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JOINT FAO/WHO EXPERT COMMITTEE ON MEAT HYGIENE

First Report

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JOINT FAO/WHO EXPERT COMMITTEE ON MEAT HYGIENE

First Session

Geneva, 6-11 December 1954

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JOINT FAO/WHO EXPERT COMMITTEE ON MEAT HYGIENE

First Report *

The first session of the FAO/WHO Expert Committee on Meat Hygiene was held in Geneva from 6 to 11 December 1954. Professor A. Jepsen was elected Chairman, Dr A. A. Sidky, Vice-Chairman, and Dr H. Thornton, Rapporteur.

INTRODUCTION

The Committee was informed of the interest and work of the World Health Organization and the Food and Agriculture Organization of the United Nations in several aspects of food hygiene. Sanitation aspects, with particular reference to food markets and restaurants, will be considered by a WHO expert committee in 1955, and a joint FAO/WHO expert committee meeting on milk hygiene is planned for 1956. The problems of food additives are currently being considered by both organizations. Food hygiene problems concerning poultry, fish, and other animal protein foods are projected for consideration at a future joint FAO/WHO meeting, so that the present Committee confined its deliberations to meat hygiene as it relates to domestic animals used for food, principally cattle, swine, sheep, and goats.

A seminar on meat hygiene sponsored by the WHO European Regional Office and FAO was held in Copenhagen in February 1954. The subjects discussed at the seminar covered in detail meat hygiene problems of particular interest to European countries. The Committee felt that the proceedings of this meeting would be of interest to all countries and recommended their early publication.

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* The Executive Board, at its fifteenth session, adopted the following resolution :

The Executive Board

1. NOTES the first report of the Joint WHO/FAO Expert Committee on Meat Hygiene ;
2. THANKS the members of the Committee for their work ;
3. EXPRESSES its appreciation to the Food and Agriculture Organization for its excellent collaboration ; and
4. AUTHORIZES publication of the report.

(Resolution EB15:R13, *Off. Rec. Wld Hlth Org.* 1955, **60**, 5)

1. SCOPE OF THE PROBLEM

Adequate meat hygiene measures span the time the live animal enters the abattoir until the final meat product is consumed. The Committee felt it possible to cover only certain aspects of meat hygiene problems [1] as they affect both relatively developed and under-developed countries. Furthermore, the Committee concentrated on general principles, rather than on specific detailed recommendations, because of the great variety of local conditions and customs which must be considered in any particular situation regarding meat hygiene practices.

2. PUBLIC HEALTH AND ECONOMIC IMPORTANCE

The lack of adequate reporting systems in most countries for food-borne outbreaks of disease makes it impossible to determine with any degree of accuracy the relative importance of food poisoning in public health (see section 5.2, page 8). Spectacular outbreaks gain the public eye and often cause considerable disruption of family or community activities, and these episodes, added to the far greater number of unreported cases which occur, provide constant difficulties to public-health authorities who bear the ultimate responsibility for prevention and control of food poisoning.

It is noteworthy that in such countries as the United Kingdom and the USA, with relatively high hygienic standards, well over one half of all reported food-borne outbreaks are caused by meat (in the USA, this figure includes poultry), particularly processed meat. Thus, in England and Wales, in the period 1949-53, 1026 out of 1590 outbreaks occurred in which contaminated food was known to be associated with meat, but in only 13 of these outbreaks was fresh meat suspected. In the remaining 1013 outbreaks, processed and made-up meats were incriminated. An analogous situation apparently exists in the USA.

In under-developed countries, infected raw meat rather than processed meat seems to be the more frequently incriminated, and, because of the low standards of hygiene found in many of these countries, meat, in proportion to the extent to which it is consumed in such countries, may play an even greater role in food-poisoning outbreaks than in the more developed countries.

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[1] See Annex 1 (page 32) for selected list of texts on meat hygiene.

Meat provides an excellent source of protein in human nutrition, and the present world scarcity of protein makes it necessary to conserve and utilize meat supplies to the fullest possible extent. A well-run abattoir and meat inspection service accomplishes this end, not only because of its efficiency in producing a wholesome product for human consumption, and a product with improved keeping qualities, but also because of the contribution made to livestock disease control. Careful ante-mortem and post-mortem inspection provides a mine of information, otherwise unobtainable, which indicates the disease status of areas of origin of the animals concerned. Thus the enormous losses encountered in all countries through livestock diseases, and the resultant toll in meat and meat products, can be lessened appreciably if the information gained from abattoirs is properly used by agricultural authorities.

3. THE PRINCIPLES AND OBJECTIVES OF MEAT HYGIENE IN RELATION TO THE QUALITY AND STANDARDS REQUIRED BY THE CONSUMER

3.1 Meat hygiene in relation to meat production and qualities

Standards of meat inspection have as their objective the establishment of adequate controls to ensure the production of a meat supply that is safe when handled and used in a way customary to the consumer population concerned. The controls must ensure the production of an acceptable meat supply, taking into consideration the customs of the different population groups provided that this does not imply the breaking of the basic principles of meat hygiene.

3.2 Standards of meat hygiene

Although the principles of meat hygiene are the same throughout the world, there are difficulties in setting standards which can be applied to meet conditions in different communities.

Generally speaking, there are two main categories :

(1) Standards to meet the requirements of the rural communities. Here, the animals are slaughtered in sufficient numbers to serve the normal immediate requirements of the community ;

(2) Standards to meet the requirements of the industrial communities. In this case, meat is frequently held in refrigerators for the necessary period of time needed for its particular use.

In both these categories, the basic principles in meat hygiene problems as elaborated in this report do not differ. However, the strict application

of certain principles in the treatment of animals slaughtered in undeveloped countries is often difficult to achieve without seriously damaging the economic condition of the inhabitants, as well as depriving them of their requirements for a vital protein food. In dealing with such circumstances, the basic principles of meat hygiene should be strongly supported by public education accompanied by strong measures of general sanitation in the community concerned. By so doing, slow but sure progress will be achieved in protecting human beings from human and animal diseases transmitted through the meat supply. In all measures taken priority should be given to all the more dangerous diseases transmitted to man (see section 4, page 7), without, however, neglecting other disease problems.

The following is a list of the points at which it is essential to apply controls to assure a safe meat supply:

(1) Examination of the animal before slaughter, to assure the elimination of unfit animals;

(2) Examination of the carcass and parts of carcass immediately after slaughter, to separate for human food the normal, wholesome product from diseased or otherwise unfit material;

(3) Removal and destruction of all diseased and otherwise unfit materials, to assure their elimination from the food supply;

(4) Separation from edible products of all unfit materials in a way that will avoid contamination of the edible products by the unfit materials;

(5) Adoption of such environmental sanitation controls as will ensure against the contamination of edible products;

(6) Prohibition of the addition of harmful materials in the handling and preparation of the edible products.

The following are some considerations affecting the acceptability of a meat supply, apart from its safety:

(1) Religious ceremonies that apply in the slaughtering of animals;

(2) Considerations dealing with adulteration of a food with another food article or a harmless substance;

(3) Masking of inferiority;

(4) Standards for food formulation;

(5) Mis-labelling;

(6) Deceptive packaging.

The fulfilment of the basic principles in meat hygiene should be the aim to be reached in all communities. It is therefore the duty of all those concerned in enforcing and applying regulations for the achievement of

such an aim to synchronise all measures taken so that they may work together to produce a safe and acceptable supply of meat.

4. MEAT-BORNE DISEASES

Disease agents in meat arise either from original infection in the animal carcass, or through secondary contamination from human beings or environment. The major diseases involved may be classified as follows:

Disease in man	*Principal sources of meat infection*
Anthrax	cattle, goats, sheep, swine
Botulism	all animals, environment
Brucellosis	cattle, goats, sheep, swine
Clostridium welchii (B. perfringens) gastro-enteritis	all animals, environment
Erysipeloid	swine
Hydatidosis (cycle must be completed through dog or other carnivore)	cattle, goats, sheep, swine
Salmonellosis	all animals, man
Shigellosis	man
Staphylococcal enterotoxic gastro-enteritis	all animals, man
Streptococcal gastro-enteritis	all animals, man
Taeniasis	cattle, swine
Trichinosis	swine
Tuberculosis	all animals

5. REPORTING AND INVESTIGATION OF FOOD POISONING

5.1 Definition of terms

The Committee considers the phrase " food poisoning and food-borne diseases " to be the best general term for describing illness due to the ingestion of contaminated foodstuffs. So far as meat is concerned, it includes illnesses due to the following (see also section 4, above):

(1) Living agents:

(*a*) micro-organisms, e.g., *Salmonella* sp.

(*b*) parasites, e.g., *Trichinella spiralis*

(2) Products of living micro-organisms, e.g., staphylococcal enterotoxin.

The term " outbreak " also requires to be defined. Some use it only when five or more related cases occur; others consider that it should be used only if ten or more cases occur. The Committee felt that it should be used to describe two or more epidemiologically related cases.

The term " processed and made-up meat " is used from time to time in the report. In different countries it will have a different connotation. A list of the dishes described in the report on food-poisoning in England and Wales for 1953 is given in Annex 2 (see page 34). From this, it is clear that these dishes do not include fresh meat, freshly cooked and eaten hot.

5.2 Reporting of food poisoning and food-borne diseases

In all countries, the reporting of food poisoning and food-borne diseases to the health authorities is incomplete. In some countries, cases are notifiable, in others they are not, and it is impossible to use such information as is available for estimating the real incidence within countries, or for making comparisons between countries.

The Committee recommended that food poisoning and food-borne diseases should be made notifiable and that, as in England and Wales, the practitioner notifying the case should be required to provide the medical officer of health with any information he may have about the food suspected as the vehicle of infection. Notification will not give accurate or complete information on incidence, but it will increase the number of cases and outbreaks brought to the notice of the medical officer of health in time for him to make useful investigations.

The function of notification is to acquaint the medical officer of health with the occurrence of cases. It is the investigation of the circumstances of such cases which provides information on the common causal agents and incriminated foods, and it is the reports on these investigations which should be collated and published instead of bare lists of the numbers of cases notified.

Medical officers of health will not obtain information only from notifications. The victims themselves, the shop-keeper, the caterer or food processor concerned, or sometimes the police, may be the first to intimate that an outbreak is in progress. Health authorities should encourage such sources of information, as food poisoning is often mild and the symptoms not severe enough for the patient to seek medical advice.

Even when all possible methods of ascertainment are employed, they will not provide reliable information on the real incidence of food poisoning and food-borne diseases. Care should be taken to make it clear in published reports that the reported incidence does not necessarily give much indication of the true incidence, which may actually be much higher.

5.3 Investigation of food poisoning

5.3.1 *Parasitic infections*

Of the parasitic infections, those caused by tapeworms are insidious in their onset, and it is uncommon to trace them to the food source. On the

other hand, trichinosis may occur in groups of cases, and where large numbers of parasites are ingested acute gastro-intestinal symptoms with pyrexia may occur in a few hours. There is nothing which clearly differentiates these symptoms in the early stages from some cases of bacterial food poisoning. If undercooked fresh pork is a common denominator among those ill, the diagnosis of trichinosis should be considered and the parasites sought for in samples of the incriminated pork.

