REVIEW ARTICLE

# Pulmonary Tuberculosis as an Occupational Disease

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## Introduction

It is common knowledge that tuberculosis is a serious health concern and that the disease is becoming more common throughout the world, particularly in poorer countries where most of the cases are concentrated. The disease was thought to be under control in countries considered to be developed. Nevertheless, such countries have not attained the epidemiological situation of either elimination (disappearance of cases although not of causes, and no more than 1 bacilliferous person per 1 000 000 inhabitants and less than 1 infected person per 100 inhabitants) or eradication (elimination of cases and causes, with no more than 1 bacilliferous person per 10 million inhabitants and less than 1 infected person per 1000 inhabitants).

Tuberculosis is not only a public health concern but also an occupational health concern, that is, it can be directly related to work. Most people aged between 16 and 65 years work as part of a team rather than in isolation so, on average, workers coincide for 7 hours a day, 35 hours a week, 140 hours a month, 1540 hours a year, and 75 460 hours in total during their working life. Given that tuberculosis is usually transmitted through the air, potential tuberculosis contacts and infections may occur in the workplace. Thus, tuberculosis is included in the Official Spanish List of Occupational Diseases.[1] In fact, the risk of transmission of this disease in health care facilities is considered to be high.[2] Risk varies considerably from one facility to another and depends on the prevalence of tuberculosis in the community, the population of patients with tuberculosis, the various groups of health workers at risk, the various health care settings, and the control measures adopted at the different facilities.

Since the 1980s, there have been many reports of nosocomial transmission of tuberculosis in the United States of America, including multidrug-resistant tuberculosis in patients and health care workers.[3] Many patients and some health care workers were infected by the human immunodeficiency virus (HIV). In these individuals, the tuberculosis infection progressed rapidly to disease and was associated with a high mortality rate.[4,5] Analysis of these outbreaks revealed a decrease or elimination of tuberculosis transmission after implementation of the preventive measures suggested in the 1990 and 1994 guidelines for control of nosocomial tuberculosis published by the Centers for Disease Control and Prevention in Atlanta. Reports of outbreaks of tuberculosis infection among Spanish health care workers have also been published.[6,7]

In the field of occupational health, and particularly after the 1995 Law for Prevention of Hazards in the Workplace was passed in Spain, preventive measures and regular monitoring should be implemented for all workers who may be exposed to a biological risk of tuberculosis.[8]

The aim of this review is to raise awareness among specialists who have to deal with tuberculosis that it can be an occupational disease and, as such, notification is necessary for those workers who contract it because of their work (causal effect) but not for those who contract it in the workplace through interpersonal relationships inherent in their work (coincidental effect). Protocols should be encouraged for medical monitoring of workers exposed to the Koch bacillus who may develop occupational tuberculosis. Likewise, those who, for different reasons (immigration), find themselves in occupations such as the restaurant business, where tuberculosis is more prevalent, should also be monitored. Such protocols should be applied as workers take up their position and regularly thereafter.

## Analysis of Risk of Tuberculosis Infection in the Workplace

The probability of infection depends on the potential for contact with the bacillus. The risk of contact in health care facilities,[9,10] geriatric facilities,[11] homeless shelters, and prisons,[12] among others, is particularly high and so the risk of contracting the disease is also high. The situation is most worrying in places where the opportunities for infection are greatest. Situations in which the opportunities for infection are evidently higher include emergency rooms before the patient is diagnosed with tuberculosis, isolated, and started on treatment, pulmonology services, bronchoscopy rooms,[13] aerosol

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rooms,[10] histopathology laboratories, general pathology services, microbiology laboratories,[14] sickbays of prisons, and autopsy rooms.[15]

In practice, tuberculosis is almost always transmitted through the air. In aerial transmission, uptake occurs naturally by the involuntary and vital action of breathing by the recipient or contact. In the rare instances of infections by other routes (digestive, skin, or mucosa), the exposed surfaces of the host must be damaged (cuts or lesions).[5] Given that infection propagates principally through the air,[6,16] transmission is subject to certain conditions, thus allowing us to assess the risk of transmission.

### *Assessment of the Risk of Transmission*

Risk assessment considers the following:

*1.* The source: the reservoir that emits the infectious agent—generally the person who is ill. In developed countries, it is much less common for the source to be a sick animal. The bacilliferous nature of the source will determine whether the bacilli are emitted as aerosols from breathing, coughing, or sneezing, or else by talking, shouting, singing, or whistling.[17] The most bacilliferous individuals are patients with active laryngeal and pulmonary tuberculosis, patients carrying the most virulent strains of tuberculosis, and immunodepressed patients (due to HIV infection). The cadavers of tuberculosis patients are also a possible source of contagion (particularly when aerosols are generated with saws and pneumatic instruments used in autopsies).[18]

*2.* The transmission vehicle: aerosols from index cases that transport the infectious agent. The disease is generally transmitted in droplet nuclei, described by Wells, which remain suspended in the air because of their small size (1-10 μm). (Alternatively, tuberculosis may also be transmitted by droplets of the type first described by Flügge, though such transmission is rare because of their larger size.) During a coughing attack, a source can emit up to 3000 infectious droplets. Sputum itself does not cause infection unless it has dried and is then dispersed in the air.

