Advisory Committee on the
Microbiological Safety of Food

Report on *Mycobacterium bovis*

A review of the possible health risks to consumers of meat from cattle with evidence of *Mycobacterium bovis* infection

Advises the Food Standards Agency
on the Microbiological Safety of Food

CONTENTS

EXECUTIVE SUMMARY

1. In September 2000 the Advisory Committee on the Microbiological Safety of Food (ACMSF) considered a Food Standards Agency (FSA) briefing paper on the current incidence and trends in *Mycobacterium bovis* infection in cattle and humans, and on the measures in place to protect the food chain.

2. The milk and dairy products exposure pathway seemed well protected by existing legislation and control measures. Questions remained, however, about the meat exposure pathway and the level of protection afforded by current legislation and practice.

3. ACMSF members were reassured that the marked increase seen in tuberculosis (TB) in cattle had not been reflected in human cases of TB due to *M. bovis*. These remained very small (on average, about 50 cases a year out of approximately 3,500 bacteriologically-proven cases of human TB from all members of the *Mycobacterium tuberculosis* complex taken together, including *M. tuberculosis*, *M. africanum* and *M. bovis*). The Committee nevertheless regarded the increase in bovine TB as of concern and decided to set up an ACMSF Working Group to review the possible health risks associated with the consumption of meat from animals with evidence of *M. bovis* infection and to provide advice to the FSA on the adequacy of current control measures.

4. Following the Working Group's deliberations, the Committee has adopted this as an ACMSF Report and agreed that it should be submitted as advice to the FSA.

5. **Chapter 1** of the Report provides background on the Working Group's consideration of the question of whether there is a risk to human health from consuming meat from cattle with *M. bovis* infection.

6. **Chapter 2** addresses the question of *M. bovis* in humans. We note that *M. bovis* may be under- or mis-diagnosed and recommend that laboratories should be encouraged to continue to refer all mycobacterial isolates from cases of human tuberculosis to a Reference Laboratory for identification. We also note that, in response to the increase in tuberculosis in cattle, the Public Health Laboratory Service undertook enhanced surveillance of *M. bovis* disease in humans retrospectively for cases in England and Wales between 1993 and 1997. While available evidence from that exercise is insufficient to draw firm conclusions regarding risk factors, we recommend that this enhanced level of surveillance be maintained; that support is provided for a long-term analytical study based on the enhanced surveillance; and that the Food Standards Agency is alerted to any emergent significant trends which might indicate that eating meat from animals infected with *M. bovis* constitutes a health risk.

7. **Chapter 3** looks at *M. bovis* in cattle. This Chapter includes information about the tuberculin test and how TB test reactors, inconclusive reactors and contacts are dealt with.

8. **Chapter 4** deals with meat inspection. We note that *post mortem* meat inspection requirements in the UK are specified in the Fresh Meat (Hygiene and Inspection) Regulations 1995, and that these Regulations do not mirror precisely the requirements of the European Union which are stipulated in Council Directive 64/433/EEC. We recommend that the UK legislation be brought into line with the EU Directive. We also recommend that certain improvements are introduced governing the collection of data by the Meat Hygiene Service, on the scheduling of animals for slaughter, and on the conditions under which carcass sampling and inspection is carried out.

9. **Chapter 5** comprises a risk assessment. The absence of reliable data on the prevalence and incidence of *M. bovis* infection in humans in the UK makes it difficult to assess the risk to human health through the meat exposure pathway. We have nevertheless attempted to carry out a reasonable estimate of risk. This suggests that the risk of infection from eating meat is very low. We welcome the intention of the Food Standards Agency to commission a study to investigate whether *M. bovis* is present in the edible tissues of salvaged carcasses from cattle which have reacted to the tuberculin test or show evidence of *M. bovis* infection at *post mortem* inspection. We note the aim that, should this prove to be the case, then the study will endeavour to determine the level of contamination in each of the tissues examined.

10. **Chapter 6** summarises our key conclusions and recommendations. We conclude that the risk, if any, from the consumption of meat from animals with evidence of *M. bovis* infection, sold as fresh meat for human consumption following assessment and action by the Meat Hygiene Service in UK abattoirs, is very low. Current controls seem adequate to protect public health from the risk of *M. bovis* and we therefore conclude that a possible option is to retain current practices largely unchanged (but with the improvements recommended in paragraphs 4.16-4.18).

11. In the event that the Food Standards Agency considered that steps should be taken to reduce still further the very small risk from fresh meat sold for human consumption being infected with *M. bovis*, we have offered some possible options for consideration. One option would be to cease to allow meat from reactor cattle with visible lesions or from cattle found to have localised tuberculous lesions on routine *post mortem* inspection to be sold as fresh meat. If, in accordance with the legislation, condemnation of the whole carcass did not occur, the meat should not go for sale as fresh raw meat but could go for manufacture where there was an adequate heat treatment step in the process.

12. As up to 10% of reactor cattle which have no visible lesions are likely to prove culture positive, another option would be to require these to be held in cold storage until culture results were available. Carcasses giving positive results would then be either partially or totally condemned. We recognise that this option would require cold storage for some 2 months, and the practical implications would therefore need to be carefully assessed.

13. In relation to paragraphs 11 and 12, it should be noted that unpublished data from the Department for Environment, Food and Rural Affairs (DEFRA) suggest that about half of cattle slaughtered under the TB Control Programme are excluded from human consumption under the Over Thirty Months Scheme.

14. In the event of adopting the heat treatment or cold storage options, appropriate procedures would clearly be needed for ensuring proper compliance with control arrangements. These would include determining time and temperature profiles for the heat treatment step. We recognise that there will be an additional cost from cold storage, but we also recognise that there are a number of outlets for frozen meat.

CHAPTER 1

BACKGROUND

Introduction

1.1 At its thirty-eighth meeting on 19 September 2000, the Advisory Committee on the Microbiological Safety of Food (ACMSF) considered a briefing paper[1] on the current incidence and trends in *Mycobacterium bovis* infection in cattle and humans, and on the measures in place to protect the food chain. The Committee's views were sought on the level of protection offered by current legislation and on the need to establish an ACMSF Working Group to provide advice to the Food Standards Agency.

1.2 The Committee was reassured that the marked increase in tuberculosis (TB) in cattle had not been reflected in human cases of TB due to *M. bovis* and saw no problem in relation to milk and dairy products. The Committee agreed, however, to set up a Working Group to review the possible health risks associated with the consumption of meat from animals with evidence of *M. bovis* infection and to advise on the adequacy of current control measures.

Terms of Reference and Membership of ACMSF and *M. bovis* Working Group

1.3 The terms of reference and membership of the ACMSF and of its *M. bovis* Working Group are shown at Annex A. The Group met on 28 February, 2 April and 4 June 2001.

1.4 The Committee is grateful to Dr Matthew Strutt and Dr Heather Jebbari of the *Mycobacterium* Reference Unit of the Public Health Laboratory Service who provided oral briefings to the Working Group on 4 June. These covered *M. bovis* detection rates, laboratory methods, an epidemiological study in farming areas, and a study on a new phage test.

The bacterium

1.5 Mycobacterium bovis is one of a genus of bacteria which cause disease in humans and in animals. All age groups are susceptible. Cattle, goats and pigs are most susceptible; sheep and horses show a high natural resistance.[2] Wildlife reservoirs are important in some regions.

1.6 *M. bovis* is the specific cause of TB in cattle, but it can also cause TB in humans.

1.7 Identification of the organism has, until recently, been dependent on laborious determination of cultural characteristics.

CHAPTER 2

MYCOBACTERIUM BOVIS IN HUMANS

Human TB

2.1 The aetiological agents of tuberculosis in mammals, classified as members of the *Mycobacterium tuberculosis* complex, include *M. tuberculosis*, *M. bovis* and *M. africanum*. Tuberculosis in humans is mainly due to *M. tuberculosis.* In recent years, *M. bovis* has accounted for only about 1-1½% (ie. around 50) of culture-confirmed tuberculosis in humans in the UK.