5.3.2 *Bacterial infections*

Some of the characteristics of bacterial food poisoning associated with meat are given in Annex 3 (see page 35). Speedy action is essential if the true cause of an outbreak is to be established. Delay will often mean that samples of vomit or faeces from the acute stage of illness will be unobtainable, and that the suspected food has been destroyed. If the food is still available, changes in the bacterial flora may have occurred, especially if it has not been refrigerated in the interval.

5.3.3 *Procedure*

The steps to be taken in the investigation should include the following :

(1) *Extent of the outbreak*

By visits to the patients and their relations, friends, or guardians, by inquiries from the family doctor and others, a complete list of cases should be prepared. It should include the ages and the occupations of the patients.

(2) *Clinical features and incubation period*

For each patient, a record should be made of the date and hour of the first symptoms and of the nature of the earliest and the most characteristic symptoms.

(3) *Suspected food*

In order to obtain information quickly on the foods possibly involved, a record should be made of the foods eaten at previous meals. Where large numbers of persons have developed symptoms after a common meal a few hours earlier, attention should obviously be immediately centred on this meal and specimens of the dishes concerned should be taken for examination. If *Salmonella* infection is suspected, information may have to be obtained about all meals up to 48 or even 72 hours earlier. It is a good plan to write down the foods consumed along the top of a sheet of paper, and the names of the victims down the side of the sheet. By marking against each person's name the foods eaten, the evidence against a particular food will often stand out very clearly. Food is not necessarily evenly contaminated, and some partakers of a dish may not have ingested the offending micro-organism or toxin, while others may have received a very large dose.

Occasionally it may be found, especially in staphylococcal food poisoning, that a dish may be eaten with impunity one day but may be thoroughly dangerous the next day if circumstances for bacterial multiplication have been favourable. Sometimes where food in mass (for example, a pile of sliced ham), has been put in a refrigerator, multiplication of pathogens, such as staphylococci, may continue for some hours in the centre of the mass, where cold penetration is slow, though growth on the outer layers has been inhibited.

(4) *Food handlers*

At the earliest possible moment, a complete list of all food handlers should be made and a history of both recent and remote illnesses should be obtained from each one. Evidence of scratches, sores, pyogenic infections, or recently healed cuts should be looked for.

(5) *Specimens for laboratory examination* (see also section 9.3, page 24)

Successful investigation of food poisoning demands the early assistance of the laboratory staff. They should be consulted as soon as the first intimation of an outbreak has been obtained, for they will frequently be able to advise on methods of investigation likely to yield useful information and will be able to say exactly what kind of specimens should be collected and how they should be transported. The laboratory will usually require :

(*a*) specimens of vomit and faeces from patients (blood, spleen, and intestinal contents from fatal cases) ;

(*b*) specimens of a number of different portions of the food suspected as the vehicle of infection ;

(*c*) specimens from utensils, preparation tables, etc. ;

(*d*) if possible, specimens of the ingredients from which the food was prepared ;

(*e*) specimens from the food handlers : in staphylococcal infections, moistened swabs from the hands, finger-nails, and nose, and from any cuts or sores which are still open or recently healed ; in *Salmonella* infections, specimens of faeces ; if typhoid or paratyphoid fever is suspected, samples of blood.

If there is evidence of illness in animals, including pets, specimens should be obtained from them. If there is evidence of rats and mice, traps should be laid to obtain specimens for laboratory examination.

In some cases it may be helpful to repeat the process by which the incriminated food was prepared, so that, by taking samples at each stage of the process, evidence can be obtained of the stages at which contamination of the food or multiplication of the organisms already present took place.

Where the atmospheric temperature is high or where some hours may elapse before the specimens arrive at a laboratory, arrangements should be made for the specimens to be kept cool, preferably refrigerated.

It is important that the results of investigations should be collected as far as possible in a uniform fashion. The form in Annex 4 (see page 36), which has been based on that used by the Public Health Laboratory Service for England and Wales, might be found useful for this purpose.

6. THE ABATTOIR

6.1 Construction

Experience has shown that there is a considerable risk of a " build-up " within the abattoir of enteric pathogens introduced by either animal or human carriers. It is therefore necessary to devote great care to sanitary arrangement and construction, in addition to giving consideration to convenience and speed of operation.

The basic principles of construction of abattoirs are the same whether large and industrialized, or small and rural. These principles include the following points :

6.1.1 *Site*

When selecting a site, it is necessary to consider the availability of a plentiful supply of pure water, accessibility in relation to road and rail, suitability of terrain, the problem of effluent disposal, the use of electric power, and environmental factors to produce the least interference with the community, while giving thought to future expansion both of the community and of the abattoir.

6.1.2 *Size*

There should be a reasonable relationship between the size of the abattoir and the numbers of animals to be killed, bearing in mind potential expansion and the fact that congestion makes sanitation impossible.

6.1.3 *Type of building*

Consideration should be given to climate. In tropical countries, a more open type of building may be required. In all types, it is desirable to use impermeable materials for floors and walls, the former being non-slippery and the latter smooth.

Both abattoir and equipment should be simple and of a type which can be maintained in a sanitary condition. Non-essential features should be

dispensed with, not only on the grounds of hygiene, but also in the interests of economy. Good lighting is essential throughout the abattoir, and particularly in the section where inspection of meat is to be carried out.

6.2 Design (see Annex 5, page 37)

It is of great hygienic importance to aim at the best possible separation between clean and unclean operations. This requires planning to permit of unclean products, such as live animals, hides and skins, stomachs and intestines, and feet, proceeding in one direction only, and clean edible materials, namely, meat and organs, in another.

In providing for this, the need for assigning different groups of workers to the two classes of operations should be borne in mind. Annex 5 contains diagrams indicating these principles.

Pens for resting animals prior to slaughter should be adequate in size and comfort. (In Sweden, for example, cattle requirements are based on 1.65-1.8 m^2 per animal, and 0.5-0.8 m^2 for small animals, all pens being provided with water.)

Access to the killing pen should be easy ; where range animals are to be dealt with, suitable control measures, such as a crush-pen for roping, may be needed.

The provision of a separate room for killing and bleeding is an indispensable condition for clean abattoir operations.

Wherever possible, facilities for performing butchering work above floor level should be provided. Hoists and overhead rails are required in the simplest abattoir.

It is important to estimate and provide adequate floor space for skinning. For cattle, it is recommended that each bay have a space of 4 $\times$ 3 m ; this permits two workers to skin 4-5 animals per hour. With small animals, e.g., sheep, calves, and goats, 4 animals may be dealt with in one hour by one man in a space of 3 m^2.

All hanging rails for carcasses should allow an adequate space to ensure convenience of handling and avoidance of contact with the floor.

The special requirements for the slaughtering of pigs should include scalding and dehairing.

Unopened stomachs and intestines should be removed by sanitary means to a separate room for cleaning. Under no circumstances should stomachs and intestines be opened where carcasses are being dressed.

Adequate refrigeration facilities are highly desirable in all abattoirs, although the Committee realized that for the present such facilities are hard to achieve for some countries. Large-scale refrigeration facilities are more a matter of economy, being provided for a trade structure which

requires the holding and storing of meat. However, as a measure of hygiene, refrigeration, even if on a limited scale, is also desirable (*a*) to render safe for human consumption carcasses infested by certain parasites, and (*b*) to permit of the detention of carcasses under suspicion, pending further examination by laboratory methods.

Water points, hoses, and cleaning equipment must be provided in sufficient number. Whenever possible, adequate installations for the sterilization of equipment and utensils by steam and hot water should be made. Where steam and hot water cannot be provided, chemical disinfection which leaves no taint, e.g., chlorine, should be used.[1] Whatever method is adopted, preliminary cleansing with water and soap or soap substitute is essential.

Proper accommodation in respect of wash-rooms and lavatories for staff must not be forgotten.

Drainage from the abattoir floor requires special attention. Each dressing bay should have its own drain and all drains must be accessible for cleaning. Particular attention should be given to preventing open drains from unclean sections—namely, killing, bleeding, skinning, and cleaning of stomachs and intestines—from passing through clean sections of the slaughter-house.

The method of effluent disposal will depend largely on local circumstances, and the local sanitary officials should be consulted. The Committee suggests that this problem be given careful consideration by the WHO Expert Committee on Environmental Sanitation.

A reliable method of disposal of condemned carcasses or portions of carcasses must be provided. Where conditions are not favourable for economic utilization of such material, incineration is recommended.

In certain countries, to render carcasses safe for consumption, it is necessary to provide for sterilization by boiling, and in this case cooking facilities are required.

Where hides and skins are to be dealt with on the premises of the abattoir, separate rooms for salting should be provided; these should be cool. Cellars may conveniently be sited for the purpose under the skinning section. Where hides and skins are to be preserved by drying in the atmosphere, this should be done at a safe distance to prevent fly nuisance.

The economic use of by-products from the slaughter-house is to be recommended wherever possible, and if the preparation is to be undertaken

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[1] Where terminal disinfection is required in cases of spore-forming organisms (anthrax, clostridia), 2% lye solution is a good and cheap disinfectant. Lye solution is caustic, and workers should take suitable precautions when it is used. Lye should not be permitted in the operating abattoir during the normal routine.

in the abattoir buildings, it is necessary to ensure that there is complete separation from butchering sections.

The elimination of dust and refuse from the abattoir environs is a desirable objective. Strong fencing should be used to keep out trespassing animals, particularly dogs. Premises should be fly- and vermin-proof. Yards should be paved or macadamized for an adequate area around the buildings. One-way traffic of animals and motor transport is desirable.

6.3 Abattoir management

There are two main systems of management:

System 1. The abattoir operations are carried out by a permanent staff of workers employed by the one single authority operating the slaughter-house. This body may be governmental, municipal, or co-operative, or a private enterprise. In this system, the organization either takes over the livestock from the producer and later returns it to him after processing (it is essential, therefore, to maintain identity of the animal and its products), or the organization purchases the animals and subsequently markets the finished products.

System 2. The management simply hires space to private firms or individuals who, although subject to some general rules, bear the responsibility of the butchering operations and provide their own labour.

The Committee is of the opinion that the basic requirement mentioned for separation between clean and unclean operations can best be fulfilled by adopting system 1, which allows for a specialized permanent staff of workers, as opposed to changing groups, and the exclusion of unauthorized persons from the abattoir.

In system 1, the slaughter-house is divided into sections for each operational stage. All are connected by the overhead rail system and each section has its own staff specially trained (see Annex 5, fig. 1 and 2, pages 37-38).

In system 2, it is not possible to maintain complete separation of skinning and evisceration from dressing and quartering, but even so bleeding, killing, and removal of stomach contents should still be carried out in separate compartments of the abattoir (see Annex 5, fig. 3, page 39).

6.4 The provision of plans for standard types of abattoir

The Committee, believing that there is a need in many under-developed countries for plans of abattoirs to meet particular requirements, recommends that WHO and FAO be requested to appoint a small technical committee, which would be composed of specialists in meat hygiene and abattoir construction, to work out detailed standard blue-prints and

specifications. This committee should be given the opportunity to visit some of these countries in order to familiarize itself with local conditions.

7. MEAT INSPECTION

All processes in an abattoir, including slaughter and dressing, should be under the supervision of the meat inspection organization in the abattoir.