*3.* The transmission medium: the air between the source that emits the droplets and possible contacts. The medium will depend on factors such as the volume of shared space, the distance between the emitting source and the contact, and the time they coincide with one another.

### *Risk of Infection*

The probability of infection is assessed by taking into account the virulence and infectious dose emitted by the tuberculosis patient, and the susceptibility of the recipient host to infection or disease, given that host factors will increase the risk of infection regardless of dose.[19]

The ability of the source to infect others depends on the type of tuberculosis (laryngeal or pulmonary), the nature of the bacillus (estimated directly by sputum-smear examination or indirectly by x-ray evaluations), situations that affect the ability of the source to emit pathogens (treatment duration at the time of contact and personal behavior of the index case). The number of bacilli taken up by the contact is also important and depends essentially on the bacillary load in the air inhaled. The bacillary load in turn depends on the volume of the shared room (larger volumes of air will mean more dilution, thus lowering the bacillary load) and the ventilation of the room—good ventilation will keep infected particles in suspension and so facilitate their dilution and elimination.

In addition, germicidal factors, such as sunlight, artificial ultraviolet light, and low relative humidity, may be present in the shared environment and should be taken into account.

The infectious dose of tuberculosis is estimated as with any other dose, that is, from the number of bacilli in the shared air and the duration of contact. This factor means that it is possible for low bacillary loads to be infectious if combined with long exposure times and vice versa. Apart from unusual cases of contacts over large distances caused by shared air circulated through closed air-conditioning systems, the risk of transmission decreases logarithmically at distances above 0.5 m. Thus, contact times should be estimated for close contacts between 0.5 and 2 m and expressed in hours per day.

## Identification of Occupationally Exposed Workers

Snider[20] classified the professions or occupations carrying risk of tuberculosis into 3 groups (Table 1). In Groups 2 and 3, a clear causal relationship links the

TABLE 1
**Professions or Workers at Risk of Tuberculosis: Groups According to Snider***

| |
|---|
| Group 1 (occupations of workers at high risk of contracting tuberculosis) |
| Immigrant workers |
| Laundry workers |
| Food operatives |
| Prison warders |
| Poorly qualified manual workers |
| Group 2 (occupations that increase susceptibility to development of active disease) |
| Work with risk of contact with silica |
| Extraction industries (mines, quarries) |
| Sand-blasting |
| Ceramic industries |
| Iron and steel works |
| Tunneling (civil engineering works) |
| Group 3 (positions that increase the risk of exposure) |
| Those at risk of contact with tuberculosis (people or animals) |
| Geriatric facilities |
| Homeless shelters |
| Health care facilities |
| Drug rehabilitation centers |
| Prisons and reformatories |
| Animal research facilities |

*Adapted from Snider.[20]

workplace with possibility of tuberculous infection, which occurs when work material or workplace procedure is able to actively transmit pathogens or passively provoke susceptibility to the disease in workers who are performing their normal duties.[21] In Group 1, Snider includes occupations and, therefore workers, who are more affected by tuberculosis, normally for sociocultural reasons. Although the classification was drawn up for the sociocultural situation in North America, Spanish society increasingly resembles that of North America. If we extrapolate Snider´s system to Spain, the population most at risk would probably be workers in the restaurant industry (waiters, cooks, etc).

*Group 1: Nonoccupational Tuberculosis—No Causal Relationship to the Workplace*

Nonoccupational tuberculosis cases would comprise those in workers of a similar sociocultural status, for example immigrants, who congregate in the same jobs and workplaces, and therefore face a higher risk of contagion among themselves because of a coincidental occupational relationship.

*Group 2: Occupational Tuberculosis Cases With a Direct Passive Causal Relationship Considered Intrinsic to the Workplace*

Occupational pathology recognizes the increased susceptibility to tuberculosis due to silicosis and pneumoconiosis. Among workers exposed to pneumoconiosis, the prevalence of tuberculosis has been seen to be particularly high.[22]

In occupations associated with risk of silicosis and pneumoconiosis, the worker is exposed to inhalation of free silica dust. Particularly risky work includes that done in mines, tunnels, quarries and galleries, as well as the cutting or polishing of silica rock, masonry work, dry grinding, sieving and handling of minerals and rocks, production of silicon carbide, glassware, porcelain, earthenware and other ceramic products, production and maintenance of abrasives and other detergent powders, removal of pieces from molds, trimming, and desanding in casting, work with grinders (polishing and finishing) that contain free silica, sand-blasting, and stone polishing. With regard to asbestos, all tasks in which the worker is exposed to asbestos dust are worthy of mention. Examples are the extraction, handling, and treatment of asbestos minerals or rocks; production of asbestos textiles, card, and paper; preparation of asbestos fibers (combing, spinning, weaving, etc); pistol application of asbestos (chimneys, and car and wagon bases); work with thermal insulation in shipping and buildings and their demolition; production of brake and clutch pads, fiber cement products, firefighting equipment, and asbestos and rubber seals; and disassembly and demolition of facilities that contain asbestos.

