinate and multiply. The situation is made worse if new batches of boiled rice are added to the remains of old rice not fried on the previous day. Over a period of several days enormous numbers of bacteria can be produced.

Vibrio parahaemolyticus

Example 1

Passengers arriving in London on a aircraft were found to be ill. Three passengers were immediately admitted to hospital and information about other cases was obtained. Three of the cabin crew who had left the aircraft at an intermediary stop were also ill. Everyone who was ill had eaten meals prepared in the town where the flight originated. Samples of complete meals prepared from the same batches of food served on the flight were frozen and flown to the United Kingdom for examination. *Vibrio parahaemolyticus* was isolated from cooked crab meat found in the hors d' oeuvre. The organism was of the same serotype as that isolated from stool specimens of the three patients in hospital. Raw meat from crab claws flown from the town of origin of the flight was also found to contain the same serotype of *Vibrio paraheamolyticus*.

FAULTS

- There are two possible faults. The organism may not have been killed by the cooking process. Alternatively, the cooked crab meat was recontaminated from raw crab meat during preparation of the dish. *Vibrio parahaemolyticus* is sensitive to heat, so contamination of the crab meat, after cooking, from sea water or uncooked marine products is the most likely cause of the illness.

Typhoid fever

Over a period of two months, 72 cases of typhoid fever were reported to a local public health department. The average age of the patients was 19 years and an initial investigation revealed no common source of exposure.

All the patients had used water only from the municipal system and the city authorities reported no recent breaks in water lines for the area where most of them lived. A questionnaire was given to the first 25 patients in a search for common foods or food sources.

Analysis revealed four potential sources: ice cream cones bought from street vendors; Food from two popular «fast food» establishments; and food from a specific tortilla molino (mill). At this mill, the two items purchased most commonly were corn tortillas and barbacoa (a Mexican barbecue dish).

Barbacoa is salted unspiced cow head cook overnight under steam pressure. Meat from the cow head was deboned manually, by employees not wearing gloves, and held in a container on a heated grill at 71-79^{0}C.

Corn tortillas were prepared from corn kernels mixed with a lime slurry to remove cuticles. The mixture was boiled, washed and ground into masa (meal), which was then shaped by hand into tortillas. These were then heated for approximately 2 minutes on rollers warmed by gas jets and then sorted manually by employees.

A stool culture from one employee of the mill yielded *Salmonella typhi*. This employee worked in several locations in the mill including the area where barbacoa was deboned and the area where corn tortillas were shaped and handled.

FAULT

- Likely contamination from a typhoid carrier handling food after cooking and during final preparation.

Shigellosis (bacillary dysentery)

Example 1

Fifty two cases of dysentery were reported among people eating in a dining hall. Shigella was isolated in a number of faecal specimens from infected people and from a cook. The cook had become ill with gastroenteritis about five days prior to the outbreak, but had continued to work.

FAULT

- The cook was an excreter and carrier of Shigella and may have contaminated working surfaces, utensils or food. He should not have been allowed to work during the illness.

Viral gastroenteritis

Nausea, diarrhoea and fever were reported among people who had been to one or more of a series of eight receptions held over a week. Raw oysters, served at the receptions, were the suspected cause of the illness. Investigation revealed that, between them 181 affected people had eaten about 950 oysters.

Examination of faeces revealed the presence of small, round viruses. A total of 4900 oysters had been transported direct from the fishery for the receptions. At the fishery the oysters had been purified by a depuration process as follows. The oysters were kept for 72 hours in a 5500-litre sea-water tank, where the water was continuously circulated through a 30-watt ultraviolet light sterilization unit.

Routine bacteriological sampling of the oysters from the fishery over a period prior to the receptions had shown low levels of faecal bacteria. After the outbreak, however, a sea-water sample from the fishery area and a water sample from a river draining into the fishery area both revealed the presence of high levels of faecal bacteria.

FAULT

- Because of the presence of increased numbers of faecal bacteria in the sea-water, the depuration process (although successful in killing the bacteria in the oysters) was not fully effective in destroying the pathogenic viruses also present. Sufficient numbers of these survived to cause a gastroenteric illness when the raw oysters were eaten.

Chemical poisoning

Example 1

There was an outbreak of severe vomiting among people eating at a restaurant. Illness occurred a few minutes after eating. Investigation revealed that a badly worn, obsolete soda-fountain was

being used. The soda-fountain allowed carbon dioxide to get into the fresh water system which was constructed of copper piping. The carbon dioxide caused copper from the pipes to be dissolved into the drinking-water. Soft drinks served at the restaurant contained enough copper to cause illness.

Example 2

Customers in large restaurant became ill during breakfast. Investigation revealed that the restaurant had bought a government surplus stock-pot which had been used by the night staff to mix reconstituted orange juice. The juice had been held in the pot for a number of hours before use. Laboratory tests showed that the pot was cadmium-plated. Cadmium from the plating had dissolved in the acidic juice.

FAULT

- Susceptible or worn metal piping and other worn metal surfaces had been allowed to come into contact with acidic liquids, causing the metal to dissolve and cause chemical poisoning.

FOODBORNE DISEASES*

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Bacterial diseases						
Aeromonas enteritis.	*Aeromonas hydrophila, A. salmonicida, A. punctata.*	Watery diarrhoea, abdominal pain, and fever.	Water, frogs, seafood (fish, shrimp, oysters), snails.	Faeces, water, suspect food.	Various antibiotics such as aminoglycosides, TMP/SMX.	*Common in soil and water. Opportunistic pathogen.*
	Gram-negative rod, aerobic, faculative anaerobic.		Salt mackerel, fish, shrimp, oysters, and snails.			
	24-48 hours.	Days-weeks.				

FOODBORNE DISEASES*

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Anthrax (intestinal). ICD-9: 022, ICD-10: A22	*Bacillus anthracis.* Gram-positive, non-motile, sporeforming rod, aerobic, faculatively anaerobic. 2-3 days.	High fever, general malaise, headache, insomnia, nausea, acute abdominal pain, vomiting (containing bile and blood), bloody diarrhoea, shock, cyanosis and death. Weeks.	Rarely transmitted by uncooked meat of infected animals. Usually transmitted by tissue, hide and faeces. *Raw or undercooked meat and sausages.*	Blood, sputum, autopsy specimens (lymph nodes), animal tissues, environmental swabs, suspect food, soil.	Penicillin is the drug of choice for naturally acquired gastrointestinal anthrax. Ciprofloxacin is second choice.	Gastrointestinal anthrax is frequently fatal. Intestinal anthrax is rare and difficult to recognize.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Arizonosis infection. ICD-10: A02.9	*Salmonella arizona (Arizona hinshawii).* Kauffman's subgenus III. Gram-negative, non-spore-forming motile rod. Delayed fermentation of lactose. Over 300 serotypes. 2-46 hours	Abdominal pain, diarrhoea, nausea, chills, headache, weakness, fever. Few days.	Faeces of infected humans and animals (rodents). Eggs, turkey, chicken, cream-filled pastry, ice cream, custard containing eggs.	Faeces, serum, suspect food.	Supportive care. Antibiotics such as ampicillin, TMP/SMX.	
Bacillus cereus foodborne intoxication. ICD-9: 005.8, ICD-10: A05.4	*Bacillus cereus.* Exo-enterotoxins. Diarrhoeal toxin (heat-labile) and preformed enterotoxin causing vomiting (heat-stable). Gram-positive, sporeforming, motile rod. 8-16 hours (diarrhoeal toxin) or 1 hour-6 hours (enterotoxin causing vomiting).	Nausea, abdominal pain, watery diarrhoea, some vomiting. 24 hours.	Soil and dust. Custards, cereal products, puddings, sauces such as vanilla sauce, meats, meat loaf, stews, fried rice.	Faeces, suspect food.	Fluid replacemement (supportive care).	*Spores survive in cooked food.*

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Botulism. ICD-9: 005.1, ICD-10: A05.1	*Clostridium botulinum.* Preformed toxins. Gram-positive, sporeforming, anaerobic, motile rod. It produces neurotoxins, which interfere with acetylcholine at peripheral nerve endings. Spores are heat-resistant. Toxins are heat labile. 2 hours-6 days.	Nausea, vomiting, abdominal pain, headache, vertigo, double vision, loss of reflex to light, dysphagia, dysphonia, ataxia, respiratory distress or paralysis. Partial paralysis may persist for 6-8 months. Conscious level usually not affected. Variable (days-months).	Soil, mud, water and intestinal tract of animals. Home canned meat, fish and vegetables inadequately heat-treated or preserved with acids or salts.	Blood serum, faeces, stomach contents, suspect food.	Supportive care. Botulinum antitoxin.	It can be complicated by respiratory failure and death. Botulism toxins can be easily used by terrorists. Although the greatest threat may be via aerosol use, the more common threat may be via its use in food and drink.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Botulism (intestinal). ICD-9: 005, ICD-10: A05.1	*Clostridium botulinum.* Preformed toxins. Gram-positive, sporeforming anaerobic, motile rod. It produces neurotoxins, which interfere with acetylcholine at peripheral nerve endings. Spores are heat-resistant. Toxins are heat-labile. 3-30 days.	In infants <12 months, lethargy, weakness, poor feeling, constipation, hypotonia, poor head control, poor suck. Variable.	Soil, mud, water and intestinal tract of animals. Honey, home-canned vegetables and fruits.	Faeces, serum, food.	Supportive care. Botulism antitoxin is not recommended for infants.	Hypotonia extends to generalized weakness (the "floppy baby").