7.1 Ante-mortem inspection

Ante-mortem veterinary inspection of animals intended for slaughter should be regarded as an essential procedure in any efficient meat inspection service. One advantage of such a procedure is that it is the means of detecting animals suffering from some affection which might be injurious or prejudicial to human health. Perhaps the greatest service this procedure can confer is to make possible the detection of animals which are in the early stage of septicaemia. Experience has repeatedly shown that if such animals are slaughtered in the early stage of the disease the carcass, although perhaps dangerously infected, may exhibit few of the classical lesions of septicaemia. Thus the post-mortem lesions, being out of all proportion to obvious illness of the animal when alive, may easily be overlooked.

The temperature of any suspect animal should always be taken as a routine procedure, and the ante-mortem examination of any animal awaiting slaughter should be carried out not longer than twelve hours before actual slaughter takes place.

It is impossible to procure good and durable meat unless the animal from which it is obtained was given an adequate period of rest prior to slaughter. There is no more inimical factor to the good keeping quality of meat than a prolonged and wearying journey of the animal to the slaughter-house. Likewise, animals should not be beaten or subjected to rough treatment when they are being moved from the lairage pens to the abattoir.

7.2 Methods of slaughter

In many countries of the world, the methods by which animals are slaughtered are based on time-honoured procedures which bear little or no relationship to the two cardinal factors which should be observed, namely, (1) that the animal should be dispatched with a minimum of suffering, and (2) that the bleeding of the animal should be as complete as possible so that maximum durability of the carcass is ensured.

Broadly speaking, the methods by which animals are slaughtered are two—those in which the neck vessels of the animal are cut without its first being rendered unconscious, and those in which the animal is first

rendered unconscious before the act of bleeding takes place. A method which does not fall within either of these categories is that of pithing, which is practised in cattle in some countries and consists in severing the spinal cord by means of a sharp knife inserted into the occipito-atlantal space. The humaneness of such a method is open to question and there is little to recommend it.

In many countries of the world, legislation is now in force requiring that an animal shall be rendered unconscious by means of a mechanically operated instrument before the cutting of the neck vessels takes place. The desirability of all animals being rendered unconscious by such means is now beyond question, but exceptions may be made (*a*) where religious objections prevail, and (*b*) in the case of cattle which are not used to being handled and are therefore intractable, for such animals cannot be approached without danger to the operator of a mechanically-operated instrument.

It is not only necessary that any method of slaughter should ensure that the maximum amount of blood is extracted from the carcass, but it is also of commercial importance that any untoward effects should be avoided, the chief of these being the production of small haemorrhages due to capillary rupture. " Splashing ", the term by which this condition is known, may occur in all animals, but it is seen most commonly in swine and though it is a condition in no way prejudicial to human health, it may be present to such a degree that it renders the flesh repugnant to the purchaser and therefore unmarketable.

7.2.1 *Electrical stunning*

The assertion that " splashing " in swine was associated with the use of the slaughter pistol led to research into other methods of slaughter which would obviate this condition, and eventually the use of anaesthetization of animals by an electric current was devised and has become widely adopted, not only in swine but also in sheep and calves. Some doubts have been cast, however, on the humaneness of electrical anaesthetization, it being contended that the animal remains conscious after the application of the current but is paralysed and can therefore give no vocal demonstration of discomfort or pain. Recent investigations [1] have now shown conclusively that a genuine electroplectic shock is produced and unconsciousness attained, provided that certain requirements are observed. These requirements include an alternating current of not less than 75 volts and 250 milliamperes ; and application of the current to the head for a period of not less than 10 seconds.

[1] See Croft, P. G. (1952) *Vet. Rec.* **64**, 255 ; Croft, P. G. (1954) *Electric stunning of pigs*, London (Publication of the Universities Federation for Animal Welfare).

The use of electrical means for anaesthetization of cattle have until recently proved less satisfactory, possibly because of the insulating effect of the fine hairs covering the animal's head, but instruments of the electrical type have recently been devised and have proved of value in the slaughtering of cattle as well as of sheep, pigs, and calves. Instruments of this type are in daily use in the Netherlands and in other countries in Europe.

7.2.2 *CO_2 stunning*

In the USA, a method of anaesthetizing swine has been developed using carbon dioxide gas, the animals being transported along a moving platform through a concave tunnel in which they inhale the gas and rapidly become unconscious. On emerging from the tunnel, the animal is shackled by a hind limb, elevated to a bleeding-rail and bled while still unconscious. Further experimentation is needed to determine whether this method is applicable in plants of different sizes and for animals other than swine.

7.2.3 *Collection of blood*

The method of collection of the blood of slaughtered animals varies according to the use to which it is to be put. If it is not intended for manufacture into human food, it should be removed as quickly as possible from the bleeding room. Where it is intended for the manufacture of edible products, e.g., blood sausage, it should not be collected in dirty containers or manipulated with unclean equipment.

7.2.4 *Dressing of carcasses*

A desirable feature in any system of slaughtering and dressing of animals is that the process should be divided into three distinct phases. Firstly, the stunning and bleeding should take place in a special room ; secondly, the skinning and evisceration should preferably take place in separate locations ; and, thirdly, the dressed carcasses, whether in whole carcasses or sides, should be moved from the location where skinning and evisceration have been conducted.

Certain basic principles should be observed irrespective of the size of the slaughter-house : (*a*) the hide or skin should be removed without causing contamination of the carcass ; (*b*) during evisceration, care should be taken not to pierce the gut ; (*c*) the uterus, urinary bladder, and udder should be removed without causing contamination of the carcass by the contents of these organs ; (*d*) on no account should the use of dirty wiping cloths be permitted (see below).

7.2.5 *Air inflation*

The practice of inflating carcasses for skin removal or other purposes should be discouraged. In countries where such a practice is traditionally

accepted, only mechanical means of inflation with proper sanitary precautions should be used.

7.2.6 *Washing of meat*

Practices differ with respect to the routine washing of carcasses or meat after dressing. Spray washing is valuable for cleaning purposes. In all instances where washing is practised, potable, freely running water should be used. When wiping cloths are employed, they should be scrupulously clean and preferably used on only one carcass before being re-washed and sterilized. It should be recognized that wet meat which is not subsequently refrigerated is subject to more rapid decomposition than is dry meat.

7.2.7 *Floor sanitation*

During the routine operations in an abattoir, the floors should be kept as clean as possible by continually collecting and removing refuse from the floor. If continuous washing of the floor is practised, care should be taken not to splash and soil the carcasses.

7.3 Post-mortem examination

No matter how efficient the inspection staff in an abattoir, satisfactory inspection cannot be ensured unless the carcasses and organs can be examined under good lighting conditions, whether natural or artificial. It is also important that all the organs of a carcass be kept so that they are readily identifiable with their own particular carcass.

7.3.1 *Techniques*

Although the technique of a post-mortem examination may require some modification in accordance with local conditions (for example, a close and detailed examination must be made of the masseter muscles, heart, and diaphragm of pig carcasses in countries where *Cysticercus cellulosae* is common), it is essential that an orderly routine procedure be followed. The technique required by the German meat inspection law and given in Annex 6 (see page 40) forms a useful guide. The diseases and pathological conditions which may be encountered in meat inspection, together with the judgements which are applicable in the Danish code, when these diseases or conditions are found, are listed elsewhere.[1]

A most important requirement is the provision of an apparatus by which the knives of slaughterers and inspectors can be cleansed satisfactorily by means of immersion in boiling water or other adequate forms of heat between use on consecutive animals.

[1] See: *Meat hygiene*, Geneva, 1956, Annex 12 (*World Health Organization : Monograph Series*, No. 30 — in press).

7.3.2 *Emergency slaughter*

Experience has shown that the most potentially dangerous carcasses are those of emergency slaughtered animals, and the Committee would draw attention to an admirable provision in many meat inspection codes, namely, that in all cases of emergency slaughter, whether this is undertaken in the slaughter-house or on the farm, no carcass of such an animal shall be passed for food until it has been subjected to a bacteriological examination (see section 8, page 21).

7.3.3 *Official meat stamp*

Meat and organs passed as fit for food should be marked by an official stamp and unauthorized use of a similar stamp should be severely dealt with.

7.4 Special diseases of public health importance

While the Committee has not felt it possible in the time at its disposal to consider in detail in the body of this report the judgement of carcasses affected with various disease processes, certain conditions warrant special mention because of their public health importance.

7.4.1 *Anthrax*

Diagnosis of the less acute forms of this disease in the live animal is often impossible by clinical examination alone, and dependable laboratory aids for this purpose are still not available. The Committee recommends that research on such aids be encouraged. On post-mortem examination, the Ascoli precipitation test (see Annex 7, page 43) is very useful, and this test should be coupled wherever possible with the usual microscopical smears and bacteriological culture. Positive findings of anthrax, of course, should require condemnation of the entire carcass.

7.4.2 *Cysticercosis*

In areas of low enzooticity, the usual masseter and cardiac muscle cuts are generally sufficient to give reasonable assurance of a safe carcass. It should be stressed, however, that in highly enzootic areas all feasible inspection procedures used to date, i.e., cuts in additional different portions of the carcass (diaphragm, shoulder muscles, etc.) are fallible in that they may frequently miss moderately and sometimes even heavily infected carcasses. Under these circumstances, public health authorities should undertake vigorous educational campaigns in favour of adequate cooking of all meat before consumption.

Infected beef or pork should be frozen, heated, or salted sufficiently to kill the parasite (see Annex 8, page 46, for temperatures and salt

concentration) before being released, where this type of product is acceptable to the public. In such areas and where such treatment is not possible because of lack of facilities, the carcasses should be plainly identified with suitable markings and directed wherever possible into channels where health authorities can assure adequate heating of the product before consumption.[1]

7.4.3 *Hydatidosis*

The abattoir is very frequently the key point in the dissemination of this disease. A corner-stone in hydatidosis control programmes is the strict exclusion of all dogs from abattoir premises and the careful destruction, preferably by incineration or sterilization and not by burying, of all organs with hydatid cysts. The Committee strongly recommends that these measures be enforced in all abattoirs, and particularly in the small rural abattoirs of countries where hydatidosis is enzootic.

7.4.4 *Trichinosis and trichinoscopical examination*

The question frequently arises as to the value of trichinoscopical examination as a routine procedure in the inspection of swine carcasses. Trichinoscopical examinations will detect heavily infected carcasses, which are the ones likely to produce massive infection and serious clinical disease in human beings. Light and moderate trichinal infections are frequently missed with the trichinoscope. The great disadvantages of such examinations are the cost involved, which adds to the expenses of running an abattoir and thus indirectly to the cost of meat, and the impracticability of trichinoscopical examinations when very large numbers of swine carcasses are processed each day in a packing plant.

The Committee feels that trichinoscopical examinations can serve a useful purpose in countries having a high enzootic level of trichinosis in swine, and where such operations do not add appreciably to the cost of the meat product. The Committee emphasizes, however, that other more effective approaches to trichinosis control are available :

1. The use of heat or cold for the sterilization of trichinal cysts in pork products likely to be consumed in a raw state has been used successfully for many years (see Annex 8, page 44). Persistent propaganda should also be carried out concerning the adequate cooking of pork in the home.

