THE SCOTTISH OFFICE

Welsh Office
Y Swyddfa Gymreig

The Interdepartmental Working Group on Tuberculosis

The Prevention and Control of Tuberculosis in the United Kingdom:

UK Guidance on the Prevention and Control of Transmission of

1. HIV-related Tuberculosis

2. Drug-resistant, Including Multiple Drug-resistant, Tuberculosis

September 1998

The Interdepartmental Working Group on Tuberculosis

The Prevention and Control of Tuberculosis in the United Kingdom:

UK Guidance on the Prevention and Control of Transmission of

1. HIV-related Tuberculosis

2. Drug-resistant, Including Multiple Drug-resistant, Tuberculosis

September 1998

CONTENTS

Summary boxes

EXECUTIVE SUMMARY

1. HIV-related and drug-resistant tuberculosis are separate issues. However, preventing the transmission of tuberculosis infection *to* HIV-infected (and other immunocompromised) individuals and *from* patients with drug-resistant (especially multiple drug-resistant) tuberculosis involves similar considerations. They are therefore covered together in this guidance.

HIV-related tuberculosis

2. Infection with the human immunodeficiency virus (HIV) is a well-recognised risk factor for tuberculosis. In developing countries, tuberculosis is the most common co-infection in people with HIV, and the HIV epidemic has been a major contributing factor to a resurgence of tuberculosis in recent years.

3. In the UK, the overlap between HIV infection and tuberculosis is still relatively small. It is estimated that in 1993 about 2.3% of tuberculosis notifications in England and Wales were HIV-related, the figure being higher for London (4.3%) than outside London (0.8%). In the same year, 1.6% of tuberculosis notifications in Scotland were HIV-related. Looking at it the other way round, data suggest that about 4.6% of HIV-infected individuals in the UK develop tuberculosis. Again, the figure is higher for London (about 6% in 1991) and appears to be increasing.

4. Tuberculosis in patients with co-existing HIV infection may develop more rapidly and present in an atypical way, but there is no evidence that it is more infectious than tuberculosis in HIV-negative individuals and it can generally be treated following standard treatment protocols. More stringent infection control measures are recommended in HIV settings to prevent HIV-infected individuals being exposed to tuberculosis infection because of their greatly increased risk, once infected, of developing tuberculosis.

Drug-resistant tuberculosis

5. Drug-resistant tuberculosis has been recognised since chemotherapy for tuberculosis first became available when it soon became evident that resistance rapidly emerged unless a combination of anti-tuberculosis drugs was used in treatment. In recent years drug resistance has increased in many countries, mainly as a result of poor treatment, and the prevalence of multiple drug-resistant strains (those resistant to rifampicin and isoniazid, the two most useful drugs for treating tuberculosis, with or without resistance to other drugs) has increased.

6. Drug resistance in the UK, where standard treatment protocols have been in place for many years, is still relatively rare. In 1996, in England and Wales, 6.1% of initial isolates of *M. tuberculosis* (the first isolate in a disease episode) were resistant to isoniazid and 1.8% were resistant to rifampicin; 1.6% were multiple drug-resistant. Nonetheless, this represents a small

but significant increase since 1993.

7. Prevention of the emergence of drug resistance is one of the stated aims of national tuberculosis policy[1], but it may still occasionally emerge during treatment and it is inevitable that some patients will be seen in the UK with drug-resistant infection which was acquired abroad.

8. All drug-resistant tuberculosis is more difficult to treat than drug-sensitive disease: few alternative drugs are available and they are less effective and more often associated with side effects than the standard drug regimens. Treatment therefore also takes longer. Multiple drug-resistant disease is particularly difficult to manage and generally carries a higher mortality. These more serious consequences of infection make prevention of transmission of infection to others vital.

9. HIV infection of itself does not increase the risk of an individual with tuberculosis developing drug resistance, but should an HIV-infected individual acquire infection with a drug-resistant organism, as with drug-sensitive organisms it is more likely to progress to active disease than it is in an immunocompetent person. In the UK, the incidence of isoniazid resistance is increased in HIV-infected patients, and the two nosocomial outbreaks of multiple drug-resistant tuberculosis which have occurred affected mainly HIV patients.

KEY POINTS

10. General guidance on tuberculosis control and detailed guidance on the drug treatment of tuberculosis are published elsewhere[1, 2, 3].

11. Key elements in the control of tuberculosis are the prompt recognition, confirmation and treatment of cases, and the institution of certain infection control measures to reduce airborne spread of infection from infectious patients to others. Effective control requires a team approach. Decisions in this area are often difficult. Making them, implementing them and avoiding misunderstandings will be more easily achieved through close working relationships, between health care workers, and between all involved in the care of an individual patient, in particular between the TB physician, HIV physician, microbiologist, hospital infection control doctor and team, TB nurse specialist and the consultant in communicable disease control (who has overall responsibility for tuberculosis control). Lapses usually involve a 'human fallibility factor' which these recommendations aim to minimise.

12. The guidance in this document aims to minimise the risk of transmission of tuberculosis in HIV settings, and of drug-resistant tuberculosis, especially in healthcare facilities, by addressing those factors previously reported as having contributed to the transmission of infection[4], namely:

- delay in considering the diagnosis of tuberculosis;
- delay in confirming the diagnosis;
- delay in considering and establishing drug-resistance;

- delay in starting treatment;
- treatment with inappropriate drugs (and dosages);
- default from treatment;
- lapses in isolation (eg inappropriate accommodation taking into account the infectiousness or likely infectiousness of the case, the immune status of the surrounding patients/contacts, and any suspected or confirmed drug resistance; the patient wandering from an isolation room into other patient areas; inadequate or incorrect ventilation of isolation rooms);
- performance of aerosol-generating procedures on a patient with (sometimes unsuspected) pulmonary tuberculosis in an open ward containing immunocompromised patients.

13. As a general principle, all patients with suspected or confirmed pulmonary tuberculosis should be considered potentially infectious until proven otherwise and patients with potentially infectious tuberculosis and individuals infected with HIV should not mix.

14. All hospitals caring for patients with tuberculosis should develop and implement a tuberculosis control plan, based on a risk assessment for the transmission of tuberculosis (including HIV-related and drug-resistant tuberculosis) in all patient areas, including out-patient clinics. The risk assessment should also inform decisions about the number and type of isolation facilities for which access will be required.

15. This guidance also addresses measures for the protection of health care workers and other contacts.

1. INTRODUCTION

1.1 The Interdepartmental Working Group on Tuberculosis (IDWGTB) published general guidance on the prevention and control of tuberculosis at local level in June 1996[1]. Tuberculosis in settings where HIV-infected (or other immunocompromised) patients are cared for, and drug-resistant, especially multiple drug-resistant, tuberculosis present particular problems. In response to demand from the NHS, the IDWGTB established a further Expert Working Group in January 1996 to prepare more detailed guidance covering these two areas. The remit and membership of the Group are at Annex A. The guidance re-iterates and builds on the earlier guidance. It is written primarily for health care professionals, but is intended also to provide the information from which others, including voluntary organisations, can develop guidance relevant to their own needs, in consultation with their own specialist advisers.

1.2 There is now ample evidence that outbreaks of tuberculosis among HIV-infected individuals, and of drug-resistant tuberculosis, result largely from lapses in basic infection control practices. Nonetheless, these guidelines recommend more stringent infection control measures for tuberculosis patients in HIV settings (and settings where other immunocompromised patients are cared for) and for all patients with multiple drug-resistant tuberculosis (MDR-TB), than are recommended in the general guidance. This is because of the more serious consequences of transmission of infection in these circumstances. Many of the infection control issues are common to the two situations and it is for this reason that they are considered together in this document. The guidance relating to HIV-infected individuals should be taken also to refer to other severely immunocompromised patients throughout.

1.3 The guidance is based on evidence wherever possible, although unequivocal evidence was often not available. The emphasis for infection control is on the need for the development and implementation of policies based on local risk assessment, taking into account factors relating both to the patient with tuberculosis and to others with whom the patient may come into contact, be it in hospital or the community.

2. EPIDEMIOLOGY

Tuberculosis in the UK

2.1 The incidence of tuberculosis in the UK was at its highest at the beginning of the 19th century. It had fallen considerably even before the introduction of specific anti-tuberculosis measures such as chemotherapy (in the 1940s) and BCG immunisation (in the 1950s) helped to hasten the decline. Some slowing of the decline occurred in the 1960s in association with substantial immigration from parts of the world with high rates of tuberculosis, such as the Indian sub-continent, although the incidence in the majority white population continued to decline.

2.2 The overall decline in tuberculosis notifications ceased in the late 1980s and was followed by small increases. Several factors are thought to have contributed, including improved case ascertainment, demographic change (especially an ageing population), continued high rates of tuberculosis among new immigrants and the effects of poverty and homelessness, as well as, to a relatively small extent, the HIV epidemic[5-8].

The epidemiology of tuberculosis and HIV infection in the UK

2.3 Various studies have attempted to estimate the extent of the overlap between tuberculosis and HIV infection in the UK. Using a register-matching technique, only one of 3,002 patients (0.03%) reported in the 1983 Survey of Tuberculosis Notifications in England and Wales was known to be infected with HIV, compared with 9 of 2,163 patients (0.42%) in the 1988 survey[9]. In the 1993 National Survey of Tuberculosis Notifications, 2.3% of adults (16-54 years) notified with tuberculosis in England and Wales were estimated to be HIV-infected[10]; the corresponding figure for Scotland was 1.6%. Under-notification of tuberculosis in patients with HIV infection may mean that these figures underestimate the true prevalence.

2.4 In the 1993 survey, the prevalence of HIV infection in adults with tuberculosis was higher in males than in females (2.5% and 1.3% respectively) and higher in London than outside London (4.3% and 0.8% respectively); it was lower in the Indian subcontinent ethnic group (0.4%), but higher in those classified as 'other' ethnic groups (6.0%), than in the white ethnic group (1.6%).

2.5 In a study reported in 1990, 6% of a cohort of over 200 AIDS patients in London had developed tuberculosis[11]. Another study found that of 4,360 patients with AIDS reported to the PHLS AIDS Centre by 30 June 1991, 200 (4.6%) were reported to have had tuberculosis[9].

Drug-resistant tuberculosis in the UK

2.6 Most hospital laboratories in England and Wales submit isolates of *M. tuberculosis* to one of the PHLS Regional Centres for Mycobacteriology, or the Mycobacterium Reference Unit, for speciation and drug susceptibility testing. In Scotland, isolates are sent to the Scottish Mycobacteria Reference Laboratory. Between 1982 and 1991, of approximately 2,000 initial isolates of *M. tuberculosis* submitted each year to the PHLS laboratories, 10% were resistant

to one or more first line anti-tuberculosis drugs, including 6% resistant to isoniazid (with or without resistance to other drugs) and 0.6% resistant to isoniazid and rifampicin (with or without resistance to other drugs)[12]. No increasing trend was apparent. The National Surveys of Tuberculosis Notifications in 1978/79, 1983 and 1988 also examined the occurrence of drug resistance but in previously untreated patients with pulmonary disease only[13-15]. Rates were found to be very low with no increasing trend, but were higher in immigrant groups than in the indigenous white population.

2.7 With the emergence of drug resistance in tuberculosis as a problem world-wide[16], the PHLS, in co-operation with the Scottish Mycobacteria Reference Laboratory, has instituted an active surveillance scheme for drug resistance - the UK Mycobacterial Resistance Network (MYCOBNET). Data from this scheme show that between 1993 and 1996 initial resistance to isoniazid (with or without resistance to other drugs) increased from 4.6 to 6.1% and resistance to rifampicin increased from 0.6% to 1.8%. Multiple drug-resistance (resistance to isoniazid and rifampicin with or without resistance to other drugs) was found in 0.6%, 1.3%, 1.5% and 1.6% of initial isolates in 1993, 1994, 1995 and 1996 respectively (including PHLS unpublished data). It is not known how many of these patients had a history of previous treatment.

2.8 Resistance to isoniazid in 1996 was higher in England (6.5%) than in Scotland (3.6%), Wales (3.7%) or Northern Ireland (3.4%). In the English regions, isoniazid resistance was highest in the South and West (8.7%) and the two Thames regions (North Thames 7.4%, South Thames 7.3%). Isoniazid resistance in the remaining regions ranged from 4.0-6.7%. Resistance to isoniazid was higher in patients born abroad, but place of birth was reported in only 25.8% of cases. Resistance to isoniazid, to any first line drug, and to more than one first line drug, was highest in those of black African ethnic origin and lowest in those of white ethnic origin. In 1994, isoniazid resistance was higher in the 180 patients reported to be HIV seropositive (11.1%) than in the 3,106 patients in whom HIV status was not reported (5.4%).

2.9 These results suggest a small but significant increase in the number of drug-resistant cases of tuberculosis in the UK in recent years but this will need to be confirmed by further monitoring by the MYCOBNET system over the next few years. The results are consistent with the general increase in the proportion of tuberculosis in England and Wales in individuals from ethnic minority populations among whom drug resistance is recognised to be more common. The suggestion of higher rates of drug resistance in the HIV-infected group, which echoes results from several other European countries (unpublished data), requires careful monitoring.

Tuberculosis in the United States and Europe

2.10 In the United States (US) a decline in reports of tuberculosis cases this century ceased in the mid-1980s and was followed by small increases, which then levelled off[17]. The increases in the US have been attributed to a combination of the HIV epidemic and disintegration of public health programmes providing tuberculosis treatment services[18]. In a number of other western European countries a cessation of the former decline was also seen in the late 1980s and early 1990s[19]. In France, Italy and Spain, the HIV epidemic is thought to have been responsible, whereas high rates among new immigrants have been a more important cause in most other European countries.

Outbreaks of HIV-related and drug-resistant tuberculosis

2.11 Outbreaks are a well recognised feature of the transmission of tuberculosis in the community, usually arising as a result of infection from a patient with sputum smear-positive pulmonary disease and a cough. Outbreaks of drug-resistant tuberculosis have also occurred from time to time since the introduction of anti-tuberculosis drug therapy[20-22]. Following the advent of the HIV epidemic, and the assembling of immunocompromised HIV-infected patients in institutions such as hospitals (sometimes referred to as 'immunocompromised convergence'), there was a large increase in the number of reported tuberculosis outbreaks in the late 1980s and early 1990s, particularly in the United States but also in Europe. Outbreaks of both drug-sensitive[23-25] and drug-resistant tuberculosis[26-30] occurred, and in settings such as prisons and residential facilities as well as hospitals[31-34]. They have mainly, but not exclusively, affected HIV-infected individuals, and transmission to health care workers has been demonstrated[35-37].

3. TRANSMISSION OF M. TUBERCULOSIS AND FEATURES RELEVANT TO HIV-RELATED AND DRUG-RESISTANT TUBERCULOSIS

Transmission of tuberculosis

3.1 Tuberculosis is spread person-to person almost exclusively by the respiratory route. When a person with infectious pulmonary or laryngeal tuberculosis coughs (or talks, sneezes, shouts or sings) he/she produces airborne particles of different sizes (respiratory droplets) which contain tubercle bacilli. The larger droplets quickly settle onto surfaces where they aggregate with dust and are not involved in respiratory transmission. Even if briefly resuspended by air currents produced by normal room activity, they remain too large to be able to carry tubercle bacilli into the alveolus of the lung on inhalation. (There is no evidence that *M. tuberculosis* can be transmitted by dust particles or by fomites). Smaller respiratory droplets evaporate almost immediately to leave 'droplet nuclei' of approximately 1 to 5 microns (µm) in diameter which are the infectious units of tuberculosis. An individual becomes infected as a result of inhaling droplet nuclei into the alveoli. Normal air currents keep droplet nuclei airborne for long periods and can spread them throughout a room or building. Ventilation normally dilutes them, however, and fairly prolonged close contact (living in the same household or equivalent) with an infectious person is generally required for transmission to occur.

3.2 The acquisition of tuberculosis *infection* is not necessarily followed by tuberculous *disease*. One of three courses may follow:

i. the infection may heal spontaneously;

ii. over weeks or months active disease may develop;

iii. the infection may be contained and remain inapparent ('latent' or 'dormant'), sometimes for many years, but become active later in life (reactivate) especially if the person becomes debilitated or immunocompromised.

In the general population, there is an estimated 10% lifetime risk of tuberculosis infection, once acquired, progressing to tuberculous disease[38].

Features relevant to HIV-infected individuals

3.3 Tuberculosis in an HIV-infected individual may result from recent infection or re-infection or from reactivation of previous infection[39].

3.4 Although probably no more likely than an HIV-negative person to acquire infection following exposure to *M.tuberculosis*, HIV-infected individuals are at significantly increased risk of infection progressing to active tuberculous disease. Studies suggest that the risk is about 5-10% per year with a lifetime risk of over 50%[40].

3.5 HIV infection alters not only the risk, but the characteristics of tuberculosis, making diagnosis more difficult. Pulmonary tuberculosis may present with non-specific features, including bilateral, unilateral or lower zone shadowing. Pleural and pericardial disease are more common[41-43], and extrapulmonary tuberculosis, particularly disseminated disease and mycobacteraemia, is more frequent. Some studies have suggested that HIV-infected patients with pulmonary tuberculosis are more likely to have sputum smear negative disease, although others have failed to confirm this[39, 44-47].

3.6 Pulmonary tuberculosis tends to occur earlier in the course of HIV infection than other HIV-related infections, when CD4 counts are relatively high (250-500/uL)[47]. The full range of tuberculous disease, including disseminated extrapulmonary and miliary tuberculosis, becomes more common as the CD4 count falls[48].

3.7 The development of anergy in HIV infection may suppress the tuberculin skin reaction, making it unreliable as a diagnostic test for tuberculosis.

The effect of tuberculosis on HIV infection

3.8 There is some evidence that the development of tuberculosis in an HIV-infected individual has an adverse effect on the progression of the HIV infection[49, 50]. Tuberculosis infection can lead to an increase in viral load with the potential to worsen HIV disease, mediated by the release of cytokines[51]. The CD4 lymphocyte count may fall during tuberculosis infection and rise again with treatment of the tuberculosis[52, 53]. This makes the early diagnosis and treatment of co-infected individuals even more important.

The infectiousness of tuberculosis in HIV-infected individuals

3.9 An individual with tuberculosis is no more infectious by virtue of the co-existence of HIV infection. There is no evidence that HIV-infected individuals with tuberculosis cough up more viable bacteria, nor that with appropriate treatment the duration of production of viable bacteria is greater. However, the more rapid progression to active tuberculosis following primary infection is likely to increase the pool of infection that others may be exposed to. This is especially serious if, as is often the case, the contacts include other HIV-infected individuals.

Response to treatment

3.10 Tuberculosis in HIV-infected patients is treated using standard six month drug treatment regimens, unless, as for non-HIV-infected patients, there is a medical indication for a different course of action[3]. Some important drug interactions need to be taken into account[3].

BCG immunisation and HIV-related tuberculosis

3.11 BCG immunisation has been shown to offer about 70% protection from tuberculosis in UK teenagers, lasting at least 15 years. BCG is probably less effective in HIV-infected individuals and, by analogy with natural infection, any immunity from a previous BCG can be expected

to wane as the CD4 count falls. In the UK, BCG, which is a live vaccine, is contra-indicated in HIV-infected individuals: as the UK is a low prevalence country for TB, any benefit of the vaccine is thought to be outweighed by the risk of a serious disseminated BCG reaction, even though this risk is small.

Features relevant to drug-resistant tuberculosis

3.12 Drug-resistant organisms initially emerge as a result of inadequate treatment of drug-sensitive disease, either through incorrect prescribing, poor quality or poor absorption of drugs or poor compliance with treatment. The emergence of drug resistance is more likely where the bacterial load is high, such as in extensive or cavitatory pulmonary disease.