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Brucellosis (Malta's fever, Mediterranean fever, undulant fever). ICD-9: 023, ICD-10: A23	*Brucella melitensis,* *B. abortus,* *B. suis.* Gram-negative, encapsulated, non-motile coccoid cells, aerobic (*B. abortus* requires carbon dioxide). 5-12 days (may be several months).	Insidious onset. Continued, intermittent or irregular fever of variable duration, chills, profuse sweating, insomnia, weakness, malaise, headache, muscle and joint pain, weight loss, anorexia, bloody stools during acute phase. Several days, or months (occasionally a year).	Tissues, blood, placenta, urine, milk, vaginal discharges and aborted fetuses of infected animals. Main mode of transmission: contact with infected tissues. *Raw milk, cheese and dairy products.*	Blood, bone marrow, milk, urine, animal tissues.	Tetracycline. Acute phase: Rifampicin or streptomycin and doxacycline daily for >6 weeks. Infections with complications require combination therapy with rifampicin, tetracycline and an aminoglycoside.	Induces abortion to animals. Hazardous to animal attendants.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Campylobacter enteritis. ICD-9: 008.4, ICD-10: A04.5	*Campylobacter jejuni.* Gram-negative, motile, "S" shaped organism. Microaerophilic. 3-5 days.	Fever, chills, malaise, headache, aching joints, myalgia, diarrhoea, abdominal pain, nausea, and vomiting. Diarrhoea may be bloody. Up to 10 days.	Intestines, liver and gallbladder of productive and other animals. Main mode of transmission: contact with infected animals or their tissues. Raw meat and milk, unchlorinated water.	Suspect food, milk, water.	Rehydration and electrolyte replacement (supportive care), erythromycin and quinolones, TMP/SMX, tetracycline. Duration of treatment: 1 week.	An important cause of diarrhoeal illness in all parts of the world. Guillain-Barré syndrome can be a sequela. Excretion of the organism can continue for 2-3 weeks.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Cholera. *ICD-9: 001,* ICD-10: A00	*Vibrio cholerae.* Gram-negative, motile, curved rods, aerobic and faculatively anaerobic. Serogrpoups O1 (including classical and El Tor biotypes) or O139. 2-3 days.	Sudden onset, abdominal discomfort, profuse painless watery diarrhoea containing mucus (rice water stools), occasional vomiting, and, in untreated cases, rapid dehydration and collapse, cold skin, drawn face, intense thirst, muscular cramps in extremities. 3-7 days.	Faeces and vomitus of infected human cases, persons incubating the disease and convalescents. Mode of transmission: waterborne. Raw vegetables, moist foods, raw mussels, shrimp and fish. All raw foods washed with contaminated water or prepared in utensils washed with contaminated water.	*Faeces, serum, suspect food, water.*	Aggressive rehydration therapy (rapid fluid replacement iv also per os, if iv is not possible). Administration of effective antibiotics (tetracycline for 3 days). Treatment of complications.	Vaccine of dead bacteria available. In severe untreated cases, death may occur within a few hours, and the mortality rate may reach 70%.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Citrobacter gastroenteritis.	*Citrobacter freundii (Escherichia freundii), Citrobacter intermedius.*	Mild diarrhoea, abdominal pain, nausea, vomiting.	Faeces of animals and humans.	Faeces, suspect food.	Aminoglycosides, quinolones, cephalosporins, piperacillin/tazobactam.	
	Formerly known as Bethesda-Ballerup group. Gram-negative, motile rod. Aerobic, faculatively anaerobic. Citrate positive, coli-aerogenes organism.		Corn pudding, raw milk, macaroni with meat, liver sausage, smoked meat.			
	1 hour-48 hours.	12 hours				
Clostridium perfrigens (Clostridium welchii) foodborne intoxication.	*Clostridium perfringens (Clostridium welchii).*	Sudden onset of colic (acute abdominal pain) followed by watery diarrhoea. Nausea, vomiting, fever and chills are rare.	Faeces of infected persons and animals. Soil, dust, sewage. Raw and cooked foods are frequently contaminated.	Faeces, suspect food, environmental swabs.	Penicillin G. Tetracycline, cefoxitin, cefotetan, clindamycin, piperacillin/tazobactam.	Spores survive cooking.
ICD-9: 005.2 ICD-10: A05.2	Enterotoxin that is produced by type A strain. Gram-positive, sporeforming, non-motile, anaerobic rod.		Cooked meat and poultry that have stayed at room temperature for several hours or cooled slowly.			
	8-24 hours.	1 day or less.				

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Diphtheria. ICD-9: 032, ICD-10: A36	*Corynebacterium diphtheriae.* Gram-positive, non-motile, pleomorphic rod, aerobic, faculatively anaerobic. 2-5 days or longer.	Insidious onset. Throat and nose inflammation with adherent greyish membranes. Fever, chills, sore throat, malaise, difficulty in swallowing, oedema of pharynx, cervical lymphadenopathy. Yellow bloodstained discharges from nose. Albuminuria, haematuria. 2-3 days or longer.	Discharges from mucous surfaces of nose, pharynx, and nasopharynx. Skin and other lesions in humans. Main mode of transmission: airborne. *Raw milk.*	Throat and nose swabs, blood, milk.	Antitoxin in conjunction with erythromycin or penicillin for 10 days. Only antitoxin of equine origin is available.	The only effective control measure is widespread active immunization with diptheria toxoid. The only severe complication is myocarditis.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
EHEC infections (Diarrhoea caused by SLTEC*or VTEC**(11) or EHEC). ICD-9: 008.0, ICD-10: A04.3	*Escherichia coli.* Over 150 different serotypes of enterohaemorrhagic strains (EHEC) that produce potent toxins called Shiga-like toxins I and II or verotoxins 1 and 2 have reported. The commonest EHEC is O157:H7. Gram-negative, non-sporeforming rods, aerobic, faculatively anaerobic. 12-60 hours.	Bloody diarrhoea (haemorrhagic colitis); haemolytic-uraemic syndrome (HUS) associated mainly with 0157:H7 serotype. 5-10 days.	Cattle are the main reservoir of SLTEC. Mode of transmission: consumption of faecally contaminated foodstuff of bovine origin. Direct person-to-person transmission or by contact with infected domestic animals is also possible. Foods of bovine origin (especially ground beef and raw milk). Poultry, tap water and recreational water, yoghurt, salad dressing, fresh apple cider have also been implicated (11).	Faeces, suspect food and water.	Fluid and electrolyte replacement (supportive care) is important when diarrhoea is watery or there are signs of dehydration. Use of antibiotics is not recommended. Renal function, Hb and platelets should be closely monitored.	Very high public health impact, due to severe systemic complications (HUS), and low infectious dose (highly transmissible organism). Waterborne outbreaks are being increasingly recognised.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
ETEC infections & EIEC infections (Infantile & Traveller's diarrhoea caused by ETEC & EIEC). ICD-9: 008.0, ICD-10: A04.1-A04.2	*Escherichia coli.* Enterotoxigenic (ETEC) and invasive (EIEC) strains. Gram-negative, non-sporeforming rods, aerobic, faculatively anaerobic. 5-48 hours.	Invasive illness: fever, chills, headache, myalgia, abdominal pain, watery diarrhoea (similar to shigellosis). Enterotoxigenic illness: diarrhoea, vomiting, dehydration, and shock (similar to cholera). 5 days.	Faeces of infected man (person-to-person spread). Infants are more susceptible. Airborne and waterborne spread may also occur. Various foods, water contaminated with human faeces.	Suspect food, water.	Fluid replacement, TMP/SMX, ciprofloxacin, tetracycline, ampicillin, ofloxacin. Electrolyte-fluid therapy to prevent or to treat dehydration is the most important measure. Duration of treatment: 5 days.	Do not use intestinal sedatives, e.g. diphenoxylate, opiates.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Glanders (Malleus). ICD-9: 024, ICD-10: A24.0	*Pseudomonas mallei.* Gram-negative, long, slender rod-shaped bacterium. 1 day-14 days.	Pneumonia, bronchopneumonia, lobar pneumonia, with or without bacteraemia, mucopurulent discharges from the nose, nodural lesions in the lungs, ulcers in the nostrils and pharynx, lymphangitis and lymphadenopathy. The course may be either chronic or acute.	Ingestion of contaminated food. Food contaminated.	Serum, autopsy specimens.	TMP/SMX. Ceftazidime plus TMP/SMX plus gentamycinin in cases of sepsis.	Difficult to be differentiated serologically from melioidosis.
Klebsiella foodborne infection. *ICD-10: B96.1*	*Klebsiella pneumoniae,* *K. ozaenae,* *K. rhinoskleromatis.* Gram-negative non-motile, encapsulated rods, aerobic, faculatively anaerobic. 10-15 hours.	Headache, dizziness, nausea, abdominal pain, watery diarrhoea. Fever is not reported Most of the patients recover in 6-8 hours, and all within 24 hours.	*Faeces of animal and humans. Respiratory tract of humans.* *Beef, rice.*	Faeces, suspect food.	Specific antibiotics such as cephalosporins, aminoglycosides.	Proof of foodborne transmission is inconclusive.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Leptospirosis. ICD-9: 100, ICD-10: A27	*Leptospira* Spirochetes, aerobic.Over 150 serotypes. 4-19 days.	Fever, headache, chills, malaise, vomiting, muscular pain. Few days-3 weeks or longer.	Infected tissues and urine of animals. Main mode of transmission: waterborne. Milk, meat, ham, kidneys.	Animal tissues, blood, urine, water.	Penicillins.	Typical zoonosis. Dogs may be immunized with a vaccine usually combined with rabies and distemper.
Listeriosis. ICD-9: 027, ICD-10: A32	*Listeria monocytogenes.* Gram-positive, motile rod, aerobic-microaerophilic. 4-21 days.	Fever, headache, nausea, vomiting, monocytosis, meningitis and/or septicaemia in neonates and adults, abortion in pregnant women, localized external or internal lesions, pharyngitis. Sometimes the normal host may have influenza-like symptoms. Variable	*Tissues, urine, milk of infected animals.* Unpasteurized or inadequately pasteurized milk and milk products such as fresh soft cheeses. Eggs, poultry, meat, ready-to-eat deli meats, hot dogs.	Animal tissue, milk, suspect food, blood, urine, cerebrospinal fluid, placental tissue, autopsy specimens.	Penicillin or ampicillin alone or together with aminoglycosides. TMP/SMX.	Practically pasteurization kills the bacterium effectively.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Pasteurellosis. ICD-9: 027.2, ICD-10: A28	*Pasteurella multocida (septica).* Gram-negative, non-motile coccobacillus, aerobic, faculatively anaerobic. 24-36 hours.	Depend upon the part of body affected 5 days.	Infected animals and their faeces. Poultry, vegetables, meat or other foodstuff soiled with animal faeces. Milk.	Sputum, pus, cerebrospinall fluid, blood, urine, infected tissues.	Penicillin G, cefuroxime axetil.	Most serious is the septicaemic form.
Proteus foodborne infection. ICD-10: B96.4	*Proteus vulgaris,* *P. mirabilis,* *P. morganii,* *P. rettgeri.* Gram-negative, motile rods, aerobic, faculatively anaerobic. 3-5 hours.	Diarrhoea, nausea, vomiting, abdominal pain, collapse. 40 hours.	Faeces of animals and humans. *Headcheese, ham.*	Headcheese, ham, fish such as Spanish mackerel and albacore (see scombroid poisoning).	Specific antibiotics such as aminoglycosides, cephalosporins, piperacillin/tazobactam.	Proof of foodborne transmission is inconclusive.

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Providencia gastroenteritis.	*Providencia alcalifaciae, P. stuartii (Proteus inconstans).* Gram-negative, motile rod, aerobic, faculatively anaerobic. 2-24 hours	Watery diarrhoea, nausea, vomiting, abdominal pain. 24 hours.	Faeces of animal and humans. *Contaminated food, (fricasseed chicken was incriminated in a food outbreak).*	Faeces, suspect food.	Third-generation cephalosporins, aminoglycosides, aztreonam.	Providenciae have been recovered from food handlers and patients with gastroenteritis. However, bacteria of this group occur also in faeces of normal individuals.
Pseudomonas aeruginosa foodborne infection. ICD-10: B96.5	*Pseudomonas aeruginosa.* Gram-negative, motile rod, aerobic, faculatively anaerobic. Few days.	Diarrhoea, abdominal pain, nausea, vomiting, dehydration, cyanosis. *1 day-several days.*	Skin lesions, faeces of humans; water, sewage, soil. Also nosocomial infection. Milk (community milk supply), syrup on pancakes, rabbit meat.	Faeces, urine, pus, suspect food, autopsy srecimens.	Ticarcillin/clavulanate or piperacillin/tazobactam alone or in combination with aminoglycosides.	Forms blue pus in infections. The disease is more severe among children and neonates. High resistance to most common antimicrobial agents and disinfectants. Proof of foodborne transmission is inconclusive.