2. The trichinosis problem should be attacked at its source by preventing the infection of swine. Garbage-fed swine have been shown to be the

[1] Public health authorities should exert every effort to discover and have treated individuals, particularly agricultural workers, infected with tape-worms. Wherever possible in heavily infected areas, sewage treatment should include sand filtration to eliminate the tapeworm eggs. The provision of suitable latrines and health education also play basic roles in cysticercosis control.

main offenders in transmission of trichinosis to man, and experience has shown that the adequate heating of all garbage before it is fed to swine is an important factor in the control not only of trichinosis but also of other diseases transmitted through garbage to swine, e.g., swine fever and other virus diseases.

Recently,[1] irradiation of fresh pork containing cysts of *Trichinella spiralis* with an exposure insufficient to destroy bacteria has been shown to interfere with the sexual development of the parasite so that the worms developing from the cysts do not produce offspring. The Committee feels that since many problems, such as flavour and odour from irradiation, must be solved, as well as engineering developed to make irradiation feasible, the future practical use of the method is uncertain.

Dependable and practicable tests are not yet available to detect trichinal infection in live swine.

8. LABORATORY SERVICES IN MEAT HYGIENE

The use of the laboratory for the examination of meat and meat products is of inestimable value in improving meat hygiene. Laboratory tests provide strong support for the ultimate passage or rejection of carcasses retained on suspicion during inspection, and thereby minimize losses due to unnecessarily condemned carcasses. Furthermore, laboratory findings can be used to keep a constant check on abattoir hygiene and the post-abattoir handling of the meat, and these checks serve to ensure closer adherence to sanitary regulations and standards.

Meat hygiene laboratories also serve as sentinels in that they are in a position to detect the appearance of previously undetermined causes of food poisoning in a particular district. Their facilities can be used for investigation of these and other meat hygiene problems.

In many countries it would be uneconomical and unnecessary to establish special laboratories for meat examinations in the abattoir itself. The Committee suggests as alternatives the use of regional laboratories to serve relatively large areas. These laboratories could profitably be concerned with all food examinations and not be limited to meat. Such a service would be instrumental in lifting the level of food hygiene as a whole and would economize in the use of trained personnel and funds. Regional public health or veterinary diagnostic laboratories can also be used for this purpose.

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[1] See Gould, S. E., Gomberg, H. J. & Bethell, F. H. (1954) *J. Amer. med. Ass.* **154**, 653 ; Gould, S. E., Van Dyke, J. G. & Gomberg, H. J. (1953) *Amer. J. Path.* **29**, 323.

9. LABORATORY METHODS

Laboratory examinations can serve for (1) abattoir control, and (2) post-abattoir control.

9.1 Abattoir control

Apart from the methods of bacteriological examination which are to be considered later, a group of tests is available which, when properly applied and interpreted, often gives valuable suggestive information on meat quality. These meat tests should be considered as being in the development stage as yet, but in experienced hands they are often very useful. It should be stressed, however, that these tests are not applicable as general procedures and should not be used indiscriminately in the abattoir routine.

The tests include pH determination, estimation of water and blood content, and the boiling test. A pH of more than 6.4-6.6 is considered indicative of poor keeping qualities of the meat. Similarly, a high water or blood content permits the same interpretation because of the unusually rapid decomposition which can occur in such meats. The boiling test is useful to detect undesirable flavours and odours. Biochemical tests are often useful in detecting icteric carcasses.[1]

Bacteriological tests

The use of bacteriological methods in post-mortem inspection is based upon the theory that the internal organs without direct connexion to the exterior, and muscular and lymphatic tissues of healthy animals which were slaughtered while in a physiologically normal condition, are sterile. If bacteria can be cultivated by these methods, that indicates a possibility of an abnormal condition.

The Committee cannot stress too strongly, however, that laboratory findings cannot be interpreted unless they are considered along with all other evidence available, including a careful examination for gross pathological changes in the carcass.

The micro-organisms found in cultures from aseptically obtained specimens of organs and of muscular and lymphatic tissues may be either species usually recognized as specific pathogens, or potential pathogens or saprophytes.

Findings of pathogenic bacteria should result in condemnation or sterilization of the carcass when the bacteriological results, taken together with pathological findings, indicate a generalized infection.

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[1] For details, see: Schönberg, F. & Zietzschmann, O. (1951) *Die Ausführung der tierärztlichen Fleischuntersuchung*, 4. Aufl., Berlin.

The finding of saprophytic bacteria is frequently very difficult to interpret, and equally in this instance the finding must be correlated with the results of inspection of the carcass and other factors (handling of specimen, time interval before examination, etc.). While saprophytic bacteria *per se* are not considered dangerous to human health, their presence indicates the risk of rapid decomposition of the meat and the presence of a fertile medium for the multiplication of organisms causing food poisoning, e.g., *Cl. welchii (B. perfringens)*.

Experience has shown that disease processes which are normally localized in nature present little danger, and if no other signs are present, those carcasses so affected may be passed unconditionally for food after removal and destruction of the locally diseased tissue.

Annex 9 (see page 47) gives the routine bacteriological procedures developed in Denmark during the past thirty years. These techniques should serve as a useful guide to countries undertaking the development of laboratory control of meat hygiene.

9.2 Post-abattoir control

At this stage of the meat product, bacteriological examinations are usually carried out for the following purposes: (1) For epidemiological purposes if the meat product is suspected of causing food poisoning; in this instance, pathogenic bacteria are looked for, but the final interpretation depends not only on the finding of pathogenic strains of bacteria, but also on factors such as numbers of bacteria, epidemiological history, etc. (2) For routine qualitative and quantitative examinations to grade the bacteriological quality of meat products, and for a sanitary check. So far, the second type of analysis (2) has been useful only for products submitted to heat treatment (sausages, meat paste, etc.). In processed food, bacteriological examinations help to judge sanitary conditions of production, storage, and transport.

In determining the hygienic quality of meat by bacteriological examination, it is difficult to establish standards for specific meat products which will be valid in all or even several countries. Standards must be worked out for each country according to the methods of manufacture used and other local factors. A country can establish its own standards by examining the products held under both good and bad conditions, under different systems of storage, under artificial incubation, and by other procedures.

Code numbers on meats

The identification by code numbers of pieces of processed meat has proved very useful in meat control procedures. By means of the code, an article incriminated in an outbreak of food poisoning may be traced back

to the meat factory, thus facilitating investigations. Frequently, abattoirs and meat-packing plants are unjustifiably blamed for faults which are in fact caused by poor post-abattoir handling of the meat. This can often be determined by careful investigation of the meat factory itself, and at the various stages at which the product is handled before it reaches the consumer.

9.3 Bacteriological procedures for investigating human epidemics

Many laboratories have their own preferred methods of bacteriological examinations of specimens submitted during a human outbreak of food poisoning. Rapid submission of specimens, properly taken and preserved (see also section 5.3.3, sub-section (5), page 10), is essential. The Committee, however, would like to stress the necessity for careful evaluation of all factors—bacteriological and epidemiological—before a particular organism is incriminated as the etiological agent. For example, a mere finding of large numbers of staphylococci in a specimen is of little significance. If the staphylococci are to be incriminated they must be present in very large numbers, they should be coagulase-positive, the phage type should be determined, the toxigenic properties should be demonstrated if possible, and a typical clinical syndrome in human beings should be encountered. In all outbreaks of food poisoning, it is essential to attempt isolation of the organism from both the patient and the suspected food.

The Committee suggests, as a useful guide for the isolation and identification of pathogenic agents in human outbreaks of food poisoning, the special publication of the American Public Health Association on this subject.[1]

10. HYGIENE OF MEAT HANDLERS

Men employed in abattoirs obviously cannot keep their clothes as clean as meat handlers in shops or markets, but in the abattoir, as in the shop, men and their clothing should be as clean as possible. Cleanliness cannot be obtained by regulation alone. Lasting results can only come from education and example. Meat handlers who are regular employees will be easier to educate and supervise than casual workers.

10.1 Examination of meat handlers

On the question of the routine examination of meat handlers, the Committee does not believe that regular bacteriological examinations will

[1] See: *Meat hygiene*, Geneva, 1956, Annex 5 (*World Health Organization: Monograph Series*, No. 30 — in press).

ensure that they do not harbour dangerous pathogens. Indeed, these examinations may give a sense of false security. Nevertheless, in countries where infectious diseases, such as enteric fevers (typhoid, paratyphoid, shigellosis) are rife, the risk of meat handlers spreading infection might be lessened if they were always employed in the same occupation, and if periodical examinations were performed. In such countries, new applicants could be examined clinically and bacteriologically before they are employed, and at regular intervals afterwards. This examination should include :

(1) a medical history to determine past infections, with special reference to dysentery, typhoid and paratyphoid fevers, venereal diseases, and skin diseases ;

(2) blood serology (for example, for typhoid) and bacteriological examination of stools and urine.

Where meat handlers change rapidly, routine examinations should not be made.

10.2 Reporting of illness

Emphasis should be placed upon the necessity of meat handlers immediately reporting to the proprietor or manager if they are suffering from discharging wounds, sores, or discharging ears, or if they or any members of their families are suffering from diarrhoea or vomiting. Such persons should not be allowed to resume work until they are known not to be harbouring dangerous pathogens. These instructions should apply to both regular and casual employees.

10.3 Cleanliness of meat handlers

Suitable protective clothing which can be washed or changed as soon as it is dirty should be provided. Meat handlers should have short fingernails and meat porters should wear protective head-clothing. Ample water, soap, nail-brushes, and clean towels, should be available for washing hands. There should be facilities for washing in running water in or adjacent to the water-closet, so that employees have no excuse for not washing their hands after a visit to the water-closet. One or more water points with freely running water should be placed in the different parts of the abattoir or shop, so that hands can be washed frequently during working hours.

10.4 Education

The effectiveness of these measures depends on the education of the men and the example they are shown. Personal standards of cleanliness vary in different countries and in different persons. The proprietor or manager

must ensure that employees understand the reason for the rules and that they adhere to them.

Meat inspectors and sanitary inspectors should be trained to recognize the importance of these measures, and should be able to take steps to see that they are fulfilled.

Suitable posters and placards may be of value. On the door of each water-closet and over each wash-stand obvious notices, placards, and posters should be placed, drawing attention to the necessity for washing hands thoroughly before returning to work.

These recommendations should apply to all meat handlers, including those transporting meat to shops and those handling meat in shops.

11. TRANSPORT OF MEAT

The transport of meat from the abattoir to the retailer provides many opportunities for gross contamination of the product. This is especially true of countries where individual butchers take charge of their meat at the abattoir and transport it to their own shops. For delivery purposes, it is advisable to have hygienically constructed vehicles with impermeable and easily cleaned interiors. Such vehicles have been provided by some municipalities or co-operative societies, and individual butchers have made use of them at a nominal cost. Regulations to cover the hygienic transportation of meat should be rigidly enforced.

12. SANITATION OF RETAIL SHOPS AND RESTAURANT KITCHENS

Since this subject will be covered by a future expert committee session (see page 3), the present Committee wishes to stress only a few points in this connexion.