Infectiousness of drug-resistant tuberculosis

3.13 Drug-resistant organisms, once emerged, can be passed to other people as described in 3.1 above. There is no evidence that drug-resistant tuberculosis, including MDR-TB, is more infectious than drug-sensitive disease, although because the available treatment regimens are less effective, patients with MDR-TB are likely to be infectious for a longer period of time.

Treatment of drug-resistant tuberculosis

3.14 Drug-resistant tuberculosis is more difficult to treat than drug-sensitive disease. Few alternative drugs are available and they tend to be more commonly associated with adverse reactions and less effective (so that treatment needs to be longer). Inappropriate treatment, for example through failure to recognise drug-resistance promptly, may result in the selection of further drug resistances, making treatment even more difficult.

BCG immunisation and drug-resistant tuberculosis

3.15 In immunocompetent individuals there is no reason to believe that the protection afforded by BCG against drug-resistant disease will be any different from that against drug-sensitive disease.

4. PRINCIPLES OF THE CONTROL OF HIV-RELATED AND DRUG-RESISTANT TUBERCULOSIS

4.1 The earlier guidance from the IDWGTB outlines the principles of tuberculosis prevention and control[1]. As tuberculosis is spread almost exclusively by people with active pulmonary disease who have visible tubercle bacilli in their sputum when examined under a microscope (sputum smear positive) and who cough, the two overarching objectives of tuberculosis control are:

i. to reduce the pool of infectious individuals - by identifying and treating people with active disease as early as possible, first to render them less infectious and then to cure them;

ii. to reduce the spread of infectious airborne droplets while patients with tuberculosis are still infectious, by infection control measures.

4.2 Infection control requires that an individual with an infectious disease, and those responsible for the management of such an individual, take reasonable precautions to prevent transmission of the infection to susceptible individuals. The extent of such precautions depends on the risk of infection being transmitted and the consequences of infection.

4.3 Since the consequences of transmission of infection with *M. tuberculosis* are greater if the individual affected is HIV-infected, or if the infecting organism is drug-resistant, greater care should be taken to reduce the risk of transmission of infection in these circumstances. *As a general principle, patients with infectious or potentially infectious tuberculosis should not mix with immunocompromised patients (especially those infected with HIV) and should not be managed on the same ward (or wing, where wings of a ward are separated by doors and a corridor) other than in an appropriate negative pressure isolation room.*

4.4 Tuberculosis requires at least six months' treatment with a combination of drugs. Incomplete or inappropriate treatment may lead not only to recurrence of illness in the individual, but also to the emergence of drug-resistant strains of *M.tuberculosis* which are difficult to treat and may be passed on to others. (Anti-tuberculosis drugs should now be prescribed as combined preparations wherever possible so that the patient cannot take one drug without the other(s).)

4.5 Tracing contacts of an infectious case, and their appropriate investigation and management, is an integral part of tuberculosis control.

4.6 Important lessons can be learned from previous outbreaks of HIV-related and drug-resistant tuberculosis[4, 20-37, 54]. These have identified the following as having been important contributory factors:

- a low index of suspicion for tuberculosis
- prolonged infectiousness due to delays in diagnosis

- delays in establishing drug susceptibility/resistance patterns
- delays in the initiation of effective treatment
- inadequate infection control measures, especially
- lapses in respiratory isolation
- inadequate ventilation in respiratory isolation rooms
- convergence of immunocompromised patients.

5. IDENTIFICATION OF PATIENTS

Box 1 Initial assessment of patients with suspected tuberculosis

i. Diagnosis - Does the patient have tuberculosis?

Suspected:	clinical symptoms and/or signs suggestive of the diagnosis of tuberculosis, with or without microbiological/histological support (a high index of suspicion should be maintained in HIV-infected individuals with respiratory symptoms, remembering that TB may co-exist with other infections).
Confirmed:	culture positive disease

ii. Infectiousness - Is the patient with suspected or confirmed tuberculosis likely to be infectious to others?

Infectious:	sputum smear positive pulmonary disease (for suspected pulmonary disease, assume infectious until proven otherwise) disease of the airway
Potentially infectious:	sputum smear negative pulmonary disease in which one or more cultures positive or culture result not yet known
Non-infectious:	sputum smear negative, culture negative pulmonary disease non-pulmonary disease (for exceptions - see text)

iii. Drug resistance - Is the patient with suspected or confirmed tuberculosis likely to have drug-resistant disease?

Suspected drug resistance:	previous treatment for tuberculosis contact of patient with known drug-resistant disease likely to have acquired infection in a country with a high prevalence of drug resistant tuberculosis HIV-infected failure of clinical response to treatment prolonged smear or culture positive while on treatment
Drug-resistant:	drug resistance to one or more first line anti-tuberculosis drugs confirmed by conventional or molecular techniques

5.1 The early identification and treatment of tuberculosis, particularly sputum smear positive tuberculosis, is recognised as the single most important means of controlling tuberculosis. The early recognition of drug resistance is vital. Clinicians need to ask three questions (Box 1):

i. Does the patient have tuberculosis?

ii. If so, is the patient likely to be infectious?

iii. Is the patient likely to have drug-resistant tuberculosis?

Does the patient have tuberculosis?

5.2 Tuberculosis should be suspected in any patient, regardless of HIV status, with a cough without other cause lasting more than three weeks with or without weight loss, anorexia, fever, night sweats or haemoptysis.

Recognition of tuberculosis in HIV-infected individuals

5.3 It has been recommended that assessment of all HIV-infected individuals at the time of their HIV diagnosis should include as a baseline[55]:

a. a full history (including past TB and BCG immunisation history) and a chest radiograph;

b. a tuberculin skin test;

c. a peripheral blood CD4+ T-lymphocyte cell count; *and*

d. if the tuberculin test is negative and/or the CD4+ cell count below 200, skin testing with other recall antigens (although patients may become anergic with CD4+ counts as high as 400).

5.4 HIV-infected individuals should have regular follow-up, with chest X-rays as appropriate, but as tuberculosis may progress rapidly, it is important that they are also advised of symptoms to look out for and asked to attend urgently if such symptoms develop between follow-up appointments. They should be encouraged to have a role themselves in early diagnosis.

5.5 Respiratory symptoms are very common in HIV-infected individuals, but tuberculosis should be considered every time they develop respiratory symptoms or signs. Persistent cough, night sweats, weight loss, anorexia and fever are all compatible with, but not specific for, tuberculosis.

5.6 Establishing a diagnosis of tuberculosis in people with HIV infection who have a significant degree of immunosuppression may be difficult: the presentation of tuberculosis in such people is often atypical and may mimic or co-exist with opportunistic infections, particularly *Pneumocystis carinii* pneumonia. Chest X-rays may not show the classical changes of tuberculosis, and a higher percentage of sputum smear negative cases may occur (which are

subsequently positive on culture). Tuberculin skin tests may be non-reactive.

5.7 An immediate sputum sample, and at least two early morning sputum samples taken on consecutive days, should be obtained from patients with suspected pulmonary tuberculosis and sent without delay for mycobacterial stain, culture and drug susceptibility testing. Specimens obtained in hospital should be sent to the laboratory on the day of expectoration. The quality of sputum samples is crucial: if the specimen is mainly saliva, a negative result may lead to an underestimate of the infectiousness of the patient. Quality may be influenced by the technique used by the patient to expectorate spontaneously. Samples obtained by sputum induction may also be watery and resemble saliva; the laboratory should be informed that the sample was induced. Results may also be affected by any delay in collecting and processing the specimens, as well as by the expertise of the laboratory. All smears should be examined in the laboratory on the day of receipt and positive results telephoned to the clinician, infection control team and usually also the TB nurse specialist. However, the clinician should not assume that no telephoned result means that it is negative. The possible use of more rapid diagnostic tests in an individual patient should be discussed with the microbiologist (see also 6.8).

5.8 Mycobacterial culture of bone marrow, faeces, blood or other fluids may be appropriate in individual cases.

5.9 Confirmation of an alternative diagnosis may not exclude the diagnosis of tuberculosis as they may co-exist. A response to treatment for an alternative diagnosis makes tuberculosis less likely, but symptomatic improvement can sometimes be misleading - steroids, for example, given for another disease, may also have a positive effect on some aspects of tuberculosis such as meningitis.

Is the patient likely to be infectious?

5.10 A practical approach to whether a patient should be considered infectious on presentation is in Box 1. Any patient with suspected or confirmed pulmonary tuberculosis, or tuberculosis of the larynx or respiratory tract, and all patients with sputum smear positive pulmonary disease, must be assumed to be infectious until proven otherwise. This is so regardless of the patient's HIV status.

5.11 Three negative sputum smears on consecutive days makes infectious tuberculosis unlikely, but if there are still clinical grounds to suspect it, the patient should continue to be treated as infectious until further investigations clarify the situation. Molecular techniques such as PCR can be used if available, but their appropriateness and the interpretation of the results must be discussed with the microbiologist. PCR results do not equate with smear results as far as infectiousness is concerned (nor does a negative PCR result rule out active tuberculosis).

5.12 Patients with suspected or proven pulmonary tuberculosis who are sputum smear negative (as defined above), can be regarded as non-infectious for most practical purposes but must still be considered a potential risk to immunocompromised contacts until the sputum cultures are known to be negative.

5.13 Patients with extrapulmonary disease, including respiratory extrapulmonary disease such as

pleural effusion, can be considered non-infectious other than in exceptional circumstances such as an open abscess or other lesion in which the concentration of organisms is high and drainage from the lesion extensive. A significant percentage of HIV-infected patients with extrapulmonary tuberculosis have concomitant pulmonary disease and, consequently, may be infectious.

5.14 The criteria described above apply to the assessment of patients when they first present, and when patients who are established on anti-tuberculosis treatment re-present. *Greater caution is required for patients who have, or have had, multiple drug-resistant tuberculosis: such patients may be intermittently sputum positive for a prolonged period and must be assumed to be infectious on every new admission until the physician in charge of their tuberculosis treatment and the infection control doctor have assessed them as being non-infectious.*

5.15 More stringent criteria for non-infectiousness may also be required when considering termination of isolation or discharge from hospital for a patient with previously infectious tuberculosis, depending on the setting they are to move to. This is dealt with in more detail at 7.27-7.40.

Is the patient with suspected or confirmed tuberculosis likely to have drug-resistant disease?

5.16 Any of the following factors should increase suspicion that a patient might have drug-resistant tuberculosis:

i. Any past history of tuberculosis, particularly if there has been erratic or incomplete tuberculosis treatment recently or in the past.

ii. Contact with a person with known drug-resistant disease.

iii. Birth, travel or residence in an area with a high prevalence of drug resistance, eg countries in Asia, Africa, Latin America and Southern and Eastern Europe.

iv. HIV infection.

v. Failure to respond clinically to a standard treatment regimen, eg temperature still elevated after two weeks' treatment.

vi. Persistently positive sputum smears after two months' anti-tuberculosis treatment, or positive sputum culture after three months' treatment.

5.17 *For infection control purposes*, patients who are thought to have acquired infection from an index case with known multiple drug-resistant disease, and those who have failed to respond to standard treatment taken compliantly, should be assumed to be multiply drug-resistant until drug susceptibility test results are available.

Box 2 Minimum data required on test request form

Hospital Attended:

Patient Surname (or unique patient identifier):

Forenames:

DOB: Sex: Hospital Number:

Consultant: Location (ward/OP/GP etc):

Specimen: Site of Lesion:

Main Clinical Features:

Tests Requested: Previously Tested:

Features suggesting the need for rapid/more extensive tests, eg:

i. previous history of TB

ii. previous drug treatment for TB

iii. contact of known drug resistant TB

iv. recent immigrant from area with high prevalence of drug resistant TB

v. immunocompromised (eg HIV+ve, transplant patient, immunosuppressive drugs)

6. LABORATORY DIAGNOSIS

6.1 The laboratory has a vital role in the early identification and treatment of all patients with tuberculosis, in their longer term management, particularly for MDR-TB, and in infection control. Investigations assist in confirming the diagnosis, determining infectiousness and assessing the drug susceptibility pattern. Diagnostic tests should be performed in laboratories which have appropriate facilities and expertise and a good quality assurance record for mycobacteriology. Further details about mycobacteriology laboratory organisation, safety and services are in Annex B.

6.2 Clinicians and the microbiologist in the primary laboratory, i.e. where smears are examined and, usually, cultures are inoculated and incubated, should have a close working relationship and an appreciation of the practical constraints and difficulties of the others' practice to minimise the potential for poor communication, delay or confusion.

Test requests

6.3 As with all laboratory testing, the quality of investigation is related to the quality of the specimen and the request. The test request constitutes a request for a professional opinion on a technical, scientific and clinical level and for all patients with suspected mycobacterial disease the minimum data required to ensure a full range of appropriate tests with timely and complete reporting is given in Box 2.

6.4 In some circumstances, cultures of blood, other fluids, bone marrow or faeces may be appropriate in addition to, or as an alternative to, sputum.

Tests available

6.5 Available tests, their uses, advantages and disadvantages, are summarised in Box 3.

6.6 Microscopic examination of direct smears for acid fast bacilli, although less sensitive than culture, remains a key test in the diagnosis and control of tuberculosis. Microscopy results should be available within one working day and positive results should be telephoned to the clinician in addition to sending a written report. It is good practice for the laboratory also to inform, by local agreement, the CCDC/CPHM, TB nurse specialist and, for in-patients, the infection control team. The sensitivity of the test may be increased by concentration of secretions (if this has been done it should be noted on the report as, for infection control purposes, a positive result using this technique is not strictly equivalent to a positive unconcentrated smear).

6.7 All specimens should also be cultured and all positive cultures identified and tested for drug susceptibility. Provisional identification of positive cultures may be possible based on colonial appearance, growth characteristics and from the appearance and staining of a smear of the

growth. Formal identification and susceptibility tests are usually performed at one of the mycobacterial reference laboratories (Annex F). Conventional drug susceptibility tests are performed on cultures on solid media.

6.8 More rapid tests are now available for screening specimens, culture and identification, and may be able to give an early indication of likely drug resistance. They are more expensive and most are not routinely available except at specialised centres. The appropriateness of their use should be discussed with the microbiologist on a case by case basis. Some of the criteria for consideration are listed in Box 4. In all cases where drug resistance is suspected, faster testing should be considered and susceptibility tests set up against additional antibiotics at the outset, rather than waiting for the results of testing first line agents (see Annex B for further details). Accurate and complete clinical information must be included on the specimen request if the most appropriate investigations are to be performed.

6.9 References 56-67 are provided for further reading.

Box 3. Laboratory tests for mycobacteria

1. Tests for detection

Microscopy

Screening test for most specimens (though not usually performed on urine or stools). Result should be available within one working day.

Auramine phenol stain: Sensitive (and preferred) screening test. Simple to perform and permits more rapid examination of a smear but requires fluorescent microscopy and not easy to perform out-of-hours. Less specific for mycobacteria than ZN stain. Usual to confirm results by overstaining with ZN.

Ziehl-Neelsen (ZN) stain: Traditional stain for acid-fast bacilli. Alternative to, and usually used to confirm, positive auramine phenol smears.

Rapid molecular methods

DNA/RNA amplification tests eg PCR: Expensive - need should be discussed with laboratory/reference centre. Less sensitive than culture. For sputum, relation to infectivity not determined. *NB: all specimens, including negative ones, still require culture - a negative PCR does not exclude TB and a positive PCR does not indicate the drug susceptibility profile.* Most systems identify M.tb only.

Culture

Essential for confirmation, identification and for drug susceptibility testing

Solid media (eg Lowenstein-Jensen): Conventional method. Slow (several weeks), although some strains more rapidly growing than others. May allow provisional identification from macroscopic and microscopic appearance.

Liquid media, with radiometric/non-radiometric growth signalling mechanisms: More rapid (7-28 days) and slightly more sensitive for M.tb than solid culture but more expensive. Identification from macroscopic and microscopic appearance unreliable.

Box 3. continued

2. Tests for identification

Routine

Based on morphological, growth & biochemical characteristics. Tests usually performed at PHLS reference centres, and at the Scottish MRL.

Rapid, using gene probes

Mainly applicable to *M.tb* & *M. avium*. Test available only after discussion. Results usually available within 2-4 hrs of receipt of culture.

Novel molecular typing techniques *eg RFLP, spoligotyping*

Specialist and research tools. Usually require culture of organism. Increasingly being used to investigate clusters and related cases.

3. Drug susceptibility tests

Routine

Performed on cultures on solid media. Usually available within 10-21 days of receipt of isolate. Can be set up at the same time as routine culture for speciation to save time.

More rapid

Performed using culture in liquid media, eg automated BACTEC, microbroth dilution, non-radiometric growth systems. Molecular detection of rifampicin resistance now available through reference laboratories. More expensive.

Box 4 Criteria for consideration of rapid direct amplification tests and (liquid medium) culture methods for mycobacteria

1. Suspected drug-resistant disease

   i. History of previous anti-tuberculosis treatment in or outside the UK

   ii. Source case thought to be drug-resistant

   iii. Infection likely to have been acquired in a geographical area where drug resistance is common

   iv. Failure to respond to standard treatment regimen

   v. Immunocompromised (eg HIV-infected, transplant, on immunosuppressive treatment)

2. On the specific request of the clinician in consultation with the laboratory, where rapid diagnosis is particularly desirable because of diagnostic or therapeutic problems in an individual patient.

BOX 5. ***Minimum*** **requirements for the isolation of patients with suspected or proven tuberculosis**

Type of patient/contacts	Infectious	Potentially Infectious*	Non-infectious
Drug-sensitive disease			
Other patients Immunocompetent	Single room	Open ward	Open ward
Other patients immunocompromised	Negative pressure room†	Single room	Open ward
Drug-resistant disease			
Other patients Immunocompetent	Single room	Open ward	Open ward
Other patients immunocompromised	Negative pressure room†	Single room	Open ward
MDR-TB			
Other patients Immunocompetent	Negative pressure room	Single room	Open ward#
Other patients immunocompromised Negative pressure room	Negative pressure room†	Negative pressure room	Single room

* 'Potentially' infectious = three negative consecutive smears but one or more cultures positive or culture unknown/awaited.

† Room with continuously and automatically monitored negative pressure.

Criteria for determining non-infectiousness more stringent than for drug-sensitive and non-MDR disease.

7. MANAGEMENT OF PATIENTS WITH HIV-RELATED AND DRUG-RESISTANT TUBERCULOSIS

7.1 All patients with suspected or confirmed tuberculosis should be referred to the locally designated tuberculosis physician (usually the respiratory physician); tuberculosis in HIV-infected patients should be jointly managed in collaboration with the HIV physician[3]. Children should be managed either by a paediatrician with special experience and training in tuberculosis, or in conjunction with a suitably trained physician.

Patient isolation

7.2 Patients do not necessarily require admission to hospital either for investigation or initiation of treatment for tuberculosis. Patients with drug-sensitive tuberculosis, even if infectious or potentially infectious and regardless of HIV status, may be managed as out-patients if this does not put others at risk and suitable arrangements can be made for supervising therapy. Home contacts will normally already have been exposed to infection - they should be screened as a matter of urgency and offered treatment or chemoprophylaxis if appropriate (See Section 9).

7.3 Close association with new contacts, especially if they may be immunocompromised, should be avoided until the patient is likely to be no longer infectious - for drug sensitive disease, normally within about two weeks of starting treatment, but the tuberculosis physician should advise in individual cases.

7.4 Out-patient management is *not* appropriate for infectious or potentially infectious patients if they live in a hostel or other communal establishment, unless accommodation equivalent to that recommended for health care facilities is available. Nor is it likely to be appropriate for most patients with suspected or proven MDR-TB, who will normally require at least initial assessment and treatment in hospital.

7.5 For those requiring admission to hospital, the appropriate facility for their care should be decided at consultant level, between the admitting doctor and the infection control doctor, following local policy and taking into account the potential infectiousness of the patient, the immune status of other patients and any known or suspected drug resistance. The patient should be cared for in this or similar accommodation until the physician in charge of their care, in consultation with the TB physician (if different) and the infection control doctor, decides that they are no longer infectious or they are discharged home.

