Opinion of the Scientific Panel on Biological Hazards on Revision of Meat Inspection for Beef raised in Integrated Production Systems. [1]

(Question N° EFSA-Q-2003-026B)

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SUMMARY

The systems used in cattle production fall into six main categories – dairy farming, beef breeding herds, semi-intensive grazing systems, bobby calf production, veal farming and intensive fattening units. Cattle can be infected with pathogens causing clinical signs *ante-mortem* and/or lesions detectable at *post-mortem*. However, reports indicate that the *post-mortem* inspection of apparently healthy animals detect only 20% of all the macroscopic lesions that are actually present in 1% or less of animals. On the other hand, food animals also carry pathogenic microorganisms in their gastrointestinal tract and/or on coat without any signs of disease *ante-mortem*, or visible lesions *post-mortem*. During slaughter and dressing procedures, these pathogens, including *E. coli* O157 and other VTEC, *Salmonella* spp., *Campylobacter* spp. and *Listeria monocytogenes* can be, directly or indirectly, transferred onto the meat surface but will not be visible to the meat inspection staff during conventional meat inspection. In addition, it is recognised that physical meat inspection involving palpation and cutting (as required under 64/433/EEC, as amended) increases the risk of cross-contamination of the meat with these organisms. Therefore some modified approaches are needed in order to reduce meat inspection-mediated cross-contamination of meat, whilst improving or at least maintaining the efficacy of the conventional *post-mortem* inspection of beef cattle.

Presently, the findings at the traditional meat inspection of beef animals appear to be more related to animal health-related conditions, and less related to so for the detection of the most important public health hazards. The main abnormalities noted during *post-mortem* in cattle include emaciation, oedema, colour changes, haemorrhages, bruises, arthritis, sign of septicaemia, tumours etc., and are normally detectable by visual inspection alone. The clinical manifestation of zoonotic diseases in cattle held under integrated systems, as defined in the Opinion on Species and Categories of Animals that might be suitable for Alternative System of Meat Inspection (SCVPH, 2001), is rare.

For animals coming from an integrated production system, that are also considered as non-suspect after *ante-mortem* and visual *post-mortem* inspection, *post-mortem* palpation and incision may not be necessary in visually inspected, non-suspect animals. This alternative, simplified inspection system is applicable only under the following conditions: a) it includes other hygiene and inspection activities including microbiological monitoring; b) thorough *ante-mortem* examination is ensured with full recording systems implemented that provide for the flow of data both to and from the abattoir for both animal health and public health reasons; c) adequate conditions and facilities for an efficient visual *post-mortem* inspection are provided and d) any indication of any abnormality is followed by further detailed examination of the carcass and offal, including, where appropriate, taking of samples for further investigation.

However , the simplified *post-mortem* inspection would not apply necessarily to animals for which data from the farm of origin and/or the results of meat inspection of previously slaughtered batches from that farm indicate increase risk of animal or public health relevance e.g. salmonellosis, *Taenia saginata* cysticerci. In such cases, palpations/incisions on occasion may be necessary in some cases and the Official Veterinarian has an important role in the decision making process whether palpations, incision and/or taking samples for laboratory examination are necessary. Presently, it appears that there is no equivalence between the alternative methods available and conventional meat inspection, and *vice versa*. This is specifically the case in regard to

Mycobacterium bovis and *T. saginata* cysticerci.

The routine physical meat inspection of cattle submitted for slaughter will identify tuberculous, or tuberculous-like, lesions and the retropharyngeal, bronchial and mediastinal lymph nodes are particularly helpful in this respect. Removing the detailed inspection, i.e. multiple incisions, of these three sets of lymph nodes, as required under current meat inspection legislation would reduce the detection rate of tuberculosis in bovines. This is in accordance with the conclusion from the EFSA/BIOHAZ Opinion on Tuberculosis in bovine animals: risk for human health and control strategies (adopted in November 2003) stating that adoption of palpation only, instead of palpation and incision, for inspecting lymph nodes and of organs, (e.g.lungs), for evidence of tuberculosis would lead to a lower detection rate of such lesions. Presently, although it is unknown whether omission of these incisions would increase the risk to public health from *M. bovis* infection, it is clear that it could reduce the detection rate of infected animals, and therefore negatively affect animal disease controls.

The traditional physical *post mortem* inspection has a low sensitivity to detect *Taenia saginata* cysticercosis. Therefore use of alternative systems based on farm controls as well as on use of alternative diagnostic tests would increase detection rate and therefore benefit to public health. However, currently available diagnostic tests have not been validated yet in the EU. Consequently, incisions as currently prescribed in 64/433/EEC would need to remain as an “interim” measure until validation of *T. saginata* cysticercosis diagnostic test is completed. Among those, test based on *T. saginata* antigen detection in blood samples appear particularly promising as an alternative to muscle incisions, so the work on their validation is urgently needed.

The main public health benefits from the proposed simplified *post-mortem* beef inspection, involving reduced use of palpation/incision techniques, relate to likely reduction of cross-contamination of meat with pathogenic microorganisms. In addition, adoption of this alternative system would enable more rational and effective direction of some of the resources (both of human and material type) towards other public health-relevant activities particularly including better exploitation of the food chain information and more focus on abattoir process hygiene controls.

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BACKGROUND

The present legislation governing fresh meat and its mandatory inspection is laid down in Council Directive 64/433/EEC as amended by Directive 91/497/EEC[2].
One of the most important goals of meat inspection, as stated in a previous opinion of the Scientific Committee on Veterinary Measures on Public Health (SCVPH) providing scientific advice to the European Commission, is to prevent transmission of zoonotic infections and other contamination to the consumer.

The European Commission is revising the legislation on meat inspection, as one of the actions foreseen in the White Paper on Food Safety.

The SCVPH has already produced several opinions in relation to meat inspection revision, in particular, one opinion adopted in February 2000 and related to "revision of meat inspection procedures for fattening pigs" (SCVPH, 2000a). In this opinion the Committee stated that: not all lesions are best detected in current meat inspection system…, - there are limitations in terms of consumer health protection in the current procedures…; - there are risks of cross-contamination; - there exists a possibility to tackle meat inspection in a more targeted approach, possibly with a system of "hand-off" inspection, when an integrated system of production is applied".

A second opinion was issued in June 2001 on "identification of species and categories of meat-producing animals in integrated production systems where meat inspection may be revised". This was considered to be a first step approach for the revision of meat inspection procedures.

A third opinion was issued in May 2003 on "Revision of meat inspection in veal calves" as a second step in revising the inspection procedures for the identified species/categories of animals in the opinion issued in June 2001.

In March 2004, the Scientific Panel on Biological Hazards of the European Food Safety Authority (EFSA) issued a fourth opinion on "Revision of meat inspection in lambs and goats" (kids).

TERMS OF REFERENCE

Considering the above and in view of the future process of redrafting the legislation the Scientific Panel of Biological Hazards (BIOHAZ) is asked:

- to review the currently mandatory *post-mortem* inspection procedures for beef raised in integrated production systems, concentrating on the palpation and the incisions.

In particular, for each of the currently required palpations or incisions, to determine:

- which disease or other process is targeted;

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[2] Council Directive 91/497/EEC of 29 of July 1991 amending and consolidating Directive 64/433/EEC on health problems affecting intra-Community trade in fresh meat to extend it to the production and marketing of fresh meat. Official Journal L268, 24/09/1991 P0069-0104

- the pathogenic agent and the relevance for human health;

- the risk for Public Health if procedure(s) are to be omitted for the inspection of animals raised in integrated production systems;

- whether alternative methods, including use of laboratory and rapid methods, could ensure a level of health protection at least equivalent to that provided by the current procedure.

ASSESSMENT

1. INTRODUCTION

This document reviews the currently mandatory *post-mortem* inspection procedures for beef raised in integrated production systems, concentrating on the palpation and the incisions of the carcasses and parts thereof. Animals submitted for slaughter as reactor, inconclusive reactor or as in-contacts following the results of any on farm tests e.g. SCIDT, are not covered by this opinion.

1.1. Definition

The systems used in cattle production fall into six main categories – dairy farming, beef breeding herds, semi-intensive grazing systems, bobby calf production, veal farming and intensive fattening units. The beef breeding herds have evolved from the ancestral stock where calves are reared by their mothers and the only contact with humans was with aversive or neutral events (Gregory, 1998).

1.2. Rearing systems

1.2.1 Breeds

In the EU there are various systems of meat production which take into account the different preferences of the consumers, the different climates and the different breeds that are reared in them. The breeds used for beef production vary considerably and often reflect the region where the animals are reared. There is currently a greater use of "Continental bulls" such as Belgian blue, Blonde d'Aquitaine, Charolais, Chiania, Limousine, Simmental to produce the bigger carcasses, while there is also a market for smaller breeds such as Aberdeen Angus. The carcasses from animals with muscular hypertrophy have much greater value than normal cattle because of greater size and lean content of the meat that is considered to be tender.

1.2.2 Production and Rearing systems:

The rearing and feeding of cattle for the production of beef can be either a specialised trade or a by-product of the dairy industry. There are a number of types of beef production systems. Generally they are grouped in to three broad areas:

Growing and feeding – where the calves or yearlings are either raised or purchased and then taken through to slaughter in fattening units

Breeding herds – where the calves are sold on for the feeding stage with the age of sale depending on the herd of origin. While calves will be sold on from a dairy herd in the first 10 days of life but in the case of calves of a suckle herd they will not be sold until weaned i.e. at approximately 9 months of age then fattened through to slaughter.

Many of the offspring of the **dairy cows** are destined for beef fattening units. These offspring are separated from their mothers at 1 to 2 days and are artificially reared on milk or milk replacer plus solid food for a 6 to 9 weeks period. They are then weaned off milk or milk replacer and as functional ruminants are thereafter dependents on a diet solid food i.e. forages (hay, straw, grass, silage) or forages plus concentrates. These animals subsequently enter beef fattening systems. The fattening system used will depend on the region, tradition, type of diet available and market outlet.

The type of system mainly depends on the availability of the calves and of pasture land unless the system used is one in which the animals are housed at all times and fed a predominately cereal diet (e.g. barley beef). There are a number of factors that influence the quality of beef produced, including breed, age, sex, condition, pre-slaughter handling and methods of handling the meat after slaughter. The main importance of the hill breed of cattle is their capacity to live and produce either meat or milk in rigorous conditions. However, to continue the period from weaning to slaughter they have to move to less rigorous conditions on lower ground.

A large proportion of the offspring of the **beef suckler cows** in the EU is also destined for the beef fattening units. The calves from the beef suckler cow remain with their mother for a 6 to 9 month period before they are weaned. At weaning the calf undergoes a change of diet from a dependence on their mothers' milk to a dependence on a forage diet and a change in environment. The weaned suckler calf's route from the suckler herd to a beef fattening unit is again influenced by region, tradition, type of diet available and market outlet. There may be passage through markets or assembly centers as part of the progress from either the weaned stage en route for fattening and again when gathered and sold before slaughter. The Opinion on the welfare of cattle kept for beef production, SCAHAW, adopted 25 April 2001 provides a useful description of beef production while further detail is given in the Annex to this report.

1.2.3 Organic farming

Production of beef by organic methods is clearly defined by the Regulation EEC N°1804/99. This regulation sets out rules for conversion, origin of the animals, feed, disease prevention, veterinary treatment, husbandry management, free range areas and livestock housing.

The minimum net area available to animals indoors must be 5m^2 per animal for cattle over 350 kg live weight with a minimum of 1m^2 per 100 kg. In addition, an outdoor area (exercise area, excluding pasture) has to be provided, extending at least 75% of the indoor area. The housing must be provided with a resting area, consisting of a solid construction which is not slatted and where ample dry bedding strewn with litter material is

prescribed.
The regulation also states that at least 60% of the dry matter in daily rations is to consist of roughage, fresh or dried fodder, or silage.

Rules for organic farming give rise to certain limitations on veterinary treatments for sick animals. This may have implications for animal welfare, particularly if treatment is delayed or if less effective treatment is administered.

1.3. Husbandry through to dispatch for slaughter

The design and use of shelter and housing facilities for beef cattle should promote the health, well-being and good performance of animals at all stages of their lives. Natural or constructed shelter areas should adequately protect animals from weather fluctuations characteristic of the region. Feedlots and paddocks used during cold seasons must have adequate windbreaks to reduce wind speed and hence the wind-chill effect on cattle.