Meat should be kept covered and its handling prevented. It should be kept cool and preferably refrigerated. Fly, insect, and rodent control and the scrupulous cleanliness of floors, walls, and table tops are of the greatest importance. A less obvious, but equally important, aspect of the problem is that cooked meats—which are eaten without further preparation—may be contaminated by pathogenic organisms from table tops or instruments used previously on raw products of animal and vegetable origin. It is therefore highly desirable that cooked meats and utensils for these meats should be kept in a separate part of the shop or kitchen. Shopkeepers and cooks should not handle raw and cooked products alternately, without a careful washing of the hands.

In countries with a well-developed meat industry, meat cuts and individual packages are frequently made at the meat factory and delivered to retail shops. This procedure has value in preventing contamination. It should be recognized, however, that when dealing with such packaged products, refrigeration facilities at all stages from the factory to the retailer are essential.

13. EDUCATION AND TRAINING OF MEAT INSPECTORS

In no case must inspection of meat be entrusted to untrained persons, and it is recommended that meat inspection be carried out, wherever possible, by veterinarians or at least under the supervision of veterinarians. It is recognized, however, that the trained meat inspector has a useful part to play in many countries where there are not yet sufficient veterinarians.

In training veterinary surgeons so that they may play their part in meat hygiene, it is essential that the veterinary schools of all countries should include in their curriculum adequate tuition in meat hygiene and meat inspection. It is also recommended that these schools should conduct special post-graduate courses to provide a nucleus of highly trained veterinary surgeons, who should occupy the higher administrative positions in any meat inspection service. It is desirable that meat hygiene be entrusted as much as possible to veterinarians employed in a whole-time capacity.

Laymen should be recruited from persons in possession of a good general education, and it is an advantage if they possess some knowledge or experience of meat technology or the meat trade. In order to provide for training of this lay personnel, it is recommended that certain approved scholastic establishments should conduct courses in meat hygiene. These should include both theoretical training and an adequate period of practical training in the abattoir. Such courses should be conducted by veterinarians and by other fully qualified personnel. A certificate or diploma should be granted to successful candidates at the end of such a course, this being accepted as an essential qualification before a person may be employed as a meat inspector.

In general, the duties devolving on the veterinary inspector relate to the technical and administrative duties in a public abattoir, to the inspection of carcasses detained by the lay meat inspectors, and to arranging for or conducting such laboratory examinations as may be necessary to arrive at a scientific assessment of the state of carcasses and organs affected with various pathological conditions. The duties devolving on the lay meat inspector include the control of the slaughter and hygienic dressing of the animal, the general hygiene of the slaughter-house, and the routine examination of the carcasses and organs of the slaughtered animals. In all cases,

the lay meat inspector should operate under the control of the veterinarian in charge.[1]

14. PROBLEMS REQUIRING INVESTIGATION

During these discussions, the Committee noted many problems in connexion with meat hygiene which require attention and clarification, and recommends that wherever possible FAO and WHO encourage investigations on these problems, some of which are:

(1) improvement and standardization of laboratory techniques for the rapid identification of pathogenic micro-organisms encountered in food poisoning;

(2) laboratory procedures for sanitary control at all stages in the handling of meat and meat products;

(3) laboratory aids in ante-mortem diagnosis of anthrax;

(4) investigations into the epidemiology of cysticercosis;

(5) irradiation in the sterilization of meat and meat products;

(6) bacteriological and other controls of quality of processed meat;

(7) hygienic problems in the packaging of meat and meat products.

15. PUBLIC SUPPORT FOR IMPROVED MEAT HYGIENE

The Committee strongly emphasizes the necessity of enlisting the support of the public—the consumer—to improve meat hygiene practices. In this connexion, consumer demand for a meat product of high quality from

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[1] A minority of the Committee members consider that the following expresses their views more adequately on this subject:

In meat inspection the veterinarian is well qualified to carry out ante-mortem and post-mortem inspections, but the medical officer of health and his team are responsible for safeguarding the consumer by preventing food poisoning. Food poisoning associated with meat is, in countries from which information is available, usually associated with processed or made-up meat, and the causes of these outbreaks have to be investigated by the public health authorities.

Both veterinarians and sanitary inspectors, representing medical officers of health, are therefore concerned with the provision of safe meat. The veterinarian's main object should be to investigate the sources of disease in herds, and the sanitary inspector's to trace sources of contamination of human food. Their duties are complementary and both are required in the abattoir. In some countries, it may be convenient to give the veterinarian supervisory power over the sanitary inspector; in others, a different arrangement may be favoured. Both, however, should be employed by the authority responsible locally or centrally for the health of the community, and should be under the general direction of the medical officer of health.

both the hygienic and the culinary standpoints has been of great assistance in many countries. The best legislation on meat hygiene will in many respects fail to achieve its purpose if consumer support for its enforcement is lacking. Public health authorities should therefore seek every means possible to marshal such support in endeavouring to improve meat hygiene practices in their communities.

ANNEXES

Material included in the Annexes is for information only, and the specific recommendations they may contain are not necessarily endorsed by the Committee.

Annex 1

SELECTED TEXTS ON MEAT HYGIENE

AMERICAN PUBLIC HEALTH ASSOCIATION
Diagnostic procedures and reagents for public health laboratories in bacteriology, mycology, parasitology and immunology, 4th ed.
New York, 1955 (in press)

DACK, G. M.
Food poisoning, rev. ed.
Chicago, University of Chicago Press, 1949. 184 p. (New edition in press).

DEWBERRY, E. B.
Food poisoning : its nature, history and causation ; measures for its prevention and control, 3rd ed.
London, Hill, 1950. 318 p.

EDELMANN, R.
Text-book of meat hygiene, with special consideration of antemortem and postmortem inspection of food-producing animals, 8th ed., rev. by J. R. Mohler & A. Eichhorn
Philadelphia, Lea & Febiger, 1943. 468 p.

GOULD, S. E.
Trichinosis
Springfield, Ill., Thomas, 1945. 356 p.

HARVEY, W. C. & HILL, H.
Food hygiene
London, Lewis, 1952. 511 p.

HOBBS, B. C.
Food poisoning and food hygiene
London, Arnold, 1953. 174 p.

JACOBS, M. B., ed.
The chemistry and technology of food and food products, 2nd ed.
New York, Interscience Publishers, 1951. 3 vol.

JEAN-BLAIN, M.
Les aliments d'origine animale destinés à l'homme
Paris, Vigot, 1948. 544 p.

JENSEN, L. B.
Meat and meat foods ; processing and preservation from meat plant to consumer
New York, Ronald Press, 1949. 218 p.

JENSEN, L. B.
Microbiology of meats, 3rd ed.
Champaign, Ill., Garrard, 1954. 422 p.

LACHENSCHMID, B.
Praktikum der tierärztlichen Schlachttier- und Fleischbeschau. Anleitung zur Untersuchung und Beurteilung der Schlachttiere nach den Bestimmungen des Fleischbeschaugesetzes, 4. Aufl.
Stuttgart, Enke, 1952. 294 p.

LAFENÊTRE, H. & DEDIEU, P.
Technique systématique de l'inspection des viandes de boucherie
Paris, Vigot, 1946. 456 p.

MARTIN, C. R. A.
Practical food inspection, 4th ed.
London, Lewis, 1950. 2 vol.

MILLER, A. R.
Meat hygiene
Philadelphia, Lea & Febiger, 1951. 420 p.

NÉVOT, A.
Contrôle bactériologique pratique des denrées alimentaires d'origine animale
Paris, Flammarion, 1947. 363 p.

PIETTRE, M.
Inspection des viandes et des aliments d'origine carnée [Nouv. éd. rev. et augm.]
Paris, Baillière, 1952. 2 vol.

SCHÖNBERG, F. & ZIETZSCHMANN, O.
Die Ausführung der tierärztlichen Fleischuntersuchung, 4. Aufl.
Berlin, Parey, 1951. 324 p.

THORNTON, H.
Textbook of meat inspection, including the inspection of rabbits, poultry and fish, 2nd ed.
London, Baillière, Tindall & Cox, 1952. 646 p.

TRAWIŃSKI, A.

Mięsoznawstwo. Podręcznik do użytku lekarzy weterynaryjnych, lekarzy i studentów, Wydanie 2 [*Meat science. Manual for the use of veterinarians, physicians, and students*, 2nd ed.]
Warszawa, Lekarski Instytut Naukowo-Wydawniczy, 1948. 918 p.

WUNDRAM, G. & SCHÖNBERG, F.

Tierärztliche Lebensmittelüberwachung, 6. Aufl.
Berlin, Parey, 1953. 412 p.

Annex 2

FOOD-POISONING OUTBREAKS IN ENGLAND AND WALES, 1953, ASSOCIATED WITH PROCESSED AND MADE-UP MEATS

Dishes	Presumed causal agents					
	Salmonella	*Staphylococcus*	*Clostridium welchii*	other organisms	agent not discovered	total
Cold meat (beef, mutton, veal, pork, and poultry)	9	3	4	1	9	26
Meat pies	9	2	6	0	9	26
Pressed meats	6	8	0	0	5	19
Ham, boiled bacon	0	11	0	1	4	16
Meats in gelatin	5	6	1	0	3	15
Sausages, liver sausages, and the like	5	3	0	0	5	13
Re-heated meat	5	4	8	0	7	24
Tongue	1	3	0	0	3	7
Canned meat (corned beef, luncheon meat, etc.)	0	2	0	0	4	6
Sandwiches	2	2	0	0	0	4
Stuffed meat	1	1	0	0	1	3
Various other meats	1	2	0	0	2	5
Total	44	47	19	2	52	164

Annex 3

SOME CHARACTERISTICS OF BACTERIAL FOOD-POISONING

Causal agent	Interval from ingestion of food to onset of illness	Reservoirs of the infecting organism	Types of food usually incriminated (and number of cases)	Characteristic symptoms
Salmonella (food-poisoning types)	8-72 hours; often 8-12 hours	gastro-intestinal tract of animals	fresh meat .. 1 canned meat. 19 processed and made-up meats . 170 "meat" ... 20 other foods (not meat) 275 total... 485 *	abdominal pain; diarrhoea; nausea; pyrexia; sometimes vomiting; prostration
Staphylococcus	1-6 hours; often 2-4 hours	man (skin and nose, and cuts); animals	fresh meat .. 2 canned meat. 35 processed and made-up meats . 205 "meat" ... 7 other foods (not meat) 72 total... 321 *	salivation; nausea; vomiting; abdominal pain; prostration; diarrhoea; subnormal temperature; recovery in about 24 hours
Enterococcus	4-12 hours	gastro-intestinal tract of animals	processed meat ..... 2 other foods (not meat) 2 total... 4 **	abdominal cramps; diarrhoea; no prostration or pyrexia; rapid recovery
Clostridium welchii (B. perfringens)	8-22 hours	gastro-intestinal tract of animals	fresh meat .. 2 canned meat. 1 processed and made-up meats . 74 "meat" ... 4 other foods (not meat) 3 total... 84 *	abdominal cramps; diarrhoea; no prostration or pyrexia; rapid recovery
Clostridium botulinum	2 hours to 8 days; often 12-48 hours	soil	meat, mainly processed meat ..... 36 other foods . 426 total... 462 * (In Europe, meat, and in the Far East, fish, are the commonest foods associated with botulism)	difficulty in swallowing; double vision; no pyrexia; in fatal cases, respiratory paralysis

* Data obtained from reports on food-poisoning outbreaks in England and Wales, 1949-53, issued by the Public Health Laboratory Service, Medical Research Council of Great Britain.