7.6 Recommendations for isolation are summarised in Box 5. Isolation rooms can be considered as a hierarchy consisting of three broad types:

i. Ordinary single room

ii. Single room with ventilation to render it under negative pressure, checked either by looking at and recording relative pressures on a wall-mounted gauge, or by smoke testing by a qualified engineer (the monitoring itself must be monitored).

iii. Negative pressure single room with automatically controlled air pressure and continuous automatic monitoring.

7.7 All patients with **suspected or confirmed** *infectious* **tuberculosis** (as defined in the Glossary, p91), whether or not they are co-infected with HIV, should at the minimum be admitted to a single isolation room until three consecutive good quality sputum samples are smear negative or the diagnosis is excluded. If the room is in, or contiguous to, a ward or area in which significantly immunocompromised (especially HIV-infected) patients are housed, the isolation room should be at negative air pressure and this should be continuously and automatically monitored (see Annex D).

7.8 Patients with *potentially infectious* **tuberculosis (sputum negative, but culture positive or culture result not yet known)**, regardless of HIV status, need not be isolated unless they are to be housed in or contiguous to a ward or area with significantly immunocompromised (including HIV-infected) patients, in which case they should, at the minimum, be in a single isolation room. Criteria for considering discontinuation of isolation in these patients are covered at 7.27 onwards.

7.9 Patients with pulmonary disease in whom **MDR-TB is likely (rather than just suspected, see 5.16) or confirmed** should, at the minimum, be admitted to a negative pressure isolation room (category ii above) until multiple drug-resistance is excluded or until sputum *smears* have been negative on three consecutive occasions over 14 days. If a suitable negative pressure room is not available, the patient should be transferred to a centre where such facilities and the relevant treatment expertise are available until negative sputum smears have been confirmed or laboratory or clinical evidence suggests MDR-TB has been excluded. They may then be considered for transfer to an ordinary single room, as long as this is not in, or contiguous with, a ward or wing containing HIV-infected or other severely immunocompromised patients, until at the minimum sputum *cultures* have been negative on three consecutive occasions over 14 days (the full clinical picture will need to be taken into account in each case).

7.10 If patients with **suspected or confirmed MDR-TB are to be cared for in a room in or contiguous with wards or areas housing significantly immunocompromised (including HIV-infected) patients,** they should be in a negative pressure isolation room with automatically controlled air pressure and continuous automatic monitoring as in 7.7 above until they are considered no longer infectious. This will need to be decided on a case-by-case basis, taking into account the full clinical picture as well as recent sputum culture results.

7.11 In major HIV units, the negative pressure facilities and any single rooms for nursing HIV-infected patients with tuberculosis should ideally be situated near, but physically separate

from, the HIV ward. This reduces the risk of transmission of infection due to lapses in isolation precautions while allowing continuity of care for the patients' other, sometimes complex, medical problems. However, local arrangements will depend on local case loads, facilities and organisation.

Readmission of patients on anti-tuberculosis treatment

7.12 Patients on treatment for previously infectious **non-MDR** tuberculosis should be admitted to a single side room away from patient areas catering for immunocompromised patients unless or until the clinician in charge of their tuberculosis, with the ICD, has assessed them as non-infectious.

7.13 Any patient on treatment for tuberculosis admitted to an HIV ward, or other ward containing severely immunocompromised patients, should be admitted to a fully automatically monitored negative pressure isolation room on every new admission unless or until assessed as smear negative (when single room accommodation is acceptable) or non-infectious.

7.14 Patients who are on treatment for, or who have previously had, **MDR-TB** must be assumed to be infectious on every admission until confirmed otherwise by the supervising physician and ICD, and admitted to rooms as set out in 7.7-7.11 above.

Drug Treatment

Treatment of tuberculosis in HIV-infected patients

7.15 Treatment of tuberculosis in HIV-infected patients should be according to British Thoracic Society (BTS) guidelines[3], starting with a four drug combination (RHZE) for the initial phase of treatment (unless further drug resistances or MDR-TB are suspected) because of the increased risk of isoniazid resistance. Account must be taken of known drug interactions including that between rifampicin and protease inhibitors taken for the HIV infection[3, 68]. Response to standard six month anti-tuberculosis regimens is usually good, although adverse reactions may occur more commonly. Ideally, treatment should be directly observed (DOT, see 7.42) at least initially and in hospital in-patients; DOT is essential in cases where compliance with treatment is in doubt[69].

7.16 Detailed information on drug treatment, interactions and reactions are contained in the BTS treatment guidelines[3].

Treatment of drug-resistant and MDR tuberculosis

7.17 The choice of anti-tuberculosis drug regimen and the subsequent management of treatment for patients with suspected or confirmed drug resistance must be the responsibility of the designated tuberculosis physician, for HIV patients in collaboration with the HIV physician, until treatment is completed. Detailed information is contained in the BTS guidelines[3], but the TB physician may need to take advice regionally or nationally from experts with experience in managing drug-resistant tuberculosis (see Annex F).

7.18 Treatment regimens should where possible be based on the results of laboratory susceptibility tests, together with the best available epidemiological information.

7.19 Patients at higher risk of, or with suspected or confirmed *single drug resistance* - most commonly isoniazid resistance - should normally start treatment with a four drug regimen for the initial phase, the drugs chosen taking into account any definitely known pre-treatment resistance, with the exception that since rifampicin resistance alone is rare and usually a marker for MDR-TB, it should be treated as MDR-TB until full drug susceptibilities are known.

7.20 In principle, patients with suspected or confirmed MDR-TB should initially receive at least five drugs to which the organism is, or is likely to be, susceptible, including at least two, and preferably three, drugs which have not previously been prescribed for the patient. In all cases, the regimen should be discussed with someone with appropriate expertise.

7.21 Patients with non-MDR drug resistance should have their therapy directly observed (DOT) at least initially, and closely supervised throughout. For rifampicin-resistant or MDR-TB, and if there is any doubt about compliance, DOT should be continued throughout the course, other than in exceptionally compliant patients. This may be onerous, as some drugs may need to be taken twice or even four times a day and for a considerable period of time, but the consequences of irregularly taken treatment may be dire. DOT has been associated with reduced rates of drug resistance[69]. A DOT regimen in which the drugs are given three times a week, rather than daily, may sometimes be possible for a drug-resistant case, but many of the drugs that are used to treat drug-resistant tuberculosis have to be given daily. Only daily regimens are normally appropriate for MDR-TB.

Patient care in isolation rooms

7.22 Patients require careful explanation about the need for them and their visitors to adhere to infection control measures, focussing on how tuberculosis is transmitted, the reasons for their isolation, the medications that have been prescribed, and the importance of adhering to treatment plans. Patients need to understand that they must remain in the room with the door closed during the period that they are infectious. If they need to be transported to other areas within the hospital, special precautions may be needed (see also 11.22).

7.23 The period of isolation, especially if prolonged, should be made as tolerable as possible. Patients should be allowed special dietary requests. Facilities such as telephone, television, radio, stereo/CD players and exercise machines are all important in establishing cooperation and compliance with treatment.

7.24 Patients may need support during withdrawal from addictive substances, e.g. tobacco, alcohol and other drugs. Rifampicin potentiates the metabolism of opiate drugs. It may therefore induce withdrawal symptoms, which in turn may discourage an injecting drug user from continuing treatment. A pragmatic decision may have to be made as to whether to continue or even to supplement previously taken addictive substances, eg methadone, until treatment for tuberculosis has been completed.

7.25 While patients are infectious, visitors should generally be limited to those who have already been in close contact with the patient prior to his/her diagnosis. (Close contacts should have been screened first and active tuberculosis excluded). When masks are being recommended for visitors to an individual patient (see Box 6), authorised visitors need to be instructed on how to use them and be required to comply with infection control precautions.

7.26 People visiting HIV-infected patients may themselves be immunocompromised (including children). The physician in charge will need to assess the likely risk of transmission from the index case and make recommendations, for example, whether visitors should be restricted to a limited number of named individuals and/or whether visitors should be advised not to visit if they believe themselves to be immunocompromised.

Discontinuation of isolation

7.27 The decision to discontinue isolation, or to transfer a patient to a lower category of isolation, is a clinical one, made by the designated TB physician and the infection control doctor, and taking into account the same factors as the original assessment, namely the infectiousness of the patient, the susceptibility of contacts and any drug resistance (see Box 5), in the context of the complete clinical picture. It is important to stress to patients that discontinuation of isolation does not imply cure; the requirement for compliant treatment continues.

7.28 The following are reasonable criteria for considering discontinuation of isolation for patients with drug-sensitive and non-MDR drug-resistant pulmonary tuberculosis in an HIV setting:

i. the patient has had a minimum of two weeks of appropriate drug therapy; ***and***

ii. at least 3 consecutive negative sputum microscopy smears taken on different days (or complete resolution of cough) over a period appropriate for the drug susceptibility of the disease but at the minimum over 14 days; ***and***

iii. definite clinical improvement as a response to treatment e.g., remaining afebrile for at least one week; ***and***

iv. demonstrated tolerance of the prescribed treatment and an ability and agreement to adhere to treatment.

7.29 *For patients with confirmed MDR-TB*, clinicians should discuss the discontinuation of isolation with the hospital infection control team, the microbiologist and the consultant CCDC/CPHM. Each case must be considered on its own merits and if clinicaly indicated isolation may need to be maintained until sputum *cultures* are confirmed to be negative. Further advice on the management of patients with MDR-TB is available from the experts listed in Annex F.

7.30 The accommodation of patients with previously infectious tuberculosis should be kept under review while they remain in hospital and they should be returned to an appropriate isolation

room if they deteriorate clinically or sputum smears become positive again.

Discharge from hospital

7.31 Before discharge, a treatment plan should be agreed between and known to all relevant people and arrangements should be in place for accommodation, any necessary support, supervision of therapy and follow-up. Discharge plans may take some time to finalise and so should be started in plenty of time while the patient is in hospital. One person needs to be designated responsible for ensuring the plan is carried out, and a fallback position should be discussed in the initial planning period should the plan not be adhered to.

7.32 Any of the following people may need to be involved in discharge planning in an individual case:

- the patient, close relatives and/or friends who will be involved in care, the designated tuberculosis physician, the HIV physician, the microbiologist, the infection control team, the patient's general practitioner, the CCDC/CPHM, the tuberculosis/respiratory nurse, the community nurse, the social worker, people who are to provide support at home, eg HIV support team, voluntary sector support group.

Involvement of all relevant people may enable earlier discharge into the community than might otherwise be possible, if the patient wishes it and it is feasible without presenting a risk to others.

7.33 The discharge plan needs to take into account:

- the type of accommodation the patient is being discharged to and the likely contacts (at the accommodation and visiting);
- whether the patient should still be considered infectious (bearing in mind the likely contacts);
- who is going to supervise (and/or observe) therapy and where;
- the need for, and arrangements for, further bacteriological tests;
- arrangements for follow-up (for the tuberculosis and HIV infection or other co-existing condition);
- transport for follow-up appointments;
- whether and what support services are required and who is to provide them;
- whether any support services previously provided should be reconsidered because of the risk of infection to support staff.

The patient should understand any risk he/she might pose to others and how to minimise that risk.

Discharge home

7.34 Patients with presumed drug-sensitive tuberculosis, regardless of HIV status, do not necessarily need to be sputum smear negative before discharge home unless close home contacts are HIV-infected or otherwise severely immunocompromised. Reasonable baseline criteria for considering discharge are:

i. completion of a minimum of two weeks standard chemotherapy;

ii. clinical response to treatment;

iii. clinical assessment that the patient is tolerating the drugs;

iv. agreement by the patient to satisfactory arrangements for the future administration of treatment (including DOT if indicated) and regular medical supervision.

7.35 If close home contacts may be HIV-infected or otherwise severely immunocompromised, the patient should normally, in addition, have had three negative sputum smears, taken on different days over a 14 day period, before discharge, unless the contacts have been screened and are on tuberculosis chemoprophylaxis or treatment.

7.36 **Patients with MDR-TB** may remain, or be intermittently, sputum positive for many months, or may never become sputum smear and/or culture negative. It may be impractical, or indeed, unreasonable, to insist on three consecutive negative sputum smears before considering discharge home for patients who are none-the-less feeling relatively well, in view of the lengthy treatment required. Decisions about discharge will need to be made at consultant level on a case-by-case basis, the discussion involving the CCDC/CPHM and clinical microbiologist as well as other clinicians, the GP and relevant carers(see 7.32), taking into account the full clinical course, the clinical condition of the patient, the drugs available for treatment, information on compliance with treatment, and the level of understanding of the condition, and any necessary precautions, on the part of the patient and others in the household.

7.37 If other occupants at home are immunocompromised, patients with MDR-TB should preferably have had at least three consecutive negative sputum *cultures* over a period of two weeks before discharge. Again, each case will differ and earlier discharge may be possible, if informed carers and contacts agree, with enhanced community infection control measures such as the appropriate use of face masks. Patients should have their own room.

Discharge to hostel or other communal accommodation

7.38 In general, patients with pulmonary tuberculosis should not live in hostel or other communal accommodation, or a hospice, unless they fulfill the criteria at 7.28 or have had a minimum of three consecutive negative sputum smears over a period of at least two weeks, are known to be compliant with treatment (normally receiving DOT) and single room accommodation is available. If single room accommodation is not available, at least one negative culture may be acceptable. Decisions will depend to some extent on the type of accommodation available and the nature of the other residents, and will need to be decided on a case-by-case basis, between the relevant health professionals and those running the hostel or other accommodation.

7.39 Commmunal/hospice accommodation will rarely be appropriate for patients with **MDR-TB** as the infectious state may vary, and clinical expertise and clinical or microbiological facilities will not usually be available. Such accommodation may be possible, after discussion with all concerned, if accommodation equivalent to that recommended in health care facilities is available, for example if the patient has had three consecutive negative sputum *cultures* over a period of at least two weeks, a single room is available (if a negative pressure room is available, three negative sputum smears over two weeks may be acceptable) and if arrangements are in place for transfer of the patient back to the referring hospital should any new respiratory symptoms develop.

7.40 Any patient who has or has had HIV-related or MDR-TB should be reassessed before moving to respite care.

Patients who seek their own discharge

7.41 Patients who insist on taking their own discharge while infectious should have the necessary arrangements to protect their contacts at home explained to them. It should be pointed out that if they do not agree to these arrangements, compulsory admission to a secure room or ward may be required under Sections 37 and 38 of the Public Health Act. Whilst in general such compulsory admissions are undesirable (and practically difficult), and seeking patients' co-operation is preferable, in extreme circumstances it may be essential in order to safeguard the public health (see Section 16).

Supervision of therapy

7.42 Some home checks of compliance with treatment are required in all patients with tuberculosis and are usually undertaken by the TB nurse specialist. Ideally, all HIV-infected patients with tuberculosis (because of the higher risk of drug resistance) and all patients with suspected or confirmed non-MDR drug-resistant tuberculosis, should have their treatment directly observed (DOT) at least for the initial phase of treatment. Patients with MDR-TB, and all patients suspected of being poorly compliant with treatment (including those in whom poor compliance becomes apparent during treatment), should have their therapy directly observed throughout the course of treatment. This means that arrangements must be in place for a suitable responsible person (eg chest clinic or community nurse, family member, social worker, voluntary organisation worker or 'buddy') to watch every dose of treatment being taken and

tick it off on a chart. The supervisor should be someone regarded as a 'friend' by the patient but must undertake to report back to a named health care worker if doses are omitted. Both the patient and the supervisor will require a 24 hour contact number for a member of the tuberculosis treatment team and written advice about possible side effects of treatment and what to do if treatment is missed or side-effects occur. The chest clinic nurse should liaise regularly with the DOT supervisor and view the record.

7.43 A financial or other incentive, such as a meal or meal token, dependent on the patient's successful compliance with DOT may be successful where other measures have failed, but may be difficult to resource.

7.44 If a patient with MDR-TB becomes non-compliant, or their clinical condition deteriorates, the GP should be informed and the patient readmitted promptly to a suitable isolation facility in hospital for reassessment.

Follow-up

7.45 The follow-up of patients with tuberculosis is a specialist activity. All patients with tuberculosis should be followed up by the designated TB physician and TB nurse. For HIV-infected patients, this is in addition to any follow-up by the HIV physician.

7.46 Patients with either HIV-related or drug-resistant tuberculosis should have regular clinical examinations, chest x-rays, and sputum smears and cultures to detect any relapse early. Patients should have a sputum culture arranged approximately monthly (earlier if clinically indicated) until three consecutive cultures are negative or sputum cannot be obtained. Cultures should also be taken towards the end of treatment before the treatment is stopped.

7.47 As a guide it is suggested patients are seen at two to four weekly intervals until culture negative or sputum cannot be obtained and then at four to eight weekly intervals. If symptoms recur before the next planned appointment, or there is other evidence of failure to respond to treatment, they should be seen earlier and a chest X-ray taken.

Length of follow up

7.48 HIV-infected patients who have had tuberculosis should be followed up lifelong for both conditions. If they develop sputum production or have a chest infection, sputum smears should be examined and sputum cultured for tuberculosis as a routine.

7.49 The BTS suggest that immunocompetent patients with non-MDR drug-resistant tuberculosis should normally be followed up for at least 12 months after completion of treatment.

7.50 The length of treatment required for MDR-TB is not known with certainty -some patients have relapsed four years after completing what was thought to be adequate treatment. The length of treatment will vary between patients and according to the drug regimen used. At the minimum, patients should continue treatment until they have had negative cultures (or no sputum) for at least nine months; some regimens need to be continued for 18-24 months after conversion to negative cultures. Immunocompetent patients with MDR-TB should be

followed up for at least five years after completion of treatment, and the need for further follow-up then assessed by the TB physician.

Arrangements for follow-up appointments (and out-patient visits in general)

HIV-related tuberculosis

7.51 Patients with drug-sensitive pulmonary tuberculosis, whether HIV-related or not, are likely to be rendered non-infectious after about two weeks' treatment with a standard regimen; however, until drug susceptibility tests are confirmed, or they become sputum negative, they should be separated from other immunocompromised patients in out-patient clinics.

Drug-resistant tuberculosis

7.52 Patients with drug-resistant tuberculosis, especially MDR-TB, should preferably be seen outside an HIV setting, eg in the thoracic clinic, if possible at the end of the day after other patients have left the department (though adequate ventilation should reduce infectious airborne particles). If there is no alternative to patients being seen in an HIV clinic, they should be seen at the end of the day after other patients have left or in a separate area designated for seeing patients with possible transmissible respiratory infections. They should be seen promptly. Patients with infectious MDR-TB who need X-rays should as far as possible be booked appointments at the end of the day and should wear a mask while going through patient areas (see 11.22).

7.53 These arrangements should continue until three consecutive negative sputum cultures have been obtained and the clinician believes the patient is complying with and responding to treatment. Patients may, however, become sputum positive again because of inadequate drug absorption due to vomiting, diarrhoea or malabsorption rather than poor compliance.

7.54 Even when treatment has been completed, patients who subsequently develop respiratory symptoms should let the receptionist or clinic nurse know on arrival, or when making an appointment, and should be seen at appropriate times or in rooms which have adequate ventilation (ideally confirmed negative pressure ventilation).

7.55 Domiciliary visits for clinical assessment should be considered for patients with MDR-TB who are sent home before they are culture negative, or who may have relapsed.

Intercurrent Interventions

7.56 Patients with tuberculosis will sometimes require surgery or other procedures, for conditions either incidental or related to the TB eg drainage of empyema, tracheostomy, drainage of abscesses, surgery to remove MDR-infected disease. The implications for theatre staff, anaesthetic equipment and the theatre environment should be discussed on a case by case basis.