2.2 The incidence of human TB in the UK was around 50,000 new cases annually at the end of the Second World War. This had fallen to about 5,000 pa. by the 1980s. There were some 6,500 cases reported in 2000, a 10% increase over 1999. The overall incidence in Scotland has been similar to that in England and Wales, although Scotland has not experienced the recent sustained increases seen south of the border. The geographical distribution of human cases of TB does not mirror the pattern in animals, most human TB being seen in large conurbations. The largest increase has been in young adults and there is a high incidence in ethnic minority groups, particularly in those born in countries with a high incidence of TB. Extra cases of tuberculosis have also occurred in the UK as a result of co-infection in some people infected with HIV.

2.3 TB data for humans are based on statutory notifications of clinical cases. Only about 50% of notified cases are microbiologically-confirmed. There are around 3,500 confirmed cases annually. This figure covers all members of the *Mycobacterium tuberculosis* complex, including *M. tuberculosis*, *M. africanum* and *M. bovis*.

M. bovis TB

2.4 The number of human *M. bovis* isolates in England and Wales over the period 1977-90 was small and the trend was downward (see Table 2.1).

Table 2.1 : Isolates of human *M. bovis* received by the Public Health Laboratory Service (PHLS) *Mycobacterium* Reference Unit and Regional Centres for Tuberculosis : England and Wales

Year	No. of isolates	Year	No. of isolates
1977	112	1984	57
1978	127	1985	56
1979	121	1986	54
1980	100	1987	50
1981	100	1988	53
1982	71	1989	40
1983	75	1990	31

Source : PHLS

2.5 Since then, in the period 1993-99, numbers of *M. bovis* isolates from humans in the UK have remained low with no apparent trend up or down (Table 2.2).

Table 2.2 : Isolates of *M. bovis* from humans

	England	Wales	Scotland	N. Ireland	UK
1993	37	0	7	3	47
1994	29	2	13	5	49
1995	17	3	10	2	32
1996	29	1	3	4	37
1997	32	0	11	2	45
1998	24	5	11	0	40
1999	29	2	6	4	41
Total	**197**	**13**	**61**	**20**	**291**
Total as average annual rate per 100,000 population*	**0.05**	**0.06**	**0.16**	**0.17**	**0.07**

* Based on 1996 mid-year population estimates.

Source : Public Health Laboratory Service

2.6 In recent years, isolates of *M. bovis* from human TB cases have accounted for approximately 1-1½% (around 50) of all isolates of the *M. tuberculosis* complex. The infection rate in Scotland has been double the rates in England and Wales. This is likely to be largely due to reactivation of the disease in older people, reflecting higher historical exposure. Techniques used by different laboratories vary in their efficiency for culture of *M. bovis* and this could have made a small contribution to lower detection rates in England and Wales.

2.7 The ethnic origin of almost half of the UK cases from which isolates have been obtained is unknown; of those that are known, over 90% are of white ethnic origin. Most of these were aged 40 or over. Of the 13% of cases under 40 years, approximately half were of non-white ethnic origin.[3]

2.8 It is possible that the data presented in Tables 2.1 and 2.2 under-estimate the true prevalence and incidence of disease caused by *M. bovis*. There are a number of reasons for under reporting :-

- Misdiagnosis : several factors may contribute to the initial misdiagnosis at the bedside and in the clinic of tuberculosis due to *M. bovis*. If *M. bovis* infection is acquired via the gastro-intestinal tract, the presentation of subsequent disease may be more likely to be extra-pulmonary, without the more common clinical features of tuberculosis, and may masquerade as other conditions (such as haematological malignancies and osteomyelitis) on initial presentation. Because *M. bovis* infection is rare, it is likely to be low on a clinician's list of differential diagnoses. Subsequently, the diagnosis of disease due to tuberculosis is likely to be made, but *M. bovis* rather than *M. tuberculosis* may not be identified as the cause, for the reasons given above. Around 50% of *M. bovis* cases reported are based on respiratory specimens (and this proportion is true for the under 35s). If infection is acquired via the gastro-intestinal tract, it may be more likely that primary

progressive disease is seen in the gastro-intestinal tract. Reactivation disease is probably most likely in the lungs.

- Status of specimens : if specimens have been initially sent to histology to exclude a non-infective diagnosis, they will normally have been transported in formalin and are not suitable for microbiological analysis. If granulomata or acid fast bacilli are seen, it will not be possible to subsequently speciate the organism because it cannot be cultured. Such specimens are often obtained intra operatively and are not repeatable. Unless there is good reason to suggest otherwise, a presumptive diagnosis of *M. tuberculosis* infection will normally be made.

- Failure to culture : even if the laboratory receives specimens for mycobacterial culture, some obstacles to successful culture remain. Optimal growth of *M. bovis* is considered to be enhanced by pyruvate-containing media. Conversely, it is not well supported by media containing only glycerol. This will, however, support the growth of *M. tuberculosis* and, hence, glycerol-containing media tend to be favoured in some laboratories. Laboratories are increasingly using automated liquid culture systems. Manufacturers' data suggest that these systems will support the growth of *M. bovis*, but experience of these systems is not yet widespread in the UK.

- Failure to identify : although culture requirements and antibiotic sensitivities may differ, *M. tuberculosis* and *M. bovis* are genetically virtually identical. Commercial molecular amplification methods and commercial DNA probes, which might be in use in local laboratories for TB diagnosis in primary specimens, do not distinguish between the two organisms; this must be achieved by biochemical phenotypic tests on isolates. Molecular methods are becoming increasingly attractive to laboratories. In part, this is because they are fashionable and heavily promoted, but also they often offer quicker results than conventional procedures and, although they require an expertise in molecular methods, they do not necessarily require expertise in the specific microbiology of the organisms under consideration. This highlights the importance of referral of isolates from all cases of human TB to a Reference Laboratory for identification. In this connection, it should be noted that almost all isolates in the UK are already sent to one of the reference centres where *M. bovis* can be reliably diagnosed. The considerations in this sub-paragraph may therefore be largely theoretical.

2.9 A survey of laboratory methods (Annex B) provides evidence of the potential for under or mis-diagnosis of *M. bovis* infection. Fortunately, in the UK the network of regional mycobacterial reference centres and mycobacterial reference units undertake free identification of mycobacterial isolates, using phenotypic methods. This reduces the incentive for laboratories to undertake costly molecular identification in-house. **We recommend that the Food Standards Agency should do all that it can through the Department of Health to encourage laboratories to continue to refer all mycobacterial isolates from cases of human TB to a Reference Laboratory for identification.** It is possible that the trend towards liquid culture may enhance the capabilities of diagnostic laboratories to isolate this organism.

2.10 No information is available on the prevalence of infection with *M. bovis* in the absence of clinical disease. With current technology it would be possible to perform a study based on culture of abdominal lymph nodes removed at surgery for other reasons. In the future, it may be possible to perform serological surveys; some

suitable candidate techniques are currently under investigation at the PHLS Mycobacterium Reference Unit.

2.11 Notwithstanding the difficulties highlighted in paragraph 2.8 above, the Committee considers that the majority of cases of *M. bovis* in humans are likely to be successfully diagnosed by existing procedures.

Regional *M. bovis* trends

2.12 In an attempt to test whether there was any developing trend of *M. bovis* TB infections in humans in the South West of England (where the prevalence of TB in cattle is highest – Chapter 3), data for all cases of human TB were compared between the South West and the Eastern region (where the prevalence of cattle TB is lowest). This showed numbers and rates to be low in both of these rural regions, with the rates higher in the Eastern region (Table 2.3). The number of cases of TB in children in the South West over the period 1982-1998 were very low and decreasing (Table 2.4).

Occupational exposure

2.13 The Committee has found difficulty in assembling data on the occupational background of those infected with *M. bovis* TB. Numbers are low and are highest among those groups who, by virtue of their age, are more likely to be retired. TB is a reportable disease under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR95). These regulations apply to all persons at work (both self-employed and employees). It does not follow that, because a case was reported, it was caused by occupational exposure. It simply means that, for the particular work activity involved, the disease is a recognised risk. However, there is thought to be substantial under-reporting under RIDDOR95.

2.14 An alternative source of information on occupational exposure is the Occupational Disease Information Network (ODIN) which includes the Surveillance Scheme of Infectious Disease at Work (SIDAW), a surveillance scheme for infectious disease consultants, SWORD for chest physicians and OPRA for occupational physicians. There has been no evidence of *M. bovis* being reported under these schemes.