** Data obtained from: Dack, G. M. (1949) *Food poisoning*, Chicago.

Annex 4

SPECIMEN REPORTING-FORM FOR INVESTIGATION OF FOOD-POISONING OUTBREAKS *

FRONT

Date of onset of symptoms in first case .....

Investigator .....

Administrative area(s) ..... No. at risk .....

No. affected ..... Fatal cases: No..... Age(s) ....years Incubation period(s) .... hours

Characteristic symptoms:

Presumed causal agent ..... Presumed vehicle (food) .....

History of food remnants (where stored and at what temperature) between time eaten and time examined:

Origin and preparation of food (ingredients, where bought and prepared, how stored, where consumed):

Probable reservoir of infecting organism (include animal investigations):

(Please turn over)

BACK

Details of laboratory investigations

	Number inves-tigated	Type of specimens	Num berof specimens	Organisms isolated	Number of specimens positive	Number of *persons* or *foods* positive
Patients						
Food handlers						
Healthy persons at risk						
Foods						

Notes and comments:

* To be used for outbreaks involving two or more related cases or excretors.

Annex 5

DESIGN OF ABATTOIRS

The following charts (fig. 1-3) are suggested designs of abattoirs incorporating essential divisions of operations discussed in the text of the report.

FIG. 1. SINGLE-LEVEL ABATTOIR WITH SEPARATE ROOMS FOR KILLING AND BLEEDING, SKINNING, AND DRESSING

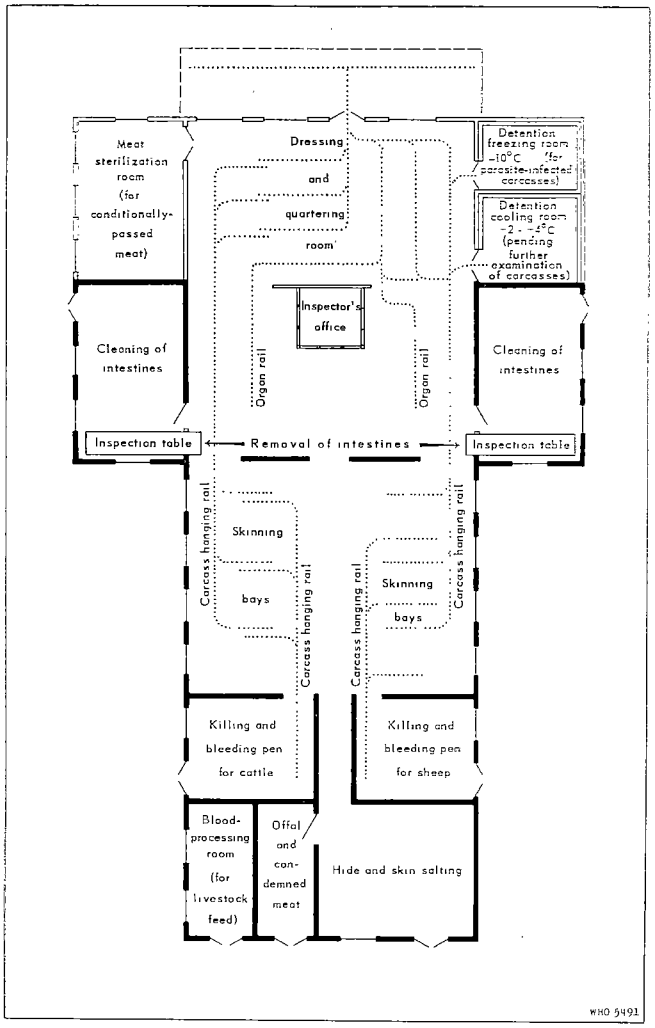
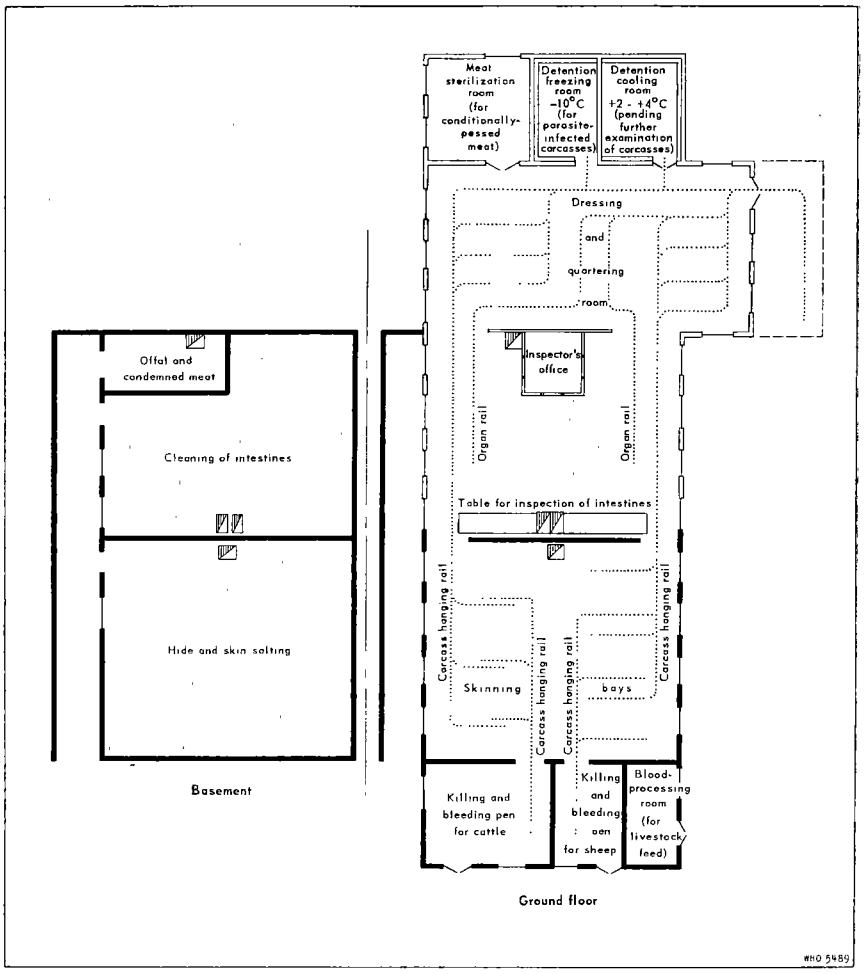


FIG. 2. TWO-LEVEL ABATTOIR WITH SEPARATE ROOMS FOR KILLING AND BLEEDING, SKINNING, AND DRESSING

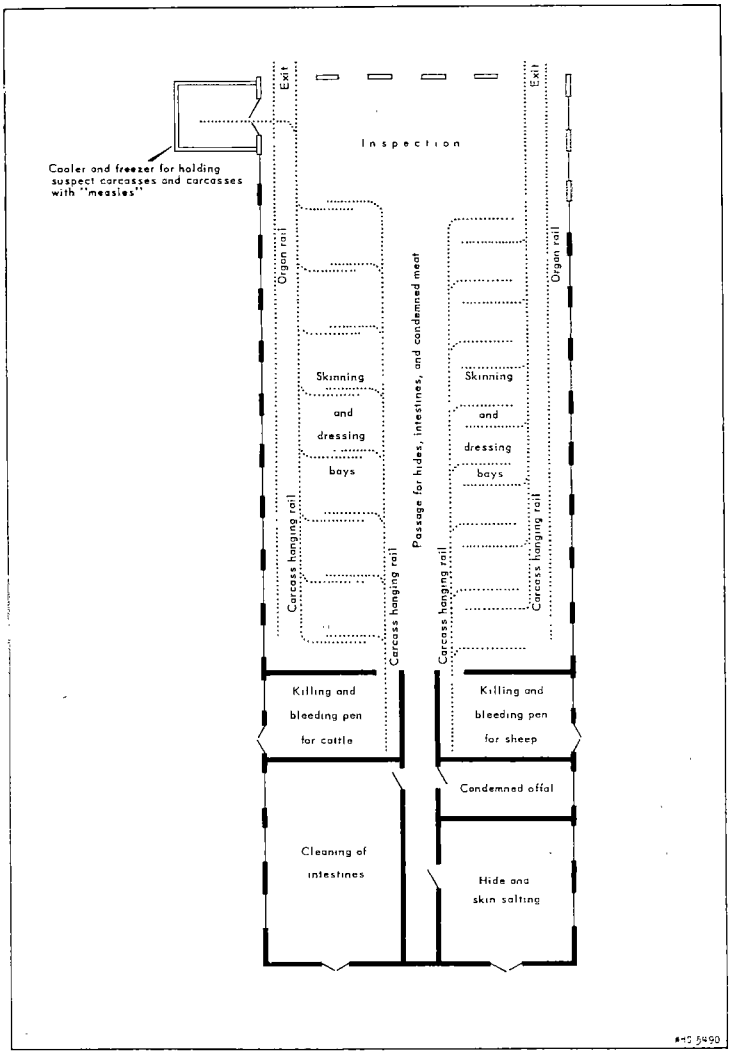


Unclean operation

A basement is provided under the abattoir for salting hides and skins, cleaning stomachs and intestines, and treating condemned material.

The design given in fig. 3 is for a relatively simple construction suitable as a public abattoir made available to individual private meat dealers—a practice common in many countries, including the less developed ones. For this type of abattoir, it is suggested that the killing and bleeding of the animals be performed by special personnel, while the skinning and dressing of the carcasses can be left to the private dealers. This would bring a desir-

FIG. 3. SINGLE-LEVEL ABATTOIR WITH A SEPARATE ROOM FOR KILLING AND BLEEDING, BUT WHERE SKINNING AND DRESSING ARE DONE IN THE SAME ROOM



able separation of the traffic of live animals, their slaughter and bleeding, from operations in the dressing bays. Mechanical hoists will be necessary in the slaughtering compartment for cattle, and skinning and dressing of the carcasses can take place partly on the floor if economic considerations

preclude more-elaborate installations. In the sheep section, carcasses can be hung by hand and placed on individual loose benches for skinning and dressing. On-the-rail skinning and dressing of sheep has been successful principally in large abattoirs with a high daily turnover.

For designs of large abattoirs with highly mechanized installations, information can be obtained upon application of national authorities to the United States Department of Agriculture, Meat Inspection Service, Washington, D.C. Their publication, *Information for Applicants for Federal Meat Inspection* (revised July 1952), contains detailed specifications on installations for abattoirs of various sizes.

Annex 6

MEAT INSPECTION TECHNIQUE *

Article 19

Instructions for meat inspection.

(1) In the examination of the meat or organs, the inspector shall not make incisions which are greater in number or more extensive than those necessary for the aim in view, as laid down in Articles 20-27.

(2) On making incisions into diseased parts, every care should be taken to avoid contamination of the meat, floor, hands, etc., with morbid material.

(3) If the meat inspector (" Fleischbeschauer ") realizes that he is not competent to give a decision (Articles 29 and 30), he shall break off the examination, refer the owner of the meat to the veterinary meat inspector (" Fleischbeschautierarzt "), and immediately inform the local police authorities (Article 10, paragraph 5). The meat inspector shall inform the veterinary meat inspector of his findings.