*Group 3: Occupational Tuberculosis With an Active Intrinsic Causal Relationship to the Workplace*

An active, causal relationship is considered to be intrinsic to an occupation when the work material or workplace procedure is the source or origin of the bacilli or microbial agents of a disease. The classic example is health care workers who are infected by the bacillus and contract tuberculosis through person-to-person clinical contact, face-to-face with the patients who they are attending.[23]

Certain current clinical procedures increase the risk of infection from clinical contacts, for example, procedures that provoke cough to induce sputum, therapeutic tracheobronchial intubations, anesthetic intubations, intubations for examination or simple cleaning of the upper airways, bronchoscopies, lung function tests, or the administration of curative or preventive pharmacological aerosols.

In these cases, the working procedures are what intrinsically provide active, direct contact that can lead to contagion. These procedures determine which subproducts of the clinical material or object transport or carry the pathogen.[24]

Special circumstances, also involving transmission to health care workers, are those that occur in the laboratory or during autopsies when working with human samples from tuberculosis patients or cadavers of individuals who had tuberculosis. In the case of autopsies, certain procedures generate aerosols and cause contact with infectious airborne agents (use of electric saws or pneumatic aspirators-injectors). In clinical or research laboratories, particularly risky procedures are those that require shaking or stirring of samples.

Although rare, dermal-mucosal contact may occur by splashes on skin lesions or on mucosa directly exposed to these materials or subproducts.

In similar circumstances, whether clinical or not, transmission of tuberculosis may also arise among veterinary surgeons or those who care for animals infected by bovine bacilli or diseases of the tuberculosis complex in the laboratory or on the autopsy table.[25,26] Bovine tuberculoses, though rare today, may also be directly occupational.[27]

Apart from the specific context of health care, populations in homeless refuges and shelters, prison inmates, and refugees and asylum seekers form groups in which the prevalence of bacilliferous patients is high for a variety of reasons. Therefore a direct intrinsic occupational risk for transmission of tuberculosis to the workers at these facilities exists.[11] This risk is particularly high in prisons because of certain environmental conditions (overcrowding, limited ventilation due to the small size of the cells) and also contemporary selection (concentration of groups of inmates with a higher prevalence of severe infectious tuberculosis, for example, because of HIV infection or full development of acquired immune deficiency syndrome).

Other groups of health care workers or auxiliary health care workers are exposed to greater risk because of the service they offer, for example, those who work for nongovernmental organizations in countries where tuberculosis is endemic, and also workers who provide home health care for patients.

## Tuberculosis as an Occupational Disease

Tuberculosis is considered an occupational disease when it affects those whose work brings them into direct contact with tuberculosis patients or materials infected with the Koch bacillus and no other nonoccupational means of infection has been demonstrated.[28-30]

In Spain, the list of diseases considered occupational under law is found in the Annex to Royal Decree 1995/1978, dated May 12. This document formed the basis for the List of Occupational Diseases Covered by Social Security. Within Section D of this list (infectious and parasitic occupational diseases), tuberculosis would be included among D/3 and D/4 diseases. In Section C (occupational diseases caused by inhalation of substances and agents not listed in other sections) of the same official Spanish list of occupational diseases, silicotuberculosis (C.1/a) and asbestos-related tuberculosis (C.1/b) are explicitly recognized (Table 2).

## Reporting Tuberculosis as an Occupational Disease

Tuberculosis must be reported as an occupational disease to the appropriate entities that provide health and economic cover. The company may have this contingency covered by the National Institute for Social Security (INSS) or the Mutual Assurance for Occupational Accidents and Diseases of the Social Security (MATEPSS). For notification, the worker´s company will fill out a mandatory report of the occupational disease. At the same time, the corresponding health service of the Spanish autonomous community should be notified.

The MATEPSS or INSS are entirely responsible for health, medical, pharmaceutical, outpatient, and hospital care, as well as for covering the statutory workman´s compensation due to temporary incapacity. If the patient were permanently disabled or died, this contingency would be covered by the INSS.

It is important to highlight the importance of reporting the disease as an occupational contingency and not a normal one, not only to improve epidemiological monitoring within the community, but also because the patient will receive more economic support in the event of temporary disability (Table 3).

## Prevention

Tuberculosis is a preventable disease in that we know its causal agent and how it is transmitted, and because an effective treatment is available.[31] True primary prevention should aim to destroy the causal agent wherever possible.