2.15 There are obvious health and safety implications of TB reactor cattle for slaughterhouse operators, State Veterinary Service (SVS) and Meat Hygiene Service (MHS) staff. There is Department for Environment, Food and Rural Affairs (DEFRA) guidance on the health and safety implications of TB reactor cattle for these groups. In addition, employers are required, under the provisions of the Control of Substances Hazardous to Health Regulations 1999, to carry out an assessment of the risks from TB to their employees and to identify the precautions necessary to control that risk.

Table 2.3 : Human tuberculosis notification rates (per 100,000 population)

Year	South West Region		Eastern Region		England & Wales Total	
	Number	Rate	Number	Rate	Number	Rate
1982	308	6.3	372	7.0	7,406	14.2
1984	261	5.4	304	5.7	6,141	11.8
1986	214	4.4	316	5.9	5,992	11.5
1988	212	4.3	272	5.1	5,161	9.9
1990	173	3.5	261	4.9	5,204	10.0
1992	199	4.1	290	5.4	5,798	11.1
1994	203	4.1	245	4.5	5,590	10.7
1996	201	4.0	260	4.8	5,654	10.8
1998	213	4.3	268	5.0	6,087	11.6

Source : PHLS

Table 2.4 : Cases of tuberculosis in children (<15 years of age) in the South West Region of England and Wales

Year	Pulmonary	Non-pulmonary only
1982	10	5
1983	6	8
1984	40*	5
1985	4	4
1986	2	3
1987	5	4
1988	8	8
1989	5	10
1990	1	4
1991	2	-
1992	2	3
1993	6	9
1994	4	6
1995	1	6
1996	7	1
1997	5	1
1998	5	2

* Local *M. tuberculosis* outbreak.

Source : PHLS

Risk factors

2.16 In response to the increase in tuberculosis in cattle, the PHLS undertook enhanced surveillance of *M. bovis* disease in humans retrospectively for cases in England and Wales between 1993 and 1997. The available evidence is insufficient to draw firm conclusions regarding risk factors, but neither travel abroad nor occupational exposure appear to be strongly implicated.

2.17 **We recommend that the Food Standards Agency should, through contact with the Public Health Laboratory Service and the Department of Health, ensure that this enhanced level of surveillance is maintained, and provide support for a long-term analytical study based on the enhanced surveillance; and that the Agency is alerted to any significant trends which emerge which might indicate that eating meat from animals infected with *M. bovis* constitutes a health risk.**

CHAPTER 3

MYCOBACTERIUM BOVIS IN CATTLE

Introduction

3.1 *M. bovis* is the specific cause of TB in cattle. In the early part of the 20th century, when *M. bovis* was endemic, there was a wide variety of pathological syndromes, some of which were associated with clinical disease.[4,5] Between 1930 and 1939, over 40% of dairy cows were infected with *M. bovis*. Many were kept near large cities to provide urban dwellers with fresh milk. Most were closely confined in poorly ventilated cowsheds, ideal conditions for the disease to spread first to the lungs, and then to other organs including the udder. Many cows were seriously affected with tuberculous udders and, because most milk was drunk raw (untreated), *M. bovis* spread easily to humans and was a major problem. A compulsory TB eradication programme, based on routine tuberculin testing of animals, began in 1950. A flow chart showing the steps in the cattle testing and meat inspection procedures for bovine TB in the UK is at Annex C.

3.2 The herd incidence of bovine TB has been rising in Great Britain over the last 6 years. In 1996, 1.3% of all tests in cattle herds not subjected to restrictions resulted in a confirmed TB incident. This percentage gradually increased in the following years and reached a provisional estimate of 2.7% in 2000. This increase has not been uniform across Great Britain. Cornwall, Devon, Gloucestershire, Wiltshire, Hereford and Worcestershire, and areas of West and South East Wales sustained the highest county incidences of TB and still account for the majority of new TB cases (see latest TB herd statistics published by DEFRA on its website <http://defraweb/animalh/tb/default.htm).

3.3 The latest figures published by DEFRA for the three month period ending February 2001 indicate that a little under 3% of tests on unrestricted herds (ie. herds not previously known or suspected to be infected with *M. bovis*) resulted in a confirmed new incident.

Herd size and distribution

3.4 The national dairy breeding herd in the UK fell from 3.3 million to 2.4 million between 1981 and 1999. The number of herds with more than 100 cows remained stable. The number of herds with less than 100 cows fell.

3.5 The average dairy herd size in 1999 was largest in Scotland (86.7 cows), followed by England (77.8) and Wales (60.6). In 1999, suckler herds were on average almost twice as large in Scotland (50.6 cows) as in England (25.8) and Wales (23.2). In England, herd size was largest in the South East (93.8 cows), followed by the South West (81.5), and smallest in York & Humberside (63.7).

3.6 Over the period 1981-1999, the UK beef breeding herd increased from 1.4 million to 1.9 million. There was a sharp fall in the number of beef breeding herds with less than 10 cows; but a rise in each of the size categories with 10 or more beef breeding cows.

3.7 Herd size may be important in the risk of cattle-to-cattle transmission of TB (although other factors such as the intensification of production and the rising prevalence of TB in wildlife reservoirs may also be contributory factors). The risk of any one animal becoming a reactor was shown in one study[6] to increase in proportion to the size of the herd. There were increases in herd incidence and in number of reactors per herd as herd size increased. Increased density of cattle may increase the opportunity for lateral cow-to-cow spread.

Slaughter of cattle

3.8 In 2000, almost 2.3 million prime stock and 153,000 calves were slaughtered in the UK. The slaughter of prime stock has fallen from a peak of over 3.3million p.a. in the mid 1980s. Since 1996, cows and adult bulls have been slaughtered and their carcasses rendered under the Over Thirty Months Scheme (OTMS). OTMS was introduced in 1996 as a mechanism to ensure that meat sourced from beef animals over thirty months old at slaughter did not enter the food chain. The OTMS formed part of the BSE control measures designed to protect consumers. In the period 1996-2000, some 4.2 million cows and adult bulls were removed via OTMS. In addition, the Calf Processing Aid Scheme (CPAS) was introduced in 1996 as an industry support measure. Some 2.2 million calves, predominantly pure dairy males, were removed under the CPAS between 1996 and 1999, when the scheme ended. The CPAS is one of the prime reasons for the decline in prime stock slaughter.

Tuberculin Test

3.9 Member States of the European Union carry out tuberculin testing of animals in accordance with Council Directive 64/432/EEC. All cattle in the UK are regularly tested for TB using the single comparative intradermal tuberculin test. The test involves injecting 0.1ml of tuberculin into the skin of the animal. In most cattle infected with TB, this will cause the animal's immune system to react to the tuberculin and cause a swelling where the injection has taken place. So that animals infected with *M. bovis* can be distinguished from those infected by other mycobacteria, the animals are also injected with tuberculin produced from *Mycobacterium avium*, a bacterium commonly found in the environment. The reaction to the two injections is compared at 72 hours post injection to see whether or not the result is positive (ie. the response to *M. bovis* is stronger than to *M. avium*). This is why the test is called the "comparative intradermal tuberculin test". Tuberculin testing is seasonal, as more herds are tested in the winter when the animals are housed. The animals do not represent a random sample of the whole GB herd, as more tests are carried out in areas with known high incidence of infection.

3.10 If a reactor[a] or an inconclusive reactor[b] is discovered at a tuberculin test, then movement restrictions are placed on the farm. It is for the State Veterinary Service (SVS) to decide what further action is necessary. This will consist of slaughter of reactor cattle, together with further herd testing. Inconclusive reactors will be subject to repeat tuberculin testing. In most cases, inconclusive reactors are re-tested after at least 42 days to see whether the reaction has changed. If an animal

[a] an animal reacting to (ie. failing) the tuberculin skin test.
[b] an animal which has given readings to the tuberculin skin test between the clear (ie. pass) and reactor (ie. fail) ranges.

is still an inconclusive reactor, the test may be repeated again, but if the result is inconclusive for a third time, the animal will usually be classified as a reactor and slaughtered.