Adequate feed must be provided regularly with access to fresh, clean water at all times. When cattle are fed animals should have adequate access to the feeders. A feature of beef rearing is by grazing on pasture when sustainable beef production optimizes the use of pasture while reducing the dependence on grain and harvested forage. Everyone working with cattle or managing animal facilities must understand and accept their responsibility to prevent unnecessary suffering of animals. An important skill of cattlemen is the ability to recognize early signs of distress or disease in animals so that the cause can be identified and prompt, appropriate action taken. Cattle should have access to fresh, clean water at all times and with good herd health management that includes all animals and facilities inspected routinely, and if necessary, appropriate action being taken immediately. Distressed cattle should be dealt with humanely, effectively and promptly to prevent suffering. Abnormal health conditions must receive proper treatment. Sick, injured or disabled cattle in severe distress should not be subjected to the rigors of loading and transportation. Under no circumstances should sick, injured or disabled animals be transported either to livestock auction markets or long distances to meat plants.

For the integrated production of beef it is considered that provided the animals have full traceability at all times they may pass through a sale centre before going on a farm for the fattening phase. The use of assembly/sale centres would not be acceptable between fattening farm and slaughter.

From a global meat safety assurance perspective, the possibility that along the transport-markets-abattoir chain of events even animals from pathogen-free farms can become contaminated with pathogens introduced in the environments by animals originating from “contaminated” farms, is of particular concern. If such spread of pathogens occurred to a significant extent, it could largely diminish or negate positive effects achieved in their on-farm control. Namely, it is well recognised that any contamination of the animal coat can result in meat contamination during the skinning and processing of the carcass (Collis *et al*., 2004; Vivas Alegre and Buncic, 2004). One should bear in mind that abattoir lairages, in addition to livestock markets, are places where, directly or indirectly, mixing of animals from different farms takes place, with potentially negative consequences from the perspective of transmission of zoonotic agents (Small *et al*., 2002)..

Therefore, it could be assumed that significant spread of pathogens (animal-to-animal, animal-to-environment and environment-to-animal) can occur in animals during the farm-t-abattoir phase. A range of different related scenarios are possible and each can carry different levels of meat safety risks as illustrated in previous documents (Opinion SCVPH on Veal Calves, May 2003). Nevertheless, at present, the knowledge regarding the exact, quantitative effects of spread of health hazards in cattle (as well as in other meat animals) during the farm-to-abattoir phase on carcass meat safety is insufficient.

1.4. Certification/Quality Assurance schemes

There are number of certification and assurance schemes for beef in use in different countries throughout the world. The assurance schemes may be national or producer based both from the farm and or from the meat plant sectors. In the past with many schemes the focus is not on food safety but on quality of meat or on animal welfare matters. More recently there has been a trend towards producer schemes, frequently initiated by the major retailer sector that links the production stage through to the slaughter industry and emphasize or insist on the use of the good farming practice and full traceability of animals, feedstuffs and also documentation of medicines used and pest control. They set production standards for all aspects of the production (annex – over view of one) and include specifications for herd health and hygienic production practices. They now encourage the use of production of health data and feedback from the abattoir as well as the implementation of herd health plans.

1.5. Diseases in cattle

1.5.1 Conditions affecting different systems and organs

Although a range of disease conditions can be seen in adults, the most predominant diseases relate to intestinal and respiratory conditions. Because of the variety of conditions that may be recorded we have omitted, unless specified, all organic (i.e. non-infective) diseases (no specific aetiology).

In this section, the diseases of animals are considered in relation to the different body systems. Some of the diseases listed have public /animal health implications, whereas others do not.

1.5.1.1 Skin

Dermatophytosis (ringworm) is a fungal, zoonotic disease caused by *Trichophytum verrucosum* and is seen more frequently in younger animals (1 year-old 65% and 2 year-old- 30%), although, sporadically, it may infect older cows (Rosenberger, 1975).

Cow pox, (Orthopoxvirus), causes pox on udder and teats, not present in Europe,

Lumpy skin disease (Capripoxvirus), characterised by fever, cutaneous nodules, limited to African continent and has occured in a few Middle East countries (ISID, 2004, http://www.promedmail.org).

Gaseous oedema (*Clostridium* spp., *Proteus* spp.), malignant oedema (*Cl. septicum*, *Cl. perfringens*), blackquarter (carbonchio sintomatico, *Cl chauvoei*),)

Actinobacillosis (*Actinobacillus ligneresi*), which affects lymphatic nodes, tongue, skin. Actinomycosis (*Actinomyces bovis*) affects mandibular bone, but can also spread to oral cavity and organs in forms of are granulomatous and purulent non contagious lesions.

So-called Skin tuberculosis: cutaneous lesions caused by atypical mycobacteria (PPEM: potentially pathogen atypical mycobacteria).

1.5.1.2 Alimentary system

Stomatitis: *stomatitis vesicularis* (*Rhabdoviridae, Vesiculovirus*) not present in Europe, differential diagnose with foot and mouth disease,

Actinobacillosis and actinomycosis (see previous section 1.6.1.1), when spread to oral cavity and organs.

Oral cavity mycosis: *Candida albicans*;

Bovine are important as a reservoir for blue tongue but the lesions are less frequent than in sheep the disease can affect tongue, oral cavity. Differential diagnose with all condition causing inflammation of oral cavity and nose: **foot and mouth disease** (Picornaviridae, Aphtovirus), bovine pestis (**cattle plague**) (Paramyxoviridae), **vesicular stomatitis** (*Rhabdoviridae, Vesiculovirus*), **papular stomatitis** (Poxviridae), **malignant catarrhal fever** (Herpesviridae,), **IBR** (Herpesviridae, BHV-1), **BVD** (flaviviridae, which cause also multiple necrotic foci and haemorrhagic inflammation in rumen, abomasus, and intestine).

Colibacillosis affect only young calves, *Salmonella* infections can affect older animals with limited pathological findings.

Necrobacillosis: *Fusobacterium necrophorum* may cause large necrotic foci in liver.

Johne's disease, *Mycobacterium paratuberculosis*, affects mainly adults, diarrhoea and emaciations are, if present, the only symptoms. Possible associations with Chron's diseases are discussed in section 1.6.3.

Mycobacterium tuberculosis, *Actinobacillus lignieresii* cause nodular lesions in the liver.

Enteroxaemia (*Clostridium* spp.), practically only veal calves are affected.

Sarcocystosis may cause lesions in oesophagus (but also in myocardium)

Coccidiosis may cause haemorrhagic colitis.

Among worms *Trichostrongylus, Ostertagia, Haemoncus, Cooperia, Nematodirus, Bunostomum, Oesophagostomum. Chabertia* and *Trichuris* may affect different tract of intestine.

Hepatic distomiasis/fascioliasis (fascioliasis), *Cysticercus tenuicollis* (*Taenia hydatigena*) and *cystic echinococcus/hydatidosis* (*Echinococcus granulosus*) infect the liver and cause, respectively, cholangiohepatitis and cysts.

Rift Valley Fever (Phlebovirus, Bunyaviridae) is usually inapparent disease, but some animals develop peracute or acute disease with icterus, hepatomegalia and liver haemorrhagic, with free blood in abomasums and small intestine. It can cause Influenza-like disease in humans.

Anthrax (*Bacillus anthracis*), which is a peracute, acute or sub-acute septicemic disease, has been recently diagnosed in Ukraina and Italy Basilicata, southern Italy, in September 2004, we have had many outbreaks of anthrax, affecting dairy cattle, horses and (3) wild deer. All these animals were at pasture. The 1st outbreak was noted in late July 2004 and in retrospect was probably just the usual summer incident. But in late August this epidemic started, and by 24 Sep 2004 totalled some 36 known outbreaks; in this hilly area, there are certainly other cases not observed or not reported. The total recorded cases are 54 cattle, 7 horses, 11 sheep, and 4 red deer. Presumably there have been subsequent outbreaks in the region. 2 veterinarians have developed cutaneous anthrax. This mountainous area normally has 2 to 3 outbreaks each summer. This series of outbreaks has been ascribed to the heavy rains eroding historically contaminated cattle graves and thus depositing spores in the pastures (Ref -ISID, www.promedmail.org).

1.5.1.3 Respiratory system

Upper respiratory tract. Tracheitis, either pseudomembranous or purulent, may be detected in infectious bovine rhinotracheitis (IBR, Herpesviridae). Tubercular lesions (e. g. ulcerative tubercular tracheitis, tubercular rhinitis) are detected in adults as a consequence of tubercular pneumonia.

Lower respiratory tract. Verminous bronchitis (*Dictyocaulus viviparus*) can occur, as well as, nodular bronchiectasis associated with chronic bronchiectatic bronchitis often as a consequence of tuberculosis.

Lungs. Sporadic (enzootic in calves) fibrinous pneumonia caused by *Pasteurella* spp., fibrinous pneumonia caused by *Mycoplasma mycoides* subsp, mycoides (small colony, contagious bovine pleuropneumonia, lungsickness), pulmonary tuberculosis, lung actinobacillosis, parasitic bronchopneumonia and nodular pneumonia due to protostongylidae (*Dictyocaulus viviparus*). Cysts of *E. granulosus* may also occur in the lungs. Enzootic bronchopneumonia may affect also adults and is caused by myxovirus, parainfluenza-3 and other agents. The most important disease of this group being contagious bovine pleuropneumonia, which is endemic to certain countries in Asia, East and West Africa, Zambia, Angola and Northern Namibia and which has been eradicated from most of the Member States.

1.5.14. Urinary, reproductive system and mastitis.

Kidney pathologies, such as hydronephrosis, cysts, haemorrhages, infarcts, necrosis, nephritis, etc. are detectable by observation, provided that fat covering and kidney capsule are removed. Incision can be useful for the final decision of meat destination for conditions relevant to public health (multiple abscesses from omphalophlebitis, pyelonephritis, metastasis of tumours, tuberculous nodules) or to animal health (petechial haemorrhages from infectious diseases).

Renal amyloidosis, which affect animal at any age and pyelonephritis caused by *Corynebacterium*, which mainly affects cows are, along with renal tuberculosis and nephritis the basic pathological conditions of kidneys. Vaginitis caused by BHV-1 and brucella abortus, along with several kind of mastitis should also be considered.

1.5.1.5 Skeleton and muscles

Lipomatosis, lesions at injection sites, malignant oedema (*Cl. septicum*) blackquarter, gangrenous myositis (*chauvoei*), eosinophilic myositis. nodular necrosis (Roeckl's granuloma) are the conditions to take into account when considering muscles, along with infestations caused by *Sarcosporidium* spp. and cysticercosis (*T. saginata).*

Bones and joints may be affected by necrotic purulent osteomyelitis, mandibular actinomycosis and tuberculous osteomyelitis, and arthritis (important for fitness for human consumption is fibrinous arthritis). Zanthosis, a form of porphyria causing brown discoloration of bone, may also be considered.

1.5.2 Associations between occurrence of diseases: age versus seasonal influence

With the exception of conditions related to the following periods in veal calves production (Opinion of the SCVPH on Veal Calves, May 2003): neonatal period and three periods of the fattening phase ('start-up', 'intermediate', and 'end' periods) diseases show a seasonal influence with an increase of respiratory diseases in autumn/winter. Among these the so-called enzootic **bronchopneumonia** has a higher incidence in winter and is enzootic. Diseases transmitted by insects, such as the Culicoides vector of **blue tongue**, are more frequent in the late spring/early summer period (Castrucci, 1986). Also the **vesicular stomatitis** is an example of seasonal disease: summer/autumn in colder regions, all year long in southern regions (Rosenberger, 1975). Some epidemiological findings seem to be related to taenoisis/cysticercosis also in cattle other than in pigs (Ngowi *et al*., 2004).

Many cases of death within the first day of life are a sequel to obstetric complications and congenital disorders. The diseases and deaths which occur subsequently can mostly be attributed to digestive or infectious problems, especially septicaemia. A contributory factor can be inadequate colostral immunity, improper feeding or housing, or adverse environmental conditions. Neonates that survive acute sepsis often develop localised infections, such as pneumonia, uveitis, synovitis, meningitis, hepatitis and enteritis. These conditions may have the consequence of increasing the age at slaughter. (See also Opinion SCVPH on Veal Calves, 2003).

1.5.3 Zoonotic agents associated with slaughtered beef

Zoonotic agents associated with slaughtered cattle can be transmitted to humans either via ingestion of derived foods (e.g. meatborne infections) or via other routes such as direct contact (e.g. occupational infections).