TABLE 2
**Pulmonary Tuberculosis in the Spanish List of Occupational Diseases**

*Occupational Disease D/3*
Infectious or parasitic diseases transmitted to humans by animals or by animal products or carcasses (for tetanus, work with human or animal excrement is also included)
- Work that entails direct contact with animals, vectors, or reservoirs of infection or animal carcasses
- Handling or use of animal remains
- Loading and unloading of shipments and handling of products of animal origin
- Personnel who work in biological laboratories (clinical or investigative, human or veterinary), and particularly those who use or raise animals for scientific purposes
- Health care workers in hospitals, nursing homes, and laboratories

*Occupational Disease D/4*
Infectious and parasitic diseases of workers who carry out prevention work, or attend and care for patients and those who carry out research
- Work of health caregivers and ancillary personnel who are in contact with patients, whether in closed institutions or open facilities and in home services
- Work in research and clinical analysis laboratories
- Work that involves sampling, handling, or use of human blood or its derivatives for viral assessment of patients with viral hepatitis and work that involves direct contact with such patients

*Occupational Disease C.1/ Pneumoconiosis*
C.1/a. Silicosis, whether or not associated with pulmonary tuberculosis
- Work with exposure to inhalation of free silica dust and in particular:
  - Work in mines, tunnels, quarries, galleries
  - Working and polishing of silica rocks, masonry work
  - Work that involves dry grinding, sieving and handling of minerals and rocks
  - Production of silicon carbide, glassware, porcelain, earthenware and other ceramic products, production and conservation of silica-based bricks
  - Production and maintenance of abrasives and other detergent powders
  - Work that involves removal of pieces from molds, trimming and desanding in casting
  - Work with grinders (polishing and finishing) that contain free silica
  - Work with sand-blasting and polishing stone

C.1/b. Asbestosis, whether or not associated with pulmonary tuberculosis or lung cancer
- Work that involves exposure to inhalation of asbestos dust and in particular:
  - Work of extraction, handling, and treatment of asbestos minerals or rocks
  - Production of asbestos textiles, card, and papers
  - Preparatory treatment of asbestos fibers (carding, spinning, screening, etc)
  - Pistol application of asbestos (chimneys, car and wagon bases)
  - Work with thermal insulation in shipping and buildings and their demolition
  - Production of brake and clutch pads, fiber cement products, firefighting equipment, asbestos sheet filters, asbestos and rubber seals
  - Disassembly and demolition of facilities that contain asbestos

TABLE 3
**Differences Between Benefits for Common Disease and Occupational Disease***

| Detail | Occupational Disease | Common Disease |
|---|---|---|
| Temporary incapacity | For calculation of the scale of contributions, overtime in the last year is counted (and the contribution rate for the previous month)<br>Previous contribution is not required | Overtime is not counted<br>It is necessary to have contributed for 180 days within the previous 5 years |
| Contribution | A single monthly upper limit: actual salary<br>Maximum: 2652 €<br>Minimum: 526.50 € | Groups of contributions (1a/11) with maximums and minimums<br>(before it was more, now it is tending to even out) |
| Partial disability | No contribution required | <21 years: to have contributed half the time between 16 years and the start of temporary disability<br>>21 years: to have contributed 1800 days in the previous 10 years before termination of the temporal disability |
| Total disability and severe disability | No contribution period required | <26 years: to have contributed for a quarter of the time from 20 years until the causal event<br>>26 years: to have contributed a quarter of the time from 20 years until the causal event and also a fifth of this period should be within the 10 years prior to the causal event |
| Permanent disability | Paid by the INSS (an accident in the workplace is paid by MATEPSS) | Paid by the INSS |
| Permanent nondisabling injury | Compensation according to the scale for accidents in the workplace | No compensation |
| Scale of contributions (%) | 75% from the day after sick leave begins | 60% from days 4 to 20, inclusive<br>75% from day 21 onwards |
| Observation period | Time necessary for medical study of the occupational disease. Sick leave with temporary disability pay, maximum of 6 months, with extension for a further 6 months | Not applicable |
| Change of position at work | No temporary disability at present but there is a possibility thereof in the future, the position at work should be changed.<br>If this is possible, the same salary is retained, although the position is of a lower level (not including productivity bonuses)<br>If this is not possible, the worker will be laid off from the company, but will have preferential right in the unemployment office, and the company will pay the entire salary for 12 months, with an extension for a further 6 months. During these 18 months without work, if treatment is required for the occupational disease, the costs will be met by the MATEPSS | Not required (unless the individual is disabled) |

*INSS indicates National Institute of Social Security (of Spain); MATEPSS, Mutual Assurance for Occupational Accidents and Diseases of the Social Security.
For both occupational diseases and common diseases (bear in mind that the change is the way in which the scale of contributions is calculated):
– Partial permanent disability: 24 months on the scale of contributions for temporary disability.
– Total permanent disability: for those under 55 years, 55% of the scale of contributions; for those above 55 years, 75% of the scale of contributions.
– Absolute permanent disability: pension at 100% of the scale of contributions.
– Severe disability: 100%+50% to pay for personnel who attend the individual and which can be used to pay for admission to a public institution.

We can identify links in the chain of transmission where the bacillus can be attacked, namely, the patient who is the reservoir of the disease, the air that transports the infectious agent, the contact-exposure site, and the potential recipient host. A focus on these links will actually prevent transmission by attacking either the causal agent, or the vehicle that transports the agent, the infection, or the tuberculous disease.

We will now analyze how to attack these links by technical preventive medical measures, nonmedical personal measures, and administrative approaches.