3.11 The currently used tuberculin test is highly specific (>99%) but its sensitivity at standard interpretation appears to be only about 90%. However, the prevalence of TB, as well as the sensitivity and specificity, need to be taken into account in order to be able to calculate the predictive values of both positive and negative results. Where reactors are disclosed at a test, the herd is routinely re-tested at 60 day intervals until 2 clear tests are achieved. Because a positive skin test result is often based on measuring small differences in skin thickness, the test may be subject to error on the part of the operator. The interpretation of the test is also complicated by non-specific responses induced by other species of mycobacteria. These are controlled by the use of *M. avium* antigen in the test.

3.12 The slaughtered animals are subject to *post mortem* meat inspection. If tuberculous-like lesions are found at the *post mortem* examination, samples are taken and sent to the Veterinary Laboratories Agency mycobacteriology laboratory in Weybridge where the bacterium is grown to see whether it is *M. bovis*. In the absence of typical lesions, a pooled sample of targeted lymph nodes is collected from the carcass and submitted for culture. There is a time lag of 6-8 weeks on average between taking of samples from the slaughtered animals and confirmation of results of culture. If bovine TB is not found at *post mortem* examination or in the laboratory, the animal is classified as an "unconfirmed reactor" and further herd tests are carried out to ensure that there is no other evidence of infection on the farm concerned.

Slaughter of TB test reactors, inconclusive reactors and contacts

3.13 The number of cattle compulsorily slaughtered as reactors or contacts is published by DEFRA on their website (address <http://defraweb/animalh/tb/default.htm>). In 2000, 7,033 cattle were slaughtered as reactors and a further 1,322 as dangerous contacts. The figures for 2000 are still provisional. The data from the most recent 5 years in the DEFRA statistics report of 18 May 2001 are given in Table 3.1. It should be noted that unpublished DEFRA data suggest that about half of cattle slaughtered under the TB Control Programme are excluded from human consumption under the Over Thirty Months Scheme.

3.14 Schedule 8(5)c of the Fresh Meat (Hygiene and Inspection) Regulations 1995 prohibits the slaughter for human consumption of animals with clinical signs of tuberculosis. Animals going for slaughter from restricted premises are required to be covered by specified documentation, as follows :-

- Form TB55 - proposal to slaughter bovine animals. This form should be faxed by the Divisional Veterinary Manager to the Official Veterinary Surgeon to forewarn of the arrival of cattle from premises under restrictions because of TB.

- Licence form TB24 - authorising movement of cattle to a slaughterhouse.

- An OTM 17 form (if applicable) – completed by the owner/keeper of any reactor over 30 months of age.

- A Schedule 18 Certificate (if applicable) - covering cattle under 30 months of age.

- A Schedule 19 Certificate (if applicable) – covering on-farm casualty animals.

3.15 Carcasses from reactor and inconclusive reactor animals are subject to the extra inspections required by Schedule 10 Part IX of the Fresh Meat (Hygiene and Inspection) Regulations 1995. It is recommended in the Meat Hygiene Service's Operations Manual that such animals "should, wherever possible, be slaughtered last on the line so as to minimise the risk of contamination". The method of collection of samples from carcasses and offal is set out in the MHS Operations Manual.

Table 3.1 : Cattle compulsorily slaughtered as reactors or contacts (see also paragraphs 3.13 and 4.7).

Year	Total tests on Herds	Total cattle tests	Cattle compulsorily slaughtered as reactors or contacts:		
			Total	Reactors	Contacts
	(1)	(2)	(3)	(4)	(5)
1996	37,744	2,311,711	3,752	3,132	620
1997	35,386	2,224,687	3,669	3,213	456
1998	38,214	2,506,994	5,884	4,958	926
1999 (provisional)	42,689	2,881,626	6,772	5,910	862
2000 (provisional)	42,087	2,997,937	8,355	7,033	1,322
Dec 00 to Feb 01 provisional	10,684	877,904	2,553	2,047	486

The data are a snapshot on the date on which they are extracted from the Animal Health Database. They are provisional and subject to revision each month. Data from 1999 onwards will remain provisional until all culture results are available and various final data validation exercises have been carried out.

(1) Herds in which tuberculin skin testing is carried out on at least one animal during the period shown.
(2) Number of animals tested.
(3) Animals compulsorily slaughtered because they reacted to the tuberculin test or because they were considered to be direct contacts (see below). Not all of these animals will necessarily be confirmed as being infected with *M. bovi*s.
(4) An animal which gave a positive result (ie. reacted) to the tuberculin test and was compulsorily slaughtered.
(5) An animal which, under the terms of Directive 64/432/EEC as amended, was considered to have been a direct contact exposed to TB and therefore was compulsorily slaughtered.

Source : DEFRA

CHAPTER 4

MEAT INSPECTION

Introduction

4.1 Meat inspection was developed in the 19th century originally for the detection of animal diseases and parasites such as tuberculosis and *Taenia saginata* that were important zoonoses. Van Logtestijn[7] summarised the purposes of meat inspection as the removal of grossly abnormal products from the meat chain, prevention of the distribution of infected meat that could give rise to disease in man, and assisting in the detection and eradication of certain diseases of livestock. The removal of grossly abnormal products is the easiest of these to accomplish by traditional meat inspection methods. An important function of meat inspection is to assist in monitoring disease in the national herds and flocks. A flow chart showing the steps in cattle testing and meat inspection procedures for bovine TB in the UK is at Annex C.

Ante mortem inspection

4.2 In the UK, animals intended for human consumption undergo an *ante-mortem* health inspection at the slaughterhouse within 24 hours of arrival (in accordance with the provisions of the Fresh Meat (Hygiene and Inspection) Regulations 1995). This has the purpose of determining whether there are any signs of abnormality (such as clinical disease, injury, fatigue or stress) and whether the animals are reluctant to stand, or are in any way different from the others.[8] Not only is *ante mortem* inspection necessary for the detection of diseases which pose a human health hazard, it makes an equally important contribution to the detection of animal diseases like Foot and Mouth Disease. However, the lack of information about the disease history and/or medical treatments of the animals to be examined, in combination with the inflexibility of uniform inspection of different categories of animals, reduces the effectiveness of *ante-mortem* inspection.[9] Any animal submitted for slaughter as a "reactor", "inconclusive reactor" or "in contact" will be identified prior to arrival and sent to the slaughter plant with a certificate defining which of these three categories apply (see Chapter 3).

Post mortem inspection

4.3 *Post mortem* meat inspection requirements in the UK are defined in the Fresh Meat (Hygiene and Inspection) Regulations 1995, (as amended). The Regulations are designed to implement Council Directive 64/433/EEC. Inspection involves visual examination, palpation, and prescribed cuts of the carcass and offal, with detailed examination of certain lymph nodes by multiple incisions. Inspectors may also make such additional inspections as they consider necessary and can detain a carcass and offal for further examination. The legislation provides for partial or total seizure, and subsequent disposal is required for parts deemed unfit for human consumption. The additional *post mortem* examination of animals following the identification at routine meat inspection of one or more lesions suggestive of TB is detailed in the legislation, as is the subsequent action. If the animal has been sent for slaughter by the State Veterinary Service (SVS) as one of the three categories above, this higher level of inspection is applied in every case.

Transmission of infection

4.4 Inhalation is the major method of transmission of TB infection for animals.[2] In the vast majority of infected cattle identified by tuberculin testing, pathological changes are confined to the respiratory tract and associated lymph nodes. Many natural cases have only a few, small lesions grossly detectable at *post mortem* examination. Disseminated disease is rare. Costello *et al,*[10] in a study of infected animals in depopulated herds in Ireland, found disseminated lesions in only 4 out of 353 tuberculous animals. Moreover, available data (see Table 4.1) indicate that the likelihood of confirming infection by microbiological culture from tissue samples, in the absence of grossly visible lesions, is very low. It therefore follows that the proportion of infected animals where visible lesions are detected will depend on the thoroughness of the *post-mortem* examination.