Microbial human health hazards associated with slaughtered beef cattle comprise zoonotic bacterial fungi and parasites. Among these, of particular interest is *M. bovis*. Tuberculosis can presently be detected at meat inspection by incision and visual inspection of lymph nodes and some organs. Other zoonotic bacteria potentially present in some healthy slaughtered beef cattle include *Listeria monocytogenes*, *Leptospira* spp., *Yersinia enterocolitica*, and *Brucella.* The transmission of zoonotic fungi (ringworm / dermatophytosis) to humans can occur via contact with the skin of affected cattle and they also may have intermediate stages of parasites.

Zoonotic agents potentially causing human infections via foods

Beef cattle can be healthy carriers of, or surface contaminated with, other zoonotic pathogenic bacteria e.g. human pathogenic ETEC, *Campylobacter, Salmonella and L.monocytogenes.* Those pathogens can cross-contaminate meat during slaughter and dressing process, and mostly represent a process hygiene-related problem, which is addressed in other chapters (Hygiene of laughter and dressing). Among them, enterohemorrhagic *Escherichia coli* (EHEC), including E. coli O157:H7 and other verocytotoxic E. coli (VTEC) serotypes producing Stx 1 and/or Stx2, have attracted particular attention with respect to beef safety. The nature of the human illness can range from mild form of diarrhoea to more severe forms known as hemorrhagic colitis (HC), haemolytic ureamic syndrome (HUS) and thrombotic thrombocytopenic purpura (TTP) and the sources of infection include contaminated raw or undercooked meat of food animals or other foods (Bartocci *et al*. 2004).

Bovine tuberculosis detailes on the disease and the etiological agent are reviewed previously (EFSA Opinion on Tuberculosis in Bovine Animals: Risks for human health and control strategies, 2003). Tuberculosis in cattle is caused by *Mycobacterium bovis* and occasionally by other species. These infected cattle may also serve as the source of infection for man. Man usually contacts the infections by eating the *M. bovis* bacteria in raw milk and milk products. Controlling tuberculosis in livestock and milk pasteurization are the most effective way to prevent M. bovis human infections.

Other species of *Mycobacterium* (e.g. *M. avium. M. tuberculosis*) may complicate the diagnosis of tuberculosis in cattle caused by *M. bovis*, but cattle are resistant to these infections and they rarely cause clinical signs of disease. However they can cause the cattle to be sensitive to tuberculin testing and give false positive reactions when tests are being conducted to detect M. *bovis* infections. Bovine tuberculosis is still present in livestock within the EU despite many years of concentrated effort to completely eradicate. These other bacteria are more important as causes of infection in swine, sheep, goats and humans. In summary, bovine tuberculosis is still present in livestock within the EU despite many years of concentrated effort to completely eradicate the disease. In addition, cattle populations are mobile between EU member states and this increases the risk of exposure of naïve cattle populations to this zoonotic disease

Johne's disease (**paratuberculosis**) caused by *Mycobacterium paratuberculosis* (*M. avium* subspecies. paratuberculosis, *M. johnei*) results in enteritis and/or enlargement of mesenteric lymph nodes often with haemorrhages. Diagnosis of paratuberculosis by blood tests

(AGIDT, ELISA, CFT) is possible. Human infection may be acquired primarily *via* contaminated milk, although there is still somecontroversy as to whether an association between Johne's disease (in animals) and Crohn's disease (in humans) really exists.

Brucellosis (*Brucella melitensis*, *B. abortus*) Uterine discharge and milk from infected animals contain the pathogen. Some viable offspring from infected females may be infected but seronegative. Available diagnostic blood tests include ELISA, Rose Bengal Test (RBT) and/or agglutination. Human infection usually occurs via milk, but also via handling of slaughtered infected animals by abattoir workers. Consumption of meat is of little importance as an infection route, as the pathogen in meat does not remain viable for long.

Listeriosis is caused by *Listeria monocytogenes*, usually in the form of meningoencephalitis but can also be associated with placentitis with abortion, whilst septicaemia occurs primarily in calves. The infection often occurs from contaminated feeds, with poor quality (insufficiently acidic) silage playing a major role. Human food borne infections can occur *via* milk and meat, and are normally associated with pregnant/immuno-compromised groups.

Toxoplasmosis (*Toxoplasma gondii*, a protozoan parasite) may also be asymptomatic. The occurrence of meat-borne human infection is unclear .The aborted foetus and placenta contains high numbers of Toxoplasma and should be handled with safety measures.

Cysticercosis/Taenosis/ (*Taenia saginata*, the zoonotic beef tapeworm) (see also Opinion of SCVPH on the control of taeniosis/cysticercosis in man and animals, September 2000) occurs in the EU. Humans serve as the definitive host being infected with the adult tapeworm (taeniosis) while cattle serve as the intermediate host harbouring the cystic larval stage of the parasite (cysticercosis). Humans become infected by ingesting the parasitic larvae, i.e the cysticerci, in raw or undercooked beef. Cattle become infected by ingesting eggs from pasture, *foodstuffs* and/or water contaminated with human faeces.

Zoonotic agents potentially causing human infections via other routes

Q-Fever is a disease caused by a rickettsial microorganism, *Coxiella burnetii*, which may affect bovines in a subclinical form. Human infection usually occurs *via* inhalation of dust contaminated with infectious after birth, urine or faeces.

Ringworm (dermatophytosis, *Microsporum gypseum*) is a skin fungal disease in cattle, predominantly of younger animals. Humans can become infected by direct or indirect contact with spores (either from animal skin or from livestock equipment) which enter the skin through cuts/abrasions.

Rift Valley fever (Virus family Bunyaviridae, genus Phlebovirus) is a disease in Africa, but is not present in the EU. This is a major zoonoses in affected areas, and human infections occur via aerosols when handling tissues, secretions and excretions of acutely infected animals via mosquitoes.

1.5.4 Farm to slaughter phase: public health risks

During transport, animals are exposed to environmental stresses including heat, cold, humidity, noise and motion, and the stress caused by social regrouping. The major risks in cattle transport are falls, carcass bruising, and deterioration of meat quality with high-pH meat. The most important disease associated with the transportation of cattle is shipping fever but it is not a zoonotic disease. However, the stress enhances the susceptibility of animals for infection and disease especially for reared animals than for slaughtered cattle.

Carriage of pathogenic organisms

The preparation of animals for transport and the journey cause stress to the animals. These stresses can cause changes in microbiological conditions in living animal and physiological conditions of muscle. The movement of animals is a factor for the initiation and spread of diseases. Much of the on-farm infections are asymptomatic and are due to transient residence in the gut of organisms such as *Salmonella*, *Campylobacter* or *E. coli*. (Gill, 1991). Stress has a negative effect on the immune system and this increases susceptibility to pathogenic agents. The exposure to carriers and sub-clinical ill animals is one of the sources of infection in a healthy population. The mechanism of spreading micro-organisms by stressed carrier animal is not clear. It is considered that after high physical activity in clinically healthy animals carrying salmonella and other pathogenic microorganisms, the excretion pattern from the intestinal tract may change from intermittent to constant (Lambooij and Mulder, 1996).

The starvation during the period between farm and slaughter can lead to enhance excretion of enteric pathogens by transiently infected animals. This ensures the spread of these organisms both directly and through contamination of the environment. Stress increases peristaltic activity and predisposes latently infected animals to excreting pathogenic organisms. The result of this is contamination of trucks and equipment which favours the spread of organisms among all slaughtered animals. The close mixing of infected with non-infected stock under stressful conditions must be expected to increase the incidence of enteric infection in the pre-slaughter period. In the study of Bach *et al*., 2004 on calves, the susceptibility of infection by *E. coli* and *E. coli* O157:H7 was likely elevated by stresses of weaning, transport and relocation. Lack of preconditioning and long periods of transport increased faecal shedding of *E. coli.*

There is evidence that cattle play a pivotal role in the epidemiology of VTEC. However the direct link between a live cattle source and human infection is not really established. But, if the bovine reservoir is of major importance to the occurrence of VTEC infections in humans, the reduction of the spread of this organism is essential. The control of VTEC in the animal population and food includes the studies of transportation (i.e. the effects of stress during transport on the shedding of VTEC, and the effects of grouping animals in the spread between herds or among animals entering slaughterhouses.) (Reinders *et al*., 2001). In the study of Jordan *et al*.1999 fasting appears to have little impact on the average risk of mean carcass contamination by *E. coli O157*.

In intensively raised cattle the main stress associated with transportation is caused by confinement in the moving vehicle. The distress may be avoided by good management and use of suitably designed and equipped transport vehicles and facilities (Tarrant and T. Grandin, 2000). A recent study by Collis *et al*. (2004, in press) demonstrates the transfer of microbial contaminants onto hides both within and between batches of cattle in the livestock market. So, the mixing of animals from different farms enhances the risk of cross-contamination. At abattoir, the spread of contamination from the hide to the carcass is more extensive than the spread between animals. An indirect transfer of bacterial contamination (animal-environment-animal) is possible at the abattoir and its implication for the epidemiology of foodborne pathogens is important.

1.6. Slaughtering and dressing background information

Process hygiene performance in cattle abattoirs is a reflection of the relationship between the microbial loads brought in/on live animals and the microbial loads present on dressed carcasses (Vivas and Buncic, 2004). The principal sources of microbial contamination of bovine carcasses are the alimentary tract and the hide (Bell 1997, Empey *et al* 1939). Even with good process hygiene, some degree of carcass contamination from these sources during slaughter and dressing is inevitable (Eustace 1981, Kriaa *et al*. 1985, Dixon *et al*. 1991, Gill *et al*. 1996). Carcass contamination from the alimentary tract during evisceration can be prevented or made very infrequent, provided the intestinal tract is not ruptured or punctured (Nottingham *et al*. 1974, Bell 1997) and its ends are sealed by rodding and tying off the oesophagus and bunging the anus/rectum. In contrast, contamination from hides during skinning operations is considered to be the main contributor to the final microbiological load of the carcasses (Biss and Hathaway 1995, Korsak *et al*. 1998, Elder *et al*. 2000, Buncic et al ,2002, Small *et al*. 2004,). In a recent study, marker bacteria were inoculated on hides of cattle during lairaging; an extensive transfer of the hide markers onto the resultant carcasses occurred during dressing operations (Collis *et al*. 2004)

Animal coats/skins can became contaminated on-farm and/or during transport-livestock market-lairage phase (Berends *et al*. 1996, Edwards 1996, Hannan 1996). In the UK, all cattle are assessed for visible cleanliness before slaughter using a 5-point scoring system implemented by the UK Meat Hygiene Service (MHS). The excessively dirty animals (MHS scores 4 and 5) are not accepted for normal slaughter. However, the visual cleanliness and microbial counts of the hide do not necessarily correlate quantitatively, as different kinds of dirt (e.g. mud, faeces and straw) can also differ microbiologically. This is confirmed by recent findings that microbial loads on hides of slaughtered cattle considered as visually clean for slaughter (MHS scores 1 and 2) differed by a factor 166-fold i.e. ranged from 5.2 to 7.4 log CFU/cm^2 (Small *et al*. 2004).

Overall, in addition to *ante*- and *post-mortem* inspection, beef safety assurance and controls at abattoir are based on three main aspects: GHP programme, HACCP-based plan, and SRM controls.

1.6.1 Assuring slaughter/dressing process hygiene through Good Hygienic Practices (GHP) programme

GHP principles related to transport-lairaging phase

Animal transport-unloading-lairaging facilities should be such to enable easy cleaning and sanitation, particularly between loads and batches, so to prevent microbial cross-contamination. Extended duration of lairaging should be avoided, as it can reduce animal cleanliness and increase microbial cross-contamination. During lairaging, stress in animals should be prevented, as it may increase shedding of pathogens and/or diminish meat quality and/or storage life.

GHP principles related to stunning and sticking phase

In case of penetrative stunning methods, the stunning equipment including penetrating bolt is changed or regularly cleaned/sanitised between animals, so as to reduce between-animals microbial cross-contamination. Concerns have been raised with respect to the potential for meat contamination (and between-animals cross contamination) via penetrative captive bolt stunning, either with CNS material emboli or with bacteria, or both (Schmidt *et al* 1999, Buncic et al., 2002, Coore *et al*. 2004). Such a possibility have been addressed by Biohazard Panel's Scientific Opinion (EFSA Opinion of the European Food Safety Authority on BSE risk from dissemination of brain particles in blood and carcass following stunning, 2004). The stun box including its floor and roll-out ramp need to be regularly cleaned/sanitised so as to prevent/reduce microbial cross contamination of hides between animals. During sticking, use of separate (sterilised) knives for cutting of skin and blood vessels reduces risk of meat contamination from the skin (SCVPH Opinion on the sterilisation of knives, 2001).