*Preventive Medical Measures*

These are based on the identification, diagnosis, and treatment of the index case and the recipient host. Detection of the patient for curative treatment is essential for eradication of this disease because it interrupts the continued generation of infectious droplets and thus prevents infection of possible contacts within 2 weeks of starting effective treatment. We should also identify the recipient host so as to implement treatment to prevent development of tuberculosis and to

administer treatment to uninfected contacts to prevent them from becoming infected (treatment of tuberculosis and primary chemoprophylaxis, respectively).[32]

Regular medical monitoring of personnel who work in environments with risk of tuberculosis infection is a particularly important tool that enables identification of potentially susceptible or future hosts. Medical monitoring aims to detect tuberculin test (TT) conversions in order to treat recent infection, to provide regular monitoring of individuals with possible respiratory symptoms to rule out diagnosis of the disease, and to monitor individuals with known fibrotic lesions to control their course and initiate possible preventive treatment. Medical monitoring is also required to issue rulings on changes in position and lack of occupational aptitude for positions of high risk in highly susceptible workers.

In Spain, vaccination against tuberculosis should not be recommended for prevention at any level for many different reasons. The protection afforded is poor and irregular, and vaccination has the drawback that it interferes with medical monitoring of TT reactions and conversions.[33,34]

*Technical Preventive Measures*

Technical preventive measures comprise ventilation, sterilization, and isolation.[35] Ventilation acts on the transporting air to dilute and remove infectious droplets that are inevitably generated in exhaled air. Measures include ventilation and air-conditioning systems engineered to aspirate and replace contaminated air with uncontaminated air. Sterilization aims to remove infectious droplets from air through the germicidal action of ultraviolet light and highly efficient air filtration systems. The isolation technique uses negative pressure and physical barriers to try to prevent contact with potential recipient hosts.

*Nonmedical Personal Preventive Techniques*

Techniques for personal protection include face masks and filters for use by the index cases and potential recipient hosts. They aim to prevent contact when all other preventive measures or techniques are ineffective. They are indicated only for use in hospital settings—particularly in ambulances during transport of patients—and in the homes of patients. They are uncomfortable, and discomfort is greatest with the most effective masks, thus reducing the likelihood that they will be used correctly.[36,37]

Another personal preventive technique is health education for the index cases and potential recipient hosts. For index cases, education aims to promote certain forms of behavior, such as strictly following curative and preventive treatments until they are finished and the correct use of personal protection, to ensure physical isolation in the contagious phases of the disease.

With potential recipient hosts, the aim is to ensure that they submit to monitoring and, if necessary, that they comply with chemoprophylaxis. Education is also given on self-monitoring of initial symptoms of the disease, as well as on the adverse effects of chemoprophylaxis.

*Administrative Preventive Measures*

Administrative measures are based on enforcing temporary incapacity for work or sick leave for index cases during the contagious phase when transmission may occur, and establishing criteria for fitness for work and/or change in position for workers in high-risk positions.

Another such measure is the recording and declaring of detected cases, comprising keeping records in preventive programs and declaring cases to the health authorities (obligatory nominal reporting).

## Health Monitoring in Workers Potentially Exposed to Tuberculosis

The Law for Prevention of Hazards in the Workplace (Law 31/1995, dated November 8) has been in force since 1995 in Spain. Article 22 of this law on health monitoring states that employers should guarantee regular health checkups for their workers in accordance with the inherent risks in their work. In the guidelines for prevention issued by a working group of the Assembly on Tuberculosis and Respiratory Infections of the Spanish Society of Pulmonology and Thoracic Surgery (SEPAR), the TT is still considered useful today for study and screening of groups at risk of contracting tuberculosis.

With regard to monitoring workers at risk of contracting tuberculosis, it would be useful to define guidelines or protocols to detecting cases, monitoring workers for infection, and follow up. The Center for Disease Control and Prevention in Atlanta compiled instructions which were later reproduced in many developed countries and that can also be applied in Spain. In this country, some centers and groups of workers follow these instructions, but they are not uniformly applied.[2,38]

In certain population groups, such as health care workers and ancillary health care workers, prison warders and other workers in frequent contact with prisoners, workers in geriatric facilities, homeless shelters and refuges for immigrants, and workers in countries where tuberculosis is endemic, etc, control measures should be applied to prevent propagation of the disease. Frequent medical checkups should also be made in all teaching staff in contact with children and young adults in nurseries, schools, and colleges. These checkups should aim to detect teachers with tuberculosis who might infect the primary school, adolescent, and young adult populations, and should follow the same criteria as those for health care workers, penitentiary workers, etc.