Effectiveness of meat inspection arrangements

4.5 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), can result in the carcass, offal and abattoir becoming contaminated with bacterial pathogens such as *Salmonella* or *M. bovis*.[9,11-15]

4.6 With *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.[16-18] In most developed countries, however, tuberculosis is a rare cause of lymph node lesions in slaughter animals. The removal of incision as part of meat inspection does not appear to reduce the efficacy of the procedure significantly. 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.[19-20]

Tuberculous lesions found at *post mortem*

4.7 Data on visible lesions of TB in cattle and on culture results for *M.bovis* are provided in Table 4.1. The apparent discrepancies between the data in Tables 3.1 and 4.1 reflect the fact that the data from the Veterinary Laboratories Agency incorporate *post mortem* findings of any inconclusive reactor cattle voluntarily submitted for slaughter by their owners before they become inconclusive reactors for a third time. Such animals are not subject to compulsory slaughter and compensation by the State Veterinary Service, although their carcasses are subject to examination and sampling for *M. bovis* culture at VLA. These animals are not included in the official TB statistics published by DEFRA, hence the smaller total yearly figures in Table 3.1. Table 4.1 also includes data from infected carcasses disclosed in the course of routine meat inspection. These are not part of the statistics presented in Table 3.1.

Table 4.1 : *Post mortem* findings in cattle showing evidence of tuberculosis at the abattoir in the five years 1996 to 2000 (see also paragraph 4.7).

Culture result	Year animal tested or slaughtered				
	1996	**1997**	**1998**	**1999**	**2000**
1. Commercially slaughtered cattle found to have lesions, although not previously thought to have TB					
M. bovis found	44	66	97	142	165
M. bovis not found	31	44	40	34	12
Animals not cultured	1	0	1	2	0
% cultured samples positive	58.7	60.0	70.8	80.7	93.2
Estimated total TB positive animals*	45	66	98	144	165
2. Cattle found to have visible lesions after slaughter in DEFRA TB control programme+					
M. bovis found	1,124	1,140	1,580	1,951	2,462
M. bovis not found	167	145	180	230	250
Animals not cultured	180	157	614	741	1,072
% cultured samples positive	87.1	88.7	89.8	89.5	90.8
Estimated total TB positive animals*	1,281	1,279	2,132	2,615	3,436
3. Cattle found not to have visible lesions when slaughtered in the DEFRA TB control programme#					
M. bovis found	110	129	154	196	199
M. bovis not found	1,721	1,984	2,384	2,498	2,691
Animals not cultured	764	445	1,302	1,497	2,080
% cultured samples positive	6.0	6.1	6.1	7.3	6.9
Estimated total TB positive animals*	156	156	234	306	343

* Calculated as [Number of cattle in which *M. bovis* was found] + [number of animals not cultured x proportion of cultured samples positive].

Visible lesions may have been found at the abattoir, at the VLA laboratory, or at both places. The figures shown are the averages for all slaughtered animals, ie. skin test reactors, inconclusive skin test reactors, and dangerous contacts.

+ Cattle found to have visible lesions after slaughter may be reactors, direct contacts or inconclusive reactors. The majority of animals with visible lesions are cattle that have reacted to the tuberculin test, both in absolute and comparative terms.

NB : Unpublished DEFRA data suggest that about half of cattle slaughtered under the TB Control Programme are excluded from human consumption under the Over Thirty Months Scheme.

Source : Veterinary Laboratories Agency

4.8 In 2000, visible lesions were identified either in the abattoir or by the VLA in 43%[c] of cattle slaughtered in the DEFRA TB control programme (the averages for all slaughtered animals, skin test reactors, inconclusive skin test reactors, and dangerous contacts). *M. bovis* was isolated from 90.8% of the cattle in which visible lesions were found and for which culture results are available. *M. bovis* was also isolated from 6.9% of the cattle in which no visible lesions were found and for which culture results are available. In total it has been estimated that 3,779[d] of the cattle slaughtered in the

[c] [All cattle in category 2 of Table 4.1] expressed as % of [all cattle in category 2 + all cattle in category 3].

[d] Estimated total TB positive animals in category 2 of Table 4.1 + corresponding figure for category 3.

DEFRA TB control programme would have been positive for *M. bovis* on culture in 2000.

4.9 In addition to those cattle slaughtered in the DEFRA TB control programme, lesions were found in an additional 177 commercially-slaughtered cattle not previously thought to have TB. *M. bovis* was isolated from 93.2% of these cattle.[e] (It should be noted that the percentage refers to data from the year 2000 only.)

Judgement of tuberculosis at *post mortem* meat inspection

4.10 Where tuberculosis is suspected in any part of the carcass or offal, a detailed inspection of the carcass and offal is required, beyond what would be required as a routine for the species presented, and in addition to any examination required by the SVS. On this latter point, the additional requirements by the SVS apply only to the collection of samples and reporting of suspected TB in a carcass to the Divisional Veterinary Manager (DVM), as outlined in Chapter 14 of the Meat Hygiene Service (MHS) Operations Manual. The Manual states that the inspection should be carried out according to the extra inspection requirements under Section 10 Part VIII of the Fresh Meat (Hygiene and Inspection) Regulations 1995 where tuberculosis is suspected. There are no additional checks on the carcass required by the SVS above those already prescribed by the Regulations.

4.11 A comparison of the requirements imposed under European Union and UK legislation is at Annex D. There is a difference between the requirements of the UK legislation in respect of generalised TB (see footnote 2 (e) of Annex D), and the EU legislation in respect of localised TB where localised lesions are found in a number of organs or areas of the carcass. In practice, the EU legislation requires the carcass to be condemned if lesions are found in a number of organs or areas of the carcass (ie. more than one organ/area), while the UK Regulations allow lesions in two organs and one system before requiring total condemnation. It is difficult to reconcile the two legislative requirements.

4.12 EU Member States appear to deal with tuberculin test reactors in a similar way, carcasses being salvaged subject to any decision made at meat inspection. In Great Britain, there are three possible actions by the MHS :-

- pass the carcass and offal if MHS staff are certain that there is no evidence of TB;

- partial seizure, with the remainder going forward as fresh meat if the MHS consider it to be a localised infection of TB;

- total seizure of carcass and offal as unfit for human consumption if the MHS staff consider it a generalised infection of TB.

4.13 We believe that the differences in the national and EU legislative requirements for *M. bovis* (as set out in Annex D) are significant and should be removed. **We therefore recommend that UK legislation should be brought fully into line with the requirements of EU Directive 64/433/EEC.**

[e] Table 4.1, category 1.

4.14 It is understood that, in a recent Communication from the European Commission covering a draft Regulation on the organisation of official controls, the Commission has proposed, pending an opinion by the European Food Authority, that meat from TB reactor animals and those giving an inconclusive result should be heat treated prior to being sold for human consumption.

4.15 In Great Britain, the MHS is responsible for reporting any suspicious lesions found at routine *post mortem* meat inspection to the DVM of the SVS. MHS staff must positively differentiate between lesions that are "tuberculous" and those that are tumorous. The SVS, with the assistance of the MHS, is responsible for arranging the collection of relevant samples from reactors, inconclusive reactors and contacts. In most instances, the inspection of carcasses from such animals for evidence of TB is carried out by Veterinary Officers of the SVS. However, the final judgement as to the fitness for human consumption of those carcasses is a matter for the OVS.

4.16 It seems that, while the SVS has complete records of the lesions found in the slaughtered animals, and the culture results, this information cannot be linked back to the judgement and action at *post mortem* meat inspection in the abattoir. That being so, the Committee had difficulty in assessing the effectiveness of *post mortem* meat inspection in removing infected meat from the market. To rectify this omission, **the Committee therefore recommends that the Meat Hygiene Service reviews its record keeping of *post mortem* inspection findings, judgement and action, samples taken, and culture results collated for each animal, as a basis for regularly assessing their performance and the need for any improvements therein.**

4.17 The Committee is concerned that all practical steps should be taken to reduce cross-contamination in the abattoir. At present, there is only guidance in the MHS Operations Manual as to the time when, and in which part of the abattoir, the animals under licence are allowed to be slaughtered. **We recommend that, in all cases, such animals are either slaughtered last in the day, before the full cleaning and disinfection of the slaughter line, or are slaughtered and dressed in a dedicated room in the abattoir.**

4.18 The practice of collecting samples on the line is difficult to support in microbiological terms, unless the animals are being slaughtered as a defined group. **We recommend that, where an animal is found to have a tuberculous-like lesion at routine *post mortem* meat inspection, that carcass and offal be placed immediately in the detained area before further detailed inspection and before any samples are collected.** The only exception to this rule would be for groups of animals being slaughtered at the end of the day where there is full cleansing and disinfection of the slaughter hall immediately afterwards.