GHP principles related to skinning phase

It is very important to prevent contact (in-rolling) of hide and meat surface, or meat contamination via dirt flicked/aerosolised from the hide. Contamination of meat surfaces via knife cutting, or hands holding, dirty hide can be prevented/reduced through effective hand washing and knife sterilisation.

GHP principles related to evisceration phase

The highest risks of meat contamination, with digesta containing pathogens, during evisceration are associated with the viscera being punctured or ruptured. The use of appropriate types of knives and sealing the natural openings can prevent/reduce these risks.

GHP principles related to carcass splitting/washing phase

Regular sterilisation of the splitting equipment prevents/reduces between-carcasses cross contamination. Bovine carcasses, in principle, should be washed as little as possible, so as to prevent/reduce airborne cross-contamination carcasses. Any surface contamination should be removed by trimming.

GHP principles related to carcass chilling

Carcasses should be moved into the cold room as soon as possible in order to speed-up surface drying, which inhibits the growth of bacteria, and which is further suppressed by rapid refrigeration to deep-meat temperature of $\leq 7^{o}$C.

1.6.2 Assuring slaughter/dressing process hygiene through Hazard Analysis and Critical Control Points (HACCP) base programmes.

HACCP is the main, widely used and internationally accepted food safety management system. The main goal of applying HACCP-based plans in abattoirs is to use specific and specified measures, in addition to the foundation laid down through the application of general GHP principles, to ensure that the meat will present minimal public health risks.

At each abattoir process step, every hazard and related source(s)/route(s) of its transfer, as well as distribution/redistribution, on/in meat, have to be considered using a risk assessment approach, with specific controls applied at critical control points (CCPs) where serious public health risks exists. In cattle abattoirs in the EU, CCPs relate to reduction of the risk of microbial contamination rather then eliminating microbial hazards, as the use of bactericidal carcass decontamination treatments is not permitted under current EU legislation. Some generic CCPs applicable to all cattle abattoirs include acceptance of animals as being suitable for slaughter, skinning, evisceration, and chilling.

The current EU microbiological criteria, in the context of HACCP, for beef carcasses sampled after dressing but before chilling are shown in Table 1.

Table 1. EU microbiological criteria (Commission Decision 2001/471/EC) for beef carcasses as amended by 2004/379/EC of 26 April 2004.

Daily result (mean log cfu/cm^2)	Acceptable range*	Marginal range*	Unacceptable range*
Total viable count of bacteria (TVC)	<3.5	3.5-5	>5
Enterobacteriaceae count (EC)	<1.5	1.5-2.5	>2.5

* When excision carcass sampling method used

1.6.3 Control of Specified Risk Materials (SRM)

Removal of SRM, i.e. bovine organs/tissues potentially posing high risk of BSE agent, at abattoirs is one of the most important aspects of BSE-related meat safety controls. (Regulation (EC) 999/2001 as amended)

Following removal, SRM should be indelibly stained, marked and disposed of in accordance with the Regulation (EC) N°1774/99, and in particular Article 4(2).

Council Directive 64/433/EEC, as amended, requires that abattoirs and meat processing plants have facilities for disinfecting tools with hot water supplied at not less than 82ºC. The Opinion of the SCVPH on the cleaning and disinfection of knives in the meat and poultry industry (SCVPH, June 2001) recognised that the probability of microbial contamination associated with the continuous use of other tools used in slaughter lines may be considerably higher than from contaminated knives. Although this Opinion considers the possible use of a combination of water at temperatures lower than 82ºC with chemical disinfectants (such as lactic acid or other agents), at present in the UE, abattoirs are only authorised to carry out such disinfection with hot water soley. Batch sanitisation of all knives during breaks and overnight can be adopted as a standard operational practice.

2. MEAT INSPECTION PROCEDURES FOR BEEF

2.1. Cattle at slaughter

2.1.1. Ante-mortem

Ante-mortem inspection of animals at the abattoir is an important part of the health assessment of animals intended to be slaughtered in relation to meat safety. Its traditional goal is to identify (1) animals with a disease or condition that may be transmitted to animals or humans, (2) animals showing clinical signs of systemic disease that may make the meat unfit for human consumption and (3) animals considered fit for slaughter for human consumption. *Ante-mortem* inspection is very important to detect diseases that might not present gross lesions (e.g. listeriosis, heavy metal toxicoses) and to identify suspect animals that might contain residues of veterinary medical products in excess of the levels laid down by the Community legislation or residues of prohibited substances. On the other hand, it also permits the assessment of welfare conditions as well as identifying dirty animals that may present an unacceptable risk of contamination of the meat during slaughter.

Many diseases and pathological conditions that can be detected or suspected in the *ante-mortem* inspection, as well as the condition of dirtiness of animals presented for slaughter, lead to a considerable risk of contamination of the slaughter line, working tools and workers' hands when the animals are being slaughtered and dressed. As a result, this can produce cross contamination of the meat. Since an efficiently performed ante-*mortem* inspection can prevent the slaughter of these animals under the normal conditions of slaughter and require them to be killed separately so as to avoid cross contamination, such inspection is of crucial importance to food safety.

There are several factors that limit the effectiveness of the *ante-mortem* inspection as required at present, such as previous scientific opinions have indicated (Opinion SCVPH on fattening pigs, February 2000). Some of these factors are: the current lack or limited information about the history of the farm of origin of the animals, the facilities in relation to conducting the meat inspection, the time allocated for *ante mortem* inspection in relation to the speed of modern slaughter lines, the tendency, in many cases, for meat inspectors to pay more attention to postmortem inspection, etc. A report on the value of *ante mortem* inspection of pigs by Harbers et al.(1991 and 1992) indicated that the detection rate of abnormality in the *ante mortem* inspection at the abattoir was lower than when it was carried out at the farm of origin of the animals.

Animals that might contain residues of veterinary medical products or prohibited substances may be identified, or considered suspect, at ante-mortem inspection. Published reports or those in preparation and the expressed opinion of experienced meat inspectors indicate that some prohibited growth promoters produce recognizable changes in secondary sexual characteristics, behavioral changes, better conformations in relation with the animal breed, homogeneous conformations in groups of animals of different breeds,

2.1.2. Post-mortem findings in slaughtered cattle

2.1.2.1. Mandatory requirements

The table below summarises the current meat inspection requirements in bovine animal over six weeks old as laid down in Council Directive 64/433 /EEC as amended and updated and Regulation (EC) N°854/2004, and presents the revised meat inspection.

Table 2: Mandatory meat inspection measures in bovine animals over six weeks old under Council Directive 64/433/EEC as amended and updated and under Regulation (EC) N°854/2004.

Parts to be inspected	Observation	Palpation	Incision	Remarks	Under revised rules
Skin and carcass surface	+		(▲)		visual
Head and throat	+				visual
Submaxillary lymph nodes	+		+		
Retro-pharyngeal lymph nodes	+		+		Multiple incisions
Parotid lymph nodes	+		+		
External and internal masseters	+		+		Continue to incise until alternative available e.g. antigen test validated
Mouth and fauces	+				Visual
Tongue	+	+		Tongue must be freed	Visual
Tonsils	+			Tonsils must be removed	
Lungs	+	+	+	Lungs must be incised in their posterior third, perpendicular to their main axes. Incisions not needed if lungs are excluded from human consumption	Visual
Oesophagus	+	+			Visual
Bronchial lymph nodes	+		+		Incise
Mediastinal lymph nodes	+		+		Incise
Trachea and main branches of bronchi	+		+	Open lengthwise. Incisions not needed if lungs are excluded from human consumption	

Parts to be inspected	Observation	Palpation	Incision	Remarks	Under revised rules
Pericardium and heart	+		+	Heart incised lengthwise to open ventricles and cut through interventricular septum	Continue to incise until alternative available e.g. antigen test validated
Diaphragm	+				Visual
Liver	+	+	+	Incision of gastric surface of the liver and at base of caudate lobe to examine bile ducts*	Visual
Bile ducts	+		+		Visual
Hepatic lymph nodes	+	+			Visual
Pancreatic lymph nodes	+	+			Visual
Gastro-intestinal tract and mesentery	+				Visual
Gastric and mesenteric lymph nodes	+	+	(▲)		Visual
Spleen	+	(▲)			Visual
Kidney	+		(▲)		Visual
Renal lymph nodes	+		(▲)		Visual
Pleura	+				Visual
Peritoneum	+				Visual
Genital organs	+			Palpation of uterus if necessary.	Visual
Udder and its lymph nodes	+	(▲)	(▲)	In cows, each half of the udder must be opened by a long, deep incision as far as the lactiferous sinuses and the lymph nodes of the udder must be incised, except when the udder is excluded from human consumption	Visual
Blood	+				Visual
Muscles	+		(▲)		Visual
Connective and fatty tissue	+				Visual
Bones	+			e.g. spine, sternum. Splitting of carcasses when older than 6 months.	Visual

(▲) on a case by case basis if considered necessary.

2.1.2.2. Post-mortem findings in slaughtered cattle

The following *Tables 3, 4, 5 and 6* collate the diseases that can be diagnosed on *post-mortem* inspection of beef. Not all the diseases mentioned in the Tables are important for meat safety. Indeed, a number of them are not of public health significance but can be important for animal health surveillance or for meat acceptability. The working party took into consideration rejection data from a number of countries. The main pathologies observed are pneumonia-pleurisy, liver distomiasis/fascioliasis, *Dicrocelium dentriticum*, hepatic abscesses, arthritis and icterus and in decreasing order of frequency according to available data, fibrinous pleurisy, fibrinous arthritis and the following diseases:

Kidney: nephritis, pyelonephritis, hydronephrosis, petechiae

Lungs: inflammation of the lungs and pleura, mainly in a chronic form; tuberculosis and cysts of *E. granulosus* (cystic echinococcosis)

Heart: pericarditis fibrinosa, *T. saginata* cysticercosis

Liver: abscesses, fatty change, hepatic distomiasis/fascioliasis, *Dicrocoelium dendriticum*, cholangiohepatitis, cystic echinococcosis

Bowel: enteritis

Spleen: hypertrophy (splenomegalia)

Heads: abscesses, cysticercosis, tuberculosis lesions in lymph nodes

Tongue and pharynx: injuries; cysticercosis (not frequent)

Carcass: arthritis, icterus, fever (septicemia), emaciation and/or muscular oedema, icterus, chronic arthritis (non-septic and septic), transport injuries, colour anomalies; tuberculosis lesions in lymph nodes, cysticercosis

Lymph nodes: tuberculosis in retro-pharyngeal, bronchial, mediastinal, hepatic, pancreatic, gastric and mesenteric lymph nodes

Pathological conditions of the lymph nodes (inflammatory, degenerative, hyperplasia) are not always of public health significance but changes in the lymph nodes are useful indicators of the presence of disease. The number of nodes undergoing pathological changes is a reliable indicator of the extent of a disease. It has to be remembered, however, that in rapidly growing young animals lymph nodes are rather prominent and contain more fluid compared with old animals. The finding of a pathological condition in some lymph nodes, therefore, assists in establishing if the process is acute or chronic and if there has been spread to involve the entire carcass. The pathological change seen with generalised lymphadenitis could be related to septicaemia if acute and to toxic pathologies if chronic. Both cases imply a serious risk for public health.

Abscesses can be suspected from visual examination and further detailed inspection must be carried out off the slaughter line. Abscesses can be of a primary or secondary nature, the latter being crucial when deciding upon the final use of the carcass, depending on their number and type (small and widely spread) and the organs affected (lungs, liver, etc.).

Abscesses can be found sometimes in the mouth of beef cattle due to wounds deriving from the roughage used for feeding.

Actinobacillosis is normally confined to the head (tongue, mouth, masseters muscles, and lymph nodes) but has to be evaluated for the possible diffusion of granulomata/abscesses in other areas, such as lungs with bronchopneumonia. Similar attention has to be given to necrobacillosis. Visual inspection will alert the inspector and lead to detailed palpation and incision, if required.

Pathological conditions of the tongue and mouth, such as vesicles and ulcers, can be related to specific diseases such as malignant catarrhal fever, foot and mouth disease, etc. but although these specific diseases are not frequently detected in the abattoir, the meat inspector has an important role in the detection of these diseases; this was clearly demonstrated during the last food and mouth disease epidemic. A detailed inspection of tongue, mouth and fauces may permit the detection of important epizootics. It also permits the detection of parasitic cysts (*Taenia saginata* cysticercosis).