A TT should be performed (2 tuberculin units [TU] of purified protein derivative RT-23 or its

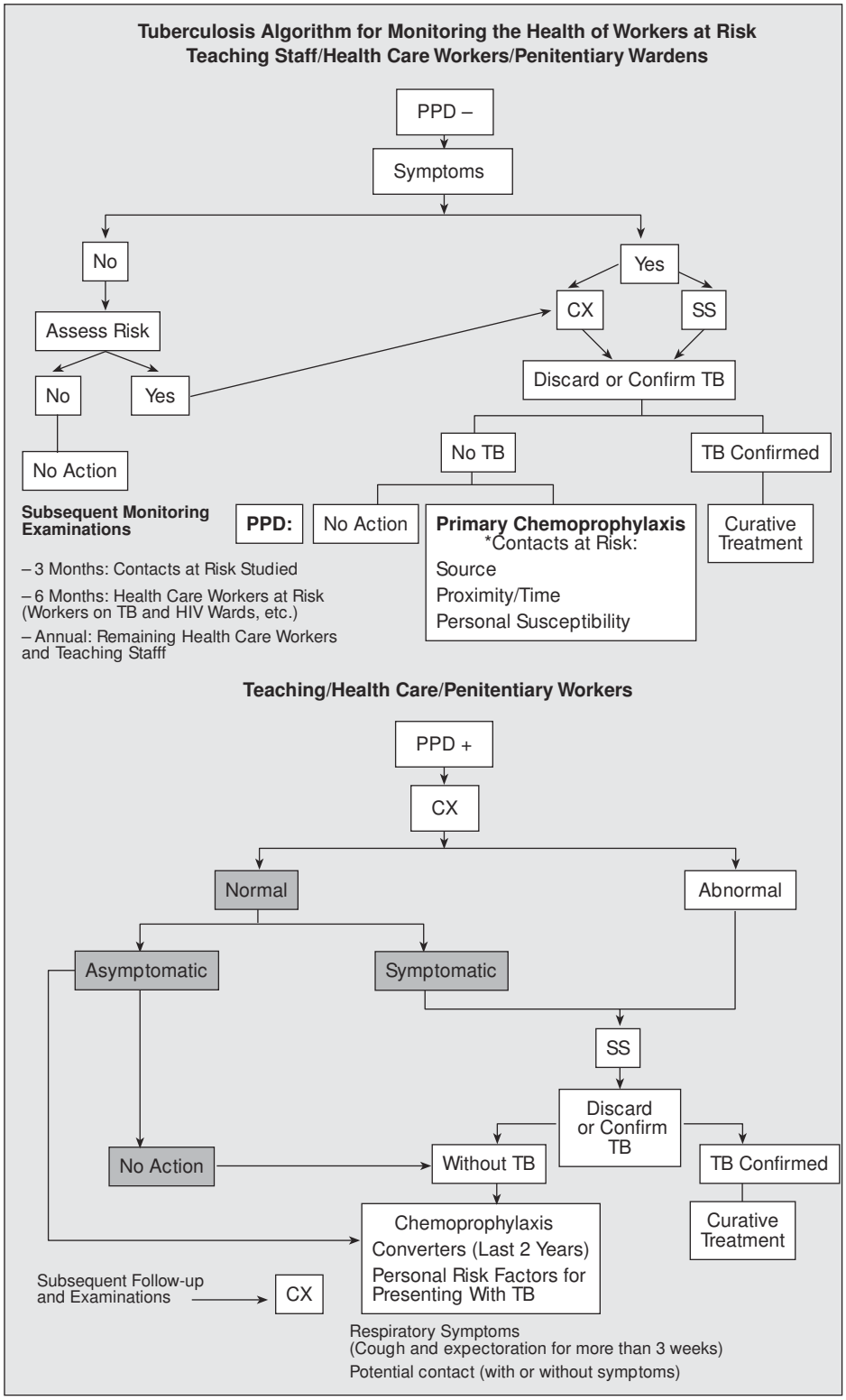



**Figure 1. Decision tree for Tuberculosis (TB) Contact Investigation. HIV indicates human immunodeficiency virus; PPD, purified protein derivative tuberculin; CX, chest x-ray; SS, sputum-smear.**

they test positive, active tuberculosis disease would have to be ruled out with a chest x-ray. A negative result in individuals who have been vaccinated against tuberculosis, in those older than 55 years, and perhaps in those who have arrived from countries with a higher prevalence of atypical mycobacteria, would have to be confirmed by a second TT after 7 to 10 days to rule out a false negative due to a possible booster effect.

At regular intervals of 6 months, 1 year, or at most 2 years, depending on the assessment of potential risk for

At regular intervals of 6 months, 1 year, or at most 2 years, depending on the assessment of potential risk for each group, the TT should be repeated to detect conversion from negative to positive and, if applicable, the presence of tuberculosis should be ruled out or a treatment recommended for the infection. Regular monitoring of patients with a positive TT should only be carried out in those with respiratory symptoms (those with cough and expectoration for more than 2 weeks) by sputum-smear examination and chest x-ray (Figure 1).[39,40]

## Studies of Tuberculosis Contacts in the Workplace

As in the field of public health, the study of occupational contacts forms part of a program for tuberculosis control within the scope of occupational health. Such studies should be performed whenever tuberculosis is detected in a worker, although this does not imply diagnosis of occupational disease, except in the aforementioned populations at risk (health care workers, etc).