Article 20

(1) The separate parts of the carcass shall be examined in accordance with the principles laid down in Articles 21-27 and as a rule the order given therein shall be followed.

(2) The parts of the body to be considered shall be visually inspected ; the lungs, liver, spleen, uterus, udders, and tongue shall also be palpated.

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* Extract from Schedule (" Ausführungsbestimmungen ") A of the Regulations (" Verordnung ") of 1 November 1940 for the application of the Meat Inspection Law (Germany).

The blood shall be examined as regards colour, colouring power, coagulability, and presence of foreign bodies. In the case of those parts where visual inspection or palpation is not adequate for the detection of morbid states, the deeper layers shall be exposed and examined by means of incisions and dissections in accordance with the provisions which follow. Lymph-nodes which are to be examined shall be cut through longitudinally and, where necessary, excised and cut into thin slices. When there are morbid changes whose identification calls for more thorough examination, such examination shall be made in the manner suited to the nature of the case (see also Article 27). Where necessary, suspected or diseased parts shall be incised, bones shall be split, and boiling and roasting tests carried out ...

Article 21

(1) In general, the following shall be examined :

1. the blood ;

2. the head, the retro-pharyngeal, upper cervical, and submaxillary lymph-nodes, and the tonsils (the tongue shall be loosened sufficiently to make the whole of the oral and pharyngeal mucosa visible) ;

3. the lungs, trachea, and lymph-nodes at the hilum of the lungs and in the mediastinum (a longitudinal section to be made near the point where the trachea divides, through the trachea and the main bronchi, and a transverse section in the lower third of the lungs through the main bronchi) ;

4. the pericardium and the heart (a longitudinal section to be made so as to open up both ventricles and cut through the dividing wall between them) ;

5. the diaphragm ;

6. the liver, portal lymph-nodes, and gall-bladder ;

7. the stomach, and the intestinal canal, the mesentery, the mesenteric lymph-nodes, and the omentum ;

8. the spleen ;

9. the kidneys, with their lymph-nodes, as well as the bladder ; when acute miliary tuberculosis is suspected (Article 36, II, 1), the kidneys shall be removed from the carcass for careful examination ;

10. the uterus together with the vagina and vulva (a particularly careful examination should be made in the case of animals which have had young shortly before slaughter or show a vaginal discharge or morbid changes in the surface of the uterus) ;

11. the udder and its lymph-nodes ;

12. the muscular substance, including its fatty and connective tissue, the bones, particularly the split vertebrae and pelvic bones, the breast bone, joints, synovial sheaths, pleura, and peritoneum. In suspect cases,

particularly in the presence of generalized tuberculosis, examination shall be made of the lymph-nodes at the entrance of the thorax (including the lower cervical lymph-nodes), of the supra-sternal, pre-scapular, axillary, lumbar, iliac, pre-crural, popliteal, ischiatic, and inguinal lymph-nodes, where necessary after they have been excised and cut into thin slices.

(2) In exceptional cases, however, the examination shall also be extended to include other parts of the body not mentioned in paragraph 1 (e.g., brain, cranial cavities, eyes, ears, oesophagus, pancreas, suprarenals, testicles, etc.).

Article 22

In the case of oxen, the tongue, heart, and external and internal masticatory muscles—these latter by making at least two extensive incisions running parallel to the lower jaw—, as well as those parts of the flesh exposed on slaughter and the oesophagus, shall be examined for cysticerci. The internal masticatory muscles shall be incised from the lower edge of the lower jaw to their upper point of attachment, as far as this is possible without causing detachment of the lower jaw; the incision of the external masticatory muscles shall proceed upwards to the crest of the zygomatic arch and backwards as far as the parotid glands, which must also be incised. The trachea, as well as its main ramifications, shall be split open along its whole length and examined. An incision vertical to the surface of the stomach shall be made in the liver through the main bile ducts, as well as an incision near the spigelian lobe as far as the bile ducts. The kidneys shall be freed from their adipose capsules. In cows, each half of the udder shall be split by a deep longitudinal incision opening up the milk sinuses. The uterus shall be opened up.

Article 23

In the case of calves, the umbilicus and the joints shall also be inspected and incised where there is any suspicion of disease. Examination for cysticerci shall take place as with oxen. In the case of calves under six weeks of age . . . examination for cysticerci shall be restricted to careful inspection of the surface of the heart after opening the pericardium. Examination of the kidneys and renal lymph-nodes may be omitted in calves of all ages, provided there is no suspicion of disease.

Article 24

In the case of horses and other single-hoofed animals, the mucosa of the trachea, larynx, nasal cavity, and accessory sinuses shall be examined, after the head has been sawn or chopped through lengthwise near the median line and the nasal septum removed.

Article 25

(1) Pigs, apart from sucking pigs, shall be divided into two before examination, by splitting the spinal column and the head ; the internal fat (kidney fat, belly fat) shall be detached. The exposed flesh, particularly of the hams, belly, diaphragm, intercostal muscles, back of the neck, heart, tongue, and larynx, shall be examined for cysticerci. As an exceptional measure, splitting of the spinal column and head may be omitted at the request of the owner, e.g., in the case of animals intended for show, provided that general inspection of the carcass has shown it to be free from tuberculosis and that the absence of cysticerci has been adequately proved by a further careful examination, where necessary by incising the tongue and masticatory muscles as well as by numerous sections through the heart.

(2) Pigs shall also be examined for the presence of trichinae (Article 37).

Article 26

In the case of sheep and goats, the liver shall always be examined, employing the procedure laid down in Article 22. Incision of the heart as well as of the lymph-nodes in the head and lungs shall only be necessary where disease is suspected.

Annex 7

ASCOLI PRECIPITATION TEST FOR ANTHRAX

This test is very useful, particularly for the examination of hides suspected of originating from animals infected with anthrax. The success of the test depends, however, upon the employment of potent precipitating serum and careful technique on the part of the laboratory worker. Precipitating serum is best prepared in donkeys. Strains of micro-organisms vary widely in their ability to act as antigens in the hyperimmunization of donkeys. Strains of *Bacillus cereus (anthracoides)* have been found to serve as the best antigens. It is often necessary to try several strains before a good antigenic strain is found. Briefly, thick suspensions in saline are made of agar-slant growths of the different strains of micro-organisms being tested. The suspensions are boiled for a few minutes, cooled, and filtered, and the clear filtrate is stratified with precipitating serum of known potency. Such serum can be obtained from the Institut Pasteur, Paris, and from the Istituto Sieroterapico Milanese Serafino Belfanti, Milan.

Annex 8

TEMPERATURE CONTROL AND SALT TREATMENT OF MEAT CONTAINING TRICHINAE OR CYSTICERCI

A. Trichinosis

1. *Heating*

The regulations of the United States Government [8] stipulate :

" All parts of the pork muscle tissue shall be heated to a temperature not lower than 137°F [58.3°C], and the method used shall be one known to insure such a result. On account of differences in methods of heating and in weights of products undergoing treatment it is impracticable to specify details of procedures for all cases.

" Procedures which insure the proper heating of all parts of the product shall be adopted. It is important that each piece of sausage, each ham, and other product treated by heating in water be kept entirely submerged throughout the heating period ; and that the largest pieces in a lot, the innermost links of bunched sausage or other massed articles, and pieces placed in the coolest part of a heating cabinet or compartment or vat be included in the temperature tests."

2. *Refrigeration*

Wright [9] recently reviewed the present position in the USA with respect to refrigeration of meat and meat products for trichinosis. He states :

" There have been no changes in the past year in requirements of the federal meat inspection regulations concerning the freezing of pork or pork products customarily eaten without cooking by the consumer. For pieces not exceeding 6 in. (15.2 cm) in thickness or stored in crates not exceeding 6 in. in depth, the holding time prescribed is 20 days at 5°F [–15°C], 10 days at –10°F [–23.3°C], or 6 days at –20°F [–28.9°C]. For products in layers or containers exceeding 6 in. in thickness or depth but not exceeding 27 in. (68.6 cm), the holding times at the above-prescribed temperatures are respectively, 30, 20, and 12 days. The safety factor provided by these regulations has been amply confirmed in years past and more recently by Harrington, Spindler, and Hill (1950). [6]

" Several investigators have conducted limited studies on the fate of Trichinella larvae in quick-frozen pork. Augustine (1933) [1] found that quick-freezing at –15°C (5°F) for three hours killed Trichinella larvae, whereas slow-freezing at this temperature required 42 hours for destruction ;

in both instances the meat was held at –15°C for an additional 48 hours. Augustine (1952) [2] stated that pork can be made safe against trichinosis (1) by lowering the temperature immediately to –35°C (–31°F) or (2) by lowering the temperature first to –18°C (–0.4°F) with subsequent storage for three days at the same temperature. Blair and Lang (1934) [3] found that quick-freezing for three to four hours at –17.8°C (0°F) with continued holding at this temperature for a minimum of 53 hours apparently destroyed Trichinella larvae in pork roasts.

" Gould and Kaasa (1949) [5] conducted more extensive experiments with quick-freezing. Trichinella larvae were destroyed after exposure of infected pork to the following temperatures for the periods stated :

Freezing Temperatures		Freezing Time
°F	°C	
–16.6	–27	36 hours
–22	–30	24 hours
–27.4	–33	10 hours
–31	– 35	40 minutes
–34.6	–37	2 minutes

" Gould (1945) [4] has recommended that all pork produced in the United States be processed for the destruction of trichinae. The New York Academy of Medicine (1948) [7] expressed the view that more fundamental research should be conducted on the potentialities of quick-freezing in this regard. Unless there are available data of which the writer is unaware, the last recommendation would still seem to be a pertinent one. Investigations to date have dealt only with the quick-freezing of small pork cuts, none weighing over approximately 1,800 gm. (4 lb.). The results would certainly not be applicable to the quick-freezing of hog carcasses and probably not applicable to the larger cuts commonly handled in packing-house procedure. Information is needed concerning the minimum temperature and holding time required to provide a safe margin for hog carcasses and large cuts, as well as for pork cuts packed in boxes, tierces, cartons, or other containers commonly used by the trade.

" Before any sensible recommendation can be made for the freezing of all pork (by any method) for the control of trichinosis not only should we be in possession of the essential technical data, but we should give some consideration to the amount of freezing capacity available and the costs involved. Recommendations concerning quick-freezing must also take into consideration changes induced in the product and consumer taste."

3. *Salt treatment*

The United States Government regulations [8] give several methods for salting sausages and other pork products used in the USA. Different salt concentrations, temperatures, and holding times are required, depending

on the size and nature of the meat product. (The reader is referred to the original reference for details.)

B. Cysticercosis

The United States Government regulations [8] state that carcasses of hogs affected with *Cysticercus cellulosae* may be passed for cooking, but if the infestation is excessive the carcass is condemned. Also, carcasses of cattle showing a slight or moderate infestation (less than two cysts per cut within an area the size of the palm of the hand) are held in cold storage continuously at a temperature not higher than 15°F (–9.4°C) for a period of not less than 10 days. Boned meat from such carcasses, when in boxes or other containers, is held at the same temperature for not less than 20 days. Alternatively to retention in cold storage, such carcasses and parts may be heated throughout to a temperature of at least 140°F (60°C).