CHAPTER 5

RISK ASSESSMENT

Routes of infection

5.1 *M. bovis* was identified in the late 19th century as an important zoonosis. The transmission of *M. bovis* from cattle to humans is not fully understood. Human infection with *M. bovis* is traditionally associated with the consumption of raw contaminated milk, or occupational exposure to *M. bovis* by direct contact or aerosol in meat plants or while handling infected animals.[21-23] In countries where milk is pasteurised or otherwise heat-treated, and the eradication of *M. bovis* is nearing an end, the aerosol route of infection, while very rare, has become more important for humans than the oral route.[21] Robert von Ostertag[24] claimed that tuberculosis could be contracted from infected meat.

5.2 Traditionally, the failure to detect any tuberculous lesions in tissues and organs at *post mortem* meat inspection has been considered sufficient evidence that meat was safe. However, McIlroy *et al*[25] sliced multiple 5mm cross-sections of the lungs of *M. bovis* reactor cattle and found that many cattle had small lesions unlikely to be detected by routine *post mortem* meat inspection, with some lesions less than 5mm in size. This implies that, even if no visible lesions are detected at *post mortem* meat inspection on the carcass and organs of a bovine that was an *M. bovis* reactor, it cannot be assumed that *M. bovis* lesions are not present in tissues.

5.3 Theoretically, *M. bovis* infected meat can lead to the infection of people who consume the meat, especially if it is eaten raw or undercooked.[24] However, Kleeberg[26] found that there had been no documented reports or studies showing evidence for the transmission of *M. bovis* in infected meat to humans. It may be that, where *M. bovis* is widespread, it is difficult to determine whether human infection has occurred following consumption of infected milk or meat, or through the respiratory route.

5.4 Although there is evidence that meat from *M. bovis* reactor cattle cannot be judged free of *M. bovis* following meat inspection where no lesions are detected, there is no conclusive evidence from the literature that meat from such animals is a hazard to human health. Bacteraemia in cattle with *M. bovis* does occur, as evidenced by the involvement of regional lymph nodes or generalised infection throughout the carcass.[27] Meat from animals infected with *M. bovis* could thus theoretically contain bacilli, but the question then is whether there are sufficient bacilli to provide an infectious dose.[27] Of concern is the likely cross-contamination from tuberculous lesions to carcass meat if hygiene is not strictly enforced. An experiment conducted by M'Fadyean[28] illustrated that meat from tuberculous animals cut and dressed using the common place (unhygienic) practices of the late 19th century could produce disease when fed to rabbits and guinea-pigs, with 16 of 21 animals developing tuberculosis. However, when meat was taken from tuberculous animals with strict aseptic precautions, no infection developed in 32 animals fed with 14 different samples. [27-28] Lilleengen[29] recovered *M. bovis* bacilli from the various surfaces, utensils and all the wiping cloths in an abattoir.

FSA risk assessment study

5.5 The FSA intends to commission a 6-9 month study to investigate whether *M. bovis* is present in the edible tissues of salvaged carcasses from cattle which have reacted to the tuberculin test or show evidence of *M. bovis* infection at *post mortem* inspection. Should this be the case, then the study will also aim to determine the level of contamination in each of the tissues examined. It is intended that the study will also review published data on transmission of infection to humans and estimate the likely infectious dose by mouth for humans.

Probable risk of *M. bovis* in animals

5.6 From the evidence which the State Veterinary Service (SVS) presented to the Working Group (see Table 4.1), in excess of 90% of animals with visible lesions at *post mortem* inspection were subsequently found to be culture positive for *M. bovis*. In addition, when the animals were slaughtered under licence as reactors or dangerous contacts but had no visible lesions present at the *post mortem* inspection, 6.9% of the samples taken by the SVS were culture positive for *M. bovis*.

5.7 Furthermore, analysis of 15,937 samples from reactor animals taken from confirmed and unconfirmed incidents over the period 1994-98 showed that :-

In TB incidents where > 5 reactors were sampled :
- Probability (*M. bovis* +ve culture/No Visible Lesions (NVL) sample) = 522/4,283 = 0.123

In TB incidents where ≤ 5 reactors were sampled:
- Probability (*M. bovis* +ve culture/NVL sample) = 237/5,150 = 0.046

For all TB incidents:
- Probability (*M. bovis* +ve culture/NVL sample) = 0.080

5.8 Therefore the chances of a non-visible lesion carcass giving rise to an *M. bovis* positive culture result were smaller for incidents where samples from 5 or less reactors and contact cattle were cultured than for incidents where samples from more than 5 reactors and contact cattle were cultured. The overall proportion of samples from non-visible lesion reactors that turned out positive on culture was 0.08, i.e. 8%. This reinforces the point emerging from Table 4.1 that *M. bovis* can be isolated from a small proportion (approximately 8%) of tuberculin reactors which do not show any gross pathology at *post mortem* (ie. non visible lesion reactors). Similar statistics on direct contacts and inconclusive reactors are not available.

5.9 We have concluded that it is reasonable to assume that all animals with visible lesions should be considered positive for *M. bovis* and that, where the animals taken under licence have no visible lesions at *post mortem* inspection, up to 10% of these animals should be assumed to be culture positive for *M. bovis.*

TB Risk Assessment

5.10 The absence of reliable data on the prevalence and incidence of *M. bovis* infection in humans in the UK makes it difficult to assess the risk to human health through the meat exposure pathway. Notwithstanding these difficulties, we have attempted to make a reasonable estimate of infections due to eating meat from *M. bovis* infected cattle.

5.11 In the UK human population, most tuberculosis is due to *M. tuberculosis*. Of the average 3,500 bacteriologically-proven human cases per year, between 1 and 1.5% are *M. bovis.* Therefore only around 50 cases are identified as being due to *M. bovis* and most of these are thought likely to be reactivation of disease acquired in the past, rather than cases of new infection. Some of these may have been acquired abroad or be due to other routes of transmission, although there are no firm data on which to base an estimate of these possibilities.

5.12 Other evidence indicates that the cases ascribed to reactivation are likely to have been first acquired many years ago, when human *M. bovis* infections were more frequent. Fewer than 12% of cases in the UK from 1993-2000 were reported in people under 35 years of age – disease in the young is more likely to reflect recent infection. Therefore, if, using a more pessimistic assumption, the overall proportion of cases due to recent infection is estimated to be as high as 25%, the number of new cases of disease will be of the order of 12 per annum.

5.13 It should be noted that only about half of the annual total of notified TB cases in the UK are microbiologically-confirmed. On a worst case basis, therefore, the total number of cases from all members of the *M. tuberculosis* complex could be double the 3,500 microbiologically-confirmed cases. By the same token, the opening figure of 50 cases used for our risk assessment exercise for *M. bovis* could be 100 cases, thus doubling the total number of new cases to 24.

5.14 Even if procedures were introduced in the UK whereby all carcasses known to be from reactor cattle, and from cattle found to have localised tuberculous lesions on routine *post mortem* inspection, were required to be either destroyed or heat treated, it would still not eliminate the hazard entirely. Cattle may have become infected between the time they tested negative to the tuberculin test and the time they were slaughtered. There will be some false negative tests and those carcasses with non-visible lesions are unlikely to be detected at routine *post mortem* inspection. Meat salvaged from reactor cattle in other EU Member States (where controls less stringent than we propose were legally applied) and “exported” to the UK might be *M. bovis*-infected. There is also the possibility of “clean” carcasses becoming cross-contaminated.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 The ACMSF notes that *Mycobacterium bovis* accounts for only between 1-1½% (around 50) of culture-confirmed human tuberculosis in the UK. However, human TB data are based on clinical notifications and only 50% of notified cases are microbiologically-confirmed. There are a number of reasons why diagnosis of *M. bovis* may not be made but it seems likely that failure rates in identifying *M. bovis* TB are low. However, it is important that isolates from all cases of human TB are referred to a Reference Laboratory for identification. **We recommend that the Food Standards Agency should do all that it can through the Department of Health to encourage laboratories to continue to refer all mycobacterial isolates from cases of human TB to a Reference Laboratory for identification.**