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Salmonellosis. ICD-9: 003, ICD-10: A02.0	*Salmonella choleraesuis,* *S. enteritidis* Gram-negative, non-sporeforming rod. 5-72 hours.	Diarrhoea, fever, vomiting, abdominal pain. Infection may begin as acute enterocolitis and develop into septicaemia or focal infection. 4-7 days.	Faeces of infected animals and humans. Meat, poultry, eggs, and their products. Smoked fish. Contaminated raw fruits and vegetables (alfalfa, sprouts, melons).	Faeces, suspect food, environmental swabs.	Supportive care. Antibiotics such as ampicillin, TMP/SMX for 1 week.	Most reported foodborne disease. It may be a nosocomial infection. Food-animals are a source of antimicrobial-resistant salmonelloses in humans. Antibiotics used in humans should not be used in livestock and poultry for either nutrition or prophylaxis.
Shigellosis. ICD-9: 004, ICD-10: A03	*Shigella* spp. Gram-negative, non-motile rod, aerobic, faculatively anaerobic. Various serotypes. 1 day-7 days	Symptoms vary from mild to severe: Abdominal pain, fever, chills, diarrhoea, tenesmus, dehydration. 4-7 days.	Faeces of infected humans. Main mode of transmission: person-to-person spread. Also waterborne. Moist, mixed foods. Contaminated water, eggs, egg salads, raw vegetables, shellfish, dairy products. Ready-to-eat foods touched by infected attendants.	Faeces, suspect food.	Fluid and electrolyte replacement (supportive care). Antibiotics such as ampicillin, tetracycline, TMP/SMX for 1 week.	Shigellosis is an acute bacterial disease involving the large and distal small intestine. In typical cases, stools contain blood and mucus (dysentery)

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Staphylococcal foodborne intoxication ICD-9: 005.0, ICD-10: A05.0	*Staphylococcus aureus.* Exo-enterotoxins A, B, C, D, E, G, H. Gram-positive, non-sporeforming cocci. 1 hour-7 hours.	Sudden onset of nausea and vomiting, salivation, retching, diarrhoea, abdominal pain, prostration. 1 day-2 days.	Nose and throat discharges. Infected cuts, wounds, burns. High-protein leftover foods. Unrefrigerated or improperly refrigerated meats, potato and egg salads, cream pastries.	Vomitus and faeces, nasal swab, pus, suspect foods.	Fluid replacement (supportive care).	Foods are usually contaminated after cooking.
Streptobacillosis (Haverhill fever). ICD-9: 026.1, ICD-10: A.25.1	*Streptobacilus moniliformis (Haverhillia multiformis).* Gram- negative curved bacterium. 2-14 days.	Influenza-like onset, rash, arthralgia, polyarthritis, myalgia, endocarditis. Short time duration. Relapses are common.	Milk contaminated by rat faecal material. Raw milk.	Blood, joint fluid, lymph nodes, pus.	Penicillin or tetracyclines for 7-10 days.	Epidemic. In untreated cases mortality reaches 10%.

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Streptococcal (faecal) foodborne infection. ICD-10: B95.4	*Streptococcus faecalis;* *S. faecium.* Lancefield group D streptococci. Gram-positive cocci in chains. 2-36 hours.	Nausea, abdominal pain, diarrhoea, and sometimes vomiting. 3-4 days.	Faeces of animal and man. Foods contaminated by respiratory discharges of patient or carrier. Sausages, evaporated milk, meat croquettes, meat pie, ready-to-eat meats, pudding, cheese, egg powder, commercially frozen fruits, fruit juices and vegetables, frozen seafood.	Faeces, suspect food.	Penicillin G or ampicillin, aminoglycosides.	In cases with long incubation period the main symptom is diarrhoea, resembling salmonellosis, *C. perfrigens* or *B. cereus* foodborne intoxication. In cases with short incubation period the main symptom is vomiting, resembling stapylococcal foodborne intoxication.
Streptococcal infections (group A): scarlet fever, streptococcal sore throat. ICD-10: A38, J02.0	*Streptococcus pyogenes.* Lancefield group A beta-haemolytic. Gram-positive, non-motile cocci in chains. 1 day-3 days.	Sore and red throat, pain in swallowing, exudative tonsilitis or pharyngitis, high fever, vomiting, malaise, rhinorrhoea and, occasionally rash. Up to 1 week.	Nose, throat and lesion discharges from infected humans. Main mode of transmission: airborne. Foods usually containing egg or raw cow milk.	Nasal and throat swabs, pus, sputum, blood, suspect food, environmental swabs.	Penicillin for at least 10 days.	Prophylactic antibiotic treatment of contacts of known case. Cows become infected from patients and shed the organism in milk.

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Tuberculosis (extrapulmonary, pulmonary). ICD-9: 010-018, ICD-10: A15-19	*Mycobacterium bovis;* *M. tuberculosis.* Gram-positive, non-motile, acid-fast rods, aerobic. Variable.	Cervical or mesenteric lymph node involvement. In sceletal tuberculosis: pain, limp, restriction of movement, fatigue, weight loss. Bone destruction, spinal deformity, paraplegia. The symptoms depend upon the part of body affected. Variable.	Milk or meat from diseased cattle; respiratory exposure. Raw milk, meat.	Sputum, gastric washings, joint fluids, lymph nodes, blood, urine, bone biopsy specimens, suspect food.	Combination of antimicrobial agents such as isoniazid (INH), rifampicin (RIF), pyrazinamide (PZA), ethambutol (EMB), pyridoxine.	Immunize with BCG in high prevalence areas. Attendants with pulmonary or genitourinary tuberculosis can temporarily infect and sensitize cattle. Keep infected people away from productive animals.
Tularaemia. ICD-9: 021, ICD-10: A21	*Francisella tularensis.* Gram-positive, non-motile, sporeforming rod, aerobic, faculatively anaerobic. 8-24 hours or longer.	Ulcers at the site of pathogenic invasion. Chills, high fever, prostration, stupor, coma; swollen and suppurative lymph nodes. 3-6 months.	Rarely transmitted by foods. Usually transmitted by contact with infected tissue, insect bite and drinking water. Rabbit meat.	Rabbits. Blood, lymph nodes, muscle and other specimens.	Streptomycin is the drug of choice.	Can penetrate unbroken skin. The course of illness may be fatal.

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Typhoid fever. ICD-9: 002.0, ICD-10: A01.0	*Salmonella typhi.* Gram-negative, non-sporeforming rod. 7-28 days.	High-continued fever, bradycardia, splenomegaly, cough, anorexia, malaise, headache, vomiting, constipation or diarrhoea. Rose spots on chest and trunk in 25% of white patients. Nose and bowel bleeding, perspiration, delirium. 1 week-8 weeks.	Faeces and urine of infected humans and carriers. High protein foods, raw salads, milk, shellfish.	Faeces, urine, bile, gallstones, blood (during early course of illness), bone marrow, suspect food, sewer swabs.	Ampicillin or TMP/SMX have comparable high efficacy for acute infections. Quinolone derivatives are quite effective as are the third-generation cephalosporins. Duration of treatment: 14-21 days.	Spread from food and water contaminated by infected persons.
Vibrio parahaemolyticus foodborne intoxication. ICD-9: 005.4, ICD-10: A05.3	*Vibrio parahaemolyticus.* Gram-negative, motile rod, aerobic, faculatively anaerobic. 2-48 hours.	Abdominal pain, watery diarrhoea containing blood and mucus, nausea, vomiting, mild fever. 2-5 days.	Seawater and marine life. Undercooked or raw seafood	Faeces, suspect food.	Fluid replacement (supportive care) for 1 week.	The disease is worlwide, particularly in coastal areas, but most cases have been reported in Japan during the warm months. Cross contamination occurs in the kitchen.

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Vibrio vulnificus infection. ICD-9: 005.8, ICD-10: A05.4	*Vibrio vulnificus.* Gram-negative, non-sporeforming rod. 12 hours-3 days.	Profuse diarrhoea with blood in stools. The organism is associated with wound infections; septicaemia in persons with chronic liver diseases (presenting with bullus skin lesions), haematochromatosis, or those who are immunodepressed. 2-8 days.	*Natural habitat is coastal or estuarine waters.* Undercooked or raw seafood, particularly raw oysters.	Faeces, wounds, blood.	Supportive care. Antibiotics such as tetracycline, doxycycline, quinolones, TMP/SMX.	Case-fatality rate can be as high as 40-60%.
Yersiniosis. ICD-9: 027.8, ICD-10: A04.6	*Yersinia pseudotuberculosis,* *Y. enterocolitica.* Gram-negative, motile rods, aerobic, faculative anaerobic. 24-36 hours.	Appendicitis-like symptoms. Abdominal pain, fever, headache, malaise, anorexia, diarrhoea, vomiting, nausea, chills, pharyngitis, leucocytosis. 1 week-3 weeks.	Urine and faeces of infected animals, usually rabbits, rodents, dogs and pigs. All food and water contaminated.	Blood, suspect food, animal tissues, lymph nodes, faeces.	Supportive care, usually self-limitted. Various antibiotics such as aminoglycosides, TMP/SMX, quinolones.	Widely found in animals, in rivers and lake water.

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Viral and Rickettsial diseases						
Creutzfeldt-Jakob disease (variant)-vCJD. ICD-9: 046, ICD-10: A81.0	Prion or virus-like agent. According to the prion theory, the agent is a filterable kuru-tupe self-replicating protein referred to as a prion. Another theory argues that the agent is virus-like which carries genetic infromation. Several years-decades.	Early in the illness, patients experience most commonly depression and maybe "stickiness" of the skin. As the illness progresses, unsteadiness, difficulties in walking and involuntary movements appear. By the time of death, immobility and muteness develop. Death within 12-15 months versus 3-6 months in the Creutzfeldt-Jakob disease (CJD).	Transmission is believed to be through consumption of food infected by bovine spongiform encephalopathy (BSE), particularly central nervous tissues from infected cattle. *Food infected by bovine spongiform encephalopathy (BSE).*	Brain tissue, cerebrospinal fluid, tonsilar specimens.	No specific treatment available.	vCJD is a fatal, trransmissible spongiform encephalopathy (TSE). The characteristic EEG changes seen with CJD are absent in the vCJD. Unlike CJD, vCJD occurs in a younger age group (20-30 years of age).

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Epidemic viral gastroenteropathy. ICD-9: 078.8, ICD-10: A08.1, A08.2, B34.3	Caliciviruses. Norwalk virus is a small, 27-32 nm, RNA virus that is the prototype strain of viruses classified in the genus Norwalk-like viruses in the *Caliciviridae* family. 24-48 hours.	Nausea, vomiting, watery large-volume diarrhoea, abdominal pain, myalgia, headache, malaise, low-grade fever. 24-48 hours.	Primary community foodborne and waterborne transmission, with secondary transmission to family members. Humans are the only known reservoir. *All foods or water contaminated by human faeces.*	Faeces.	Fluid and electrolyte replacement in severe cases.	Worldwide and common, affecting all age groups. Some may be associated with diarrhoea, mesenteric enteritis and intussusception.

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Hepatitis A (acute viral). ICD-9: 070.1, ICD-10: B15	*Hepatovirus.* Hepatitis A virus (HAV) is a small RNA virion that belongs to the *Picornaviridae* family.	Systemic infection. Fever, malaise, lassitude, anorexia, nausea, abdominal discomfort, bile in urine, jaundice. 10-50 days. Mild illness lasts 1-2 weeks. Severely disabling disease lasts few weeks-several months.	Faeces, urine, blood of infected human cases and persons incubating or convalescing from the disease. Non-human primates are also infected. Main mode of transmission: person-to-person and also waterborne. Shellfish, milk, orange juice, potato salad, cold cuts, frozen strawberries, glazed doughnuts, cream cakes, sandwiches.	Urine, serum.	Prolonged rest.	The virus remains infective after 30 min. at 56°C, when frozen and in water with 1 ppm chlorine. More common in children but foodborne outbreaks occur in adults as well. Prevention in people exposed to the virus by administration of hepatitis A Ig.