The French regulations (1941) condemn carcasses showing generalized infestation. For " discrete " infestation carcasses can be held for 8 days at –5°C (23°F) or for 30 days at 0°C (32°F). Where refrigeration facilities are unavailable, the meat must be sliced into pieces of 15 cm thickness at most and either (*a*) cooked at 100°C (212°F) for two hours, or (*b*) immersed completely in a salt solution (25° Baumé) for a period of at least 21 days.

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Annex 9

DANISH RULES AND INSTRUCTIONS FOR LABORATORY METHODS OF EXAMINATION, AND THEIR APPLICATION IN THE HYGIENIC JUDGEMENT OF CARCASSES, 1954

1. *Samples*

The following samples should be sent to the laboratory:

(*a*) The spleen (intact whenever possible).

(*b*) A piece of liver (about 500 g) taken from the hilar region, together with portal lymph-nodes and gall-bladder (empty).

(*c*) Two intact lymph-nodes (prescapular, prefemoral, popliteal, ischiatic).

(*d*) A piece of muscle covered by intact fascia (at least 250 g), preferably taken from the extensor muscles of the forearm. In pigs, the whole forearm with skin should be cut off as close to the elbow as possible.

(*e*) Where special pathological findings make it advisable to have any other organ included in the examination, a fairly large piece of the organ, including its lymph-nodes (intact), should be sent with the routine samples.

2. *Precautions in taking of samples*

The samples must be taken as soon after slaughter as possible, using clean and sterilized (scalded) instruments. No incisions should be made in the lymph-nodes, and the samples must be protected against contamination throughout.

3. *Shipment*

Before being wrapped, the samples must be cooled effectively (by refrigeration). After cooling, each sample should be wrapped separately in several layers of clean absorbent paper (e.g., newspaper). Parchment or

heavy wrapping-paper should not be used for the wrapping of the individual samples. After wrapping, the samples should be packed in a cardboard or wooden box. Tight metal containers must not be used.

The samples must be accompanied by a written form stating ante-mortem findings (body temperature ; symptoms, if any ; duration of disease ; medical treatment) and post-mortem findings, the exact hour of killing, and identification number and name.

Shipment to the laboratory must be by the fastest means available.

4. *Judgement*

Final judgement must be withheld until the results of the laboratory findings are received and should not be given earlier than 48 hours after slaughter. Before the carcass is finally passed, the meat inspector must re-inspect it. It is most important that he should evaluate the state of freshness of the meat at the time of re-inspection.

Laboratory Techniques

A. Bacteriological examination

This examination is performed by cultivating material taken aseptically from the samples in the media listed below. The purpose of the examination is to provide information on the bacteriological status of the meat (muscle), the lymph-nodes, and the organs.

1. *Apparatus and equipment*

A wooden board covered with clean filter-paper and metal pins for fixing the samples ; a gas burner and a hot iron spatula to sterilize the surfaces of the tissues by burning ; knives, preferably with changeable blades ; scissors ; instrument boiler ; sterile Petri dishes and tubes (180 mm $\times$ 22 mm) ; general equipment for bacteriological work.

2. *Media*

(*a*) Blood agar : broth-peptone agar (pH 7.6) plus 5% sterile defibrinated blood.

(*b*) Bromothymol-blue/lactose/saccharose agar : to one litre of meat-extract/peptone agar (pH 7.6) is added aseptically a solution consisting of 10 g of lactose plus 10 g of saccharose dissolved in 80 ml of 0.005 N sodium hydroxide containing 0.25% bromothymol blue and sterilized at 110°C for 15 minutes. No re-sterilization of the finished medium.

(*c*) Glucose agar : broth-peptone agar (pH 7.6) plus 0.5% of glucose. The glucose is dissolved in distilled water, sterilized at 110°C for 15 minutes, and then added aseptically to the agar medium. No re-sterilization.

(*d*) Brilliant-green/lactose/saccharose/phenol-red agar: 10 g of peptone, 5 g of meat extract, 5 g of sodium chloride, and 20 g of agar are dissolved in 1000 ml of water by boiling for 30 minutes at 110°C. Filtration through flannel. Adjustment of pH to 7.2. Sterilization for 30 minutes at 110°C. To 1000 ml of melted-agar medium is added aseptically a solution consisting of 10 g of lactose and 10 g of saccharose in 80 ml of 0.005 N sodium hydroxide containing 1% phenol red. This solution has been sterilized by boiling at 100°C for 10 minutes. Finally, 2 ml of a 0.5% brilliant-green solution is added. No re-sterilization.

(*e*) Selenite broth : 4 g of sodium selenite ($NaHSeO_3$, $5H_2O$), 5 g of peptone, and 10 g of disodium hydrogen phosphate (Na_2HPO_4, $12H_2O$) are dissolved in 1000 ml of water and filtered. Sterilization at 110°C for 30 minutes. 4 g of lactose dissolved in a small quantity of distilled water and sterilized at 110°C for 15 minutes are added aseptically.

Tetrathionate broth may be used instead of selenite broth.

3. *Inoculation of media*

The samples must be fixed to the wooden board by means of the metal pins or by applying a suitable forceps. The samples of muscle from pigs must have the skin removed. Fatty tissues are removed from the surfaces of the lymph-nodes. The surfaces through which incisions are to be made must be sterilized by means of the hot iron spatula. Knives and scissors are sterilized by boiling or flaming. Pieces of the tissues, about the size of an almond, are removed aseptically from the interior layers of the tissue and transferred to the various media as follows (from the gall-bladder, scrapings of the mucosa are used for the inoculation) :

Muscular tissue and lymph-nodes	Blood agar (Petri dish) Bromothymol-blue/lactose/saccharose agar (Petri dish) Deep glucose-agar tubes Selenite-broth or tetrathionate-broth tube
Spleen	Blood agar (Petri dish) Bromothymol-blue/lactose/saccharose agar (Petri dish) Deep glucose-agar tubes Selenite-broth or tetrathionate-broth tube
Liver, liver lymph-nodes, and gall-bladder	Selenite-broth or tetrathionate-broth tube (mixed sample)

To control the sterility of the blood-agar medium, pour one non-inoculated Petri dish. The material which is transferred to selenite or tetrathionate broth must be crushed against the wall of the tube by means of a knife.

The material from muscle, spleen, and lymph-nodes which has been transferred to empty Petri dishes must be smeared against the bottom of the Petri dish in order to disperse part of the tissue material in the medium, while the bulk of the tissue block is left to be embedded in the medium. Melted blood-agar and bromothymol-blue/lactose/saccharose agar are poured into the plates. The deep glucose-agar tubes must be inoculated while the medium is melted and cooled down to about 45°C. After the inoculation the tubes are placed in cold water for the agar to solidify.

4. *Incubation*

All cultures are placed in the incubator at 37°-38°C, and a first reading is made after 16-18 hours. If the selenite- or tetrathionate-broth tubes show growth, a few drops are streaked on a brilliant-green/lactose/saccharose/phenol-red/agar plate for the isolation of salmonellae. When readings of the agar plates and glucose-agar tubes are negative, a second reading must be made after further incubation for an additional 24 hours. An incubation period of 40-48 hours is essential for the cultural demonstration of species such as *Erysipelothrix* and *Corynebacterium pyogenes*. Moreover, these organisms are very often found to have multiplied only within the embedded tissue-block itself, without giving rise to any visible colonies in the surrounding medium. All plate cultures found to be negative after 48 hours of incubation must therefore be examined microscopically. Gram-stained smears are prepared from the tissue blocks and examined for the presence of *Erysipelothrix* and *Corynebacterium pyogenes*.

5. *Identification of positive cultures*

The identification should be based upon colony morphology, haemolysis in the blood-agar plate, fermentation reactions in the bromothymol-blue agar plate, plus microscopic examination of Gram-stained slides, etc. Formation of gas in the deep glucose-agar tubes, combined with butyric acid or putrid smell, and eventually lack of growth in the aerobic cultures, indicate the presence of clostridia. Colonies suspected of being salmonellae (red colonies in brilliant-green/phenol-red agar, blue colonies in bromothymol-blue agar showing Gram-negative rods) must be identified by means of the slide-agglutination test (mixed O-serum). The triple sugar-iron-agar slants are also valuable for rapid presumptive identification of various Gram-negative bacteria. When anthrax is suspected, the Ascoli test should be applied to extracts of the tissues (see Annex 7, page 43).

Types of bacteria. Bacteria found in bacteriological meat examination may be either pathogenic bacteria or a mixed flora of non-pathogenic bacteria, resembling the natural intestinal flora. The term "specific infection" covers findings of all species regarded as specific pathogens: haemolytic

streptococci, *Diplococcus lanceolatus*, haemolytic staphylococci, *Pasteurella*, *Salmonella*, *Escherichia* in new-born animals, *Bacillus anthracis*, *Erysipelothrix*, *Listerella*, and *Corynebacterium pyogenes*.

The term " non-specific infection " covers findings of species of non-pathogenic or only potentially pathogenic bacteria : streptococci of the viridans group, enterococci, *Escherichia* in adult animals, clostridia, bacilli of the *subtilis-mesentericus* group, and non-haemolytic staphylococci.

6. *Reporting and interpretation of results*

Results are classified as follows :

(*a*) samples sterile ;

(*b*) specific infection (species, localization) ;

(*c*) low-grade non-specific infection (growth from one sample only, liver not counted) ;

(*d*) high-grade non-specific infection (growth from two or more samples, liver not counted).

Results named under (*a*) and (*c*) are no hindrance to passing the carcass.

Results named under (*b*) and (*d*) necessitate condemnation.

B. Measurement of pH of muscle

This test must be postponed until at least 24 hours after the slaughter of the animal. For the determination of pH, material is taken from the same muscle as that used for bacteriological examination. The following two methods may be employed :

1. *Methods*

(*a*) *Electrometric determination*

This method makes use of a potentiometer (glass electrodes). By means of a knife, about 10 g of muscular tissue are scraped from the internal layers of the muscle. The material is transferred to a beaker and mixed with an approximately equal quantity of distilled water. After standing for about 10 minutes at room temperature, the mixture is ready for pH measurement. The electrodes are placed directly into the water-meat mixture.

(*b*) *Nitrazine-yellow indicator test*

Reagent. An aqueous solution of nitrazine-yellow indicator, 1/10 000.

Procedure. The yellow indicator solution is poured into a small, shallow white porcelain dish, and a small piece of muscular tissue is then placed

in the dish. When the tissue is pressed and squeezed with a knife, some tissue fluid will escape and mix with the indicator solution. If a dark violet colour develops, the pH is above 6.5. Well below that point no change in colour takes place. At pH values close to 6.5 a greenish colour will appear.

2. *Reporting and interpretation of results*

pH readings above 6.5 (or definite violet colour of nitrazine-yellow indicator) are considered as evidence of a low keeping-quality of the meat, and the meat inspector will have to consider carefully the state of freshness of the carcass. Ordinarily, such meat can at best be classified as " conditionally passed ", which means that the meat is not allowed to enter the ordinary market, but is handed over, under the direct supervision of the meat-inspection services, for processing in special factories, where it is used for sterilized canned products. In this way, meat known to possess a keeping quality below standard can be kept off the fresh-meat market.