6.2 In response to the increase in tuberculosis in cattle the PHLS undertook enhanced surveillance of *M. bovis* disease in humans retrospectively for cases in England and Wales between 1993 and 1997. The available evidence is insufficient to draw firm conclusions regarding risk factors and **we recommend that the Food Standards Agency should, through contact with the Public Health Laboratory Service and the Department of Health, ensure that this enhanced level of surveillance is maintained, and provide support for a long-term analytical study based on the enhanced surveillance; and that the Agency is alerted to any significant trends which emerge which might indicate that eating meat from animals infected with *M. bovis* constitutes a health risk.**

6.3 In Annex D, we provide a comparison of EU and UK legislative requirements for dealing with material from *M. bovis* infected carcasses identified at *post mortem* meat inspection. There are significant differences in the UK and EU legislative requirements for *M. bovis* and these should be removed. **We therefore recommend that UK legislation should be brought fully into line with the requirements of EU Directive 64/433/EEC.**

6.4 ***The ACMSF considers that the risk, if any, from the consumption of meat sold as fresh meat for human consumption following assessment and action by the MHS staff in UK abattoirs is very low. A possible option would therefore be to retain current practices largely unchanged, but with the improvements recommended in paragraphs 4.16-4.18*.**

6.5 In relation to paragraph 4.16, it seems that, while the SVS has complete records of the lesions found in the slaughtered animals, and the culture results, this information cannot be linked back to the judgement and action at *post mortem* meat inspection in the abattoir. That being so, the Committee had difficulty in assessing the effectiveness of *post mortem* meat inspection in removing infected meat from the market. To rectify this omission, **the Committee therefore recommends that the Meat Hygiene Service reviews its record keeping of *post mortem* inspection findings, judgement and action, samples taken, and culture results collated for each animal, as a basis for regularly assessing their performance and the need for any improvements therein.**

6.6 It is noted in paragraph 4.17 that at present there is only guidance in the MHS Operations Manual as to the time when, and in which part of the abattoir, the animals under licence are allowed to be slaughtered. **We recommend that the requirements be reviewed and, in all cases, such animals are either slaughtered last in the day, before the full cleaning and disinfection of the slaughterline, or are slaughtered in a dedicated room in the abattoir.**

6.7 We note in paragraph 4.18 that the practice of collecting samples on the line is difficult to support in microbiological terms, unless the animals are being slaughtered as a defined group. **We recommend that, where an animal is found to have a tuberculous-like lesion at routine *post mortem* meat inspection, that carcass and offal be placed immediately in the detained area before further detailed inspection and before any samples are collected.** The only exception to this rule would be where tuberculous lesions were found in a group of animals being slaughtered at the end of the day where there is full cleansing and disinfection of the slaughter hall immediately afterwards.

6.8 As noted in paragraph 6.4, we consider that the risk, if any, from the consumption of meat sold as fresh meat for human consumption following assessment and action by the MHS staff in UK abattoirs is very low; and that a possible option would therefore be to retain current practices largely unchanged, but with the improvements recommended in paragraphs 4.16-4.18.

6.9 If, however, the Food Standards Agency were to conclude that additional steps should be taken to reduce the very small risk still further, **one option would be to cease to allow meat from reactor cattle with visible lesions or from cattle found to have localised tuberculous lesions on routine *post mortem* inspection to be sold as fresh meat. If, in accordance with the legislation, condemnation of the whole carcass did not occur, the meat should not go for sale as fresh raw meat but could go for manufacture where there was an adequate heat treatment step in the process.**

6.10 As <10% of reactor cattle which have no visible lesions are culture positive, **another option would be to require these to be held in cold storage until culture results were available. Carcasses giving positive results would then be either partially or totally condemned.** We recognise that this option would require cold storage for some 2 months, and the practical implications would therefore need to be carefully assessed.

6.11 In relation to paragraphs 6.9 and 6.10, it should be noted that unpublished DEFRA data suggest that about half of cattle slaughtered under the TB Control Programme are excluded from human consumption under the Over Thirty Months Scheme.

6.12 In the event of adopting the heat treatment or cold storage options, appropriate procedures would clearly be needed for ensuring proper compliance with control arrangements. These would include determining the time and temperature profiles for the heat treatment step. We recognise that there will be an additional cost from cold storage, but we also recognise that there are a number of outlets for frozen meat.

ANNEX A

ADVISORY COMMITTEE ON THE MICROBIOLOGICAL SAFETY OF FOOD

TERMS OF REFERENCE

To assess the risk to humans from microorganisms which are used, or occur, in or on food, and to advise the Food Standards Agency on any matters relating to the microbiological safety of food.

MEMBERSHIP

Chairman

Professor D L Georgala	Independent scientific consultant. Retired Director of the Institute of Food Research.

Members

Dr G R Andrews	Head of Technical Services, Northern Foods plc.
Dr D W G Brown	Director, Enteric, Respiratory and Neurological Virus Laboratory, Central Public Health Laboratory.
Ms S Davies	Principal Policy Adviser, Consumers' Association.
Professor M J Gasson	Head of Food Safety Science Division, Institute of Food Research.
Dr K M Hadley	Senior Lecturer, Department of Immunology and Bacteriology, University of Glasgow. Honorary Consultant in Clinical Microbiology, North Glasgow University Hospitals NHS Trust, Western Infirmary, Glasgow.
Professor T J Humphrey	Professor of Food Safety, University of Bristol.
Professor P R Hunter	Professor of Health Protection, University of East Anglia.
Mrs P Jefford	Environmental Health Services Manager, Gravesham Borough Council.
Professor A M Johnston	Professor of Veterinary Public Health, Royal Veterinary College, University of London.
Mr A Kyriakides	Head of Product Safety, Sainsbury's Supermarkets Ltd.
Ms E Lewis	Computer consultant. Consumer representative.

Professor P Mensah	Head of the Bacteriology Unit, Noguchi Memorial Institute for Medical Research, University of Ghana. Visiting E P Abraham Research Fellow, St Hilda's College, Oxford.
Dr S J O'Brien	Head of Gastrointestinal Diseases Division, Public Health Laboratory Service Communicable Disease Surveillance Centre.
Mr B J Peirce	Hotel owner. Caterer.
Mr D J T Piccaver	Farmer.
Dr Q D Sandifer	Executive Director of Public Health, Iechyd Morgannwg Health Authority.
Professor W C S Smith	Professor of Public Health, University of Aberdeen. Director of the Institute of Applied Health Sciences.
Dr T D Wyatt	Consultant Clinical Scientist, Mater Hospital Trust, Belfast.

WORKING GROUP ON MYCOBACTERIUM BOVIS

TERMS OF REFERENCE

To review the possible health risks associated with consumption of meat from animals with evidence of *Mycobacterium bovis* infection, including animals with no *post mortem* evidence of disease which have reacted positively or inconclusively to the tuberculin test and to advise on the adequacy of current control measures.

MEMBERSHIP

Chairman

Professor A M Johnston	Professor of Veterinary Public Health, Royal Veterinary College, University of London.

Members

Mr M Attenborough	Technical Director, Meat and Livestock Commission.
Dr J P Gallagher	Veterinarian.
Ms E Lewis	Computer consultant. Consumer representative.
Dr M J Painter	Consultant in Communicable Disease Control, Manchester Health Authority.
Dr N A Simmons	Emeritus Consultant in Microbiology to the Guy's and St Thomas' Hospital Trust. Honorary Senior Lecturer in Microbiology, St Bartholomew's and the Royal London School of Medicine and Dentistry.
Professor W C S Smith	Professor of Public Health, University of Aberdeen. Director of the Institute of Applied Health Sciences.
Dr J Watson	Consultant Epidemiologist and Head of Respiratory Division, Communicable Disease Surveillance Centre, Public Health Laboratory Service.
Professor D B Young	Fleming Professor of Medical Microbiology, Imperial College of Science, Technology and Medicine.

Assessors

Miss A Conroy	Food Standards Agency.
Ms J M Downes	Meat Hygiene Service, Food Standards Agency.
Dr R de la Rua	State Veterinary Service, Department for Environment, Food and Rural Affairs.