Inspection of the internal and external masseter muscles may disclose *Taenia saginata* cysticercosis cysts. Two incisions in the external masseters and one in the internal ones are set down by the present legislation (Directive 64/433/EEC) and the new regulations (Regulation (EC) N°854/2004). The incisions augment the probability of cyst detection.

The present rules and the new regulations set down that incisions must be carried out in the head lymph nodes (retropharyngiales, mandibulares and parotidei) to search for tuberculosis lesions. The combined incision and visual inspection of retropharyngeal lymph nodes is of particular importance because these procedures together result in the relatively frequent disclosure of tuberculous lesions in these locations.

The lung lesions most frequently observed are of an inflammatory nature, and normally have no public health implications for the carcass. Other conditions (e.g., regurgitation, melanosis, emphysema, etc.) are of interest in regard to the acceptability of lungs for human consumption but are not a cause for public health concern. On the other hand, important infectious diseases of animals such as bovine contagious pleuropneumonia are occasionally detected. They are usually detectable by visual inspection.

In bovine animals over 6 weeks' old visual examination and palpation of the lung and examination and incision of the bronchial and mediastinal lymph nodes must be carried out. These visual examinations, palpations and incisions of the lungs and lymph nodes permit detection of tuberculosis lesions. The visual examination and the palpation can raise suspicion about tuberculosis lesions but incision is necessary for its diagnosis.

Routine incision is required for the heart, with prior opening of the pericardium, to diagnose inflammatory, infectious and parasitic conditions. Findings that suggest septicaemia need to be followed by a detailed general inspection of the carcass (lungs, joints, liver, etc.). Traumatic pericarditis may be the cause of toxaemia condition and it is detectable by visual inspection

Visual examination is sufficient for condemning the liver on acceptability grounds such as for discolorations, congenital cysts, hyperplasia, degenerations and intoxications, with palpation being of assistance sometimes. Liver pathological conditions more frequently observed vary in regard to the animal´s age, the production system (animals reared in fattening units vs. animals reared at pasture), the feed regime (in a cereal base or fed with silage, etc.). Many conditions are linked with feeding practices (fatty change from glycogen storage, intoxications). Abscesses most commonly of a digestive nature are associated with metabolic acidosis when the animals are fed with a diet rich in concentrates. Abscesses have to be dealt with as already mentioned above. Incision is not recommended unless in case of doubts and under strict hygienic rules. Congenital melanosis has been occasionally reported, but has no public health significance.

Echinococcosis may be detected in liver and lungs but is not commonly reported and it is usually detected by observation. Palpation and incision may help in some cases. The finding of cysts of this parasite in these locations has no public health significance provided such affected materials undergo proper disposal.

Distomatosis/ fascioliasis and dicroceliosis are present in beef liver and they are frequently detected in liver inspection but they are not of public health concern. However, the importance of their detection is derived more from a quality or aesthetic point of view than in relation to public health. Although the most serious cases may be accompanied by cholangitis, detectable by visual inspection, in the other cases incision of bile ducts is necessary for its detection. Incision of the gastric surface of the liver and at the base of the caudate lobe to examine the bile ducts is compulsory.

Conditions of the gastro-intestinal tract which are of relevance to meat safety (enteritis, peritonitis) can be suspected from visual examination. The acute processes usually are linked to important signs that can be detected in *ante-mortem* inspection. This permits the killing of the animal separately so as to avoid the contamination of facilities, tools and the cross contamination of other carcasses. Incision can be left to the inspector on a case by case basis. The decision on the destination of such carcasses depends on the inspection of the entire carcass and organs; in such a case some incisions might be required and in certain cases may need to be supported by bacterial examination of the flesh and main viscera (liver, spleen and kidneys) as well as by determination of the presence or otherwise of veterinary medical residues.

Important pathologies of the spleen (e.g. abscesses, lymphomas, splenomegaly) can be suspected, and in some cases diagnosed, by visual examination and require to be evaluated in the context of the overall condition of the entire carcass.

Kidney pathologies, such as hydronephrosis, cysts, haemorrhages, infarcts, necrosis, nephritis, etc. are detectable by observation, provided that fat covering and kidney capsule are removed. Incision can be useful for the final decision of meat destined for aesthetic conditions or to animal health (petechial haemorrhages from infectious diseases). Unless the fat and kidney capsule are removed, the presence and extent of lesions in the kidney would not be identified.

In younger animals, a non purulent focal interstitial nephritis, very evident in many cases (white spot kidney) is relatively frequently detected. Although some cases may be associated with bacteria (E. coli, Salmonella, etc.) and viruses, the majority of the cases are not associated with any specific agent. In general, this leads to condemnation of the affected kidney.

Important findings that may suggest septicaemia (e.g. petechial haemorrhages) are detected in the kidney. In such cases a detailed general inspection of the carcass is indicated before deciding on the final destination of the carcass and offal.

Inspection of the umbilical region has to be carried out by visual inspection first and related to possible systemic involvement such as multiple metastasised abscesses, to the liver in particular, peritonitis and septic arthritis. Incision can be performed only on a case by case basis.

Pathology of the joints are relatively frequent in beef and require, therefore, a routine visual inspection followed by incision, in case of need, to ascertain possible septic conditions leading to involvement of the carcass as a whole. The exclusion of such animals from slaughter based upon careful ante-mortem examination is preferable, due to the possible contamination of slaughter equipment if metacarpal and metatarsal joints are cut during carcass dressing and before *post-mortem* inspection. Visual examination and palpation of the live animal *ante-mortem* would provide an indication as to the distinction between rickets and arthritis, whereas a detailed examination of the carcass and offal is still needed for a final diagnosis.

General systemic pathological conditions, such as emaciation, oedema, colour changes, tumours, haemorrhages, bruises, myositis, etc. can be readily diagnosed by observation. Such conditions can lead to total condemnation of the carcass, not only for public health but also for acceptability reasons, and might require, on a case by case basis, the incision of various parts of the carcass. Such conditions, though, require a thorough examination of the carcass and of the viscera to ascertain/exclude public or animal health related pathologies. Any abnormal muscle colour may indicate physiological conditions that, in addition to welfare implications, must be differentiated from changes of colour due to a systemic generalized inflammatory condition. Furthermore, some of these abnormalities (namely muscular haemorrhages, oedema, white, green or dark coloration) in association with some characteristics detected during the *ante-mortem* inspection (e.g. very good conformation, behavioral changes, traumatic disorders, hemorrhagic diarrhoeas, etc.) may permit the detection of suspect animals that are treated with forbidden substances (growth promoters).

Tumours and malformations may occur in any organ. Bovine leucosis (lymphosarcoma) may be detected with white tumour masses in any part of the animal body and marked enlargement of several superficial lymph nodes. In such cases a distinction requires to be made in older cattle between s poradic lymphosarcoma and the notifiable form, namely enzootic bovine leucosis. Neither of these conditions has any public health significance, however.

Bacterial contamination of the carcass and offal can be considered the primary reason for public health concern. Any case of contamination of carcass or edible organs by faecal material, ingesta or bile must require the total or partial condemnation of involved parts. Tying of the oesophagus and rectum reduces such a risk. In addition, heads that have not yet been skinned require to be treated with care, as trauma and contamination of the tongue cannot be readily detected and, even with processing of the head in hot water, the subsequent manipulation carries significant risk of microbial contamination. In Table 3 the possible findings on meat inspection have been considered excluding ante-mortem findings.

Table 3: Possible findings on *post-mortem* meat inspection of the carcass of cattle *

Parts to be inspected	Diseases/conditions detectable	Detectable by observation	Detectable by palpation	Detectable by incision
Miscellaneous				
General systemic findings	(a) Emaciation, (b) oedema, (c) fever, (d) septicaemia, (e) contamination, (f) odours, (g) colour changes, (h) injection sites (i) jaundice; (j) haemorrhages, (k) abscesses, (l) malformations	a,b,c,d,e,f,g,h ,i,j,k,l,	h ,l	b,h,l
Skin and carcass surface	(a) Skin wounds- fresh or chronic	a		
Blood	(a) clotting ability, (b) discolouration	a,b		
Muscles	(a) abscesses, (b) oedema/inflammation, (c) muscle dystrophy (d) cysticercosis	a,b, c, d	a,b	a, c,d
Bones	(a) Fractures are frequent (b) changes colour	a, b		b
Connective and fatty tissue	(a) oedema/inflammation, (b) hypodermosis	a, b	a, b	a, b
Joints	(a) Arthritis (local, chronic, generalised, septic), (b) joint ill, (c) rickets	a, b, c	a ,b	
Umbilical region	(a) Abscesses	a	a	a
Genital organs	(a) Brucellosis	a		a

(*): tumours and malformation may occur in any organ

Table 4: Possible findings on *post-mortem* meat inspection of cattle (head and throat)

Parts to be inspected	Diseases/conditions detectable	Detectable by observation	Detectable by palpation	Detectable by incision
Head and throat	(a) ringworm, (b) papillomas (c) secondary infection of any skin wounds, (d) Bovine Viral Disease, (e) Malignant Catarrhal Fever, (f) inflammation (g) abscesses	a, b, c, d, e, f, g		
Submaxillary lymph nodes	(a) tuberculosis, (b) abscess, (c) lymphadenitis, (d) generalised leucosis/lymphoma	c, d		a, b
Retro-pharyngeal lymph nodes	(a) tuberculosis, (b) abscess, (c) lymphadenitis, (d) generalised leucosis/lymphoma	c, d		a, b
Parotid lymph nodes	(a) tuberculosis, (b) abscess, (c) lymphadenitis, (d) generalised leucosis/lymphoma	c, d		a, b
External and internal masseters	(a) parasites (cysticercosis)	a		a
Mouth and fauces	(a) Bovine Viral Diarrhoea, (b) Malignant Catarrhal Fever, (c) foot and mouth disease	a, b, c		
Tongue	(a) Actinobacillosis, (b) Necrobacillosis (Fusobacterium with associated pulmonary lesions), (c) parasites (cysticercosis)	a, b	a, b	c

Table 5: Possible findings on *post-mortem* meat inspection of cattle (thorax)

Parts to be inspected	Diseases/conditions detectable	Detectable by observation	Detectable by palpation	Detectable by incision
Thorax				
Lungs	(a) Inflammation, Pneumonia, pleuropneumonia (b) abscesses, (c) infiltration, melanosis, (d) parasitic eosinophilos*is (e)* complications from necrobacilosis of tongue, (f) emphysema , (g) bleeding problems, regurgitation, (h) tuberculosis, (i) parasites, (cystic echinococcosis/hydatidosis)	a, b, c, d, f, h, i	b, f, h, i	b, d, e, g, h, i
Oesophagus	(a) Cysticercosis, (b) Bovine Viral Diarrhoea, (c) Malignant Catarrhal Fever, (d) inflammation, (e) sarcocystosis	a, b, c, d, e		a
Bronchial lymph nodes	(a) Reaction in case of pulmonary lesion , (b) lymphoma, (c) tuberculosis	a, b		c
Mediastinal lymph nodes	(a) Reaction in case of pulmonary lesion , (b) lymphoma, (c) tuberculosis	a, b		c
Trachea and main branches of bronchi	(a) Mucus, oedema and inflammation linked to lungs (b) Blood aspirated at bleeding, regurgitated from stomach, when animal suspended can leak from oesophagus	a		a, b
Pericardium and heart	(a) inflammatory lesions in pericardium, (b) inflammatory lesions in myocardium, endocardium, (c) cysticercosis, (d) sarcocystosis	a, c, d		b, c
Pleura	(a) Pleurisy	a		
Diaphragm	(a) cysticercosis	a		a

Table 6: Possible findings on *post-mortem* meat inspection of cattle (abdomen)

Parts to be inspected	Diseases/conditions detectable	Detectable by observation	Detectable by palpation	Detectable by incision
Abdomen				
Liver	(a) Abscess, (b) cirrhosis, (c) parasites (cystic echinococcosis/hydatidosis, fasciolosis), (d) discoloration (e.g. jaundice, congestion, degeneration), (e) changes in consistency of parenchyma, (f) omphalophlebitis, (g) portal vein phlebitis, (h) infections and toxico-infections, (i) military necrosis, (j) lymphoma, (k) tuberculosis	a,b,c,d, h, i, j, k	a,b,e,	a ,b ,c, f, g, i, j, k
Hepatic lymph nodes	(a) reaction in case of liver lesion (b) lymphoma, (c) tuberculosis	a, b		c
Pancreatic lymph nodes	(a) reaction in case of liver lesion (b) lymphoma, (c) tuberculosis	A, b		c
Gastro-intestinal tract and mesentery	(a) Inflammation/ enteritis , congestion, peritonitis, (b) perforated abomasal ulcers, (c) toxico infections, spread od pathogens viathe bloodstream, (d) hairballs (f) tuberculosis	A, b, c, f	d	B, f
Gastric and mesenteric lymph nodes	(a) Hypertrophy, inflammation, congestion, (b) Lymphoma, (c) tuberculosis	A,b	A,b	C
Spleen	(a) Splenomegaly, (b) leucosis/lymphoma, (c)reaction to infection/septicaemia, (d) abscess	A, b, c, d	A, d	A, b, c, d
Urinary system	(a) Hydronephrosis, (b) nephritis (may originate from omphalophlebitis), (c) pyelonephritis, (d) cystitis, (e) urolithiasis, (f)congenital cysts, (h) petechiae	a, d, f, g, h	A, g	a,b,c,d, h,
Renal lymph nodes	(a) inflammation	A		
Peritoneum	(a) inflammation / peritonitis, (b) septicaemia, (c) *tuberculosis*	a, b, c		

Consideration of the above tables indicates that in many cases the evidence of lesions and disease is available from visual inspection. The evidence that is only available from palpation and from incision must be considered in order to ensure that any omission of palpation and incision will not have an impact on public health. This follows in Section 4.3.