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Kuru. ICD-9: 046.0, ICD-10: A81.8	Self-replicating protein or virus-like agent. Filterable, self-replicating agent that is transmissible to primates and other animals. This agent may be either a self-replicating, protein or a virus similar to Creutzfeldt-Jakob disease. 4-30 years.	Insidious onset, cerebral ataxia, incoordination, tremors, rapidly progressing to complete motor incapacity and death. Speech difficulty is common and progressive. Up to 1 year.	Cannibalism. Tissues from corpses (especially the central nervous system tissues) consumed during mourning rituals. Meat from the dead.	Central nervous system tissue.	No specific treatment available.	The disease belongs to the transmissible spongiforme encephalopathies (TSE) group. It is limited to Fore language group in Papua New Guinea who traditionally were consuming the corpses of dead relatives (ritual cannibalism).

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Lassa fever. ICD-9: 078.8, ICD-10: A96.2	Arenavirus. Lassa virus. RNA virus. 6-14 days.	Gradual onset, malaise, fever, headache, sore throat, cough, nausea, vomiting, diarrhoea, myalgia, chest and abdominal pain. Fever is persistent or intermittent-spiking. 1 week-4 weeks.	Rodent faecal material. Any contaminated food by rodent faecal material.	Serum, blood, urine or throat washings.	Ribavirin is most effective within the first 6 days of illness.	Inflammation and exudation of the pharynx and conjuctivae as well as albuminuria and haemoconcentration are common. The survivors may present deafness, pericarditits, orchitis, hair loss.
Lymphocytic choriomeningitis (LCM). ICD-9: 049.0, ICD-10: A87.2	Arenavirus. Lymphocytic choriomeningitis virus. RNA virus. 8-13 days.	Influenza-like symptoms. Myalgia, retro-orbital headache, leuopenia, thrombocytopenia. In some cases acute aseptic meningitis. Orchitis, parotitis. Few weeks.	Nasal secretions, saliva, urine, faeces of house mice (*Mus musculus*) and hamsters. Any contaminated food.	Blood, cerebrospinal fluid, serum.	No specific treatment available.	The acute course is very rarely fatal.

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Poliomyelitis (acute). *ICD-9: 045,* ICD-10: A80	*Enterovirus.* Poliovirus types 1, 2, and 3. Small RNA, cubical, naked virus. Among most stable viruses known. 3-21 days.	Fever, headache, gastrointestinal disturbance, malaise, stiffness of neck and back, with or without flaccid paralysis.	Faeces and pharyngeal secretions of infected persons. Main mode of transmission: person-to-person. Milk, cream-filled pastry. Faecal contamination of materials. Water is rarely involved.	Faeces, pharyngeal swabs, spinal fluid.	No specific treatment available. Attention during the acute illness to complications of paralysis. Respiratory assistance. Physical therapy.	Currently, both injectable inactivated poliovirus vaccine (IPV) or Salk and live attenuated oral poliovirus vaccine (OPV) are available and give excellent protection. Poliomyelitis was targeted for eradication by the end of the year 2000.
Q fever. ICD-9: 083.0, ICD-10: A78	*Coxiella (Rickettsia) burnetii.* Gram-negative, small, pleomorphic, non motile rod. Obligate intracellular parasite. 2-4 weeks.	Sudden onset, chills, headache, weakness, malaise, high fever, pneumonia, mild cough, chest pain.	Tick (faeces), in wild and domestic animals. Animal dust and aerosols, placental tissue, amniotic fluid, milk, carcasses, wool, straw, etc. Milk.	Blood, sputum, urine, cerebrospinal fluid, placental tissue, milk.	Tetracycline.	Rarely transmitted by milk.

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Rotaviral enteritis. ICD-9: 008.8, 078.82, ICD-10: A08.0	Rotavirus. Rotavirus is 70 nm and belongs to the *Reoviridae* family. Group A is common, group B is uncommon, while group C is rare in humans. 24 hours - 7days.	Fever, vomiting, watery diarrhoea, dehydration and death in the young age groups. 1 week.	Faecal-oral and possibly faecal-respiratory contamination. The main reservoirs are humans. All foods and water contaminated with faeces.	Faeces.	Oral rehydration therapy with oral glucose-electrolyte solution for 1 week is adequate in most cases.	Often severe in infants and young children.

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Tick-borne viral encephalitis. ICD-9: 063, ICD-10: A84	Flavivirus. Arbovirus group B with RNA core. Tick-borne virus complex. Russian-spring-summer and louping-ill group viruses are closely related. 7- 14 days.	Sudden onset, headache, fever, nausea, vomiting, hyperaesthesia, photophobia, weakness, delirium, coma, meningoencephalitis, flaccid paralysis. Diphasic fever (and meningoencephalitis): 4-10 days after apparent discovery. 3 weeks.	Animals infected by ticks, tick bites. Raw milk from goats or sheep.	Blood, cerebrospinal fluid, brain tissues of fatal cases.	No specific treatment available.	Infection, whether unapparent or overt, leads to immunity. Tick-born viral encephalitis includes diphasic milk fever.

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Parasitic diseases						
Amoebiasis. *ICD-9: 006,* ICD-10: A06	*Entamoeba histolytica.* Protozoon with four stages: trophozoite, precyst, cyst, metacyst. 3-4 weeks.	Variable. Abdominal discomfort, diarrhoea, constipation, blood and mucus in stools, distension, headache, drowsiness, ulcers. May spread to the blood stream causing abscess of liver, lung or brain. Cases in which symptoms are present <1 month are classified as acute.	Human faeces containing eggs. Main mode of infection is person-to-person contact. Raw vegetables and fruits.	Faeces, lesion exudates, material aspirated from ulcers.	Metronidazole is recommended for carriers, especially those involved in the preparation of food.	Most infections are asymptomatic.

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Angiostrongyliasis (Eosinophilic meningoencephalitis). ICD-9: 128.8, ICD-10: B83.2	*Angiostrongylus cantonensis.* Roundworm (nematode). Adult worms live in pulmonary artery of rats and deposit eggs in blood. Larvae from eggs travel up trachea, are swallowed and pass in stools. 1 week-3 weeks.	Gastrointestinal upset, encephalitis (headache, stiffness of neck and back, paraesthesia), low-grade fever. Variable (2 weeks-2 years).	Rat faeces. Larvae penetrate snails, slugs or marine molluscs. Raw crabs, prawns, slugs, shrimps, snails. Raw vegetables.	Molluscs, rats, serum, autopsy specimens.	Albendazole, thiabendazole.	Reported in Asia and Pacific Islands. Eating habits play an important role in transmission.

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Angiostrongyliasis (intestinal). ICD-9: 128.8, ICD-10: B81.3	*Angiostrongylus costaricensis.* Roundworm (nematode). Larval stage.	Appendicitis-like syndrome. Abdominal pain, tenderness in the right iliac fossa and flank, moderate fever anorexia, vomiting, abdominal rigidity, palpable masses in the right lower quadrant with eosinophilia. Fever may persist for 2 months.	Definitive host is the cotton rat (*Sigmodon hispidus*). Intermediate host is slug *Vaginulus ameghini.* Vegetables contaminated with slug secretions containing larvae.	Blood, serum, autopsy specimens, surgical specimens.	No specific treatment exists. Surgical intervention is sometimes necessary.	
Anisakiasis. ICD-9: 127.1, ICD-10: B81.0	*Anisakis* spp. Roundworm (nematode). Gastric form: 4-6 hours. Intestinal form: 7 days.	Depending on the location of the larvae. Abdominal pain, vomiting, haematemesis, fever. 20 hours-2 weeks. The gastric form can become chronic lasting for more than a year.	Adult worm live in intestine of fish-eating sea mammals. Larvae found in herring. Herring (raw, partially cooked, pickled, smoked).	Gastric and intestinal specimens, herring.	Gastroscopic removal of larvae, excision of lesions.	Most reported in Japan, Holland, Scandinavia and Pacific coast of Latin America.

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Ascariasis (Ascaridiasis).	*Ascaris lumbricoides.*	Variable. Often vague or absent. Digestive disturbances, abdominal pain, restlessness, disturbed sleep. Large numbers of worms may cause intestinal blockage.	Infective eggs from human faeces.	Faeces.	Mebendazole, albendazole, piperazine. Pyrantel pamoate is also effective in a single dose.	Eggs remain infective in warm humid areas for a year or longer.
ICD-9: 127.0, ICD-10: B77	Giant roundworm (nematode)		Raw vegetables and fruits.			
	2 months.	Variable as it depends on the site of infection and the burden of parasites. Even a single worm can be dangerous if migrates into a bile or pancreatic duct.				
Balantidiasis (Balantidial dysentery).	*Balantidium coli.*	Diarrhoea with mucus, blood, pus, and constipation. Necrosis and ulceration produced.	Swine, rat or human faeces.	Faeces.	Tetracyclines, metronidazole.	Contact with pigs important in transmission. Symptomless carriers are common.
	Large ciliated protozoon.		Pork, raw foods.			
ICD-9: 007.0, ICD-10: A07.0	Unknown (sometimes a few days).					

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Capillariasis (hepatic). ICD-9: 128, ICD-10: B83.8	*Capillaria hepatica.* Roundworm (nematode). Eggs hatch in duodenum, larvae enter intestinal wall and migrate to liver. 1 month or longer.	Acute or subacute hepatitis. Variable	Liver (containing embryonated eggs) of peccary, monkey, hare and rodents. Liver of infected animals.	Liver biopsy or necropsy specimens.	Thiabendazole or albendazole.	An uncommon and occasionally fatal disease in man.
Capillariasis (intestinal). ICD-9: 127.5, ICD-10: B81.1	*Capillaria philippinensis.* Intestinal parasite of humans. Unknown.	Enteropathy with massive protein loss, diarrhoea, weight loss, malabsorption. Few weeks-several months	Human faeces. Raw or inadequately cooked small fish eaten whole.	Faeces, jejunal biopsy specimens.	Mebendazole, albendazole.	Case-fatality rates of 10% have been reported. In fatal cases death appears to be due to exhaustion resulting from the marked cachexia.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Clonorchiasis. ICD-9: 121.1, ICD-10: B66.1	*Clonorchis sinensis.* Chinese or oriental liver fluke (helminth). This is a flattened worm whose eggs are among the smallest trematode eggs to occur in humans. Unpredictable.	Gradual onset of abdominal discomfort, anorexia indigestion, abdominal pain or distension and irregular bowel movement. Patients who are heavily infected experience weakness. Weight loss, epigastric discomfort, abdominal fullness, diarrhoea, and anaemia. Chronic disease, sometimes of 30 years or longer duration.	Snails are the first intermediate host. Some 40 species of river fish serve as the second intermediate host. Humans, dogs, cats and many other species of fish-eating mammals are definitive hosts. Raw or under-processed freshwater fish.	Faeces, duodenal drainage fluid, serum.	Praziquantel is the drug of choice.	It is a significant factor for development of cholangiocarcinoma.

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Cryptosporidiosis. ICD-9: 136.8, *ICD-10: A07.2*	*Cryptosporidium* spp. Coccidian protozoa, which infect epithelial cells of the gastrointestinal, billiary and respiratory tracts of humans and other vertebrates. 1 day-12 days.	Diarrhoea preceded by anorexia and vomiting in children, cramping abdominal pain. Infection may be asymptomatic. In immunologically normal patients is a self-limiting disease characterized by watery diarrhoea lasting 3-14 days.	Faeces of man, cattle and other domestic animals. Mode of transmission: faecal-oral, with person-to-person, animal-to-person, and waterborne transmission important. Foods or water contaminated by human or animal faeces.	Faeces.	Rehydration.TMP/SMX, furazolidone, spiramycin.	Symptoms usually remit in less than 30 days. In immunodeficient persons, the disease has a prolonged and fulminant course, contributing to death.