8. NOTIFICATION

8.1 All patients with tuberculosis must be notified to the local 'proper officer', now normally the consultant in communicable disease control (CCDC) or in Scotland the Chief Administrative Medical Officer (CAMO), as soon as the diagnosis is made so that prompt contact tracing is instituted. Notification is the statutory duty of the doctor making or suspecting the diagnosis. The process will be greatly facilitated by the involvement of the TB physician and/or the TB nurse specialist or health visitor, and by the clinical microbiologist reporting positive results to the CCDC or relevant CPHM as well as to the investigating physician.

8.2 There is considerable evidence of under-notification of tuberculosis in HIV-infected patients compared with those known or thought to be HIV negative[70], with levels of undernotification of between 70%[71, 72] and 95%[73] reported from some units. Notification is an important part of tuberculosis control in whatever setting, particularly in HIV treatment centres where nosocomial outbreaks of tuberculosis are well documented[24, 25, 27]. The three purposes of notification apply to all cases of tuberculosis:

a. To trigger contact tracing to identify those who may have acquired infection from or been the source of infection for the index case, and those for whom preventive measures may be appropriate.

b. Through surveillance, to identify possibly related cases and outbreaks.

c. To allow local and national monitoring of trends and incidence of tuberculosis.

8.3 Confusion may arise as to whether to notify HIV-infected patients with positive sputum smears for acid-fast bacilli because of clinical doubt about the exact diagnosis (eg the mycobacteria may be non-tuberculous). In general it is better to over-notify, and subsequently have to denotify, than to under-notify. If the clinician thinks it is likely enough to be tuberculosis to be treated as such, then the case should be notified (notifying all patients who have been started on treatment is important, as the CCDC/CPHM may receive telephone calls from worried contacts and needs to know the background). On the other hand, if the patient is known to have MAI, and tuberculosis is unlikely, the case should not be notified unless confirmed.

8.4 Clinicians in England were reminded of their statutory duty to notify cases of tuberculosis in a letter from the Deputy Chief Medical Officer dated 27 April 1995[74]. Some doctors and patients may be concerned about confidentiality. The notification of tuberculosis does not breach the Venereal Diseases (1974) Regulations. If deductive disclosure about a patient's HIV status is an issue because a genito-urinary physician is signing the notification form, then local arrangements can be made for a chest physician, an infectious disease physician or the CCDC/CPHM to complete the form.

8.5 To avoid confusion, each centre treating HIV-infected patients with tuberculosis should adopt a consistent approach to notification to be used by all its doctors[75]. Each HIV centre should keep notification forms. These are available through the local CCDC (or CAMO in Scotland) to whom they should be returned preferably within three working days of a decision to treat the patient for tuberculosis.

8.6 Although the tuberculosis notification form does not mention HIV status, it is helpful if those carrying out contact tracing are made aware informally, with the patient's consent, of dual infections since some of the contacts may also be HIV-infected and this alters some of the actions needed for a proper assessment of contacts.

8.7 Individuals, regardless of HIV status, found to be tuberculin skin test positive but without evidence of disease, or who require chemoprophylaxis on other grounds[75], are not notifiable as they do not, by definition, have tuberculosis. However, HIV-infected individuals with a positive skin test will need monitoring.

8.8 When an HIV-infected patient with suspected tuberculosis has been notified but the final diagnosis is not tuberculosis (eg non-tuberculous mycobacteria are diagnosed by culture or genetic probes) the patient should be denotified. A letter or telephone call to the local CCDC/CAMO is sufficient.

9. CONTACT TRACING

9.1 Contact tracing may identify additional cases of tuberculosis who may have been infected by or be the source of infection for the index case. It also identifies those who may benefit from other interventions such as chemoprophylaxis.

9.2 Protocols for contact tracing are published elsewhere[2]. Contact tracing should be undertaken promptly to minimise the risk of an unidentified case continuing to infect others, especially if some of the contacts may be immunocompromised.

Organisation of contact tracing

9.3 The formal arrangements for contact tracing vary: they may involve the CCDC (in Scotland, the CPHM), the TB nurse specialist, health visitors, chest clinic staff and environmental health officers, depending on local arrangements.

9.4 The follow-up of known HIV-infected contacts should be coordinated between the tuberculosis and HIV services to avoid omissions and duplication of effort. If tuberculosis is identified in an HIV-infected contact, the CCDC should be informed, with the name of the potential source, as this may indicate the need for more extensive surveillance.

9.5 The HIV status of the index patient or the contacts may not be known; if it is known, it must only be divulged with the patient's consent and all staff must ensure that confidentiality is not breached during the contact tracing procedure.

9.6 In the event of an outbreak, or if a patient with sputum smear positive tuberculosis is identified in a hospital, hostel or other institution, or is a health care or other care worker, the CCDC (or CPHM) should be informed as a matter of urgency. Other than in a hospital, where the infection control doctor would take the lead, the CCDC will normally coordinate the contact tracing exercise. Occupational health departments can play a useful role, including where they provide a service to community based health care workers.

Identification of contacts - who to include in the contact tracing

9.7 For a *non-infectious index case*, close (same household or equivalent) contacts only are examined, in case one was the source of infection in the index case.

9.8 Transmission of tuberculosis generally requires prolonged close contact with an infectious case. For an *infectious (sputum smear positive) index case*, therefore, contact tracing is normally limited to close (same household or equivalent) contacts; if transmission is identified among these to an extent which suggests a greater degree of infectiousness, the screening can be extended to a larger group (the 'stone in the pond' principle)[76]. It is appropriate to include HIV-infected contacts with a lesser degree of exposure to an infectious index case in the initial contact tracing, given the more serious consequences of tuberculosis infection in HIV-infected

individuals and the large numbers of recently reported outbreaks in this group. Screening should therefore additionally be offered to any immunocompromised contacts with significant direct exposure to the index case. The degree of contact that constitutes a risk is not known with certainty, but studies of transmission of tuberculosis in aircraft[77] suggest a cumulative total exposure exceeding 8 hours within the same room as the index case during the period that the index case was considered to have been infectious would be a reasonable guideline.

9.9 Screening of others who have had regular close contact will depend on the results of the first round of screening. They may include close family and friends, colleagues working in the same office or other close work colleagues, regular carers, regular contacts in bars or clubs, and regular sexual partners.

9.10 In the circumstances of an outbreak, contact tracing may need to be more extensive from the start because the outbreak has already demonstrated the ability of the index case to transmit infection. Each incident will need to be assessed in the light of the individual circumstances.

Contacts in hospital wards

9.11 If the index case was in hospital while infectious and infection control was inadequate, hospital contacts will need to be offered screening. The infection control doctor and CCDC should consult over which contacts need to be included.

- *Patients*: Immunocompetent patients on hospital wards are generally considered casual contacts of infectious cases and do not require screening, but a record on their hospital notes and a note to their GP about the contact is advisable. Occasionally fellow patients may be considered to have had a similar degree of contact to close household contacts and should be screened.

  Immunocompromised patients on the same ward should generally be followed up if they were on the ward for 8 hours or more (see 9.8 above) at the same time as the index case.

- *Visitors*: Visitors to the ward would not usually be followed up.

- *Staff*: Immunocompetent staff do not usually require follow-up unless they were regular carers for the patient and thus had prolonged close contact, or carried out a high risk procedure.

  Immunocompromised staff spending a cumulative total of more than 8 hours on the ward should be followed up. The infection control team dealing with contact management should involve the occupational health physician so that arrangements can be made which ensure an individual's HIV status is kept confidential from employers/managers wherever possible.

- *In an outbreak*: The need for more extensive contact tracing must be considered on a case by case basis, including the need to trace all immunocompromised patients or staff who visited the ward during the stay of the index case. The ICD and CCDC/CPHM may need to take expert advice.

Contacts in outpatient clinics

9.12 Contact tracing will generally be restricted to immunocompromised contacts known to have used the same rooms or areas as the index case and again the 8 hour exposure guide (see 9.8 above) is the best we have. As a guide, it is suggested those attending outpatients on two or more occasions at the same time (from 2 hours before the index case's appointment until the end of the day) are initially contacted. If transmission has been demonstrated to have occurred in the outpatient setting, any immunocompromised patient attending on the same day as the index case should be followed up. Immunocompetent outpatient contacts will not generally require follow-up.

Contacts in a hostel or other institution

9.13 The principles for contact tracing in hospitals and clinics apply.

How far back to trace contacts

9.14 Advice should be taken from the physician in charge of the index case on how long it is likely the index patient was infectious. This will inevitably be fairly arbitrary. It is reasonable to cover the period up to one month before the patient became symptomatic; if there is no information, the 3 months preceding the date the first sputum was positive on smear or culture should be covered in the first instance. If cases are found, contact tracing should be extended backwards using the 'stone in the pond' principle, usually a month at a time, but longer periods may be more appropriate in individual cases.

Priorities in contact tracing

9.15 Priority should be given to those thought to have been at highest risk, ie those with the greatest exposure and those most susceptible, eg immunocompromised individuals (although the HIV status of contacts may not be known) and young children. Immunocompromised contacts should be screened urgently; if they are coughing it is preferable to check a sputum smear before bringing them to hospital for a chest X-ray, in order to reduce transmission opportunities.

Management of HIV-infected contacts of a patient with tuberculosis

9.16 A previous BCG immunisation, or a previous positive tuberculin skin test, cannot be accepted as evidence of immunity to tuberculosis in HIV-infected and immunocompromised individuals. A current tuberculin skin test may also be unreliable as a screening test: a strongly positive result suggests active infection, but a negative or weak positive test may result from anergy and does not rule out tuberculosis. A chest x-ray is an essential part of screening to eliminate active tuberculosis.

9.17 Once active tuberculosis has been excluded, all HIV-infected close contacts of a patient with sputum smear positive tuberculosis should be offered chemoprophylaxis, as long as a suitable regimen is available. This may not be so where the index case has MDR-TB; in this case close

clinical follow-up may be the preferred, or only, option (see 9.19 below and 10.6-10.9).

9.18 HIV-infected contacts of a case of smear negative pulmonary tuberculosis, and those for whom chemoprophylaxis was indicated but for some reason not given, need to be advised that because skin testing is unreliable, close clinical follow-up (with a high level of suspicion for the development of tuberculosis) will be required.

Management of contacts of patients with MDR-TB

9.19 Immunocompetent contacts should be screened and managed following BTS guidelines[2]. There may be difficulty in finding a suitable drug regimen for those in whom chemoprophylaxis would normally be recommended. Use of a regimen that is inadequate against a strain that is already multidrug resistant may compromise future therapeutic options. The preferred strategy may therefore be to offer regular clinical follow-up and give full treatment if signs of active disease appear. A meeting involving the respiratory physician, HIV physician if appropriate, clinical microbiologist and CCDC/CPHM may be advisable to discuss the best management, especially if contacts show tuberculin conversion (see also 10.6-10.9).

9.20 Management of HIV-infected contacts is as in 9.16-9.18 above.

Handling outbreaks and incidents

9.21 An outbreak of tuberculosis, especially if it involves a hospital or other institution, may have repercussions for other organisations and may attract widespread media attention. A comprehensive policy and a plan of action greatly assist a prompt and effective response. Advice on plans and outbreak management are contained in Health Services Guidance HSG(93)56[78]; HSG(95)10[79] covers in detail the management of outbreaks in hospital. Hospitals must have a Hospital Outbreak Control Plan and CCDCs must have a Community Outbreak Control Plan, both of which must have been agreed in advance with all relevant agencies. These plans should be activated if an outbreak is suspected.

9.22 An outbreak control group should be formed to manage the outbreak (the composition of the group should be included in the plan) and advice on the approach to handling the outbreak should be sought from the CCDC, if the CCDC is not leading the group, with input if necessary from the regional epidemiologist and/or the PHLS Communicable Diseases Surveillance Centre. The group needs to pay attention to who else may need to know (eg the Health Departments, the Public Health Laboratory Service, neighbouring health authorities, boards and trusts, voluntary organisations, patient support groups) and advise them at an early stage and in a coordinated manner, providing them with the necessary information. These bodies not only need to prepare their own response, but may provide valuable advice and assistance. Involvement of voluntary organisations and patient support groups can be helpful, particularly in contact tracing and in providing telephone help lines for the public. Plans should include a public information strategy.

9.23 The Reporting of Incidents, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR) require reports of certain types of injury, diseases and dangerous occurrences to the

Health and Safety Executive. There is a specific requirement in RIDDOR for employers to report tuberculosis infection in employees when they have been working with persons, animals, human or animal remains or any other material which might be a source of infection. A self-employed person must make such a report themselves or arrange for someone to report on their behalf.

9.24 If a person not at work is injured on hospital premises as a result of an accident arising out of or in connection with work, the injury must be reported if it falls into a category of a 'major injury'. This includes 'acute illness .... from exposure to a biological agent...'. As defined, this is unlikely to include hospital-acquired tuberculosis infection. There is also a general exclusion if a person is injured as a result of an accident arising directly from the conduct of medical procedures or under supervision of a medical practitioner or dentist. Further advice on the application of RIDDOR to people not at work can be obtained from the Health and Safety Executive.

9.25 RIDDOR also requires the reporting of certain dangerous occurrences. In the context of this guidance, this includes any accident or incident which resulted or could have resulted in the release or escape of any biological agent in hazard groups 3 or 4 (such as tuberculosis). Examples include the spillage of cultures in a laboratory or of a positive sputum sample on the ward.

10. CHEMOPROPHYLAXIS

Chemoprophylaxis in HIV-infected individuals

HIV-infected contacts

10.1 Following assessment, HIV-infected contacts who are considered to have been exposed to significant risk of tuberculosis infection should be offered standard chemoprophylaxis (either isoniazid alone for six months or rifampicin and isoniazid for three months for disease sensitive to these drugs; otherwise a regimen appropriate for the drug susceptibility pattern of the index case). If chemoprophylaxis is not given, the contact should be followed up closely, probably lifelong, and treated as necessary.

10.2 Chemoprophylaxis for MDR-TB is dealt with at 10.7 below.

Post-treatment chemoprophylaxis for HIV-infected patients with tuberculosis

10.3 Lifelong chemoprophylaxis with isoniazid following completion of treatment for tuberculosis has previously been recommended for HIV-infected individuals, to prevent recurrence[55]. It is no longer recommended as its efficacy is unproven[3]. Long-term isoniazid chemoprophylaxis could also encourage the emergence of isoniazid resistance if active disease were present when chemoprophylaxis was started or developed in spite of the prophylactic regimen. Further studies are required.

Preventive chemoprophylaxis for high risk groups

10.4 Preventive chemoprophylaxis refers to chemoprophylaxis given to prevent the development of tuberculosis in groups or individuals who are, or have been, at high risk of exposure to infection but in whom there is no known recent contact. It's place in the management of HIV-infected patients has not been established. Some large community studies and some small studies in highly-selected groups using isoniazid for six months to one year[80] showed short-term benefit in preventing tuberculosis. Recent studies in anergic patients however showed no advantage[81]. The duration and specific target population need to be the focus of further trials before any clear guidance can be given. In the meantime, it is reasonable to consider empirical preventive chemoprophylaxis for HIV-infected individuals who have evidence suggesting past tuberculosis infection, eg, if the tuberculin test is positive (Heaf test grade I or more if not immunised with BCG; grade III or IV if immunised), but no evidence of disease. (Some authors have recommended use of preventive chemoprophylaxis more widely than this[82]).

10.5 Poor compliance with chemoprophylaxis, which may be more likely in people who have never been ill with tuberculosis, is a concern as it may encourage the emergence of isoniazid resistant strains.

Chemoprophylaxis for contacts of MDR-TB

10.6 Close contacts of a patient with MDR-TB who would normally be recommended chemoprophylaxis (ie those with evidence suggestive of recent infection, or those who are HIV-infected) should be supervised by the designated TB physician. If chemoprophylaxis is given, because the contact is deemed likely to have been recently infected with MDR-TB, the regimen must include at least two, and preferably three, drugs based on knowledge of the drug susceptibility pattern of the index case. There are no data on how long such treatment should be taken, but a minimum of six months is suggested in the BTS guidelines[3]. There is a concern that chemoprophylaxis may lead to selection of further drug resistances and compliance with the regimen is essential.

10.7 If the resistance pattern is extensive there may be no suitable chemoprophylactic regimen or patients may be unable to tolerate the drugs. In practice, there are two options: the preferred option, until more data are available, is close clinical follow up without chemoprophylaxis, treating should signs of active tuberculosis develop; the alternative is to use a treatment regimen from the outset. This latter course of action is supported by some evidence that in HIV-infected individuals, aggressive treatment early can be successful. The length of treatment needs to be determined in each case[3].

11. INFECTION CONTROL IN HEALTH CARE FACILITIES

11.1 Responsibility for ensuring that their hospitals have appropriate infection control measures in place and contingency plans for outbreak management rests with the Hospital Chief Executive. While day-to-day administration is usually delegated to hospital infection control teams composed of relevant experts in infection control, it is the duty of Chief Executives to ensure that any delegated matter is adequately carried out in their establishment[79].

11.2 Effective infection control requires that:

- risk assessment informs the development of appropriate policies;
- adequate resources and training are available to support practitioners and staff in both developing and complying with agreed policy;
- ongoing quality assurance mechanisms are in place to ensure that the policy is being properly implemented;
- infection control policies remain dynamic and current as a result of regular planned audit, reassessment and policy review.

11.3 There is an absolute duty under Regulation 6(1) of the Control of Substances Hazardous to Health (COSHH) Regulations 1994 for employers to carry out a full risk assessment where an employer carries out work which is liable to expose any of his employees (or any others) to a substance hazardous to health, in this instance the organisms causing tuberculosis. This assessment must not only be suitable and sufficient, but must cover the steps that need to be taken to meet the requirements of the rest of the Regulations. Fundamentally this means that the assessment should also review the use of control strategies, the maintenance and use of control measures such as air handling systems and air filtration, health surveillance requirements and - perhaps most importantly -information, instruction and training for employees. The employer is required to protect employees as far as is reasonably practicable and commensurate to the risk. (A summary of the legislation relating to health and safety is included in Annex D of the Interdepartmental Working Group on Tuberculosis' report, The Prevention and Control of Tuberculosis at Local Level[1]).

The tuberculosis infection control plan

11.4 Transmission of *M.tuberculosis* is a recognised risk in health care settings: from patient-to-patient, from patient-to-health care worker, and, more rarely, from health care worker to patient[83, 84]. The prevention of nosocomial transmission of *M. tuberculosis* requires the implementation of a local TB Infection Control Policy or Plan based on the criteria outlined above, ie based on risk assessment; relevant staff involved in all stages of its development (or in adapting central guidelines for local use); implementation monitored. The plan should be

regularly reviewed and updated.

11.5 The plan needs to include policies and protocols for:

- the early detection, isolation and effective treatment of infectious cases
- arrangements for the care of people with HIV infection (or other immunocompromising disease) and *M.tuberculosis.*
- communication with the local CCDC and others about all suspected and confirmed cases
- infection (source) control measures
- environmental (engineering) controls (mechanical ventilation systems, air filtration systems/devices, ultraviolet germicidal irradiation (UVGI))
- personal respiratory protection
- laboratory quality assurance (requirement for College of Pathologists Accreditation (CPA) and participation in the NEQAS scheme for mycobacteria)
- delegation of responsibilities for contact tracing
- occupational health
- staff training
- quality assurance in other areas
- audit

Many of these are covered in other sections of this report.

Risk assessment

11.6 The TB Infection Control Plan must include an accurate assessment of the needs for each hospital or health care facility based on a systematic assessment (and periodic reassessments) of the potential for transmission of *M.tuberculosis* in all patient care areas within the hospital, including wards, waiting rooms, clinics, accident and emergency departments, operating theatres (which are normally under positive pressure) and recovery areas, and post-mortem rooms.