The probability of a bacilliferous individual infecting a potential contact with tuberculosis during the working day is generally lower than the probability of infection in the family because of differences in important variables such as contact time, physical proximity, and shared volume of air.[41] Nevertheless, some workplaces have confined spaces with poor ventilation that mimic family life—for example offices or premises of similar size to a family home where workers share long hours in very close physical proximity.[42]

Work colleagues of the index case should be studied according to the concentric circle system, that is, the investigation should begin with those at greatest risk of contact or the first circle, and then work outwards until the prevalence of infection found is that expected in such a population. If another case of tuberculosis is found, the study should be repeated following the same procedure.

To start a study of occupational contacts, first the index case should be confirmed. (This case is not usually diagnosed by the physician or team that carries out the study.) The type of tuberculosis should be defined and the individual should be classed as bacilliferous or not. On confirmation, potential contacts to be studied should be identified and the potential risk of contagion classified according to proximity, place, and time coincident with the index case. Likewise, variables of cohabitation outside the workplace and shared car use for work-related travel will be assessed. With this information, the risk can be classified as high, low, or nonexistent.

Once the contacts to be studied have been identified, the protocol will be implemented. This protocol will use a questionnaire to collect information on symptoms, medical history of interest, criteria of proximity and time of exposure with the index case, current medication that may lower immunity, smoking habit and history of previous TTs, antituberculosis vaccination, and chemoprophylaxis.[43,44]

At the same time, all contacts will undergo a TT unless they have tested positive previously or have already suffered tuberculosis. The TTs applied will be a Mantoux tuberculin skin test with 2 TU of purified protein derivative RT-23 with Tween 80. The contacts will then be divided into positives and negatives in the TT test. Those who test negative but are more than 55 years old or have been vaccinated against tuberculosis will be advised to confirm the negative result with a second TT to rule out false negatives and account for the booster effect. Those who test negative will be studied in a second period after 2 to 3 months. All those who test positive will undergo chest x-ray to rule out or confirm tuberculous disease. If disease is confirmed, a bacteriological study will be performed.

This protocol will allow each contact to be classified as exposed but not infected, infected but not ill, ill, affected by uncalcified fibrotic lesions, or under study for possible disease process.

Recommendations for chemoprophylaxis will depend on the assessment of each contact´s individual with regard to proximity, shared time and place, type of tuberculosis of the index case (bacilliferous or not), increased susceptibility (because of young age or immunodepression for example), possible detection of a TT conversion, or uncalcified fibrotic lesions in the chest x-ray that have never been treated.

We think that chemoprophylaxis is always indicated in TT converters, HIV patients with positive TT, those with uncalcified fibrotic lesions in the x-ray, and young individuals who test positive. In the remaining cases, recommendations for chemoprophylaxis will depend on the personal clinical assessment of benefit versus risk (Figure 2).[45]

## Considerations

Occupational health services who are responsible for medical monitoring of workers should promote programs of medical control and monitoring of tuberculosis in collaboration with pulmonologists and infectious disease specialists who treat and control this disease.[46] These programs should be designed for workers who may be at risk of contracting tuberculosis. Such workers should be monitored starting before they take up their positions of risk through *specific health examinations on arrival*. These should include medical history-taking, TT, and chest x-ray if applicable, to identify cases of tuberculous infection without disease that may require treatment for tuberculous infection. Likewise, those with respiratory symptoms (cough and expectoration that have lasted for more than 2 weeks) should undergo bacteriological study of sputum to rule out disease or, should it be confirmed, to treat it. Specific *regular health examinations* for these workers are needed at least every 6 months, 1 year, or at most 2 years, according to the occupational risk.