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Cyclosporiasis. ICD-10: A07.8	*Cyclospora cayetanensis* spp. Coccidian protozoa. *1 day-11 days.*	Watery diarrhoea (>6 stools/day), nausea, anorexia, abdominal pain, fatigue, weight loss. 9-43 days.	Contaminated water. Main mode of transmission: waterborne. Foods contaminated via contaminated water.	Faeces.	TMP/SMX.	Seasonal outbreaks in warmer months.
Cysticercosis (Cysticerciasis infection). ICD-9: 123.1, ICD-10: B69	*Taenia solium (Cysticercus cellulosae).* Cysticercus is the larval stage of pork tapeworm Taenia solium. Cysticerci develop in subcutaneous tissues, muscles, and may localize in brain, eye, heart, and central nervous system. 15 days-10 years or longer.	Depend on the organs involved. Frequent involvement of the central nervous system. The most prominent symptom in many patients is epileptiform attacks that occur at irregular intervals. Variable.	Human faeces via faecal-oral route (food or water containing taenia solium eggs, or hands contaminated with faeces). Only autoinfection or person-to-person infection. Any food or water contaminated by human faeces containing eggs of the parasite. Vegetables contaminated with night soil. Pork may introduce the tapeworm initially.	Serum, biopsy specimens.	Surgical intervention may relieve some symptoms.	Pork tapeworm may cause fatal cysticercosis. Neurocysticercosis may cause disability with a relatively low case-fatality rate.

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Dicrocoeliasis (Lancet fluke infection). ICD-10: B66.2	*Dicrocoelium dendriticum,* *D. hospes.* Small hepatic flukes (trematodae) of sheep, goats and cattle. 7 weeks.	Constipation, flatulence, dyspepsia, diarrhoea, abdominal pain (the disease is generally asymptomatic or of a mild symptomatology). Rarely, ectopic localization of parasite eggs in the brain can cause neurological symptoms. Variable.	Infected animal faeces containing eggs contaminate land snails and ants. Humans ingest ants by animals or accidentally. Raw unwashed vegetables or fruits contaminated by ants (during picnics, camping etc.).	Faeces, bile.	Praziquantel is the drug of choice.	The human parasitosis can be prevented by abstaining from consuming, nibbling, or sucking on blades of grass.
Dioctophymosis (Dioctophyme renalis infection). ICD-10: B83.8	*Dioctophyme renalis.* Roundworm (nematode). 3.5-6 months.	Renal disfunction (renal colic and haematuria). In some cases occurs ureteral obstruction because the emigration of the parasites. Variable.	Urine of infected large fish-eating mammals containing eggs. Raw fish and frogs.	Urinary sediment.	No specific treatment available. Surgical removal of the kidney.	In humans and dogs the nematode usually locates in only one kidney, most often the right one, and in most cases only one parasite is found. Human cases described to date have all been renal.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Diphyllobothriasis (Fish tapeworm infection). ICD-9: 123.4, ICD-10: B70.0	*Diphyllobothrium latum.* Flatworm (cestode). 5-6 weeks.	Usually absent. Nausea, vomiting, weakness, dizziness, diarrhoea, or constipation, anaemia may occur. Variable.	Flatworm eggs from faeces of men or fish-eating animals infect copepods, which in their turn infect fish. Raw or partly cooked or pickled fresh fish.	Faeces, fish.	Praziquantel or niclosamide.	Adult worm attaches to mucus of small intestine. Length 10 metres or more.
Echinococcus multilocularis infection (Alveolar hydatid disease) ICD-9: 122.7, ICD-10: B67.5-B67.7	*Echinococcus multilocularis.* Flatworm (cestode). Hydatid cyst 3-6 mm long. Several months-several years.	Jaundice, ascites, splenomegaly.	Faeces of foxes, sled dogs, wolves. All raw food contaminated by soil or faeces of infected canidae.	Serum.	Surgical removal of cysts. Mebendazole, albendazole.	The disease is frequently fatal.

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Echinococcus granulosus infection (Echinococcosis/hydatidosis, cystic hydatid disease).	*Echinococcus granulosus.*	Variable depending on the site and the size of cyst. Cysts can be located on liver, lungs, kidney, pelvis, heart, bone or brain.	Faeces of carnivores containing eggs. Main mode of transmission: contact with dogs, eating raw fruits and vegetables contaminated by faeces of infected dogs.	Serum.	Surgical removal of the cyst. Mebendazole, albendazole.	Definitive hosts are carnivores. Intermediate hosts are herbivores and humans. Eating viscera containing hydatid cysts infects carnivores.
ICD-9: 122.4, ICD-10: B67.0-B67.4	Flatworm (cestode). Hydatid cyst 3-6 mm long. Eggs survive for long periods in soil.		All raw food (or even water) contaminated by faeces of infected dogs.			
	Several months-several years.	The cysts may take many years to produce clinical symptoms. However, many of them are asymptomatic throughout the individuals' life and are only discovered at autopsy, during surgery or in radiographs taken for other reasons.				

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Echinostomiasis. ICD-10: B66.8	*Echinostoma ilocanum,* *E. lindoense,* *E. malayanum,* *E. revolutum.* Small intestinal fluke (trematode). Several months.	When the number of parasites is large, there may be inflammatory reaction at site of attachment to intestinal wall, intestinal colic and diarrhoea. Variable.	Infective faeces of humans, cats, dogs, fowl, rats contaminate fresh water. Raw snails, clams, limpets, freshwater, fish, or tadpoles.	Faeces, suspect foods.	Praziquantel.	In general, echinostomes are not very pathogenic.
Enterobiasis. ICD-9: 127.4, ICD-10: B80	*Enterobius vermicularis.* Embryonate eggs are ingested and hatch in the upper small intestine. Larvae develop in the large bowel into adult parasites (2-5 mm). 2-6 weeks.	Asymptomatic or associated with perianal pruritus and consequent sleep deprivation. It is a rare cause of appendicitis.	Human faeces. Any raw food contaminated with eggs of the parasite.	Scotch tape swab to the perianal region.	Pyrantel pamoate, administration of a single dose of mebendazole, albendazole. The treatment should be repeated after 2 weeks.	Concurrent treatment of the whole family may be advisable if several members are infected.

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Fascioliasis (Sheep liver fluke infection). ICD-9: 121.3 ICD-10: B66.3	*Fasciola hepatica,* *F. gigantica* Large hepatic fluke (trematode). Several weeks.	Cough, vomiting, jaundice, abdominal rigidity, diarrhoea, irregular fever, profuse sweating, eosinophilia, systemic intoxication.	Faeces from humans and animals containing the parasites eggs contaminate fresh water (Intermittent hosts are the snails). Aquatic vegetation.	Faeces, water-cress.	During the migratory phase, symptomatic relief may be provided by dehydroemetine, chloroquine or metronidazole.	Fluke burrows through intestinal wall to liver. Lesions in bile passages.
Fasciolopsiasis. ICD-9: 121.4 ICD-10: B66.5	*Fasciolopsis buski.* Large intestinal fluke (trematode). 3 months.	Diarrhoea alternating with constipation, abdominal pain, nausea, vomiting, anorexia. Intestinal obstruction may occur as well as oedema of the face. Ascites is common.	Human and swine faeces containing fluke eggs. Uncooked water chestnuts, water bamboo and other aquatic plants.	Faeces, suspect foods.	Praziquantel is the drug of choice.	Symptomatic cases are caused by large parasitic burdens. Worms are occasionally vomited.

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Gastrodisciasis (Gastrodiscoidiasis).	*Gastrodiscoides hominis.*	Mucous diarrhoea with colitis only when parasite is a large burden.	Swine, monkey, rodent and human faeces.	Faeces.	Anthelminthic drugs such as carbon tetrachloride or tetrachloroethylene.	It occurs mostly in Indian peninsula.
ICD-10: B66.8	Trematode in large intestine of humans and swine.		Raw aquatic plants containing metacercariae.			
Giardiasis (Lambliasis).	*Giardia lamblia.*	Symptoms sometimes absent or vague. Diarrhoea, mucus in stools, abdominal pain, nausea, weakness, vomiting, dehydration, weight loss, fever.	Cysts in human faeces. Main mode of transmission: personal contact.	Faeces, duodenal drainage.	Metronidazole, quinacrine, furazolidine for 1 week.	People who recover are known to become carriers and excrete the cysts for years.
ICD-9: 007. 1, ICD-10: A07.1	Flagellate protozoon forming cysts.	The acute phase of the disease lasts about 3-4 days.	Raw food.			
	1 week-6 weeks.					

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Gnathostomiasis. ICD-9: 128.1, ICD-10: B83.1	*Gnathostoma spinigerum,* *G. hispidium.* Roundworm (nematode). 1 day-2 days.	Transient inflammatory lesions or abscesses in various parts of the body. Cerebral lesions with eosinophilia. Cholecystitis, appendicitis. Several years.	Faeces containing eggs of infected animals. Third-stage larvae contaminate fish, frogs, birds and snakes. Raw or undercooked freshwater fish and poultry containing third-stage larvae.	Biopsy specimens, emerging worms from skin abscesses or natural orifices.	The effectiveness of anthelmenthic drugs such as albendazole and mebendazole is questionable.	
Heterophyiasis. ICD-10: B66.8	*Heterophyes* spp. Small intestinal flukes (trematodae). The most common species are *Heterophyes heterophyes.* Several weeks.	It is usually asymptomatic. A large parasite burden may cause abdominal pain, chronic diarrhoea containing mucus. Variable.	Fish infected with metacercariae. Raw or partially cooked, salted or dried freshwater or brackish-water fish (mullet).	Faeces.	Tetrachloroethylene.	Aberrant eggs of the parasite sometimes enter the bloodstream and produce granulomatous foci in the myocardium, brain.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Hymenolepis diminuta hymenolepiasis. ICD-9: 123.6, ICD-10: B71.0	*Hymenolepis diminuta.* Rat tapeworm. Intestinal flatworm (cestode) of rodents and, rarely, humans. 2-4 weeks.	Diarrhoea, abdominal pain, identified gastrointestinal complaints. Mainly asymptomatic. Self-limited.	*Faeces of definitive hosts, especially rats, contain eggs that are ingested by coprophilic arthropods such as flea larvae, grain beetles, cockroaches and others, which are the intermediate hosts.* Food containing insects (e.g. contaminated precooked grains and cereals).	Faeces.	Praziquantel or niclosamide.	Control rodents in grain storage areas.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Hymenolepis nana hymenolepiasis. ICD-9: 123.6 ICD-10: B71.0	*Hymenolepis nana.* Dwarf tapeworm. Intestinal flatworm of humans and rodents. 2-4 weeks.	Light infections are usually asymptomatic. Massive numbers of the worms may cause enteritis with or without diarrhoea, abdominal pain, and other vague symptoms such as anorexia, pallor. Neurological symptoms. Allergic symptoms (pruritic rash).	Faeces of mice and humans containing eggs. Grains.	Faeces.	Praziquantel or niclosamide.	The only human tapeworm without an obligatory intermediate host.
Metagonimiasis. ICD-10: B66.8	*Metagonimus yokogawai.* Fluke. It sometimes deeply invades the intestinal mucus. 1 year or less.	It is usually asymptomatic. A large parasite burden can cause irritation of the intestinal mucus; the infection is clinically apparent only when the number of parasites is large.	Cats, dogs, fish. Raw or undercooked fish infected with metacercariae.	Faeces.	Praziquantel or tetrachloroethylene.	The eggs of *Metagonimus* and *Heterophyes* are difficult to distinguish from one another. Differentiation of the two species requires examination of the adult flukes by experts.