11.7 Guidance on microbiological risk assessment has been published by the Advisory Committee on Dangerous Pathogens[85] and by CDC[4]. Factors to be taken into account in assessing the risk in individual premises are listed in Annex C. They include the number and nature of

tuberculosis patients, and of immunocompromised patients, seen in or admitted to the facility. The results of the risk assessments are used to determine the nature and location of facilities required taking into account local circumstances. All health care facilities which care for patients with tuberculosis, but in particular those that also care for patients infected with HIV, and those which care for patients with MDR-TB, will need to ensure that they have access to an appropriate number of appropriate isolation rooms either on their own or other premises, taking into account the recommendations for isolation at 7.7-7.11.

Infection control policies and procedures

Source control measures to prevent the spread of infectious droplet nuclei

11.8 Techniques which prevent or reduce the spread of droplet nuclei containing *M. tuberculosis* from a patient into the general air circulation are referred to as 'source control' methods. They are especially important when patients with infectious tuberculosis are coughing or sneezing and when procedures likely to generate aerosols containing infectious particles are performed, e.g. bronchoscopy, sputum induction, administration of medication by nebuliser. Methods include:

i. isolation in a single room with appropriate control of air flow;

ii. performance of cough inducing procedures such as the administration of nebulised pentamidine and sputum induction in special booths (or specially adapted rooms) with local exhaust ventilation;

iii. patient-focused hygiene measures.

Isolation rooms

11.9 Isolation rooms are of three broad types:

i. ordinary single room;

ii. single room with ventilation to render it under negative pressure, checked either by looking at and recording relative pressure on a wall-mounted gauge, or by a qualified ventilation engineer using smoke at the base of the door. The monitoring must itself be monitored;

iii. negative pressure single room with automatically controlled air pressure, continuously and automatically monitored.

The characteristics and requirements of negative pressure rooms are considered in more detail in Annex D. The appropriate isolation for individual patients is covered in Sections 7.7-7.11 and Box 5.

11.10 Under COSHH regulations, all control measures provided to ensure that the exposure of employees to *M.tuberculosis* is prevented or adequately controlled must be thoroughly examined and tested at suitable intervals. For local exhaust ventilation plant, as may be

provided in isolation rooms, this should be at least once every 14 months.

Patient care in isolation rooms

11.11 Patients must remain in the room with the door closed throughout the period while they are infectious, and should not wander into communal areas. Patients, visitors and staff need to be aware of this and enforce it.

11.12 Universal infection control precautions apply (as they do to all patients), but inappropriate infection control measures must not be introduced. Items contaminated with respiratory secretions are not associated with the transmission of *M. tuberculosis,* consequently disposable crockery and cutlery are not required and patients may use general ward library services. DH guidance HC(95)18 recommends that linen from patients with 'open', ie sputum smear positive, tuberculosis is handled in the 'infected' category. No special precautions are required for rubbish unless it is visibly contaminated with blood or body fluids.

11.13 A nursing system should be used which significantly restricts the number of nurses (and other health care workers) entering the room to care for the patient, while ensuring patients receive adequate support, e.g. primary nursing or the 'named nurse' system. HIV-infected health care workers should not care for patients with infectious tuberculosis (see Section 13).

11.14 While patients are infectious, visitors should be limited to those who have already been in contact with the patient prior to his/her diagnosis. (Close contacts should have been screened first and active tuberculosis excluded.) Visitors should be required to comply with infection control precautions. When masks are recommended for visitors to an individual patient (see 11.29 and Box 6), authorised visitors need instruction in their correct use.

11.15 People (including children) visiting patients who are HIV-infected may themselves be infected with HIV and may be immunocompromised. The physician in charge should make recommendations on a case by case basis, taking into account the infectiousness or potential infectiousness of the patient, on, for example, whether visitors should be restricted to a limited number of named individuals, or whether ward staff or the patient should be asked to advise visitors not to visit until the physician advises it if they believe they may be immunocompromised, as they may be at risk.

11.16 Patients should not be moved from an isolation room without the agreement of the designated TB physician and the infection control doctor.

Aerosol-generating procedures

11.17 Under no circumstance should aerosol-generating procedures such as sputum induction, the administration of medications by nebuliser and bronchoscopy be carried out on a patient who may have tuberculosis in an open ward or bay or an unventilated area. They should be conducted only in an appropriate room or enclosing device with adequate local exhaust ventilation. Sputum induction should be avoided altogether in a patient with suspected drug-resistant tuberculosis. If sputum cannot be produced spontaneously, it is preferable, and better

samples are usually obtained, if the diagnosis is confirmed by bronchoscopy, with appropriate precautions (see below).

11.18 Other procedures such as respiratory function tests may also provoke coughing (and thus generate aerosols) which may continue after the procedure. These should not be performed on patients who have or may have, pulmonary tuberculosis, nor generally should chest physiotherapy unless it is essential and performed in a suitable facility with due attention to infection control.

11.19 Various enclosing devices with local exhaust ventilation exist, including booths for sputum induction and the administration of aerosolised medications, and tents or hoods used to enclose and isolate a patient[4]. Their salient characteristics are described in Annex D. The manufacturer's instructions should be referred to for information on decontamination between patients to remove airborne particles.

11.20 Bronchoscopy should preferably be performed in an appropriate negative pressure suite with adequate ventilation. All staff involved in the procedure should wear an appropriate mask and all unnecessary staff and other patients should be excluded during the procedure. If endoscopy rooms are without air handling equipment, in addition to the above staff precautions, the procedure should be done at the end of the list for the day, or in the patient's room.

Patient-focused hygiene measures (cough hygiene)

11.21 Two patient-focused hygiene measures can help reduce aerosolisation of infected droplet nuclei:

i. patients should be taught to cover both the nose and mouth with a tissue whenever they cough or sneeze;

ii. those with sputum positive disease and a cough who are unable to co-operate with this practice, and all patients with infectious MDR-TB, should wear a mask during transportation through other patient areas. The mask is to prevent aerosolisation of droplets (as opposed to masks worn to provide personal protection against inhalation of droplets). For this purpose, a surgical mask is acceptable, although a disposable dust/mist mask gives better filtration for a longer period at similar cost.

Environmental (engineering) controls

11.22 Environmental control measures aim to reduce nosocomial transmission of infection by diluting the concentration of infectious droplets in the air. Adequate ventilation is the single most important environmental control. Other methods which have been recommended include air filtration and ultraviolet germicidal irradiation (UVGI)[86]. Further details are contained in Annex D.

11.23 Expert engineering advice should be taken, in cooperation with the local infection control team, as to the efficacy of current air handling systems in all patient care areas of the premises and in post mortem rooms, and the need, taking into account the results of the risk assessment, for

additional measures to supplement infection control procedures in any areas of the health care facility. Arrangements need to be in place for monitoring both the implementation of the advice and the performance of the systems installed.

Personal respiratory protection

11.24 The term personal respiratory protection refers to any device worn by an individual to protect them from inhaling harmful particles (as opposed to, for example, surgical masks worn to reduce transmission of infection from the wearer to another person); such devices range from particulate filter masks to powered personal respirators.

11.25 Personal respiratory protection should be regarded as inferior and secondary to other environmental and infection control measures in reducing the risk of tuberculosis transmission. Paragraph 16 of the General COSHH (Control of Substances Hazardous to Health) Approved Code of Practice (ACOP) 1994 states: 'As required by regulation 7, personal protective equipment should only be considered as a method of control after all other measures have been taken so far as is reasonably practicable'.

11.26 There have been no field trials demonstrating the efficacy of personal respiratory protection of any kind in preventing transmission of tuberculosis. Such trials would be difficult, if not impossible. As with many other control measures, basic principles and analogies with other applications have been used as criteria[87, 88].

11.27 Masks to reduce the chance of inhaling droplet nuclei containing tubercle bacilli need to filter particles of 1-5 microns. More detail about available particulate filter masks and their efficiency is at Annex E.

Considerations in determining the appropriate use of masks for personal respiratory protection

11.28 The advice at 11.29 below takes into account the likely intensity, length and frequency of an individual's exposure to tuberculosis, and the possible consequences of transmission of infection. Considerations include:

i. Health care workers in the UK are recommended to be immunised with BCG, and can therefore be expected to have substantial immunity to tuberculosis. Immunity is not complete, however, and nosocomial transmission of drug-resistant tuberculosis to previously immunised immunocompetent health care staff has occurred in Europe[89]; active tuberculosis has also occurred in BCG-immunised close contacts of patients with MDR-TB[90].

ii. Current models of nursing in which patients are assigned to named nurses mean that nurses caring for patients with tuberculosis may have a more prolonged exposure time.

iii. Immunocompromised patients with tuberculosis, especially those infected with HIV, often require intensive nursing care, increasing the amount of close contact with carers.

iv. The risk of repeated exposure to tuberculosis in some specialised units will increase if the number of HIV-infected patients being seen with tuberculosis continues to increase. (Such patients are also likely to require more frequent admission to hospital.)

v. The consequences of nosocomial transmission of MDR tuberculosis, particularly in units caring for immunocompromised patients, are so serious that added precautions are appropriate to minimise this risk.

Recommendations for the use of masks (see also Box 6):

11.29 Respiratory protection is recommended to be worn:

i. by all persons entering the room of a patient with suspected or confirmed infectious MDR-TB;

ii. by all persons during cough-inducing or aerosol-generating procedures on patients with suspected or confirmed pulmonary tuberculosis;

iii. by health care workers caring for any high dependency patient with known or suspected infectious tuberculosis;

iv. rarely, in other situations (identified during the risk assessment exercise), eg, by people exposed to tuberculosis infection in settings where ventilation is inadequate; or by health care workers who regularly care for patients with infectious tuberculosis, e.g. on an HIV ward.

11.30 The arrangements need to be made clear, otherwise it may be confusing to visitors, patients and health care workers if some but not others entering a room are required to wear a mask. Occasionally a more pragmatic approach may be necessary, for example, if a limited number of visitors is being allowed, it may be easier to advise that all persons entering the room wear a mask.

Box 6. Recommendations for the use of masks

1. For patients with infectious or potentially infectious MDR-TB: by all persons entering the room;

2. During bronchoscopy and other cough-inducing procedures: by all persons present in the room;

3. For suspected or confirmed non-MDR smear positive patients: by those health care workers (and other carers) in regular or prolonged close contact.

The Respiratory Protection Programme

11.31 Infection control nurses should take responsibility for developing and implementing a respiratory protection programme for all staff, including agency staff, which includes training on the appropriate use of masks and how to ensure a proper fit to the wearer's face. Fit testing should be done following the manufacturer's advice. If the respirators are not tightly fitted, inhalation of organisms will be possible through air channels between the respirator and the wearer's face. (Staff with beards and sideburns will not be able to obtain a tight fit with the most commonly used masks; some modified forms are available and may be suitable.) Records should be maintained of staff training.

11.32 Disposable personal respiratory protection devices should not be re-used after potential exposure to tubercle bacilli.

Decontamination of endoscopes

11.33 Patient-to-patient transmission of *M. tuberculosis* (and environmental mycobacteria) via endoscopy has been well documented[91, 92]. After cleaning, endoscopes should be disinfected following Department of Health guidance, but checking the manufacturuer's instructions to ensure the solution used is compatible with the device[93]. Glutaraldehyde is the recommended agent. It may cause respiratory sensitisation and if used, a COSHH assessment must be performed.

Transfer of patients by ambulance

11.34 Ambulance staff transporting an infectious patient need sufficient information for their own protection while maintaining patient confidentiality.

11.35 Even minimal ventilation in an ambulance will provide a very high rate of air changes leading to effective infection control without the use of masks by ambulance staff. Minimal ventilation can be ensured by turning the ventilation fan on when the vehicle is stationary for longer than a few seconds (the minimum setting should be adequate). Infectious patients with uncontrolled cough should wear a mask if available, or cough into disposable tissues.

11.36 Special cleaning is not required after carrying a patient with suspected or confirmed infectious tuberculosis.

11.37 COSHH Regulations apply to ambulance personnel. The occupational health guidance for health care workers applies to them, and ambulance personnel should have training to raise awareness of tuberculosis, on how to prevent avoidable exposure, and on the importance of single use of respiratory equipment, eg masks, oxygen, suction and intubation tubing etc.

11.38 Standard procedures for contact tracing apply to ambulance staff who have been inadvertently in contact with a patient with confirmed infectious or potentially infectious pulmonary tuberculosis.

12. INFECTION CONTROL IN THE COMMUNITY

12.1 Aspects of the care of patients in the community, including arrangements for discharge and accommodation, are dealt with in Section 7. Most patients with HIV-related or drug-resistant tuberculosis will have been initially investigated and treated in hospital, during which time contacts up to the time of diagnosis should have been identified and offered screening.

Source control measures for patients with infectious (smear positive) tuberculosis or MDR-TB in the community

12.2 The general considerations applying to patients in hospital (11.8) are relevant to patients in the community. Again, inappropriate infection control precautions must not be introduced. Items contaminated with respiratory secretions are not associated with the transmission of *M. tuberculosis,* consequently disposable crockery and cutlery are not required and linen and rubbish which is not visibly contaminated with blood or body fluids can be handled in the usual way.

12.3 Patients who are still smear positive, and patients with MDR-TB who are infectious or potentially infectious, should minimise aerosol production by covering the mouth and nose when coughing with tissues which should then be discarded into the domestic waste. This practice should continue until they are cleared by the designated TB physician as no longer infectious or potentially infectious.

12.4 Domiciliary nebulised pentamidine therapy and other cough inducing procedures which may generate infectious aerosols are contra-indicated in patients with smear positive or MDR-TB. Tuberculosis should be excluded before starting, or continuing with, such treatment if there is any doubt.

Visitors

12.5 The same criteria apply as for visitors to infectious and potentially infectious patients in hospital (11.14-11.15). Advice for visitors of a patient with MDR-TB should be decided on a case by case basis.

Support staff

12.6 Staff providing care or support for patients with infectious tuberculosis should normally be immunocompetent and have been immunised with BCG; immunocompromised staff should not be directly involved in their care (Section 13). For MDR-TB this restriction extends to the care of patients who are potentially infectious. Whether the patient should be regarded as infectious or potentially infectious will need to be decided on a case by case basis, on the advice of the TB physician.

12.7 It can be difficult for both parties if the considerations in 12.6 mean that previously provided support for an HIV-infected individual has to be withdrawn, especially that provided on a one to one basis. This can lead to a profound feeling of isolation. Continued support in other ways, for example by telephone, should be considered.

Use of personal respiratory protection in the community

12.8 Use of a mask will rarely be required in the community. Those situations in which masks should be worn by community staff and volunteers should be considered in the individual patient's discharge plan. They would include:

i. for a patient with infectious or potentially infectious MDR-TB: all those entering the room;

ii. for a patient with non-MDR infectious tuberculosis: those providing prolonged close personal care; immunocompromised individuals entering the room;

iii. for a patient with potentially infectious pulmonary tuberculosis: immunocompromised individuals entering the room.

A particulate filter mask should be used.

Cleaning rooms occupied by patients with infectious tuberculosis

12.9 No special cleaning is necessary. There has been no known transmission of tuberculosis via accommodation.

Death in the community

12.10 Funeral directors are not currently given access to the certified cause of death, but need to know whether an infection hazard exists. Local protocols should identify who is to give that advice (eg clinician/CCDC) and who is to advise on the level of precautions necessary (normally the CCDC). Observance of COSHH may include the use of gloves and other appropriate protective clothing to ensure adequate control of risk to those who handle cadavers. Other precautionary measures include:

i. The face of a deceased patient with suspected or confirmed sputum positive pulmonary TB should be covered when the body is lifted as air may be expelled.

ii. Enclosing the body in a plastic body bag for removal is advised for both HIV infection and infectious tuberculosis.

iii. Viewing: HSC Health Services Advisory Committee guidance recommends that relatives and friends are discouraged from touching or kissing the body of deceased persons with a hazard Group 3 micro-organism infection. This includes HIV and tuberculosis. Similar advice is contained in paragraph 171 of the Advisory Committee on Dangerous Pathogens guidance on blood-borne viruses[94]. Relatives should be allowed to see and spend time with the body of

the deceased before disposal. If they do so, they need to be given information on the risk of infection.

iv. Embalming is acceptable for tuberculosis but should not be performed on HIV-infected bodies unless it is essential.

v. Hygienic preparation (tidying and cleaning the body so that it presents a suitable appearance for viewing, as an alternative to embalming) is acceptable for both tuberculosis and HIV infection, but for the latter should not include extensive facial restoration.

12.11 Mortuary technicians, pathologists and embalmers are among those recommended to be immunised with BCG because of their higher risk of exposure to tuberculosis[95].

13. OCCUPATIONAL HEALTH

13.1 Under Health and Safety Legislation an employer must take all reasonable measures to protect staff from risk. The following paragraphs refer to health care staff (including bank and agency staff and locums), but the same considerations apply to social services, voluntary organisation and other workers with regular patient contact.

13.2 Recommendations for routine screening of health care workers for tuberculosis and for post-exposure management are described elsewhere[2]. A system should be in place for informing health care workers of the risks of tuberculosis and also that if they believe themselves to be immunocompromised they are advised not to receive BCG vaccine (which is a live vaccine) and not to care for patients with infectious tuberculosis (see 13.4 below).

13.3 In addition, health care staff have a duty of care not to put patients (or other staff) at risk should they themselves develop tuberculosis. They should therefore understand the symptoms of tuberculosis and seek medical advice immediately should they develop such symptoms. This is particularly important should staff come into contact with neonates or immunocompromised patients. Completion of an annual questionnaire has been found helpful as an additional screening measure.

Immunocompromised health care workers

13.4 Many HIV-infected health care workers choose to care for HIV patients. They should understand that they may not care for patients with infectious tuberculosis. It puts themselves at risk, and may put other patients at risk should they become infected. While BCG given earlier in life is likely to have protected an HIV-infected worker against earlier tuberculosis infection and thus may have reduced the likelihood of reactivated disease occurring, any immunity from the BCG will almost certainly have waned and may not protect them from new infection. The risk of exposure to tuberculosis may also be increased on an HIV ward since both the number of co-infected patients is increasing and they may require more frequent and longer admissions than HIV-negative tuberculosis patients.

13.5 The occupational health physician will advise an HIV-infected worker on whether alternative work should be recommended to avoid possible exposure to tuberculosis (the CD4+ cell count is not a reliable guide to an HIV-infected individual's susceptibility to tuberculosis). If the worker chooses to continue to work with HIV patients, arrangements may need to be made to ensure he/she is not required to care for patients with known or suspected pulmonary tuberculosis. Since so many HIV-infected patients are admitted with respiratory symptoms this will inevitably raise practical issues, such as the implications for staffing rotas (especially if several workers fall in this category) and possible difficulties maintaining confidentiality about the health worker's HIV status.

14. VOLUNTARY SECTOR ORGANISATIONS

Development of guidance

14.1 Voluntary organisations whose work involves direct contact with patients who may have tuberculosis need to have arrangements in place for obtaining infection control advice and will need to develop guidance appropriate for the staff and volunteers employed and services provided. While it is hoped this UK Guidance will be an important source document, it is essential that organisations also take specialist advice.

Staff and volunteers

14.2 Voluntary organisations have a legal obligation to take reasonable measures to protect their staff, volunteers and clients from risk. All staff and volunteers working directly with patients should be offered screening for tuberculosis, and BCG immunisation if appropriate, as recommended for health care workers (Section 13), noting that special precautions apply to workers who may be immunocompromised due to HIV infection or other causes (in particular BCG should not be given). Staff should also have a basic understanding of the symptoms of tuberculosis and the way it is spread, and of the principles of infection control.

14.3 Organisations should keep records of which staff have visited which clients and should keep day books in drop-in centres, preferably with details of times when people attended. These are invaluable for contact tracing purposes.