In addition transparency, traceability, monitoring and surveillance are the basis of such an integrated inspection. The industry is fully responsible for any defects of its products and a number of the actions shown in the tables are in fact more relevant to quality matters than animal or public health considerations. There is always a balance between meat inspection, animal health, public health and industry. However duly validated quality labels, certification and HACCP all contribute to the hygiene of production.

2.2. *Post mortem* findings at meat inspection

2.2.1. Identification of possible hazards to public health

Potentially pathogenic contaminants and diseases can be transmitted to humans via foodstuffs, but also by direct or indirect contact with living animals, skins and carcasses in the abattoir. Contamination of professionals working in the slaughterhouse or in processing and handling of meat and other products is another possible hazard to public health.

European countries are free of some infectious diseases that pose significant risk in other parts of the world. Greater open market access and possible introduction of exotic diseases highlight the need to maintain surveillance and vigilance for all zoonotic diseases and agents.

However some reports indicate than in some regions and/or farms of European countries some of these infectious and parasitic diseases (such as tuberculosis, *Taenia saginata* etc.) are already present.

Priority of the inspection process should be given to ensuring consumer and public health protection. Beef health and product integrity also deserve consideration: exclusion of sick animals, of some types of lesions and of surfaces with faecal contamination contribute to reducing the risk for the consumer. However, the risk reduction is linked to the frequency of these diseases and lesions. Faecal contamination can be reduced by control of the slaughter process. The risk is also reduced by cooking and by other thermal or other preventive or corrective treatments of beef products. Such treatments do not reduce the risk due to re-contamination. Risk reduction cannot be achieved in the case of thermo-resistant contaminants, especially bacterial spores, or chemical contaminants.

An essential component of any future meat hygiene approach to avoid the introduction of significant levels of microbiological pathogens on to any carcass, and to prevent them from growing, is by the implementation of a

Hazard Analysis and Critical Control Point (HACCP) –based approach. The European Commission's Decision 2001/471/EC requires the implementation of HACCP principles in fresh meat and poultry meat slaughterhouses and cutting plants and introduces standard procedures for carrying out microbiological checks. Verification is a 'safety net' to establish whether the HACCP-based plan is appropriate for the actual operation of the abattoir in question and should show whether or not the monitoring and corrective actions are being properly applied. A good example of verification is the regular testing of carcasses for the presence of microbial contamination. Validated HACCP plans that prevent contamination entering the system therefore provide the best assurance for food safety.

2.2.2. To what extent do current inspection procedures provide safeguards?

Sick animals should not be presented for normal slaughter, but should be detected on-farm or at ante-mortem inspection at abattoir. However, some infected animals can be asymptomatic. Traditional post-mortem meat inspection was designed primarily to detect organoleptically conditions/lesions associated with zoonotic diseases. However, some conditions/lesions can be too small or too indistinct to be detectable by visual inspection, palpation and incision. In such situations, the zoonotic character of the conditions/lesions may be undiagnosed or misdiagnosed, particularly in the absence of recognised on-farm outbreaks or of laboratory investigations which complement routine inspection. There are reports that the *post-mortem* inspection of clinically apparently healthy animals detects only 20% of all the macroscopic lesions that are actually present in 1% or less of animals slaughtered (Harbers 1991; Berends *et al*., 1993). Furthermore, the majority of gross abnormalities detected by the organoleptic examination are of animal health relevance importance and do not pose a serious threat to public health (Hathaway and McKenzie, 1989; Berends *et al*., 1993). Therefore, it has been generally recognised that the actual effectiveness of the routine organoleptic *post-mortem* examination in detecting conditions/lesions of public health relevance is limited (Blackmore, 1983; Hathaway *et al*., 1987; Hathaway and McKenzie, 1989; (Opinion SCVPH on fattening pigs, February 2000).

Another *post-mortem* inspection-related concern is the fact that, in modern times, the main meat-related public health risks relate to foodborne pathogens, such as *Escherichia coli* O157, *Salmonella*, *Campylobacter*, that can be shed by healthy animals and contaminate related carcasses/meat, but which are not detectable by traditional, organoleptic meat inspection (Moo et al., 1980; Berends et al., 1993; Edwards et al., 1997, Sorensen and Petersen, 1999). It is likely that the incidence of meat contamination with such non-detectable pathogens is much higher than the reported incidence of conditions/lesions with zoonotic potential identified at slaughter. Therefore, the absence of evidence of disease and of macroscopic lesions at traditional *post-mortem* inspection does not allow a conclusion as to the absence or otherwise of microbial hazards on the associated meat and edible organs/tissues.

A serious additional concern is that the traditional meat inspection procedures themselves, i.e. palpation and incision of organs and lymph nodes, actually can mediate microbial cross contamination between different tissues/organs of the same animal, as well as between different slaughtered animals, resulting in increased public health risks (Samuel et al., 1979; Moo et al., 1980; Blackmore, 1983; McMahon et al., 1987; Sorensen and Petersen, 1999; Opinion SCVPH on fattening pigs, February 2000, Opinion SCVPH on Veal Calves, May 2003). Obviously, from that perspective, palpation and/or incision are undesirable and their omission would be beneficial for public health, as long as such omission did not result in an unacceptable increase in un-detected conditions/lesions of zoonotic potential. So, any discussion on the efficiency of beef inspection, with or without (undesirable) palpation and incision, has to include a “what if omitted” element, i.e. balancing positive and negative effects on the prevention of frequent-but-non-detectable hazards and on infrequent-but-potentially-detectable zoonotic diseases respectively.

In conclusion, traditional meat inspection does not prevent, or eliminate, all the public health hazards associated with meat, although it significantly contributes to the control of some important hazards. Therefore, the inspection procedure needs to be improved either through omitting palpation/incision or including appropriate alternative methods, or both, so as to enable: a) reduction of risks of meat inspection-mediated cross-contamination with non-detectable hazards; b) reduction of risks associated with low efficacy in detecting some zoonotic conditions/lesions (e.g. cysticercosis); and c) reduction of risks through better separation of suspect (higher-risk) and non-suspect (lower-risk) animals before slaughter, based on additional pre-slaughter information (chain information, pre-slaughter testing, etc).

2.2.3. Assessment of the risk to public health if current procedures are omitted

Due to limited availability of relevant data, it was not always possible to quantify and categorise the risk to the consumer if current procedures are omitted. The main criticisms of traditional meat inspection, with its palpation and incision of organs and lymph nodes, are:-

(a) that it is of doubtful sensitivity; and

(b) The very nature of the procedures, eg. the incision of lymph nodes (especially the mesenteric lymph nodes), can result in the carcass, offal and abattoir becoming contaminated with bacterial pathogens such as *Salmonella* or *M. bovis*. (Berends *et al*, 1993)

(c) Regarding *M. bovis* lesions in cattle, incision of the lungs and certain lymph nodes can enable identification of up to 95% of cattle with macroscopic tuberculous lesions. In most developed countries; however, tuberculosis is a rare cause of lymph node lesions in slaughter animals. Studies have shown that the sensitivity and specificity of visual inspection and palpation did not differ significantly from the results of visual inspection, palpation and incision (Hathaway *et al*., 1998) When palpations and incisions are not compulsory, meat inspection is dependant on the performance of the visual detection. If current procedures of palpations and incisions are omitted, risks from viruses and chemical contaminants will not be altered. But bacterial-cross contamination of tissues will be reduced. Such contamination could be especially frequent and high after the removal of tonsils, the incision of lymph nodes draining the respiratory or gastrointestinal tract and the incision of abscesses not already aseptically removed from the normal tissue.

Basic epidemiological considerations indicate the efficiency of palpations and incisions is very limited when the annual frequency of detected cases in a slaughterhouse has become null or very low (see above). The efficiency is increased by a *post mortem* inspection related to information on both the origin and the sanitary status of animals. Full recording systems that may provide for the flow of data both to and from the abattoir must be implemented. This is for both public and animal health reasons.

Palpation and incisions are options to carry out inspection and must remain among the procedures of inspection of beef: they should be used by inspectors in any suspect or new context.

3. ALTERNATIVE METHODS TO CURRENT MEAT INSPECTION MEASURES

3.1 Acute phase proteins

The alternative methods may include development of rapid on-farm and/or on-abattoir tests that could provide information about the health status of the slaughter animals. Ideally, such information would enable differentiation of suspect and non-suspect animals and their *post-mortem* inspection using a visual only i.e. “hands-off” technique (Saini and Webert, 1991; Horadagoda et al, 1993; Saini *et al*., 1998, Horadagoda et al, 1999). Numerous studies indicated a possibility to identify animals with inflammatory, infectious and/or traumatic conditions via measuring the levels of so-called acute phase proteins e.g. haptoglobin and serum amyloid-A in plasma (Eckersall and Conner, 1988, Saini and Webert, 1991; Horadagoda et al, 1993; Horadagoda et al.,1999; Kent, 1992; Alsemgeest et *al.*, 1994). For these reasons, relatively more detailed information on acute phase protein is given in this document. A summary of the nature and types of acute phase responses/proteins is shown in Table 7.

Table 7. Role and types of acute phase responses and proteins (Horadagoda et al, 1999)

Main characteristics of the systematic acute phase response	
Neuroendocrinological changes	Fever, somnolence and anorexia, pain, increased secretion of corticotropin-releasing hormone, corticotropin and cortisol, increased secretion of adrenal catecholamines, glucagon and insulin
Metabolic changes	Increased protein catabolism, decreased glouconeogenesis, hepatic acute phase proteins production
Haematological changes:	Leucocytosis, thrombocytosis, hypozincemia, hypoferremia and hypercupremia
Immunological changes:	Lymphocyte hyporeactivity, decreased macrophage phagocytical activity
Degree of response and related acute phase proteins	
Major:	Serum amyloid A, haptoglobin
Moderate:	A1-acid glycoprotein, a1-antitrypsin
Minor:	Ceruloplasmin, fibrinogen, a1-macroglobulin

3.1.1 Acute phase proteins in healthy cattle

Measurements of haptoglobin and serum amyloid-A in plasma appear as the most promising in the context of meat inspection. Presently, there are no generally accepted standards for haptoglobin levels in healthy cattle (Conner *et al.*, 1988; Young *et al.*, 1995; Saini *et al*, 1998). Published studies reported average haptoglobin values in healthy cattle of around zero (Skinner *et al.* 1991; Alsemgeest *et al* 1993; Alsemgeest *et al.*, 1994; Salonen *et al.*, 1996; Horadagoda *et al.*, 1999) or up to 0.1 mg/ml (Young *et al*, 1995; Saini *et al*, 1998; Horadogada et al.,1999).