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Opisthorchiasis. ICD-9: 121.0, *ICD-10: B66.0*	*Opisthorchis viverrini,* *O. felinus* Helminths. Morphological features resemble those of the causative agent of Clonarchiasis. 1 week-4 weeks.	Fever, abdominal pain, dizziness, urticaria. Chronic cases may lead to diarrhoea, flatulence, fatty food intolerance, epigastric pain, jaundice, hepatomegaly, fever, lassitude, anorexia, emaciation and oedema.	Freshwater snail is the first intermediate host, several fish species act as second intermediate host, humans, dogs, cats, and other mammals that eat fish or fish waste are definite hosts. Raw or under-processed freshwater fish.	Faeces, duodenal drainage fluid, serum.	Praziquantel.	These worms are the leading cause of cholangiocarcinoma in the world.

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Paragonimiasis (Lung fluke disease, pulmonary distomiasis). ICD-9: 121.2, ICD-10: B66.4	*Paragonimus westermani.* Oval fluke (trematode). Many months.	Cough, haemoptysis (findings closely simulate to those of pulmonary tuberculosis). Prolonged and variable.	Infective sputum or faeces from humans or animals contaminate fresh water. Intermediate host: snails. Cercariae encyst in fresh water crab or crayfish. Raw or partly cooked crabs or crayfish.	Faeces, sputum, crabs, crayfish.	Praziquantel.	Fluke penetrates intestinal wall and reaches the lungs.
Sarcocystosis. ICD-10: A07.8	*Sarcocystis hominis,* *S. suihominis.* Coccidian protozoa. 9-10 days.	Intestinal sarcocystosis is usually asymptomatic. Nausea, abdominal pain and diarrhoea 6 hours after eating and recurred 14-18 days after ingestion. Muscular sarcocystosis is asymptomatic too. Weakness, muscular pains, myositis, subcutaneous tumefaction.	Human faeces containing sporocysts. Raw or undercooked beef or pork containing cysts (sarcocysts).	Faeces.	Intestinal sarcocystosis: anticoccidian drugs. Muscular sarcocystosis: pyrimethamine.	In general, human muscular sarcocystosis is discovered fortuitously during examination of muscle tissues for other reasons.

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Taenia saginata taeniasis (Beef tapeworm infection). ICD-9: 123.2, *ICD-10: B68.1*	*Taenia saginata.* Flatworm (cestode). Ingested larvae develop into adult worms in intestine. Adults attach to mucus of small intestines by their scolices. Average length is 5 metres. 10-14 weeks.	Variable. Usually absent. Nervousness, insomnia, hunger pains, anorexia, weight loss, abdominal pain. Digestive disturbances such as nausea, vomiting and diarrhoea or constipation may occur sometimes. Variable.	Human faeces containing eggs or proglotids infect pastures. Consuming raw or undercooked cattle meat infects humans. Beef	Faeces, beef.	Niclosamide and dichlorophen.	

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Taenia solium taeniasis (Pork tapeworm infection). ICD-9: 123.0, ICD-10: B68.0	*Taenia solium.* Flatworm (cestode). Adult worm attaches to mucus of small intestine. Average length is less than 3 metres. 8-12 weeks.	Variable usually absent. Nervousness, insomnia, hunger pains, anorexia, weight loss, abdominal pain. Digestive disturbances such as nausea, vomiting, colic and diarrhoea sometimes. Variable.	Human faeces containing eggs from proglotids infect pastures. Consuming raw or undercooked pork meat infects humans. Pork	Faeces, pork.	Niclosamide and dichlorophen.	The infection of humans by the larval stage of Taenia solium i.e. *Cysticercus cellulosae*, causes cysticercosis (see cysticercosis or cysticerciacis infection)).
Toxocariasis (Larva migrans visceralis). ICD-9: 128.0, ICD-10: B83.0	*Toxocara canis,* *T. cati.* Nematodes. Weeks or months.	Eosinophilia, hepatomegaly, hyperglobulinaemia, pulmonary symptoms, fever. Endophthalmitis (caused by larvae entering the eye) with loss of vision. Variable.	Faeces from dogs and cats containing eggs of the parasite. Directly eating dirt (young children). Indirectly eating unwashed raw vegetables. Unwashed raw vegetables.	Liver biopsy specimens.	Diethylcarbamazine, thiabendazole, mebendazole.	Prevent contamination of soil by dog and cat faeces in areas immediately adjacent to houses and children's playing grounds. The symptoms may recur for several months.

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Toxoplasmosis. ICD-9: 130, *ICD-10: B58*	*Toxoplasma gondii.* Sporozoan protozoon, forming cysts. Unknown, in one outbreak: 10-13 days.	Fever, lymphocytosis, spleen, liver and lymph nodes enlargement, headache, myalgia, rash. Spontaneous recovery in a few weeks or months or serious course with various localizations.	Cat faeces are the source of infection (mammals and birds are infected with ingestion of forage contaminated by sporulated oocysts). Raw or rare cooked meat of infected animals or contaminated (blood soiled) utensils.	Biopsy specimens (tissues affected, lymph nodes), blood.	Pyrimethamine with sulfadiazine and folinic acid in severe disease.	*T. gondii* survives very little time in extracellular environment. Placental transmission occurs. Oocysts in cat faeces are very resistant.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Trichinellosis (Trichiniasis). ICD-9: 124, ICD-10: B75	*Trichinella spiralis.* Threat-like roundworm (nematode). Females invade mucus of small intestines, travel via blood and encyst in muscles. 4-28 days.	First stage: nausea, vomiting, diarrhoea, and abdominal pain. Second stage: persistent fever, oedema of eyes, sweating, muscular pain, thirst, chills, skin lesions, weakness, prostration, laboured breathing. Third stage: toxaemia, myocarditis, eosinophilia. First stage: 4 days. Second stage: few days-few weeks.	Meat of infected animals. Pigs are the primary source of infection for humans. Pork, bear meat, dog meat.	Muscle biopsy specimens (gastrocnemius, deltoid), blood, skin test. Diaphragm muscle of swine and bear.	Thiabendazole in intestinal stage. Mebendazole in muscular stage.	The first stage is identified as intestinal invasion, the second stage is equal to the muscle penetration, and in the third stage the tissues are repaired. Trichinellosis may be a fatal disease, and it may cause death due to myocardial failure.
Trichostrongyliasis. ICD-10: B81.2	*Trichostrongylus orientalis,* *T. columbriformis,* *T. axieei*, and other spp. Thread-like round-worm (nematode) that infects the intestine and stomach of animals and humans. Several months.	Usually asymptomatic; gastrointestinal symptoms in intense infections (eosinophilia, digestive disorders, diarrhoea, abdominal pain, weight loss, and slight anaemia. Several years.	Animal and human faeces. Raw vegetables or other food contaminated by larvae.	Faeces.	Mebendazole.	Preventive measures consist of improved food, environmental, and personal hygiene.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Trichuriasis (Trichocephaliasis, whipworm infection). ICD-9: 127.3, ICD-10: B79	*Trichuris trichiura.* Roundworm (nematode). Several months.	Usually asymptomatic. Abdominal discomfort, emaciation, anaemia. Constipation, loss of appetite, vomiting.	Persons discharging eggs in stools. Source is soil contamination. Any food contaminated by soil.	Faeces.	Mebandazole or albendazole.	Eggs are very resistant to environmental changes. Common in warm, moist regions.

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Fungal diseases						
Aflatoxicosis (Toxic effect of aflatoxin). ICD-10: T64	*Aspergillus flavus.* Aflatoxin B1, B2, G1, G2 (heat stable toxins). Few weeks.	Law grade fever, ascites, jaundice and oedema of feet.	Soil and air. Cottonseed meals, Brazil nuts, palm kernels, peanuts, soybeans, corn, wheat and other cereals.	Nuts, grains.	No specific treatment available.	Possibly carcinogenic to human liver (hepatocellular carcinoma).
Ergotism. ICD-10: T62.2	*Claviceps purpurea.* Ergot alkaloids are toxic alkaloids: ergotamine, ergotoxine and ergometrine groups. 1 hour-2 hours.	Gangrenous form: lassitude, pain in limbs, gangrenous necrosis of limbs and feet. Convulsive form: tonic spasms, hallucinations, and convulsions. 3 months or longer.	Cereals, soil, air. Rye meal or bread.	Stomach contents, liver, rye.	Symptomatic treatment with vasodilators, heparin, anticonvulsants.	Probably the first mycotoxicosis recognized. Its chronic form "St. Anthony's fire" occurred in the past in frequent epidemics in USA, Russia and England. Today it continues to cause problems in the veterinary practice in some areas of the world.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Mushroom poisoning (neurological signs). ICD-10: T62.0	*Amanita muscaria.* Muscarine is a neurotoxin. Short-acting toxin. 15-20 minutes.	Rapid onset, salivation, perspiration, peripheral vasodilation, lacrimation, bradycardia, nausea, vomiting, abdominal pain, copious watery diarrhoea, slow irregular pulse, pupil constricted, asthmatic breathing, cardiac or respiratory failure.	Mushroom tissue. Mushrooms: *Amanita muscaria* (fly agaric), *A. pantherina,* *A. parcivolvata* and other related spp.	*Mushroom, urine.*	Anticholinergic agents (atropine sulphate) and apomorphine.	Occurs more frequently in May or June.
Mushroom poisoning cell destruction. ICD-10: T62.0	*Amanita phaloides.* Toxins: phaloidine, amanitahaemolysin, phaloin, amatines. Long-acting toxins. Protoplastic poison that disrupts the integrity of cellular membranes. 6-24 hours.	First phase: sudden onset, nausea, vomiting, abdominal pain, diarrhoea, thirst, muscle cramps. Feeble pulse, apathy, collapse. Second phase: jaundice, cramps, loss of consciousness, coma and death. Death within 2-8 hours. Non-fatal cases persist about 30 days.	Mushroom tissue. Mushrooms: *Amanita phalloides* (death angel or destroying angel), *Amanita verna,* *A. brunnescens,* *A. biaporigera,* *A. tenuifolia,* *A. virosa* and other related spp.	*Intact mushroom, blood.*	*fresh urine,* Thioctic acid (Thioctacid). Antiphalloidian serum.	One or two mushrooms are frequently causing death. Case fatality rate 50%. It occurs more frequently in July.

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ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Plant toxicants and toxins effects						
Conium poisoning (Toxic effect of conium). ICD-10: T62.2	*Conium maculatum.* *Conium maculatum* (poison hemlock) is a wild plant that contains 5 toxic alkaloids: coniine, N-methyl coniine, conhydrine, l-coniceine, and pseudoconhydrine. Coniine was the first alkaloid ever to be synthesized. 12min-1 hour.	Gradually increasing muscular weakness followed by paralysis with respiratory failure. Temporary albuminuria, nausea, vomiting, convulsions. The mousy odour of the plant is detected in the breath of the victims. Death within a few hours or the following day.	The plant tissue. At certain times during plant growth 1cm^2 of plant tissue may produce fatal poisoning. At other times consumption of 4% of body weight may not produce death. *The plant tissue e.g. root, bulb.*	*Odour, post-mortem specimens.*		*Conium maculatum* is considered to be the "hemlock" used to put Socrates to death.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Fava bean poisoning (favism).	Glucose-6-phosphate dehydrogenase (G-6-PD) deficiency.	*Haemoglobinaemia, haemoglobinuria, jaundice. In severe cases, abdominal or back pain, acute haemolytic anaemia (dizziness, headache, palpitations, dyspnoea), and if haemoglobinuria is severe, renal tubular necrosis and acute renal failure are risks.*	Illness results after eating fava beans.	Blood.	No specific treatment available. Emesis, lavage, sedatives, supportive care. Blood transfusion.	Avoidance is the goal. Screening tests in neonates.
ICD-10: D55.0	The normal enzyme is termed GdB. GdMed is the second most common abnormal variant and is found in people of the Mediterranean area. GdCanton is common variant in Oriental populations.		Fava beans (Italian broad beans). The clinical infestation depends on the quantity of fava beans eaten.			
	1 day-3 days.					