The provision of services to patients

14.4 It is not easy to give general guidance on the degree of contact with a client with tuberculosis which constitutes a risk. As with guidance on hospital and community care, factors related to both the client and the worker need to be taken into account. When the services to be provided for a client with suspected or proven tuberculosis are being reviewed, the following questions need to be asked:

- does, or may, the client have an infectious or potentially infectious form of tuberculosis?
- if so, is it thought likely to be drug-resistant?
- are they coughing?
- if probably drug-sensitive, are they established on, and responding to, therapy?
- is the person providing the service possibly immunocompromised? If yes, what are the patient's latest sputum smear test results?

- if likely to be drug-resistant, what are the latest sputum smear test results, and what is the TB specialist's advice about possible infectivity? (This applies whatever the immune status of the worker.)

- what length and closeness of contact with the client would be required?

14.5 In general, patients with tuberculosis do not pose a risk once established on, and responding to, treatment as long as they continue to take the medication regularly. However, if the staff or volunteer is immunocompromised, confirmation that the patient is no longer infectious should be sought from the TB physician (this will normally mean that three consecutive sputum *smears* on separate days have been negative on microscopic examination).

14.6 For MDR-TB, a hazard must be considered to continue to exist until sputum samples are *culture,* as well as *smear,* negative, which takes much longer to determine. In individual cases, it may be acceptable for a limited number of support workers to visit a patient with still potentially infectious MDR-TB if they wear a mask, in order to maintain the patient at home. Each case must be judged on its own merits.

14.7 Staff should work closely with the health care sector so that the approach to an individual patient is as far as possible consistent. If in doubt about the degree of contact or the precautions to be taken with an individual patient, they should discuss the arrangements with the TB nurse specialist, TB physician or CCDC. It is advisable that one person acts as coordinating point where several agencies are involved in the care of a patient.

Residential and day care facilities

14.8 Clients who are being investigated for pulmonary tuberculosis, and those who have sputum positive or MDR pulmonary disease, should not attend communal day care or social areas, and should not live in residential accommodation where other residents may be immunocompromised unless the facilities and infection control procedures recommended for health care premises are available. These restrictions should continue until the patient has been cleared as non-infectious by the designated TB physician in liaison with the CCDC.

14.9 Clients should normally be allowed to attend day care and social areas once sputum smear negative on three successive occasions, or, for MDR-TB, sputum culture negative on three successive occasions over a two week period. However, each case needs to be considered on its own merits. If symptoms return, the decision should be reconsidered.

Recognition of tuberculosis in the community

14.10 Voluntary and support staff working with high risk groups for tuberculosis can provide a major input to tuberculosis control by recognising symptoms at an early stage and by providing encouragement and support during investigation and treatment. Many of the symptoms of tuberculosis are similar to those of other diseases that occur in severe HIV illness, and TB may co-exist with other infections, so the diagnosis must always be kept in mind. Suggestive symptoms include: persistent cough, fatigue, weight loss, loss of appetite, fever,

night sweats and sputum which may contain flecks of blood.

15. EDUCATION AND TRAINING

15.1 There is a statutory obligation on employers to ensure training, including training on health and safety.

15.2 A high degree of awareness of tuberculosis appropriate to their work responsibilities and duties needs to be maintained among health care workers, especially those working in the HIV field, and should be part of the TB infection control plan for every health care facility. Training in tuberculosis should include its epidemiology, transmission and the opportunities for nosocomial spread and the principles underlying control. Previous outbreaks of both HIV-related and MDR-TB provide valuable lessons and are useful starting points for discussion.

15.3 Training in infection control procedures should be a regular feature in the education programme for nurses and junior doctors, and should include the use of equipment.

15.4 Success in tuberculosis management and control is the result of team effort and good communications between the different disciplines involved. Interdisciplinary meetings, case conferences and audit all contribute to good team working.

15.5 The education needs of the voluntary sector and of patients also need to be addressed. Nurses play an important role, especially in the education of patients and their carers.

16. PUBLIC HEALTH LEGISLATION IN RELATION TO TUBERCULOSIS CONTROL

16.1 Legal powers may occasionally be required where an individual patient refuses to comply with treatment and is a risk to public health. Section 37 of the Public Health (Control of Disease) Act 1984 states:

1. where a justice of the Peace is satisfied, on the application of the local authority, that a person is suffering from a notifiable disease; and

   a. that his circumstances are such that proper precautions to prevent the spread of infection cannot be taken, or that such precautions are not being taken; and

   b. that serious risk of infection is thereby caused to other persons; and

   c. that accommodation for him is available in a suitable hospital vested in the Secretary of State, or, pursuant to arrangements made by a district health authority (whether under a NHS contract or otherwise), in a suitable hospital vested in a NHS Trust or other person

   the justice may, with the consent of the district health authority in whose district lies the area, or the greater part of the area, of the local authority, order him to be removed to it.

2. An order under this section may be addressed to such officer of the local authority as the justice may think expedient and that officer and any officer of the hospital may do all the acts necessary for giving effect to the order.

16.2 Section 38 of the Act states:

1. Where a justice of the peace in and for the place in which a hospital for infectious diseases is situated is satisfied, on the application of any local authority, that an inmate of the hospital who is suffering from a notifiable disease would not on leaving the hospital be provided with lodging or accommodation in which proper precautions could be taken to prevent the spread of the disease by him, the justice may order him to be detained in the hospital.

2. An order....may direct detention for a period specified in the order, but any justice of the peace acting in and for the same place may extend a period so specified as often as

it appears to him necessary to do so.

3. Any person who leaves a hospital contrary to an order made under this section for his detention there shall be liable on summary conviction to a fine not exceeding level 1 on the standard scale, and the court may order him to be taken back to the hospital.

4. An order under this section may be addressed ....to such officer of the hospital, ...or such officer of the local authority on whose application the order for detention was made, as the justice thinks expedient, and that officer and any officer of the hospital may do all the acts necessary for giving effect to the order.

16.3 For tuberculosis, both sections apply to 'tuberculosis of the respiratory tract in an infectious state.'

16.4 The Public Health Act allows hospital staff to use 'reasonable force' to prevent a 'sectioned' patient leaving the hospital. However, this is difficult to apply in practice and limits the usefulness of both sections 37 and 38. Compulsory treatment is not permitted - only detention.

16.5 The corresponding Scottish legislation is Section 54 of the Public Health (Scotland) Act 1897.

17. REFERENCES

General

1. The Interdepartmental Working Group on Tuberculosis. The prevention and control of tuberculosis in the United Kingdom: Recommendations for the prevention and control of tuberculosis at local level. Department of Health and the Welsh Office, 1996.

2. Joint Tuberculosis Committee of the British Thoracic Society. Control and prevention of tuberculosis in the United Kingdom : Code of Practice 1994. Thorax 1994; **49**: 1193-1200.

3. Joint Tuberculosis Committee of the British Thoracic Society. Chemotherapy and management of tuberculosis in the United Kingdom: Recommendations 1998. Thorax 1998; **53:** 536-548.

4. Centers for Disease Control and Prevention (CDC). Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 1994. MMWR 1994; **43** (No RR-13): 1-132

Epidemiology

5. Hayward AC, Watson JM. Tuberculosis in England and Wales 1982-1993: notifications exceeded predictions. Communicable Disease Report 1995; **5**: R29-33.

6. Bhatti N, Law MR, Morris JK, Halliday R, Moore-Gillon J. Increasing incidence of tuberculosis in England and Wales: a study of the likely causes. Br Med J 1995; **310**: 967-9.

7. Mangtani P, Jolley DJ, Watson JM, Rodrigues LC. Socioeconomic deprivation and notification rates for tuberculosis in London during 1987-91. Br Med J 1995; **310**: 963-6.

8. Citron KM; Southern A; Dixon M. Out of the Shadow: Detecting and treating tuberculosis amongst single homeless people. London: Crisis; 1995.

9. Watson JM, Meredith SK, Whitmore-Overton E, Bannister B, Darbyshire JH. Tuberculosis and HIV: estimates of the overlap in England and Wales. Thorax 1993; **48**: 199-203.

10. Kumar D, Watson JM, Charlett A, Nicholas S, Darbyshire JH on behalf of a PHLS/BTS/DH Collaborative Group. Tuberculosis in England and Wales in 1993: results of a national survey. Thorax 1997; **52**: 1060-1067.

11. Helbert M, Robinson D, Buchanan D, Hellyer T, McCarthy M, Brown I, Pinching AJ, Mitchell DM. Mycobacterial infection in patients infected with the human immunodeficiency virus. Thorax 1990; **45**: 907-8.

12. Warburton ARE, Jenkins PA, Waight PA, Watson JM. Drug resistance in initial isolates of *Mycobacterium tuberculosis* in England and Wales, 1982-1991. Communicable Disease Report 1993; **3**: R175-179.

13. Medical Research Council Tuberculosis and Chest Diseases Unit. National survey of tuberculosis notifications in England and Wales 1978-9. Br Med J 1980; **281**: 895-8.

14. Medical Research Council Tuberculosis and Chest Diseases Unit. National survey of notifications of tuberculosis in England and Wales in 1983. Br Med J 1985; **291**: 658-61.

15. Medical Research Council Cardiothoracic Epidemiology Group. National survey of notifications of tuberculosis in England and Wales in 1988. Thorax 1992; **47**: 770-5.

16. Pablos-Mendez A, Raviglione MC, Laszlo A et al. Global surveillance for antituberculosis-drug resistance, 1994-1997. N Engl J Med 1998; **338**: 1641-9.

17. Centers for Disease Control. Tuberculosis morbidity - United States 1994. MMWR 1995; **44**: 387-95.

18. Bloom BR, Murray CJL. Tuberculosis: Commentary on a reemergent killer. Science 1992; **257**: 1055-64.

19. Raviglione MC, Sudre P, Rieder HL, Spinaci S, Kochi A. Secular trends of tuberculosis in Western Europe. Bull WHO 1993; **71**: 297-306.

20. Wosornu D, MacIntyre D, Watt B. An outbreak of isoniazid resistant tuberculosis in Glasgow 1981-1988. Respir Med 1990; **84**: 361-4.

21. Centers for Disease Control. Outbreak of multidrug-resistant tuberculosis -Texas, California, and Pennyslyvania. MMWR 1990; **39**: 369-72.

22. Shannon A, Kelly P, Lucey M, Cooney M, Corcoran P, Clancy L. Isoniazid resistant tuberculosis in a school outbreak: the protective effect of BCG. Eur Respir J 1991; **4**: 778-82.

23. Daley CL, Small PM, Schecter GF, Schoolnik GK, McAdam RA, Jacobs WR, Hopewell PC. An outbreak of tuberculosis with accelerated progression among persons infected with the human immunodeficiency virus. N Engl J Med 1992; **326**: 231-5.

24. Di Perri G, Cruciani M, Danzi MC, Luzzati R, Checchi GD, Malena M, Pizzighella S, Mazzi R, Solbiati M, Concia E, et al. Nosocomial epidemic of active tuberculosis among HIV-infected patients. Lancet 1989; **334**: 1502-4.

25. Kent RJ, Uttley AHC, Stoker NG, Miller R, Pozniak AL. Transmission of tuberculosis in a British care centre for patients infected with HIV. Br Med J 1994; **309**: 639-40.

26. Pitchenik AE, Burr J, Laufer M, Miller G, Cacciatore R, Bigler WJ, Witte JJ, Cleary T. Outbreaks of drug-resistant tuberculosis at AIDS centre. Lancet 1990; **336**: 440-1.

27. Centers for Disease Control. Nosocomial transmission of multi-drug resistant tuberculosis among HIV-infected persons - Florida and New York, 1988-1991. MMWR 1991; **40**: 585-91.

28. Centers for Disease Control. Outbreak of multidrug-resistant tuberculosis at a hospital - New York City, 1991. MMWR 1993; **42**: 427-34.

29. Edlin BR, Tokars JI, Grieco MH, Crawford JT, Williams J, Sordillo EM, Ong KR, Kilburn JO, Dooley SW, Gastro KG. An outbreak of multidrug-resistant tuberculosis among hospitalized patients with the acquired immunodeficiency syndrome. N Engl J Med 1992; **326**: 1514-21.

30. Fischl MA, Raj B, Uttamchandani MD, Daikos GL, Poblete RB, Moreno JN, Reyes RR, Boota AM, Thompson LM, Cleary TJ. An outbreak of tuberculosis caused by multiple-drug-resistance tubercle bacilli among patients with HIV infection. Ann Intern Med 1992; **117**: 177-83.

31. Centers for Disease Control. Transmission of multidrug-resistant tuberculosis among immuno-compromised persons in a correctional system - New York, 1991. MMWR 1992; **41**: 507-9.

32. Centers for Disease Control. Probable transmission of multidrug-resistant tuberculosis in a correctional facility - California. MMWR 1993; **42**: 48-51.

33. Centers for Disease Control. Transmission of multidrug-resistant tuberculosis from an HIV-positive client in a residential substance-abuse treatment facility Michigan. MMWR 1991; **40**: 129-31.

34. Centers for Disease Control. Tuberculosis outbreak among persons in a residential facility for HIV-infected persons. San Francisco. MMWR 1991; **40**: 649-52.

35. Centers for Disease Control. Nosocomial transmission of multi-drug resistant tuberculosis to health-care workers and HIV infected patients in an urban hospital - Florida. MMWR 1990; **39**: 718-22.

36. Beck-Sague C, Dooley SW, Hutton MD, Otten J, Breeden A, Crawford JT, Pitchenik AE, Woodley C, Cauthen G, Jarvis WR. Hospital outbreak of multidrug-resistant Mycobacterium tuberculosis infections: Factors in transmission to staff and HIV infected patients. JAMA 1992; **268**: 1280-6.

37. Sauret J, Jolis R, Ausina V, Castro E, Cornudella R. Human tuberculosis due to *Mycobacterium bovis*: report of 10 cases. Tubercle and Lung Disease 1992; **73**: 388-91.

Transmission of *M.tuberculosis* and principles of control

38. Murray JF. The White Plague: down and out, or up and coming? Am Rev Resp Dis 1989; **140**: 1788-95.

39. De Cock KM. The interaction of tuberculosis and HIV infection. In *Tuberculosis - Back to the future* (Eds Porter JDH, McAdam KPWJ). London: Wiley, 1994

40. Selwyn PA, Hartel D, Lewis VA et al. A prospective study of the risk of tuberculosis among intravenous drug users with human immunodeficiency virus infection. NEJM 1989; **320**: 545-50

41. Sepkowitz DV. Tuberculosis in HIV-infected Individuals, in *Tuberculosis - A Clinical Handbook*, ed. By Larry I. Lutwick, Ch 5, 1995, London, Chapman & Hall Medical.

42. Elliott AM, Lui N, Tembo G et al. Impact of HIV on tuberculosis in Zambia: a cross sectional study. BMJ 1990; **301**: 412-5

43. Long R, Maycher B, Scalcini M, Manfreda J. The chest roentgeriogram in pulmonary tuberculosis patients seropositive for human immunodeficiency virus type 1. Chest 1991; **99:** 123-7.

44. Elliott AM, Hayes RJ, Halwiindi B et al. The impact of HIV on infectiousness of pulmonary tuberculosis: a community study. AIDS 1993; **7**: 981-7

45. Barnes PF, Block AB, Davidson PT, Snider DE Jr. Review Article: Current Concepts: Tuberculosis in Patients with Human Immunodeficiency Virus Infection, *N Engl J Med*, 1991, **324**: 1644-1650.

46. Pozniak A, Watson JM. Nosocomial transmission of tuberculosis in AIDS care centres, *Communicable Disease Report* 1992, **2**: R71-2.

47. Harries AD. The association between HIV and tuberculosis in the developing world. In *Clinical Tuberculosis* (Ed Davies PDO). London: Chapman and Hall, 1994

48. De Cock KM, Soro B, Coulibaly IM, Lucas SB. Tuberculosis and HIV infection in sub-Saharan Africa. JAMA 1992; **268**: 1581-7

49. Whalen C, Horsburgh CR, Hom D, Lahart C et al. Accelerated course of human immunodeficiency virus infection after tuberculosis. Am J Resp Crit Care 1995; **151:** 129-135.

50. Leroy V, Salmi LR, Dupon M et al. Progression of human immunodeficiency virus infection in patients with tuberculosis disease. A cohort study in Bordeaux, France, 1988-1994. Am J Epidem 1997; **145**: 293-300.

51. Wallis RS, Vjecha M, Amir-Tahmasseb M, Okwera A, Byekwaso F, Nyole S, et al. Influence of tuberculosis on human immunodeficiency virus (HIV-1): enhanced cytokine expression and elevated ß$_2$-microglobulin in HIV-1-associated tuberculosis. J Infect Dis 1993; **167**: 43-8.

52. Singhal M, Banavalikar JN, Sharma S, Saha K. Peripheral blood T lymphocyte subpopulations in patients with tuberculosis and the effect of chemotherapy. Tubercle 1989; **70**: 171-8.

53. Martin DJ, Sim JGM, Sole GJ, Rymer L, Shalekoff S, van Nieke ABN, et al. $CD4^+$ lymphocyte count in African patients co-infected with HIV and tuberculosis. J Acquir Immune Defic Syndr Hum Retrovirol 1995; **8**: 386-91.

54. Dooley SW, Castro KG, Hutton MD, Mullan RJ, Polder JA, Snider DE. Guidelines for preventing the transmission of tuberculosis in health-care settings, with special focus on HIV-related issues. MMWR 1990; **39** (RR-17): 1-29.

Identification of patients

55. Subcommittee of the Joint Tuberculosis Committee of the British Thoracic Society. Guidelines on the management of tuberculosis and HIV infection in the UK. BMJ 1992; **304**: 1231-3.

Laboratory Diagnosis

56. Drobniewski, FA and Pozniak, AL. Molecular diagnosis, detection of drug resistance and epidemiology of tuberculosis. Brit J Hosp Med 1996; **56**: 204-208

57. Heifets, LB. Rapid automated methods (BACTEC) in clinical microbiology. Seminar Respir Infect. 1986; **1**: 242-249.

58. Heym, B, Honore, N, Truffot-Pernot, C et al. Implications of multidrug resistance for the future of short course chemotherapy of tuberculosis: a molecular study. Lancet 1994; **344**: 293-8.

59. Jacobs, WR, Barletta, RG, Udani, R et al. Rapid assessment of drug susceptibilities of *Mycobacterium tuberculosis* by means of luciferase reporter phages. Sciences 1993; **260**: 819-822.

60. Noordhoek, GT, Kolk, AHJ, Bjune, G et al. Sensitivity and specificity of PCR for detection of *Mycobacterium tuberculosis*: a blind comparison study among seven laboratories. J Clin Microbiol 1994; **32**: 277-284.

61. Telenti, A, Imboden, P and Marchesi, F. Detection of rifampicin-resistance mutations in *Mycobacterium tuberculosis*. Lancet 1993; **341**: 647-50.

62. Vareldzis, BP, Grosset, J, De Kantor, I et al. Drug-resistant tuberculosis: laboratory issues. Tubercle Lung Dis 1994; **75**: 1-7.

63. Shang, Y, Heym, B, Allen, B, Young, D and Cole, S. The catalaseperoxidase gene and isoniazid resistance in *Mycobacterium tuberculosis.* Nature 1992; **358**: 591-3.

64. Wilson, SM, McNerney, R, Nye, PM et al. Prgress toward a simplified polymerase chain reaction and its application to the diagnosis of tuberculosis. J Clin Microbiol. 1992; **31**: 776-782.

65. Small PM, Shafer RW, Hopewell PC et al. Exogenous reinfection with multi drug-resistant *Mycobacterium tuberculosis* in patients with advanced HIV infection. NEJM 1993; **328**: 1137-44.

66. Small PM, Hopewell PC, Singh SP et al. The epidemiology of tuberculosis in San Francisco: a population based study using conventional and molecular methods. NEJM 1994; **330**: 1703-9.

67. Saunders NA, Metherell L, Patel S. Investigation of an outbreak of multidrug resistant tuberculosis among renal patients using rpoB gene sequencing and IS6110 inverse PCR. J Inf 1997; **35**: 129-133.