With respect to serum amyloid-A (SAA), the values found in healthy cattle were 0-9 µg/ml (Eckersall, personal communication), 42.4 µg/ml (Alsemgeest et al., 1993), 22 µg/ml (Alsemgeest *et al.*, 1994), 25 µg/ml (Ganheim *et al.*, 2003), <17 µg/ml (Heegaard *et al.*, 2000) and 50.72 µg/ml (Horadogada et al.,1999). It seems that, similarly to the situation with haptoglobin, mean SAA levels in healthy cows can be significantly higher that that in healthy beef cattle (Horadogada et al.,1999), probably due to older animals potentially having a higher degree of subclinical pathological conditions (Saini *et al*., 1998).

Obviously, the reference levels of acute phase proteins for different categories of healthy cattle are not well established yet, and further research on that problem is required.

3.1.2 Acute phase proteins in cattle with pathological conditions

Published data indicate that, on average, levels of both haptoglobin and SAA are significantly higher in cattle with pathological conditions (detected *ante mortem* and/or *post mortem*) than in healthy animals (Alsemgeest *et al*., 1993; Alsemgeest *et al*., 1994; Hirvonen *et al*. 1997; Saini *et al*., 1998; Horadogada *et al*.,1999).

In addition, literature data indicate that haptoglobin and/or SAA levels can differ within category of cattle with pathological conditions, e.g. between animals with acute and with chronic infections (Alsemgeest *et al*., 1994; Saini *et al*., 1998; Horadagoda *et al*. 1999).

3.1.3 Acute phase proteins and traditional meat inspection

Overall, the consideration of the published studies indicates that the acute phase protein analysis could be an additional and useful tool to be used in a modernised meat inspection system (Eckersal 2004, Murata 2004, Horadagoda *et al*., 1999). Nevertheless, it should be kept in mind that one of the most important characteristics of acute phase proteins is their non-specific nature (Saini and Webert, 1991), so their levels can be linked only to a general severity, but not to specific form, of pathological conditions. So, no direct, specific, numerical acute phase protein-based parameters enabling diagnosis of specific pathological condition/lesions have been established yet. Therefore, the reported trends of “the higher acute proteins, the more pathology” apply primarily at animal group level, whilst the reliability of such detection of pathological conditions at individual animal level appears unclear and probably insufficient at present. Published studies also indicated that acute phase proteins methods need to be further developed and optimised before these methods could be routinely used in meat inspection, particularly with respect to more precise healthy-unhealthy threshold values, to improved method standardisation and rapidity, and to obtaining commercially available kits (Eckersall 2004)

Nevertheless, given that the indicated improvements are achievable, using acute phase proteins for differentiation of “suspect” and “non-suspect” animals before *post-mortem* inspection appears promising. In such a case, the former group could be slaughtered separately and subject it to a detailed *post mortem* examination, including additional tests if necessary. The latter group could undergo a simplified *post mortem* examination. If fully developed and implemented, such a system could enable a simplified (e.g. more "hands-off") *post mortem* inspection in the case of carcasses of non-suspect animals.

Overall, it appears that the acute phase protein analysis cannot be used as a sole tool to fully replace the traditional meat inspection procedures at this stage. However, this method has potential – particularly if used in association with other tools of a modernised meat inspection system within an integrated meat chain. Meanwhile, further research in the area is to be encouraged.

3.2 Instrumental methods to detect abnormal appearance of meat

A number of instrumental techniques (computerised image analysis; machine vision) have been used to differentiate normal and abnormal appearance of carcasses/organs in post-mortem inspection of poultry (Watkins et al., 2000; Chao *et al*., 2002; Hsieh *et al*., 2002; Park and Chen, 2000; Van Hoof and Ectors, 2002). In pigs, instrumental/ automated methods have been used primarily for assessment of some meat quality-related parameters (e.g. fatty tissue, meat colour), rather than for inspection purposes. We are unaware of published data on application of instrumental, machine vision methods for *post-mortem* meat inspection of bovines.

3.3 Methods to detect general microbial contamination

Rapid detection of microbial contamination would increase the overall public health effectiveness of the inspection system. For that, different approaches could be used.

Firstly, rapid methods could be used to directly detect foodborne pathogens. However, direct detection of pathogens on meat by on-line (i.e. non-laboratory) techniques is not available for routine use at present; also there are problems relating to the non-uniform distribution of pathogens on carcasses.

Secondly, determination of so-called indicator organisms (e.g. *Enterobacteriaceae* count) could be used. The acknowledged shortcomings of this approach include the fact that a quantitative correlation between the indicator organisms and the pathogens has not been proven, and the time required for the conduct of standardised bacteriological methods.

Thirdly, non-microbiological (instrumental) methods that detect organic (i.e. faecal) material and/or specific compounds related to microorgnisms could be used. The principles of the methods from this group are described in documents relating to an ongoing research project in the UK (Avery *et al*. 2002a,b), from which an extract is presented below.

3.3.1 Direct detection of organic (faecal) material contaminationon meat

The VerifEYE chlorophyll detector detects emissions by chlorophyll *a* and its breakdown products at 675 nm when excited by 420 nm. Such emissions are characteristic of green plant tissues and also the faeces of herbivores that have consumed green plants. This technology has been introduced into some meat plants in the USA where its use is to detect faecal contamination of carcase, thus enabling effective trimming and verification of hygienic dressing procedures (http://www.verifeye.net).

3.3.2 Detection of chemical compounds related to microorganisms

Using a biochemistry-based approach, non-microbial (usually termed somatic) ATP is selectively pre-extracted from the meat sample and hydrolysed. Although, in past, initial extraction procedures took hours to perform, a recent innovation allows microbial ATP levels to be determined in meats using a 90 second extraction technique with hygiene status results being generated within 5 minutes (rapid-mATP assay). Microbial ATP levels measured with the rapid-mATP assay from beef or skinned pork carcass surfaces can be closely correlated with directly measured TVCs (total viable counts).

A microbial phosphatase assay, based on the *Limulus* amoebocyte lysate test, but adapted for a rapid colour reaction, is available commercially (Charm Sciences Inc.). Microbial phosphatase levels measured with this kit have been correlated with measured TVCs from beef carcass surfaces.

In conclusion, rapid methods for detection of surface microbial contamination of carcasses can be useful in identifying the sources and/or the levels of the contaminants so, in turn, for reduction of public health risks non-detectable by organoleptic examination of meat alone. However, they cannot be used as a sole tool to replace the traditional meat inspection procedures, because they do not detect pathological conditions/lesions specifically associated with zoonotic diseases in slaughtered cattle.

3.4 Methods for diagnostics/prevention of diseases before slaughter

As already emphasized in previous Opinions on the revision of meat inspection of veal calves (SCVPH, 2003) and lambs/goat kids (EFSA, 2004), alternative approaches to meat inspection in an integrated system would have included veterinary herd health actions implemented during pre-harvest phase (Snijders and van Knapen, 2002), as well as actions to reduce/prevent spread of public health hazards during transport-market-lairage, in animals before slaughter. Development and implementation of zoonoses controls, disease diagnostics, monitoring/surveillance, and traceability, can be used to prevent either onset of a given disease, or presentation of animals with public health relevant conditions for normal slaughter.

3.4.1 Alternative methods for detection of cysticercosis

Based on abattoir data, the prevalence of bovine cysticercosis in the EU varies between 0.01 and 6.8%. However, such data should not be taken as being widely applicable, because the conventional meat inspection methods, i.e. incision of the predilection sites followed by visual detection - underestimate the true prevalence by a factor of 3-10 (Opinion SCVPH on cysticercosis, 2000).

At pre-harvest level, vaccination of cattle against cysticercosis (i.e. oncosphere antigens of *T. saginata* and the two recombinant antigens, with up to 99.8% protection against experimental challenge with *T. saginata*, eggs has been advocated (Lightowlers *et al*., 1996). On the other hand, at pre-slaughter level, an antigen ELISA method could be used to detect cattle with circulating *T. saginata* parasite antigen (Dorny *et al*., 2000) so to avoid *post-mortem* examination for the parasite cysts. In preliminary studies the Ag-ELISA method indicated 3.09% of cattle cysticercosis positive , whilst only 0.26% positives were detected by conventional meat inspection (Dorny *et al*., 2000), which is a 15-fold higher prevalence.

Overall, the sensitivity of the traditional meat inspection for the organoleptic detection of cysticercosis is limited and, in principle, can and should be improved through the use of alternative methods based on blood analyses (Opinion SCVPH on cysticercosis, 2000). However, it should be kept in mind that methods based on detection of specific antibodies in cattle cannot differentiate between past and current cysticercosis infection (i.e. whether the cysts are still present and or viable) and, consequently, can be useful for epidemiological studies rather than as an alternative to meat inspection. However, methods based on detection of the parasite's antigens in cattle sera can indicate active cysticercosis infection i.e. presence of live cysts. Serological tests that detect parasite antigens have indicated 3.09% of cattle to be infected with cysticercosis while only 0.26% of those same cattle were found positive by routine meat inspection (Dorny *et al*., 2000). Furthermore, in an integrated system, cysticercosis diagnostics can be considered in conjunction with other measures to control this disease e.g. protection of the environment from untreated human sewage.

In conclusion, antigen-based methods for detection of cysticercosis in cattle, with detection sensitivity levels much higher than that of organoleptic examination, have been published. As they could potentially fully replace related traditional meat inspection procedures, their field validation is urgently required.

3.4.2 Alternative methods for detection of bovine tuberculosis

Control measures for tuberculosis due to *M. bovis* in cattle, at both the pre-harvest level and by *post-mortem* inspection, were considered previously for veal calves (Opinion SCVPH on Veal Calves, 2003) and in greater detail in cattle (Opinion SCVPH on Bovine Tuberculosis, 2003). Here, the more illustrative extracts are presented.

Today, on farm tuberculosis diagnostics in cattle are based primarily on intradermal injection of *M. bovis* tuberculin, a crude protein extract (PPD) from supernatants of cultures of *M. bovis* and measurement of increase of skin thickness after 72 hours. If exclusion of cross-reactivity with *M. avium* is required, a parallel injection of *M. avium* tuberculin is used. Literature data indicate that the sensitivity (% of infected animals correctly identified) of the *M. bovis* tuberculin skin test can vary with an average of around 90%, while the specificity (% of uninfected animals correctly identified) can be as high as >99.9% (Wilesmith *et al.*, 1982; Costello *et al.*, 1997). The meat safety implications of the sensitivity of tuberculin test being less than 100% include that during on-farm testing the TB infection with *M. bovis* can remain undetected in some animals in multiple-reactors herds, or in herds containing single reactors.

In addition, interferon-gamma (IFN-gamma) laboratory-based test, based on a whole blood sample and ELISA technique, appears to have a very good performance (Morrison *et al.*, 2000). Some studies showed that relative sensitivity of the IFN-y test was 84.3%, while relative specificity 99.6%. A commercially available test kit (BOVIGAM) based on IFN-y is available and was extensively trialed on more than 200,000 cattle in a number of countries (Wood and Jones, 2001). The sensitivity varied between 81.8% and 100% for culture-confirmed bovine TB, and specificity between 94% and 100%. The IFN-y test kit is applied in New Zealand for detecting tuberculin skin-test negative bovines, and also is officially used in Australia and IFN-y test can also be prepared for differential detection of *M. avium*.

The applicability of microbiological detection of *M. bovis* appears to be limited, as several weeks are required to obtain the results. Generally, most visible lesions yield positive results, and very few positive cultures are obtained from tissues that do not contain visible lesions (Morrison *et al.*, 2000). Molecular methods for detection of *M. bovis* directly in specimens are presently less sensitive than traditional culture method.

In conclusion, and in accordance with the previous Opinion on bovine tuberculosis (2003) of this Panel stating that *post-mortem* examination (including incision) for tuberculosis should be maintained as its omission would increase the public health risk, no presently available alternative methods for the diagnosis of bovine tuberculosis if used alone could provide the same level of protection as when such methods as are available are used in combination with the existing *post-morte*m inspection procedures in parallel with animal disease eradication or control programmes.

4. CONCLUSIONS

- Healthy cattle may carry and/or excrete zoonotic pathogens that are not detectable by visual or physical meat inspection. The spread of the pathogens represents a major meat safety concern. Therefore, application of GHP- and HACCP-related principles at all stages of the beef chain is essential for reduction of these risks.

- The absence of evidence of disease, including lack of macroscopic lesions at traditional *post-mortem* inspection, does not allow a conclusion as to the absence of microbial zoonotic pathogens which is better determined at herd and/or group level.

- The cutting and palpation procedures used in *post-mortem* inspection of animals, as currently required under 64/433/EEC, carry a significant probability of meat cross-contamination with pathogens that may be present internally (e.g. in lymph nodes) and/or externally (e.g. on tissue surfaces) via utensils and hands.