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Goitre (endemic)-Iodine-deficiency disorder (IDD). ICD-10: E01	Goitrogens. Goitrogens as the derivatives of thiooxazolidone and thiocyanates prevent normal inorganic iodine accumulation by the thyroid hormone.	Adults: enormous hypertrophy and hyperplasia of the thyroid gland producing physical impairment. Infants: endemic cretinism, dwarfism and mental retardation, or spastic diplegia, squint and deafness.	Various eatable plants as *Brassica* spp.(cabbage, turnip, sprouts, broccoli, rape, kale, rutabaga, kohlrabi), *Glycine max* (soybean), *Linum usitatissimum* (flax), *Beta vulgaris cicla* (chard), Cruciferae, Rosaceae, Umbelliferae (carrot). The above vegetables, milk of cows eating these vegetables. A thiocyanate derivative from the cassava, which is eaten in large quantities in Central Africa, and a goitrogenic hydrocarbon found in the water in parts of Colombia and in Chile.	Serum.	Iodine supplementation: the treatment of iodine deficiency is to supply this element either as a food additive or by direct injections of iodinated oil.	The term goitre has been used for many years to describe the effect of iodine deficiency (IDD). Goitre is the obvious and familiar feature of iodine deficiency. Iodine is an essential constituent of the thyroid hormones thyroxine and triidothyronine.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Solanine poisoning (Toxic effect of solanine).	*Solanum dulcomara,* *S. nigrum.*	Burning of throat, nausea, convulsions, diarrhoea, dizziness, collapse, delirium, lassitude, muscular weakness.	Unripe globular berries, leaves, sprouts, eyes, skin or green shoots of potatoes.	Urine, plant.	Emesis and thorough hand washing plus management for atropine poisoning.	Exposure to sunlight increases solanine content.
ICD-10: T62.2	Solanasceous alkaloid or solanine (a cholinesterase inhibitor).		Bittersweet, potatoes.			
	1 hour-6 hours.					
Toxic Animals effects						
Ciguatera fish poisoning.	*Gambierdiscus toxicus.*	Tingling and numbness around the mouth, metallic taste, dryness of the mouth, gastrointestinal symptoms, watery stool, myalgia, dizziness, dilated pupils, blurred vision, prostration, paralysis.	Liver, intestines, roe, gonads or meat of fish from tropical reefs (reef fish).	Fish gonads, liver, intestines and muscles of epidemiologically implicated fish.	Mannitol administration is the most promising treatment (14).	There is no reliable method of detecting poisonous fish by their appearance. Neither frying, baking, boiling, salting, drying nor other ordinary cooking method destroys ciguatoxin.
ICD-9: 998.0, ICD-10: T61.0	This syndrome is caused by the presence in the fish of ciguatoxin elaborated by the above dinoflagellate that grow on reefs under the sea. Ciguatoxin is a thermostable neurotoxin. Anticholinesterase.		Numerous varieties of tropical fish. Large reef fish are more likely to be toxic.			
	3-5 hours or longer.	Few weeks.				

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Oyster poisoning. *ICD-9: 998.0*, ICD-10: T61.2	Algae. Asaritoxin is a stable to heat toxin. The toxin is not destroyed after 1 hour boiling. 6 hours-7 days.	Anorexia, abdominal pain, nausea, vomiting, constipation, headache, malaise, nervousness, bleeding of mucous membrane of nose, mouth, and gums, delirium. No paralysis occurs. Few days.	Toxin is concentrated in digestive gland and liver. Oysters and clams.	Shellfish.	Symptomatic treatment.	High case fatality rates (33.4%).

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Puffer fish poisoning (Tetrodotoxism). ICD-9: 988.0, *ICD-10: T61.2*	*Plectognathi* spp. Tetrodotoxin is non-protein neurotoxin causing paralysis of central and peripheral nervous system. Stable to boiling except in alkaline solution. Water soluble. 10 min-3 hours.	Paraesthesias, dizziness, gastrointestinal symptoms, ataxia, which progresses rapidly to paralysis and death. Death within several hours.	The viscera (ovaries, eggs, liver, intestines), and skin of the fish are most toxic but flesh may also be. About 90 toxic species of puffer fish (fugu, blowfish, globefish, porcupine fish, balloon fish, toadfish).	Gonads, liver, skin, muscle of fish.	Symptomatic treatment; intensive care.	Toxicity is highest during spawning period. Important cause of fish poisoning in Japan.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Scombroid fish poisoning (Histamine-like syndrome). ICD-9: 988.0, ICD-10: T61.1	*Scombroidea,* *Scomberesocidae.* Scombroid toxin (saurine) is a histamine-like substance. Histidine in flesh is broken down to saurine by action of *Proteus* spp. or other bacteria. This occurs when the fish has undergone bacterial decomposition after capture. Few minutes-1 hour.	Intense headache, dizziness, nausea, vomiting, metallic or peppery taste, diarrhoea, facial swelling, epigastric pain. Carotid and temporal vessels throbbing, rapid and weak pulse. Throat burning, thirst, difficulty in swallowing, oedema and itching. 12 hours.	Illness results from eating flesh of the implicated fish containing high levels of free histamine. *Tuna, bonito, mackerel, skipjack.*	Faeces, epidemiologically implicated fish.	Antihistaminic drugs.	Generally caused by the improper preservation of scombroid fish.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Shellfish poisoning (paralytic)-PSP. ICD-9: 988.0 ICD-10: T61.2	*Dinoflagelatae* spp.such as *Alexandrium* spp. Saxitoxins are neurotoxins able to block neuromuscular junction. Alkaloid, relatively heat stable, water-soluble. Concentration of these toxins occurs during massive algae blooms known as "red tides". Few minutes-several hours.	Initial symptoms: paraesthesias of the mouth and extremities, gastrointestinal symptoms. In severe cases, ataxia, dysphonia, dysphagia, total muscle paralysis with respiratory arrest and death occur. 12 hours-few days.	The illness results after eating shellfish that have been feeding on plankton-dinoflagellates. Bivalve molluscs. Mussels, cockles, clams, soft shell clams, butter clams (*Saxidomus*) and other species.	Epidemiologically implicated food e.g. clams, muscles. Seawater. Serum, urine.	Symptomatic treatment (artificial ventilation where necessary).	Shellfish accumulate and concentrate the toxins in their tissues without harm to themselves. During red tides, cell counts of plankton blooms may reach 20-40 million per ml. Red tides occur most often in warm months.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Naturally occurring toxins effects						
Gastrointestinal and foodborne allergies.	Allergens. Allergens are usually proteins, sometimes sugars or fats. They react with antibody and form histamine or histamine-like substance. 2-12 hours.	Gastrointestinal: nausea, vomiting, abdominal pain, diarrhoea or constipation, bloating, excessive gas production, backaches. Urticaria, angiooedema, itching. Swelling of tissues, oedema, hives, rash, eczema, spasms of mouth muscles, asthma, rhinitis. Variable.	Initial response to food antigen, latent period (sensitizing taking place and antibody production), reexposure, union of antigen and antibody in shock organ, release of histamine, and symptoms. Milk and dairy products, eggs (whites), cereals, corn, rice, wheat, buckwheat, oats, peas, beans, nuts. Fish and seafood, meats. Vegetables, onions, potatoes, mushrooms, fruits such as berries, cantaloupe. Chocolate.	Skin tests.	Antihistaminic drugs.	Symptoms may depend on quantity, duration during which food is eaten, and regularity with which is eaten. Cooking may destroy allergens.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Poisonous chemicals effects						
Anticoagulant rodenticide poisoning (Toxic effect of anticoagulant rodenticides). ICD-10: 60.4	Anticoagulant rodenticides. Principally warfarin. Inhibits prothrobine formation. Capillary damage. 7-10 days.	Back and abdominal pain, vomiting, nose bleeds, bleeding gums, pallor, petechial rash, massive bruises, extensive blood loss in urine and stools, shock. Acute course.	Rodenticide. Consumption of poisoned baits. Any food contaminated with the rodenticide and consumed over a period of several days.	Blood, stomach contents.	Vitamin K is the antidote of first choice. Medical attention immediately. Rapid determination of prothrobine time. Monitoring of prothrobine time for a period of many months.	Warfarin has widespread use as an anticoagulant drug in humans.
Antimony poisoning (Toxic effect of antimony). ICD-10: T56.8	Antimony. Antimony is the form of oxide, a constituent of enamels for coating cooking utensils. 5 min-8 hours.	Vomiting, metallic taste. Self-limited.	Inadvertent poisoning from antimony release from inexpensive enamelware. Metallic container.	Blood	Supportive care. Lavage, activated charcoal, dimercaprol (BAL).	