Management of patients

68. Centers of Disease Control. Clinical update: Impact of protease inhibitors on the treatment of HIV-infected tuberculosis patients with rifampicin. MMWR 1996; **45**: 921-5.

69. Weis SE, Slocum PC, Blais FX, King B et al. The effect of directly observed therapy on the rates of drug resistance and relapse in tuberculosis. NEJM 1994; **330**: 1179-84.

Notification

70. Kumar D, Watson JM, Darbyshire JH, for a PHLS/BTS/DH Collaborative Group. More ambiguities and inaccuracies in the notification of cases of tuberculosis in England and Wales. Thorax 1995; **50**: 459-60P.

71. Hickman M, Ellam T, Hargreaves S, Gazzard B, Porter J. Tuberculosis and HIV-infection. BMJ 1992; **304**: 1567-8.

72. Pym AS, Churchill DR, Coker RJ, Gleissberg V. Reasons for increased incidence of Tuberculosis: audit suggests that undernotification is common. BMJ 1995; **311**: 570.

73. Balogun MA, Wall PG, Noone A. Undernotofication of tuberculosis in AIDS. Int J of STD and AIDS 1996; **7**: 58-60.

74. Department of Health. Notification of Tuberculosis in patients with HIV infection. Letter from the Deputy Chief Medical Officer, 27.04.95.

75. Ormerod LP, Watson JM, Pozniak A, Kumar D, McManus T. Notification of tuberculosis: an updated Code of Practice for England and Wales. J Roy Coll Phys Lond 1997; **31**: 299-303.

Contact Tracing

76. Veen J. Microepidemics of tuberculosis: the stone in the pond principle. Tubercle and Lung Dis 1992; **73**: 73-76.

77. Kenyon TA, Valway SE, Ihle MPA, Onorato IM, Castro KG. Transmission of multidrug resistant mycobacterium tuberculosis during a long airplane flight. NEJM 1996; **334**: 933-8.

78. NHS Management Executive Public Health: responsibilities of the NHS and the roles of others. HSG(93)56, 1993.

79. National Health Service Executive. Hospital infection control: Guidance on the control of infections in hospitals HSG (95) 10, 1995.

80. Whalen CC, Johnson JL, Okwera A et al. A trial of three regimens to prevent tuberculosis in Ugandan adults infected with the human immunodeficiency virus. NEJM 1997; **337**: 801–8.

81. Gordin FM, Malts JP, Miller C et al. A controlled trial of isoniazid in persons with anergy and human immunodeficiency virus who are at high risk of tuberculosis. NEJM 1997; **337**: 315–20.

82. Brook MG, Miller RF. Prevention and management of tuberculosis in HIV positive patients living in countries with a low prevalence of *Mycobacterium tuberculosis.* Genitourin Med 1996; **72**: 89–92.

Infection control

83 Pearson ML, Jereb JA, Frieden TR, et al. Nosocomial transmission of multidrug–resistant *Mycobacterium tuberculosis*: a risk to patients and health care workers. *Ann Intern Med* 1992; **117**: 191–196.

84. Menzies D, Fanning A, Yean L, Fitzgerald M. Review Articles: Current Concepts: Tuberculosis among health care workers. *N Engl J Med*, 1995; **332**: 92–98.

85. Advisory Committee on Dangerous Pathogens. Microbiological risk assessment: an interim report. London: HMSO (ISBN 0–11–321990–3).

86. Segal–Maurer S, Kalkut GE. Environmental control of tuberculosis: continuing controversy. *Clin Infect Dis* 1994, **19**: 299–308.

87. American College of Chest Physicians and the American Thoracic Society in cooperation with American Hospital Association, Centers for Disease Control and Prevention, National Heart, Lung and Blood Institute, and Society for Hospital Epidemiology of American (Bates JH, Nardell E co–chairs) Consensus statement: Institutional Control Measures for Tuberculosis in the Era of Multiple Drug Resistance: ACCP/ATS Consensus Conference. *Chest 1995*; **108**: 1690–1710.

88. Wake D, Bowry AC, Crook B, Brown RC. Performance of respirator filters and surgical masks against bacterial aerosols. J Aerosol Sci 1997; **28:** 1311–29.

89. Di Perri G, Cadeo GP, Castelli F, Micciolo R, Bassetti S. Transmission of HIV–associated tuberculosis to healthcare workers. *Infect Control Hos Epi* 1993; **14**: 67–72.

90. Kritski AL, Ozorio Marques MJ, Rabahi MM, Silva Vieira MA, Werneck–Barroso E. Transmission of tuberculosis to close contacts of patients with multidrug–resistant tuberculosis. *Am J Respir Crit Care Med* 1996, **153**: 331–335.

91. Spach DH, Silverstein FE, Stamm WE. Review: Transmission of infection by gastrointestinal endoscopy and bronchoscopy. *Ann Intern Med* 1993; **118**: 117–128.

92. Michele TM, Cronin WA, Graham NMH et al. Transmission of *Mycobacterium tuberculosis* by a fiberoptic bronchoscope. Identification by DNA fingerprinting. JAMA 1997; **278:** 1093–95.

93. Medical Devices Agency. Decontamination of endoscopes. Device Bulletin MDA DB9608, November 1996.

94. Advisory Committee on Dangerous Pathogens. Protection against blood–borne infections in the workplace: HIV and hepatitis. London: HMSO (ISBNO–11–321953–9).

95. UK Health Departments. Immunisation against Infectious Disease. London, HMSO (ISBN 0–11–321815–x).

Environmental (engineering) controls

96. Riley EC, Murphy G, Riley RL. Airborne spread of measles in a suburban elementary school. *Am J Epidemiol*. 1978; **107:** 421–32.

97. Nardell EA. Transmission and Safety Issues, in *Tuberculosis – Current Concepts and Treatment*, ed. Lloyd N. Friedman. London: CRC Press, 1994.

98. Riley RL, Nardell EA. Clearing the air: the theory and application of UV air disinfection. *Am Rev Respir Dis* 1989; **139**: 1286–94.

99. National Institute for Occupational Safety and Health. Criteria for a recommended standard for occupational exposure to ultraviolet radiation. NIOSH, Cincinnati, OH, 1972.

Respiratory protection devices

100. NIOSH. Public Health Regulation 42 CFR Part 84 – Respiratory Protective Device. *Federal Register*, June 8, 1995. Washington, D.C.

ANNEX A
REMIT AND MEMBERSHIP OF THE WORKING GROUP AND ORGANISATIONS AND INDIVIDUALS CONSULTED

Remit

To prepare guidance for health professionals to supplement current general guidance on the prevention and control of tuberculosis, with particular reference to

1. tuberculosis in immunocompromised individuals and in units where most patients are likely to be immunocompromised;

2. drug–resistant and multiple drug–resistant tuberculosis, including special measures applying to immunocompromised patients and units accommodating such patients.

Membership

Dr Jane Leese (Chair)	Department of Health
Dr Diane Bennett	PHLS Communicable Disease Surveillance Centre
Dr Barbara Davis	The Scottish Office Department of Health
Dr Francis Drobniewski	PHLS Mycobacteriology Reference Unit (from April 1997)
Dr Margaret Johnson	Royal Free Hospital (representing the Expert Advisory Group on AIDS)
Dr Jane Ludlow	Welsh Office (to June 1997)
Ms Jennifer McIntyre	Department of Health
Dr Peter Ormerod	Blackburn Royal Infirmary (representing the British Thoracic Society Joint Tuberculosis Committee)
Dr Anton Pozniak	Kings Healthcare
Professor Robert Pratt	Thames Valley University
Dr Bill Smith	Welsh Office (from June 1997)
Dr Grace Smith	PHLS Birmingham
Dr Corry Van den Bosch	East London and the City Health Authority
Dr John Watson	PHLS Communicable Disease Surveillance Centre

Secretariat

Mr Nick Adkin	Department of Health
Mr Robert Freeman	Department of Health
Mr Phil Hayes	Department of Health (to 31.5.96)
Ms Emma Wilbraham	Department of Health (from 1.6.96)

ORGANISATIONS CONSULTED

Advisory Committee on Dangerous Pathogens
Association of Directors of Public Health
Association of Genitourinary Medicine
Association of Medical Microbiologists
British Lung Foundation
British Medical Association
British Society for the Study of Infection
British Thoracic Society
Central London CCDC Working Group
Chartered Institute of Environmental Health
English National Board for Nursing, Midwifery and Health Visiting
Expert Advisory Group on Aids
Faculty of Occupational Medicine
Faculty of Public Health Medicine
Health and Safety Executive
Health Visitors Association
Hospital Infection Society
Infection Control Nurses Association
Institute of Health Services Management
Medical Research Council
Medical Society for the Study of Venereal Disease
NHS Confederation
Public Health Laboratory Service
    Mycobacterial Reference Unit
    Standing Scientific Committee on Mycobacteria
    Laboratory of Hospital Infection
Public Health Medicine Consultative Committee
Public Health Medicine Environmental Group
Royal College of General Practitioners
Royal College of Nursing
Royal College of Pathologists
Royal College of Physicians

All–Party Parliamentary Group on AIDS
BMA Foundation for AIDS
Blackliners
The British HIV Association
George House Trust
London Lighthouse
Mildmay Mission
Modus Operandi Consulting
National AIDS Trust
Network of Body Positive Groups
The Terrence Higgins Trust
UK Coalition of people living with HIV and AIDS
UK Forum on HIV & Human Rights

We are also grateful for the input of the following individuals:

Dr Barbara Bannister, Dr Graham Bothamley, Dr Richard Coker, Dr Kevin de Cock, Mr David Free, Professor George Griffin, Dr Sally Hargreaves, Dr Vivienne Hollyoak, Dr John Moore–Gillon, Prof Geoffrey Pasvol, Prof Anthony Pinching, Prof Rory Shaw, Dr Edmund Smith, Dr Brian Watt

ANNEX B
MYCOBACTERIOLOGY LABORATORY ORGANISATION, SAFETY AND SERVICES

Laboratory organisation

1. The provision of pathology services is varied and has been subject to major change in recent years. The mycobacteriology service should be consultant led and provided by laboratories which have College of Pathologists' Accreditation (CPA) and have demonstrated proficiency in the mycobacteria component of an accepted quality assurance scheme (eg NEQAS). Containment facilities for handling Hazard Group 3 Biological Agents such as *Mycobacterium tuberculosis* are now covered by legislation in Schedule 9 to the Control of Substances Hazardous to Health (COSHH) Regulations 1994 and should comply with the guidance in the fourth edition of the Advisory Committee on Dangerous Pathogens' (ACDP) publication 'Categorisation of biological agents according to hazard and categories of containment'. The service should be delivered by staff who are properly trained and who continue to develop professionally and receive regular updates. Those who manage laboratories which handle MDR–TB strains should ensure that smears can be examined safely in their own laboratory; if they do not have adequate facilities or staff skills for handling propagated cultures they must transfer the propagation of TB specimens to another laboratory with appropriate facilities or be in breach of COSHH. Specimens classified as Hazard Group 3 Biological Agents (as *M. tuberculosis* is) must be double bagged and labelled 'Biohazard'. In addition, for transportation of cultures, bagged samples must be surrounded by absorbent material within properly labelled, rigid containers. The Biological Agents Approved Code of Practice, Regulation 12 requires an employer to provide information, instruction and training for persons who may be exposed to substances hazardous to health.

2. In all cases, including where the primary laboratory refers specimens or cultures for secondary work such as identification, susceptibility testing or typing, there needs to be good communication between microbiologist and clinicians and an understanding of working patterns, methods of reporting and approximate time to results. A service level agreement may be a means of ensuring clarity but is no substitute for good working relationships. Active participation of relevant health care professionals, including junior doctors, in combined educational activities and audit is to be encouraged; regular departmental/interdepartmental meetings and case conferences are particularly valuable. Training in the understanding of TB diagnostic methods should also extend to public health registrars.

Tests available

Microscopy

3. Smears should be screened preferably by auramine phenol stain, or by Ziehl–Neelsen (ZN) stain if this is not available, and confirmed by overstaining with ZN. Auramine phenol is the more rapid and sensitive screening test, but requires fluorescent microscopy and is more difficult to perform out–of–hours. Microscopy is much less sensitive than culture. The

sensitivity of the test may be increased by concentration of secretions, but the significance of a positive test on concentratedmaterial for assessing the infectiousness of the patient is not clear. All respiratory specimens, tissue, pus and aspirates will be examined by microscopy. Microscopy of gastric lavage samples may be useful in some circumstances (eg in children) but may be unreliable due to the presence of environmental mycobacteria.

4. Microscopy results should be available within one working day, and, out of hours, on request.

5. Each laboratory should provide a standard operating procedure for reporting tuberculosis results, covering whose responsibilty it is and the time within which a written report should be sent. Positive microscopy results should be telephoned to the clinician and followed by a written report. Although the statutory responsibility for notification rests with the clinician, it is good practice to make local arrangements, by mutual agreement, to reinforce notification by direct reporting of positive results to the CCDC/CPHM, TB specialist nurse and, for in–patients, the hospital infection control team. Culture results should be sent to the CCDC/CPHM when they become available.

6. Rapid molecular methods of detection such as DNA or RNA amplification tests may be employed, mainly for respiratory specimens, in certain circumstances (see Box 3, p24). They are faster, but less sensitive than, culture. Laboratories without their own facilities should make arrangements to refer specimens to another laboratory. Clinicians need to be aware of their availability and appropriate use. These services are provided by the PHLS and Scottish Mycobacterium Reference Units.

Culture

7. A number of culture systems involving solid or liquid media are available for mycobacteria. Incubation must be prolonged because of the slow growth rate, although more recently introduced liquid culture systems with a variety of signalling mechanisms may be significantly more rapid. Sensitivity is not always enhanced, particularly for smear negative specimens, and it is preferable to perform culture with Lowenstein Jensen slopes in tandem with liquid culture. Liquid culture is particularly important for some atypical mycobacteria.

8. Liquid culture with radiometric or non–radiometric signalling is significantly more expensive than culture on solid media. It is not in routine use in most laboratories but is available at specialised reference laboratories and in hospitals which manage a large number of HIV–infected patients. Where MDR–TB is considered on clinical grounds, liquid culture should be undertaken as there are significant time savings in obtaining the results. (Special precautions should be in place when handling large volumes of liquid culture of propagated tuberculosis organisms in those laboratories which do not have facilities for secondary enclosure. The local risk assessment must consider this, and consider the need for suitable racking, plastic vessels and written procedures.)

9. Laboratories should set up cultures for mycobacteria on the day the specimen is received. If laboratories with small numbers of requests for mycobacterial culture find it impracticable to set up cultures every day, they shouldconsider using the services of larger laboratories. It should be emphasised that although mycobacteria require prolonged culture for maximum sensitivity, conventional cultures on solid media may be positive in two to three weeks,

particularly where the smear is positive, and attempts should be made by each laboratory to remove all avoidable delays between the receipt of the specimen and the recognition of a positive culture. Conventional methods when applied effectively can compare favourably with some newer methods and each stage of the process should be examined to minimise unnecessary delay. Assiduous quality control and quality assurance will give confidence in the performance of media used.

Identification

10. Provisional identification of positive cultures may be possible, based on colonial appearance of culture slopes, growth characteristics and from the preparation and staining of a smear of the growth. Rapid confirmation tests, using probes based on nucleic acid hybridisation can be performed in a few hours and will identify most, but not all, strains reliably as *Mycobacterium tuberculosis* complex or *Mycobacterium avium* complex. Formal identification and susceptibility tests are usually performed where there is particular expertise: in England and Wales, at the PHLS Mycobacterium Reference Unit at Dulwich (MRU) or at one of three Regional Centres for Mycobacteriology in Cardiff, Newcastle and Birmingham; in Scotland, at the Scottish Mycobacterial Reference Laboratory, Edinburgh; and in Northern Ireland at the NI PHL, Belfast City Hospital. The PHLS MRU receives almost five thousand cultures and Regional Centres for Mycobacteriology receive at least one thousand cultures for identification and drug susceptibility testing each year. Where drug resistance is suspected, using criteria given in Box 3, p24, swift referral to the appropriate reference centre with an indication of the likelihood of resistance is mandatory. Rapid identification of *M.tuberculosis* complex can be done if it has not already been done by the primary laboratory to exclude other mycobacteria.

Drug susceptibility tests

11. Conventional drug susceptibility tests are performed using solid media with incorporated antibiotics at a variety of concentrations, relying on growth inhibition relative to control strains as an indicator of susceptibility. Unlike most bacterial drug susceptibility assay systems, those developed for TB have a direct correlate with clinical outcome based on large scale clinical trials. Drug susceptibilities for *M. tuberculosis* are usually available within ten to twenty–one days of receipt of the culture. More rapid testing, using the same principle, involves growing the test and control strains in liquid media with radiometric signalling of growth indices. Many laboratories in England and Wales do not currently perform these tests. Experimental, research based tests for rifampicin resistance are available at the PHLS MRU.

12. In all cases where drug resistance is suspected by use of the criteria given at 5.16 (and Box 1) (eg where the index case has MDR–TB), faster testing should be considered. Additional antibiotics should be tested at the outset, rather than waiting for the results of testing first line agents, and should include at the minimum a quinolone, prothionamide or ethionamide, a macrolide, streptomycin and capreomycin. This will reduce delay in choosing appropriate therapy when resistance is recognised and potentially reduce the period of infectivity. Further research is needed to develop rapid testing systems for single agents and for combined susceptibility testing.

13. While in vitro drug susceptibility tests correlate well with clinical outcome in tuberculosis, they

may not reflect the performance of unusual drug combinations (or drug combinations against some atypical mycobacteria) in vivo and must be interpreted in the light of the clinical picture.

Direct amplification tests (DAT)

14. Tests for the detection of *M. tuberculosis* complex nucleic acids in specimens are technically well developed, although their role in determining infectiousness is not – there are few data regarding the infectivity of patients whose sputum is PCR positive.

15. It is important that all such tests are properly validated. At least two manufacturers' kits have been evaluated for respiratory specimens, and various in–house tests are in use. In HIV–infected patients, where mycobacterial disease may not always be due to *M. tuberculosis* and the risk of drug resistance is raised, direct tests may be applied to respiratory specimens which are smear positive, for example, to differentiate between *M. tuberculosis* and *M. avium*. This has application to infection control as well as to patient care. The sensitivity of direct amplification tests is comparable to culture in highly positive smear specimens, but approximately one third of smear negative specimens which are positive on culture are negative by commercial amplification tests. A positive direct test in smear negative specimens should not be used as the only basis for initiating treatment and contact tracing. This is an area of diagnosis which has not been fully evaluated and these conclusions are likely to require revision.

16. DAT tests must be performed by laboratories proficient in these techniques and in standard comparative culture systems – recent evidence has shown that the proficiency of many laboratories using DAT techniques is poor. In one study (Noordhoek et al) in which coded specimens were submitted to seven laboratories with apparent proficiency, false positive rates ranged from 0–77%.

17. Advice on the suitability and performance of amplification tests is available from the PHLS Mycobacterium Reference Unit and Regional Centres for Mycobacteriology or from the Scottish Mycobacteria Reference Laboratory.

ANNEX C
RISK ASSESSMENT FOR THE TRANSMISSION OF TUBERCULOSIS IN HEALTH CARE FACILITIES

1. Risk assessment is an essential requirement under the Control of Substances Hazardous to Health (COSHH) Regulations 1994. Guidance has been published by the Advisory Committee on Dangerous Pathogens (ACDP)[85] and the Centers for Disease Control (CDC)[4]. This report recognises risk assessment as an important part of the whole process of risk analysis which includes the following stages:

    1. A statement on why a risk analysis is needed – the cause of concern, including questions relating to uncertainties that need resolution.

    2. Risk assessment – identification of the source of the hazard and conditions under which adverse consequences could occur; reviewing and quantifying the risk consequent upon each hazard.