- The omission of the current palpation/incision practices (as identified in table 2) during a revised *post-mortem* meat inspection of "non-suspect" animals would reduce the microbial cross-contamination risks. Visual examination within the revised *post-mortem* inspection has to be carried out very carefully, on all parts of the carcass and the organs, and with all the necessary facilities provided.

- Animals could be considered as "non-suspect" if they come from an integrated production system (Opinion of SCVPH, 2001), are accompanied with appropriate identification and food chain information, as required by the Hygiene rules and regulations (Regulation (EC) N°852/2004), and show no abnormalities at *ante-mortem* inspection and at visual *post-mortem* inspection.

- Any suspicion of possible abnormalities arising from the food chain information or data from inspection of animals, would require the animal to be considered as "suspect" and subject to further detailed examination of the carcass and organs, including the taking of samples for laboratory examinations when necessary.

- As the finding of zoonotic diseases-related lesions at *post-mortem* inspection is rare, the public health benefits from reduced microbial cross-contamination achieved by a revised *post-mortem* inspection would exceed the increased concerns associated with not detecting certain conditions by palpation/incision.

- However, for some conditions e.g bovine tuberculosis and *Taenia saginata* cysticercosis, this might not be the case. Presently, it appears that there are no available validated alternative methods providing information equivalent to that obtainable by palpation/incision techniques during the conventional meat inspection.

- The current conventional *post-mortem* meat inspection of cattle is important for detection of tuberculous, or tuberculous-looking lesions, and the incision of retropharyngeal, bronchial and mediastinal lymph nodes is particularly helpful in this respect. Whilst it is unknown whether omission of incising for tuberculous lesions would increase the risk to public health from *M. bovis* infection, it is clear that it would reduce the detection rate of infected animals, and therefore have implications for animal disease-related controls.

- The adoption of palpation only, instead of palpation and incision, of lymph nodes and organs, such as lungs, would lead to a lower detection rate of bovine tuberculosis. The incision of the three groups of lymph nodes (indicated above) would therefore need to remain as a routine procedure. This is in accordance with the conclusion from the EFSA Opinion on Bovine Tuberculosis, (2003)

- The present physical *post mortem* meat inspection has low sensitivity for detecting cysticercosis. Therefore, the use of an alternative system based on on-farm controls and use of other diagnostic tests (e.g. serological tests) would increase the detection rate and therefore benefit public health. Currently, the most promising, but not yet validated, available diagnostic tests are based on detection of *T. saginata* antigens in blood samples.

- Incisions of the liver, as described in current legislation, are aimed specifically at the detection of liver fluke (*Fasciola hepatica* and *Dicrocelium dendriticum*) infestations. As human liver fluke infections do not occur from ingestion of infestated bovine liver, there is little increased public health risk from omission of these incisions.

- It is concluded that the proposed revised meat inspection system would be beneficial for public health.

5. Recommendations

1) The process hygiene-related activities, aimed at avoiding meat contamination should be applied to any revised system.

2) The use of palpation/incision techniques during *post-mortem* inspection of beef should be minimised as described in this document, so as to reduce microbial cross-contamination of meat.

3) The revised system should be applied only to “non-suspect” animals coming from integrated production systems with full identification and food chain information available, and with no abnormalities detected during *ante-mortem* inspection. Data availability is a pre-requisite, so new data recording and management systems should be created.

4) The visual inspection, within the revised system, should be carried out very carefully and include all parts of the carcass and the organs. Any indications of abnormalities must be followed by a detailed examination.

5) In addition to the visual inspection, *post-mortem* inspection should continue to include detailed incision of the three groups of lymph nodes (retropharyngeal, mediastinal and bronchial) that are most important for detection of tuberculous lesions.

6) Current procedure aimed at detection of *T. saginata* cysticercosis involving muscle incisions should remain as an "interim" measure until alternative, more sensitive tests, e.g. based on the parasite's antigen detection, are validated.

7) Routine incisions of liver with no visually detected abnormalities should cease in "non-suspect" animals.

8) The Official Veterinarian should play an important role in decision-making, and auditing, based on the nature of the inspection procedures and the requirement for further laboratory examination(s).

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7. ANNEX

Production zones in the EU

Northern mountain zone: the mountain and moorland areas of Ireland and the U.K., much of Norway, Sweden and Finland.

Northern lowland zone: The western coastal area of temperature maritime climate extending from north-western Spain, through western and northern France, the lowland areas of the UK and Ireland, to the low countries and around the Baltic coast. This is the most important milk production zone of Europe.

Central zone and the Po valley.

Alpine zone: Alps and Dinaric Alps.

Pyrenees,

Mediterranean zone.

Beef fattening systems may be divided into two main categories: intensive indoor and grass based systems involving winter accommodation. The diversity of beef fattening systems in the EU is influenced by the type of diets (largely related to the climatic environments) and by the different cattle breeds. These breeds may be dairy (primary output milk) dual purpose (producing milk and beef) or beef (primary output meat)

7.1. Examples of beef Production systems

7.1.1 16 month-old dairy bulls fed grass silage and concentrates

Throughout Europe this system was first developed on a basis of grass silage supplemented with concentrates. In Scandinavia, where maize cannot grow, that system is the most usual. The 16-month old beef system is based exclusively on top quality grass silage. It is supplemented with 2 kg of concentrate (16% crude protein) in the period 3 to 12 months and with 3 to 4 kg of concentrate in the period 13 to 16 months of age. Under Irish conditions one hectare cut 3 times annually provides sufficient silage for finishing 5 animals per year (O'Kiely and Flynn, 1990). Dairy born calves are "conventionally" (as the female calves reared for replacement) reared for the first 3 months. They are then offered grass silage with 74% dry matter digestibility (DMD) *ad libitum* with the following supplementation concentrate schedule (kg/day/head: 3 to 12 months: 2 kg; 13 to 14 months: 3 kg; 15 to 16 months: 4 kg). The animals achieve a daily live weight gain of 0.95 kg/day from 3 months of age and are slaughtered at a final live weight of 505 kg .

7.1.2 16 month-old dairy bulls fed maize silage and concentrate

In continental Europe maize production has spread rapidly northwards with the development of early maturing varieties. European beef producers in Italy, France and Germany have developed maize silage beef systems for both dairy bred and suckler bred cattle (Allen, 1990). Maize silage, while being a good source of energy, is low in protein. As a result maize silage with a 76% DMD is offered *ad libitum* and the diet is supplemented with 2 kg of protein rich concentrate (30% crude protein). Dairy born calves are conventionally reared for first three months and then offered maize silage *ad libitum* to slaughter at 16 months of age. The animals achieve a daily live weight of 1.15 kg per day from 3 months of age and are slaughtered at a live weight of 550 kg.

7.1.3 12 month-old dairy calf bull beef production system fed a cereal based diet

Particular markets in Spain, Portugal and Italy require a carcass weight of 250 kg from Holstein or Friesian bulls at 11 to 12 months of age. The production targets are very similar to those outlined for cereal beef production in England by the Meat and Livestock Commission (MLC) which involves feeding concentrates *ad libitum* from 12/14 weeks of age to slaughter with a daily allowance of long roughage such as straw at approximately 5% to 10% of the total diet (Fallon and Drennan, 1998). Other cereals or cereal substitutes can replace all or part of the barley provided that the ration is properly balanced for protein, minerals and vitamins. The animals on this system achieve a live weight gain of 1.25 kg per day from 3 months of age and are slaughtered at 450 kg live weight.

7.1.4 16 month-old suckler beef bulls fed grass silage and concentrate

In the UK a substantial increase in the production of young bulls from the suckler herd occurred in the years prior to 1996. This took place because of the faster growth rate, leaner carcasses and more efficient feed conversion of bulls compared to steers. Provided that fencing is good, leaving the males as entire bulls does not cause any extra management problems during the suckling period at pasture except that they must be grazed separately from the heifers from 6 months of age.

Young crossbred bulls are fed high quality grass silage (74% DMD) and concentrates from weaning to slaughter. They are slaughtered at 16 months of age with a carcass weight of 350 kg (Drennan, 1993).

Single suckled bulls of late maturing continental crossbreds are weaned at 8 to 9 months of age. They are then offered grass silage (74% DMD) *ad libitum* and 4 to 6 kg of concentrates per head/day for approximately 240 days. The animals achieve a daily live weight gain of 1.25 kg per day from weaning and are slaughtered at 600 kg live weight .

7.1.5 16-18 month old suckler beef bulls fed on maize silage and concentrate

The system is widely practised in mainland Europe for the late maturing continental breeds. The animals are weaned at 7 to 9 months of age. Then they are accommodated indoors and offered a diet of maize silage (76% DMD) *ad libitum* and 4 to 6 kg of concentrates per head/day for the duration of the fattening period (Allen, 1990).

In all situations the maize silage concentrate diet is designed to provide adequate protein and the necessary minerals and vitamins. The animals on this system achieve a live weight gain of 1.40 kg/day from weaning and are slaughtered at 660 kg live weight.

7.1.6 12 or 15 month old bulls from the suckler herd fed with a cereal based diet

In the EU there is considerable interest in the production of beef from young continental bulls from the suckler herd. This system is for weaned single suckled bulls of the late maturing continental breeds weaned at 7 to 9 months of age (Fallon and Drennan, 1998). The animals are offered concentrate *ad libitum* with daily access to a roughage source (0.5 to 1.0 kg of straw/head/day). The animals are slaughtered at 12 to 15 months of age. The economics of offering an all concentrate diet to continental cross weaned suckler bulls are driven by the price of the weaned bull, the cost of the concentrates and the value of the final carcass. A decrease in grain prices encourages this system. The animals on this system achieve a live weight gain of 1.55 kg per day from weaning to slaughter at 570 kg live weight at 12 months of age. The animals slaughtered at 15 months of age achieve a live weight gain of 1.35 kg per day from weaning to slaughter at 640 kg live weight.

7.1.7 2 years-old steers from the dairy herd

The objective is to efficiently use the grass throughout the year either grazed *in situ* or offered as grass silage while maintaining high performance. The male calves are castrated at 2 to 3 months of age. At grass, spring born calves rotationally graze ahead of the yearling animals (leader/follower system). That system is important as it allows the calves to selectively graze and it also facilitates the control of parasites. The stocking rate is approximately 0.50 hectare of grassland in favourable growth conditions per finished animal produced per year (Drennan, Keane and Dunne, 1995).

Finishing animals are housed in mid-October after 210 days at pasture and weanling calves are housed in mid-November after 200 days at pasture, depending on the grass supply (See table12 for a comparison of times spent indoors in the various systems). The silage allowance per animal unit (weanling plus finishing) is 10 tonnes.

In the first winter weanlings are fed 1kg of concentrate per head/day and have *ad libitum* access to silage throughout the 150 day winter period. In the second winter finishing animals are fed 4 kg of concentrates per head/day and have *ad libitum* access to silage throughout the 150 day finishing period.

7.1.8 2 years old steer from the suckler herd

The objective is to efficiently use the grass throughout the year either grazed *jn situ* or offered as grass silage while maintaining high performance. This is achieved by adjusting the stocking rate during the grazing season. Areas are closed off for silage when grass growth is highest in spring and the entire area is grazed from August to the end of the grazing season. The grass conservation programme is designed to provide adequate silage, with a 72% DMD for all animals in the system from two silage cuts (Drennan, Keane and Dunne, 1995).

The male (castrated at 4 to 6 months of age) and female calves are weaned in the autumn and housed for a 150 day winter period. In the first winter they have *ad libitum* access to grass silage plus 1 kg of concentrate per head per day. The yearling animals are at pasture from April to November where they rotationally graze a number of paddocks. The female animals are supplemented with concentrate from September to November. They are slaughtered at 20 months of age. The male steers are taken indoors in November for a 150-day fattening period. In the fattening period they receive *ad libitum* access to grass silage plus 4 kg of concentrate per head per day.

7.1.9 2.5- year old steers and heifers

Animals from both the dairy and beef cow herds are involved. Animals have two winter periods (5 month duration) indoors offered a grass silage diet and no concentrate. The animals are finished during their 3rd season at pasture. Animal performance is very dependent on compensatory growth with low growth rates during the winter indoor periods and high growth rates at pasture.

Water is essential in beef production and as the average daily demand for cattle weighing 500 kg (1100 lb) is about 45 L and increases in hot weather up to 90 L adequate supply of clean, and preferably potable standard, water is essential.

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