Secretariat

Medical Secretary
Dr J Hilton

Administrative Secretary
Mr C R Mylchreest

Administrative Secretariat
Miss J Kerr

ANNEX B

SURVEY OF LABORATORY METHODS

All clinical laboratories currently sending mycobacterial cultures to the PHLS *Mycobacterium* Reference Unit and Regional Centres for Mycobacteriology were sent a questionnaire addressed to the Consultant Medical Microbiologist. One hundred and sixty four questionnaires were sent out. The response rate was 54%. Four questions were particularly germane to this review :-

- Culture medium : respondents were asked whether they inoculated sputum or lymph node samples onto Lowenstein-Jensen medium containing glycerol, pyruvate or both, and whether they employed a manual or automated liquid culture system. Sixty-eight (80%) of the laboratories used pyruvate containing media to culture lymph nodes. Of the 18 laboratories that did not, 6 used an automated liquid system, reported to successfully culture *M.bovis* by the manufacturers.

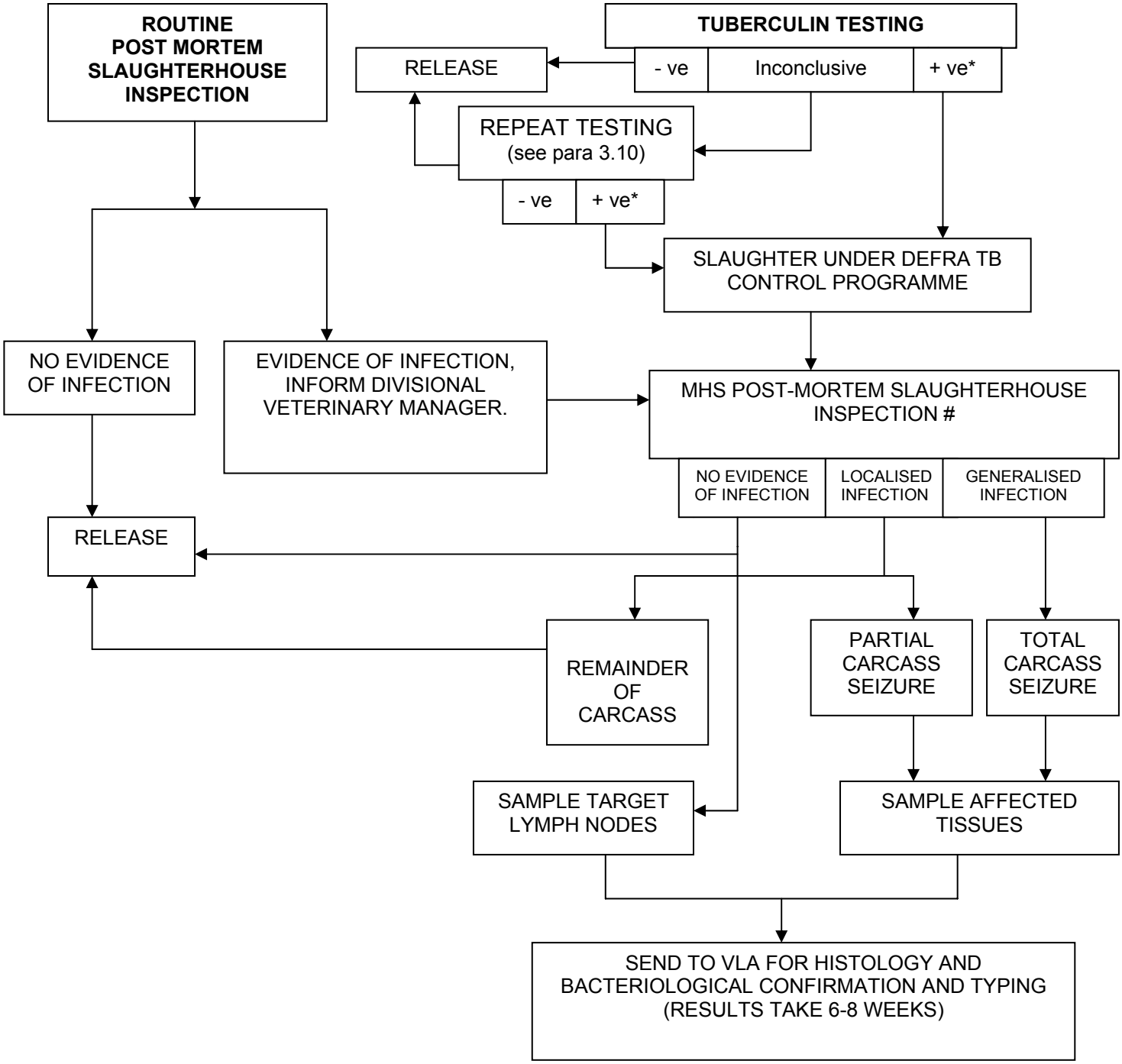
- Duration of culture : respondents were also asked the duration of incubation of their Lowenstein-Jensen slopes. Sputa and lymph nodes were incubated for at least 8 weeks in 51(80%) out of the 64 laboratories which responded to this question. Anything less than this is considered inadequate. Twelve week incubation, which would be considered the gold standard, was performed by 20(34%) of laboratories.

- Formalised specimens : in an attempt to establish the extent of the problem of specimens being received in formalin, laboratories were asked in general terms whether this occurred never, rarely, sometimes or often. Only 4 laboratories reported this as occurring often, and only one reported never receiving a specimen in formalin. The remainder reported that it occurred either rarely or sometimes. While this question does not quantify the problem, it does indicate that it is geographically widespread. Also it does not distinguish between those specimens received after histology departments have suggested a diagnosis of mycobacterial infection, and those formalised as an oversight in the operating theatre.

- Molecular methods : laboratories were asked if they were performing their own molecular analysis. Only 2 were, and these were also sending isolates to the PHLS reference units, which would perform phenotypic identification.

ANNEX C

BOVINE TUBERCULOSIS : TESTING OF CATTLE AND MEAT INSPECTION



* Including direct contacts
# In accordance with Schedule 10 of the Fresh Meat (Hygiene and Inspection) Regulations 1995

ANNEX D

COMPARISON OF EU AND UK LEGISLATIVE MEAT INSPECTION REQUIREMENTS FOR *MYCOBACTERIUM BOVIS*

	EU (Directive 64/433/EEC)	**(UK) Fresh Meat (Hygiene and Inspection) Regulations 1995**
Generalised TB	Total carcass condemnation – includes offal/blood(1)	Total carcass condemnation – includes offal/blood(2)
TB with emaciation	Total carcass condemnation for emaciated animals irrespective of the cause.	Total carcass condemnation – includes offal/blood
Localised TB If an animal is a positive (ie. a reactor), inconclusive reactor or slaughterhouse case	An animal giving a positive (ie. a reactor) or inconclusive test result and, at *post mortem*, either :- (a) localised lesions are found in a number of organs or areas of the carcass; ***ACTION: total carcass condemnation.*** (b) localised lesions are found in the lymph nodes of the same (one) organ or part of the carcass. ***ACTION: condemn the affected organ or part of carcass and the associated lymph nodes.*** If an animal is not a positive (ie. not a reactor) or is not an inconclusive reactor, and lesions are found *post mortem* in a number of lymph nodes or areas of the carcass(3). ***ACTION: judgement made on a case-by-case basis.***	If an animal is a positive (ie. a reactor), an inconclusive reactor or a slaughterhouse case, findings at *post mortem* as below dictate condemnation of affected parts:- (a) any part of the carcass showing localised tuberculosis and any other associated part; (b) The head and tongue where tuberculosis exists in any associated lymph node except where the lesion is small and inactive and the lymph node is not enlarged, in which case only the affected lymph nodes and tissues are condemned; (c) The associated organ/viscera of an affected lymph node; (d) Any meat, offal or blood contaminated with tuberculous material.

(1) "Generalised TB" is not actually defined in the Directive.

(2) "Generalised TB" is defined as:

(a) milliary tuberculosis of both lungs with evidence of tuberculosis elsewhere;
(b) multiple and actively progressive lesions of tuberculosis;
(c) widespread tuberculosis infection of the lymph nodes of the carcass;
(d) diffuse acute lesions of tuberculosis of both the pleura and the peritoneum associated with an enlarged or tuberculous lymph node of the carcass;
(e) active or recent lesions present in substance of any two of :- spleen, kidney, udder, uterus, ovary, testicle, brain and spinal cord or their membranes, in addition to tuberculous lesions in the respiratory and digestive tracts;
(f) in the case of a calf, congenital tuberculosis.

(3) ie. a slaughterhouse case.

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