    3. Risk importance – judging the significance in comparison with other risks, in order to guide action in risk management.

    4. Production of a formal record

    5. Testing the robustness of the scenario of the risk assessment

    6. Risk management – the decision on and implementation of action to eliminate or minimise risks.

    7. Risk communication

    8. Risk monitoring

2. During a risk assessment exercise for tuberculosis, the following data are needed to inform management decisions and policy development:

    i. A district/community/hospital epidemiological profile comprising:

    - trends in incidence of new cases of tuberculosis, both pulmonary and extrapulmonary

    - the number of immunocompromised people being seen in in–patient and out–patient hospital settings;

- prevalence of HIV infection and incidence of new infections;
- incidence of tuberculosis among HIV–infected (and other immunocompromised) individuals;
- number of patients with infectious tuberculosis admitted to a specific hospital;
- average length of infectiousness of tuberculosis patients admitted;
- number of patients with resistant and MDR strains of tuberculosis admitted to hospital;
- length of hospital stay for MDR patients.

ii. A baseline hospital assessment of:

- current availability of appropriate facilities, personnel, expertise and resources to care for patients with infectious and potentially infectious tuberculosis;
- the infection control strategies in place in relation to caring for patients with infectious tuberculosis, and their appropriateness and effectiveness;
- quality assurance, audit and policy review mechanisms in place to assure infection control plan is both current, i.e., based on risk assessment data and professional and statutory guidelines, and being implemented correctly.

3. The result of the risk assessment should inform decisions as to the facilities required and the appropriateness of admitting immunocompromised patients with infectious tuberculosis and patients with drug-resistant tuberculosis, or referring them to other, more specialised, hospitals.

ANNEX D
ENVIRONMENTAL CONTROLS: VENTILATION, NEGATIVE PRESSURE ISOLATION ROOMS, TENTS AND BOOTHS, AIR FILTRATION AND UVGI

Ventilation

1. The risk of a person acquiring infection with *M. tuberculosis* depends on the concentration of infectious droplet nuclei in the air and the volume of air inhaled (which primarily depends on the duration of exposure)[96].

2. Building ventilation, whether natural or mechanical, serves to dilute droplet nuclei in the air and is the single most important engineering control in the prevention of transmission of airborne infections. However, while ventilation is important, it is one part of, and cannot be relied upon as the only, environmental strategy for protecting building occupants against tuberculosis transmission.

3. There have been no scientific studies of the effect of various levels of general building ventilation on tuberculosis transmission and current guidance is based on the use of ventilation to control odour and other indoor air contaminants[87]. Advice should be obtained from a ventilation engineer, preferably one with experience in hospital infection control, in cooperation with the local infection control team.

4. Effective ventilation means that dilution of the air is achieved by removing contaminated air from the room and replacing it with air free of *M.tuberculosis*, ie outside air, air from a low–risk area in the building, or recirculated air which has been treated to kill or remove tubercle bacilli. Ventilation is expressed in terms of the room volume as *air changes per hour* (ACH).

5. Air currents may transport infection within rooms and buildings. The direction of airflow is therefore important to ensure that the clean air completely mixes with ambient room air. The outflow must also be safely exhausted so that it does not flow towards other patient areas. If air is both mechanically supplied and exhausted from a room, the supply rate must not exceed the exhaust rate in order to achieve this flow. In areas where a negative room pressure is required, the exhaust rate must exceed the supply rate by a generous margin.

6. The ventilation engineer should be consulted regarding the rates of flow sufficient for effective control without causing turbulence. Engineering and construction costs, operating costs, and occupant tolerance place upper limits on the amount of ventilation that is practical.

7. There is an absolute duty under Regulation 9 of the COSHH Regulations that all local exhaust ventilation plant should be thoroughly examined and tested at least once every 14 calendar months.

Negative pressure isolation rooms.

8. Ventilation dilutes airborne infectious particles but does not contain them. This requires the physical limits of an isolation room[97]. Where it is essential to prevent the egress of contaminated air from an isolation room through the door (or other gaps) towards other patient areas, the air in the room must be at negative pressure relative to these areas and safely exhausted.

Direction of air flow

9. The direction of airflow is more important than the pressure differential through which it flows, and must ensure that all air leaving the room does so through a controlled process and is discharged to the outside away from windows or ventilation inlets. It is important that the room is under negative pressure with respect to all its surroundings (except the bathroom/toilet, which itself should be under negative pressure to control smells). It is unrealistic to expect the door to be the only hole in the room through which air will flow. If other holes in the fabric of the room, for example surrounding the entry of electric cables, plumbing, pipes etc. do not exist already, or they are blocked up, they will rapidly (re)appear and can result in airflow between rooms.

Achieving negative pressure in a room

10. While the direction of airflow is more important, the pressure differences must be measurable. It is difficult to measure pressure differentials below 5 pascals. The USA CDC recommendation of 0.001 inch of water equates to 0.2 pascals, which is not readily measured or monitored. However, if rooms are not well sealed, it may be difficult to achieve greater differentials.

11. Extracted air volumes should exceed air supplied through the ventilation system by a large margin. (The precision with which this has to be done is open to discussion. The CDC in the USA recommends the exhaust rate from the room exceeds the intake of air by about 10–15% or 50 cubic feet per minute, whichever is greater. However, these margins are slim – it would not take much slippage in the mechanisms of the extract, the supply or both, to reverse such a slight differential, resulting in air actively blowing out of the room. There is also little practical reason to have a narrow margin: if a greater volume of air is extracted, a greater volume of incoming air will be needed. It will be supplied by air being drawn into the room (through the door and other vents), and the desired direction of flow will be obtained. With a robust flow, there should be little need for especially close fitting doors; if necessary, the pressure differential can be controlled by restricting the gap in the door–vent (which is self–sealing in the case of fire doors).

12. If the existing ventilation system is incapable of achieving the desired negative pressure, or the room lacks a separate ventilation system, steps should be taken to provide a means to discharge air from the room to the outside, such as an exhaust fan[4].

13. *Number of room air changes/outside air mix:* Current USA recommendations, for ≥6 air changes per hour (ACH), were empirically based on pre–existing recommended rates for non–specialised areas not related to infection control, and have only been justified for tuberculosis in retrospect. Ventilation rates between 6 and 12 ACH are likely to produce incrementally greater reductions in the concentration of bacteria in a room; airflow rates

greater than about 12 ACH may lead to complaints about draughts and higher heating costs to maintain an acceptable room environment.

Monitoring

14. Pressure differentials can be monitored either by a permanently–mounted magnehelic type gauge with the reading recorded regularly (eg once a day) or by an electronic micromanometer linked to a remote alarm, usually by the nurses' station. Otherwise, monitoring may be by observing the direction of airflow, using smoke tubes. This should be done by a qualified ventilation engineer and the monitoring must itself be monitored.

15. Rooms need to be frequently checked by an appropriately trained engineer for both direction of air flow and the degree of negative pressure which has been established, and accurate and detailed monitoring records kept. (There is an absolute duty under Regulation 9 of the COSHH Regulations that all local exhaust ventilation plant should be thoroughly examined and tested at least once every 14 calendar months.) It is good practice to keep the monitoring record on the wall where it can be seen by staff. It is essential that all staff are trained in facilitating the maintenance of negative pressure by ensuring that all doors (except when persons need to enter or leave the room) and windows remain properly closed in the isolation room. A small gap (<½ inch) at the bottom of the door is sufficient to provide a controlled airflow path.

Other features of negative air pressure rooms

16. A negative pressure room should preferably have windows which do not open. If the room has both mechanically supplied and extracted air, these should be linked such that, should the extract fail, the supply will cut out (otherwise the room would be under positive pressure). They should be covered by emergency power generators.

17. Rooms should have their own, preferably integral, toilet room/shower facilities, and their own television/video/radio, telephone etc.

18. *Ante–rooms* help to reduce the escape of droplet nuclei during opening and closing of the isolation room door. They are also generally acknowledged to be a useful prompt to good infection control technique. However, given a robust ventilation system and good pressure differential, if the budget for installing a new facility is limited, an ante–room may be waived in favour of installation of a high quality negative pressure room. The isolation room should be at negative pressure relative to the anteroom. Masking and unmasking should take place inthe ante–room.

Fire precautions for negative pressure rooms

19. In case of a fire elsewhere in the facility, all staff must be aware that patients in negative pressure rooms are at an increased risk as smoke and fire can be drawn into the negative pressure isolation room from the adjacent corridor.

Tents and booths for sputum inducing procedures

20. Both tents and booths should have sufficient airflow to remove at least 99 per cent of airborne particles during the interval between patients. Several factors influence the time required to do this, but in general, an ACH rate must be established which is high enough to remove 99 per cent of airborne particles within 10 minutes, e.g., 25–30 ACH[4].

21. A hood placed very near, but not enclosing, an infectious patient is another type of local exhaust ventilation device. Their use and airflow requirements have been described elsewhere[4].

22. Air from booths, tents, and hoods is preferably exhausted directly to the outside, but may be discharged into the room in which the device is located. If the latter, a HEPA filter (see below) must be incorporated in the discharge duct or vent of the device with the exhaust fan on the discharge side of the filter to ensure that the air pressure in the filter housing and the booth is negative with respect to the adjacent areas. Uncontaminated air from the room will then flow into the booth through all openings, preventing infectious droplet nuclei in the booth from escaping in the room.

Air Filtration

23. A large variety of portable and permanently installed air filtration devices are being used for infection control as an alternative to additional ventilation. Few have been rigorously and independently tested for their ability to clear airborne particles under field conditions[87]. Air filtration is not a substitute for good ventilation.

24. High–efficiency particulate air (HEPA) filters remove particles down to ≥0.3 μm in diameter. Such filters on exhausts to the outside are expensive to install and maintain and rarely necessary – air should be vented to a place where it will not re–enter the building. If extra filtration is required, total efficiency is not essential – it is better, cheaper and likely to be as efficacious to put a greater volume of air through a coarse filter with a lower retention.

25. HEPA filters are used to clean air which is recirculated to other areas of a facility, or recirculated within a room, for rooms where there is no general ventilation system, where the system is incapable of providing adequate airflow, or where increased effectiveness of room airflow is desired. Portable units areavailable. HEPA filtration may have a place as an additional measure to adequate ventilation in booths or enclosing devices designed for aerosol generating procedures. But portable HEPA filtration units have not been evaluated adequately to determine their role in tuberculosis infection control. **Recirculating air taken from areas intended to isolate a patient with tuberculosis is in any case a risk not worth taking, and is not recommended.** The consequences of a holed or improperly seated filter may be serious. The units are also expensive and need regular engineering attention.

26. If HEPA filters are to be used, expert advice is required in installing, maintaining and monitoring them[4].

Ultraviolet germicidal irradiation (UVGI)

27. Ultraviolet radiation is that portion of the electromagnetic spectrum between 100 and 400 nm wavelengths. The UV spectrum is further divided into: UV–A (long wavelengths, 320–400 nm), UV–B (mid–range wavelengths, 290–320 nm), and UV–C (short wavelengths, 100–290 nm). Commercially available UV lamps for germicidal use are low–pressure mercury vapour lamps that emit radiant energy in the UV–C range, predominantly at a wavelength of 253.7 nm. Nardell has comprehensively described both the safety and efficacy of UVGI[97].

28. UVGI was first used to kill or inactivate tubercle bacilli almost 45 years ago. However, there have been no clinical trials of its efficacy in protecting health care workers from nosocomial tuberculosis[98]. Although available, and sometimes helpful as an adjunct to other controls, e.g. in out–patient waiting areas where infectious cases spend relatively short periods, it is not generally recommended. UVGI is not a substitute for ventilation, safe local exhaust of air to the outside, air filtration, or the use of negative pressure rooms.

29. Two systems of UVGI have been used to disinfect air as a supplement to other engineering controls: duct irradiation and upper–room irradiation[4].

Duct irradiation: UV lamps are placed inside fully sealed ventilation ducts that remove air from rooms to disinfect the air before it is discharged or recirculated. In properly designed, installed, and maintained systems, high levels of UV radiation may be produced in the duct work with negligible risk of personal exposure (although maintenance procedures need special attention). Possible uses include TB isolation rooms, other patient rooms, waiting rooms, emergency rooms, and other general–use areas of a facility where patients with undiagnosed tuberculosis could potentially contaminate the air. Since many medical facilities already have the required forced ventilation, particularly if they have rooms at negative pressure, the cost of modifications to provide circulation of the air through UVGI lamps ought not to be prohibitive.

Duct systems using UVGI are not a substitute for ventilation, safe local exhaust of air to the outside, air filtration, or the use of negative pressure rooms.

Upper–room air irradiation is to inactivate tubercle bacilli in the upper part of the room, while minimising radiation exposure to persons in the lower part of the room. UVGI lamps are suspended from the ceiling or mounted on the wall. The bottom of the lamp is

shielded to direct the radiation upward but not downwards. The system depends on normal air mixing to take irradiated air from the upper to the lower part of the room, and non–irradiated air from the lower to the upper part. The irradiated air space is much larger than that in a duct system. This method may be used in TB isolation rooms and treatment rooms as a supplemental method of air cleaning. It may also be used in other patients' rooms and in waiting rooms, emergency rooms, corridors, and other central areas of a facility where patients with undiagnosed tuberculosis could potentially contaminate the air.

Using an 'up lighting' technique requires rigorous exposure assessment in order to ensure that reflected/scattered emissions are below the applicable limit. Careful attention also needs to be paid to luminaire design and placement and interior room design. These constraints make the option less appropriate for areas where there is uncontrolled access by the public or continuous occupancy by patients, as for example in isolation rooms.

30. UV–C is almost totally (95%) absorbed by the outer, dead layer of the stratum corneum of the skin. Direct exposure to high intensity UV–C can cause temporary painful, but superficial irritation of the eyes (photokeratoconjuctivitis) and skin erythema. Intensive, direct skin exposure can also cause a mild to moderate "sunburn" in sensitive individuals. Current US safety guidelines for exposure to UV–C are based on a combination of animal data and voluntary human exposure using eye irritation as the end–point[99]. The exposure limit applicable to low pressure mercury vapour lamps of 0.2 $\mu W/cm^2$ of UV–C at 254 nm over 8 hours is supported by the UK National Radiological Protection Board (NRPB) and used by HSE for enforcement purposes.

31. If a UV lamp is used, a strict maintenance regimen must be adhered to for hours of use, times for changing, and measurement of wavelength output.

ANNEX E
RESPIRATORY PROTECTIVE DEVICES

1. To prevent inhalation of airborne infectious droplet nuclei containing tubercle bacilli, particulate filtration masks must filter particles down to 1 micron in diameter and it is suggested that they provide a greater than 95% (i.e. filter leakage of 5%) filtration efficiency for particles with a median diameter of 1.0μm at a flow rate of 50 litres a minute ('CDC 1994 criteria')[4].

2. European standards for respiratory protection devices (EN149) are largely based on industrial uses. To be certified as an FFP1 Respirator, particulate filtration masks must be more than 80% efficient when tested at 95 litres per minute with 0.1 micron sodium chloride particles. This is more stringent than is required for tuberculosis. Masks which do not meet these criteria but provide sufficient filtration for tuberculosis are available in the UK and are classified as medical devices.

3. Under US (NIOSH) legislation[100], three classes of filters are recognised for certification (N–, R– and P–series), each at three levels of filter efficiency (95%, 99% and 99.97%). All three classes meet the performance criteria for tuberculosis recommended above. The N–series is the most appropriate for use in health care settings: as well as being tested against latex spheres of 1 micron diameter, they must provide greater than 95% filtration of 0.3μm sodium chloride particles at a flow rate of 85 litres a minute.

4. Tecnol is the largest supplier of dust/mist and particulate respirators to the National Health Service, although other firms, e.g. 3M Company, and Racal Health and Safety, Inc., also market particulate respirators in the United Kingdom which meet the required specification. Advice should be sought from the manufacturer on the selection of products which best meet the filtering requirements for protection against tuberculosis.

5. The Tecnol, DMR2010 Dust/Mist Respirator with FluidShield® Barrier filters 0.1 microns at 50 litres per minute at over 95% efficiency, tested against silica dust/mist. Tecnol's PFRP1 Particulate Filter Respirator (PFR) filters 0.1 microns at 95 litres per minute at over 80% efficiency, tested with NaCl.

Use of masks

6. That a mask gives a tight facial seal and is used correctly is as important as the type of mask used. Masks need to be supplied in various sizes (e.g. standard, small). Manufacturers should also supply simple, easy to use fit testing devices and procedures. Users need training in fit testing, use and maintenance.

7. *Fit testing* involves the user wearing a mask in a confined chamber into which banana oil or saccharine particles are injected into the air; if the wearer can taste the test substance, the mask does not fit.

8. Although NIOSH–approved dust/mist particulate respirators have been shown to retain their filtration efficiency over eight hours, no mask should be re–used which has possibly been contaminated with tuberculosis organisms.

ANNEX F
CONTACTS FOR FURTHER ADVICE

Clinical

The following clinical members of the Joint Tuberculosis Committee of the British Thoracic Society are willing to advise on the management of patients with multidrug–resistant tuberculosis. This should not be regarded as a complete list of physicians with expertise in this field. Further individuals may be identified locally, or via the experts listed in this annex, or through the Department of Health Communicable Diseases Branch, Room 706 Wellington House, 133–155 Waterloo Road, London SE1 8UG, Tel: 0171–972 4480, Fax: 0171–972 4468.

Dr LP Ormerod (Chairman)
Consultant Chest Physician
Chest Clinic
Royal Infirmary
Bolton Road
BLACKBURN
Lancashire BB2 3LR
Tel: 01254 294338

Dr IA Campbell (Secretary)
Consultant Physician
Llandough Hospital NHS Trust
Penlan Road
PENARTH
Vale of Glamorgan CF64 2XX
Tel: 01222 715417
Fax: 01222 350056

Dr J Moore–Gillon
Consultant Physician
Department of Respiratory Medicine
St Bartholomew's Hospital
West Smithfield
LONDON EC1A 7BE
Tel: 0171–601 8441
Fax: 0171–601 8437

Dr PDO Davies
Consultant Physician
Aintree Hospitals NHS Trust
Fazakerley Hospital
Longmoor Lane
LIVERPOOL L9 7AL

Tel: 0151–529 2479
Fax: 0151–529 2873

Dr C Skinner
Consultant Physician
Department of Respiratory Medicine
Birmingham Heartlands Hospital
Bordesley Green East
BIRMINGHAM B9 5SS
Tel: 0121–766 6611 Ext 4477
Fax: 0121–772 0292

Dr A L Pozniak
From 1 September 1998
Consultant in HIV & AIDS
Chelsea & Westminster Healthcare NHS Trust
Chelsea & Westminster Hospital
369 Fulham Road
LONDON SW10 9NH
Tel: 0181–746 8239
Fax: 0181–746 5611
E–mail: alp@crusaid–star.co.uk

Infectious disease epidemiology

Dr John Watson
PHLS Communicable Disease Surveillance Centre
61 Colindale Avenue
LONDON NW9 5EQ
Tel: 0181–200 6868
Fax: 0181–200 7868
E–mail: jwatson@phls.co.uk

Mycobacteriology Reference Laboratories

PHLS Mycobacterium Reference Unit:

Dr Francis Drobniewski
Dulwich Public Health Laboratory and Medical Microbiology
King's College School of Medicine & Dentistry
King's College Hospital (Dulwich)
East Dulwich Grove
LONDON SE22 8QF
Tel: 0181–693 2830
Fax: 0171–346 6477
E–mail: Francis.Drobniewski@kcl.ac.uk

Additional copies of this publication can be obtained from:
Department of Health Stores,
PO BOX 410,
Wetherby LS23 7LN

Produced by Department of Health
13714 1P9k Oct 98 (ANC)
CHLORINE FREE PAPER