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Arsenic poisoning (Toxic effect of arsenic). ICD-10: T57.0	Arsenic (trivalent). Systemic action on capillaries, corrosive, chelates with dithiols. Trivalent arsenic is the most toxic form. 10 min-several days.	Burning of mouth or throat, metallic taste, vomiting, diarrhoea (watery and bloody), borborigmi, painful tenesmus, haematuria, dehydration, jaundice, oliguria, vertigo, muscle spasm, stupor, delirium may occur. Acute course.	Pesticide sprays contaminate food. Weed killers. In food can be mistaken for sugar, baking powder or soda. Also in well water.	Gastric washings, urine, blood, hair, nails.	Dimercaprol (BAL) is the antidote of choice but it should be given within the first 24 hours after exposure.	Peripheral neuropathy is the usual symptom of chronic arsenic toxicity.
Beer drinker's cardiomyopathy (Toxic effect of cobalt). ICD-10: T56.8	Cobalt acetate. Cutaneous vasodilator. Trace element whose toxicity is in large part associated with haemodialysis. 2 months-several months.	Those of congestive heart failure (CHF).	Cobalt acetate (improver for head of beer). Cobalt was added to beer in the 1960s as a foam stabilizer. Beer.	Blood, urine, hair, heart muscle at autopsy.	Treatment of congestive heart failure.	Reported only in habitual, daily consumers of large amounts of beer. Mortality from heart failure or arrhythmias ranged from 5-47%.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Cadmium poisoning (Toxic effect of cadmium). ICD-10: T56.3	Cadmium. Heavy metal. Cadmium retention in body tissues is related to the formation of cadmium-metallothionein. 5 min-8 hours.	Nausea, vomiting, myalgia, increase in salivation, stomach pain. Self-limited.	Pollution of estuary and off-shore waters. Seafood such as fish (salmon, tuna), crabs, oysters, clams, lobsters. Grains, peanuts.	Blood, urine	Supportive care.	The highest concentrations of cadmium are found in kidney.
Chlorinated hydrocarbon poisoning (Toxic effect of chlorinated hydrocarbons). ICD-10: T53	Chlorinated hydrocarbon: DDT, benzene hexachloride, lindane, toxaphen. Stimulates CNS. High lipid solubility and low water solubility lead to the retention of DDT and its stable metabolites in fatty tissues, which means that toxic effect can occur in organisms remote in time and place from the point of exposure. 30 min-6 hours.	*Nausea, vomiting, paraesthesia of tongue, lip, part of the face and extremities. Apprehension, disturbance of equilibrium, dizziness, confusion, muscular weakness anorexia, weight loss.*	Insecticides. Spray applications. Leafy vegetables and any food accidentally contaminated with insecticides.	Blood, urine, faeces, fat biopsy specimens, stomach contents.	No specific antidote available. General supportive measures.	Prolonged storage of DDT in mammals and fish tissues. DDT-type compounds can be transported around the world in the bodies of migrant animals and in ocean and air currents.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Copper poisoning (Toxic effect of copper). ICD-10: T56.4	Copper salts. Emetic, irritant, and astrigent. Copper is a potent red cell poison, damaging cell membranes and inhibiting a variety of red cell membranes. Few minutes-8 hours	Metallic taste, nausea, vomiting, diarrhoea, abdominal pain. Vomitus is often green.	Copper pipes, copper containers, copper cake decorations. Carbonated beverages, acid foods, copper cake decorations, copper-contaminated drinking water.	Food container, vomitus, stomach contents, urine, blood, faeces.	D-penicillamine plus dimercaprol (BAL).	Copper forms very stable complexes with porphyrins. Great hepatotoxicity. The consumption by early-weaned infants of milk-based formulae heavily contaminated with copper after storage in brass vessels is a feature of fatal Indian childhood cirrhosis.
Cyanide poisoning (Toxic effect of hydrogen cyanide). ICD-10: T57.3	Hydrogen cyanide. Cyanogenic glucosides (amygdalin, prunacin) liberate hydrogen cyanide. Odour of bitter almonds. 1 hour or less.	Asphyxia, dyspnoea, vomiting, excitement, gasping, staggering, fibrillary twitching, paralysis, stupor, convulsions, coma, collapse, cyanosis, lassitude, prostration. Death occurs within 15 min-1 hour with lethal doses.	Seeds. Bitter almonds, cassava, choke cherry, pits, peach pits, apple and other seeds.	Plants, stomach contents, blood, urine.	Sodium nitrite with sodium thiosulphate-dicobalt edetate.	It has a high mortality and specific antidotal therapy can be life saving.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Methanol poisoning (Toxic effect of methanol). ICD-10: T51.1	Methanol (methyl alcohol, wood alcohol). Central nervous system depressant causes acidosis by inhibiting oxidative enzyme system. 8-72 hours.	Vomiting, severe abdominal pain, depression, weakness, headache, dimness of vision, dyspnoea, coma, cyanosis. Cerebral oedema, optic neuritis, blindness, oliguria. Acute course.	Paint solvent, antifreeze. Ethyl alcohol substitute. Bootleg whiskey.	Urine, vomitus, blood, autopsy specimens.	Ethanol, bicarbonate and extrarenal exchange.	Intoxication by methanol causes severe metabolic acidosis, which may rapidly lead to death if not diagnosed and treated early (13). Mortality and morbidity are more related to the time between ingestion and therapy than to the initial methanol levels.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Nitrate poisoning (Toxic effect of nitrates) Nitrite poisoning (Toxic effect of nitrites)	Nitrates (salts of nitric acid). Nitrites (salts of nitrous acid). They develop methaemoglobinaemia; interfere with oxygen-carrying capacity of red blood cells. They may form nitrosamines, which are carcinogenic *in vivo*. 1 hour-2 hours.	*Nausea, vomiting, cyanosis (blueness of lips and other adjacent areas (fingers near nails), fall in blood pressure, headache, dizziness, dyspnoea, trembling, weakness, loss of consciousness, methaemoglobinaemia, chocolate-brown discolouration of blood.*	Soil, fertilizer, colour developer for processed meat. Rural well water supplies. Processed meats and fish. Nitrates accidentally used for salt. Milk formulas. Spinach and other plants with excessive fertilization.	Blood, suspect food.	Methylene blue.	Avoid excessive nitrification of foods.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Organic phosphorus poisoning (Toxic effect of organophosphate insecticides). ICD-10: T60.0	Organic alkyl, aryl phosphate esters: Parathion, Diazinon, Malathion. Irreversiblly inhibit cholinesterase and allow accumulation of acetylcholine. Few minutes-8 hours.	Nausea, vomiting, abdominal pain, diarrhoea, excessive salivation, headache, giddiness, nervousness, blurred vision, weakness, chest pain, tearing, respiratory tract secretions, cyanosis, confusion, coma, loss of reflexes and sphincter control. Self-limited.	*Insecticides.* Parathion in bread, pastry, cereal, sugar. Diazinon is mistaken for wine. Any food accidentally contaminated with insecticides.	Blood, urine, fat biopsy specimens.	Pralidoxime with atropine.	Among most toxic chemicals known. Carbamate pesticides show similar toxic effect.

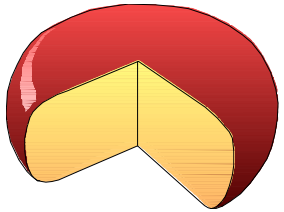
DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Selenium poisoning (Toxic effect of selenium). ICD-10: T56.8	Selenium. Selenium is a component of the enzyme glutathione peroxidase that is a component of one of the antioxidant defence systems of the body. Selenite is a catalyst for the oxidation of sulfhydryl groups. Selenomethionine can mimic methionine. Unknown.	Nausea, vomiting, abdominal pain, diarrhoea, anorexia, fatigue, sore throat, arthralgias, emotional lability, metallic taste, garlic odour to the breath, brittle nails, hair loss, bronze colour to the skin, hepatic dysfunction and diffuse dermatitis. Variable.	Seleniferous lands. Seafish. Milk, eggs, meat, vegetables and cereal grains produced in seleniferous regions. Vegetarian diets. Sea fish	Blood, urine.		The greatest extremes in selenium intake have been found in China where selenium toxicity has reported.
Sodium fluoride poisoning (Toxic effect of sodium fluoride). ICD-10: T60.8	Sodium fluoride. Fluorine in the form of fluoride occurs in nature ubiquitously. Most ingested fluoride is absorbed from the upper intestines. Few minutes-2 hours.	Salty or soapy taste, numbness of mouth, vomiting, diarrhoea, dilated pupils, spasms, pallor, shock, and collapse. Self-limited.	Fluorine enters the body as variable constituent of both drinking waters and foods. Dry foods such as dry milk, flour, baking powder, cake mixes contaminated with sodium fluoride-containing insecticides and rodenticides.	Urine.	Supportive care.	

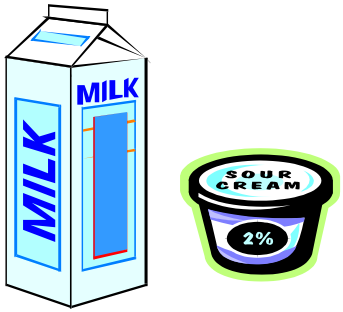
DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Thallium poisoning (Toxic effect of thallium). *ICD-10: T60.4*	Thallium. Trace metal that has a strong affinity for sulfhydryl groups and thus interferes with many enzymes systems. Additionally, it enters the cell, exchanging for intracellular potassium. Few hours.	Nausea, vomiting, diarrhoea, painful paraesthesias, motor polyneuropathy, hair loss. Several days.	In some areas it is still component of rodenticides, pesticides, and insecticides. Contaminated food.	Blood, urine.	Supportive care. Prussian blue and forced diuresis, haemodialysis.	The electrocardiogram may show arrhythmias and changes similar to those associated to hypokalaemia.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Tin poisoning (Toxic effect of tin). ICD-10: T56.6	Tin. Tin has a function in the tertiary structure of proteins or other biosubstances. Also it is close to the oxidation-reduction of certain flavin enzymes. 5 min-8 hours.	Nausea, vomiting, diarrhoea. Self-limited.	Tin is found in canned foods from defective lacquering (corroded metallic container) e.g. tin from old cans of fruit is reported in poisoning incidents. Beverages or foods from corroded tin cans (metallic containers).	Blood, faeces, urine.	Supportive care.	A can made of tin or more usually of tinned iron, especially a tin in which meat, fish, fruit, etc., is hermetically sealed for preservation. In solid foods, tin is usually protein bound and therefore unlikely to produce toxic effect.

DISEASE	CAUSATIVE AGENT/ DESCRIPTION	SIGNS/SYMPTOMS	SOURCE OF CONTAMINATION	SPECIMENS FOR LABORATORY	TREATMENT	COMMENTS
ICD CODE	INCUBATION OR LATENT PERIOD	DURATION OF ILLNESS	FOODS INVOLVED			
Zinc poisoning (Toxic effect of zinc).	Zinc salts	*Pain in mouth, throat and abdomen, vomiting, dizziness, collapse.*	Zinc-coated (galvanized) containers (pots, cans and tubs).	Food container, vomitus, stomach contents, urine, blood.	D-penicillamine.	Acids convert zinc into soluble zinc salts.
ICD-10: T56.5	Soluble zinc salts. Astrigent, corrosive and emetic. Zinc has a strong affinity for red cells and plasma proteins.		Lemonade, cooked apples, mashed potatoes, spinach, chicken and tomatoes, fruit punch.			
	10 min-3 years.					

Major Zoonoses Transmitted from Mild & Dairy Products





- **Bovine tuberculosis** (*M. bovis*), is transmitted by ingestion of unpasteurized milk or dairy products from tuberculous cows, or by airborne infection in barns and handling of contaminated animal products.
- **Typhoid fever** (*S. typhi*), **Dysentery,** and ***Salmonella*** microorganisms may contaminate milk from the unclean hands of milkers or other dairy workers being carriers.
- **Diphteria** (*C. diphteriae*), **Septic Sore Throat,** and **Scarlet Fever** microorganisms are transmitted by throat and nose discharges contaminating milk from human carriers (dairy workers).
- **Streptococci, Staphylococci** and other organisms of human origin, grow in the teats and the udder of the cow in mastitis infecting milk.
- **Brucellosis** (*B. melitensis* and *B. abortus*), transmitted to man by ingestion of unpasteurized infected milk and fresh milk products.
- **Listeriasis** (*Listeria* spp.) outbreaks are associated with unpasteurized milk and fresh dairy products.
- **Yersiniasis** (*Yersinia* spp.) is transmitted by drinking unpasteurized milk.
- **Toxoplasmosis** (*Toxoplasma* spp.) may be transmitted by consumption of raw goat's

ANNEX V

Major Zoonoses Transmitted from Food

- Taeniasis, Toxoplasmosis, Brucellosis, Trichinellosis, Botulism (*C. botulinum*), Anthrax, *E. coli* 0157:H7 intoxication, Streptococcal intoxication, Campylobacteriasis, Leptospirosis, Listeriasis, etc.

- Salmonellosis, Shigellosis, E.coli 9157:H7 intoxication, S. pyogenes intoxication, Listeriasis, *Cl. Welchii* (*perfrigens*) intoxication, Gastrenteritis (*B. cereus*) etc

- Botulism, Angiostrongyliasis, Anisakiasis, Diphylobothriasis, Paragonimiasis, Salmonellosis, Typhoid fever (*S. typhi*), Cholera (V. *cholerae*).

- Echinococcosis, Allantiasis (*C. botulinum*), Shigellosis, Typhoid fever (*S. typhi*), Ascariasis, Angiostrongyliasis, Dysenteria (*E. histolytica*), Cholera (*V. cholerae*) etc.

- Brucellosis, Tuberculosis, (M. bovis), Salmonellosis, Listeriasis, Campylobacteriasis, Yersiniasis, Clostridiasis, Toxoplasmosis,