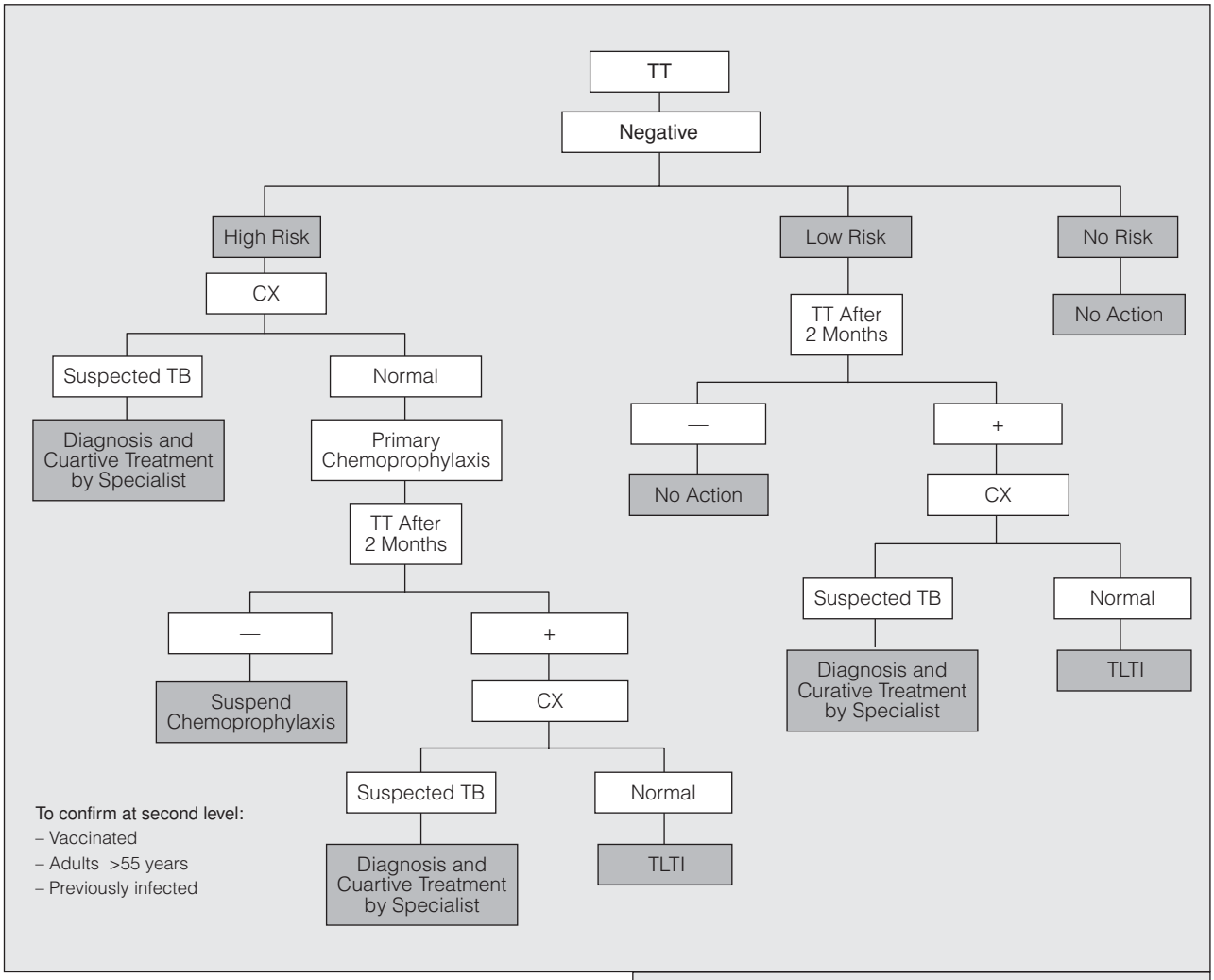
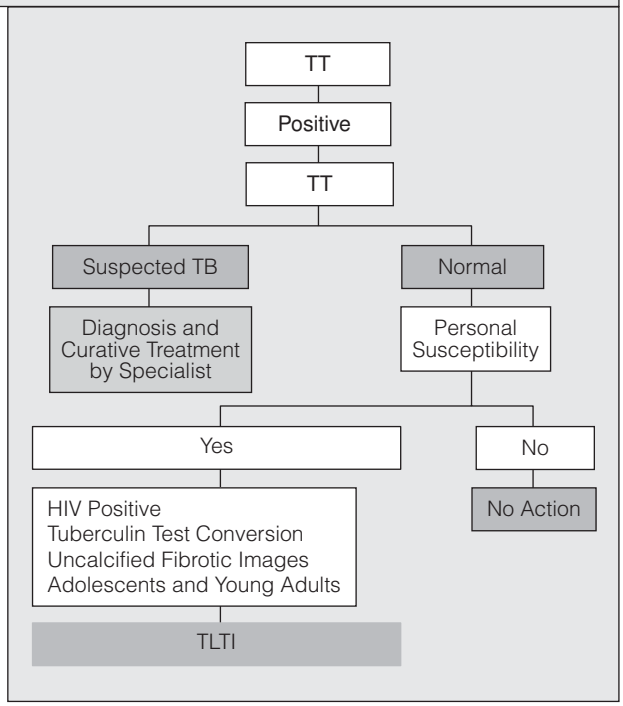



**Figure 2. Preventive medical protocol for the investigation of occupational contact with tuberculosis (TB), 2002 (abbreviated). TT indicates tuberculin test; CX, chest x-ray; TLTI, treatment of latent tuberculous infection; HIV, human immunodeficiency virus.**

Occupational physicians, whose tasks among their workers are sometimes similar to those of family physicians, should consider the possibility of tuberculosis if a worker presents with clinical signs and respiratory symptoms compatible with this disease to facilitate early diagnosis. Also, once the disease has been diagnosed, the occupational physician should monitor treatment compliance.

Cooperation with the occupational health service is needed when a tuberculosis case is confirmed to control and monitor the disease in the active and passive search for possible cases of infection or illness. Occupational contacts are studied with the same criteria as those in the family environment. However, in the occupational setting, the number of cases investigated will usually be larger, and low risk cases and those with nonexistent risk may also have to be studied to alleviate the panic that arises in a company when a case of tuberculosis is detected (tuberculophobia).



Given that identification and treatment of patients are fundamental measures to break the epidemiological chain, it is necessary to heighten awareness about potential diagnosis of the disease as an occupational contingency that affects us as health care workers. If we are alert to the dangers of tuberculosis, we will be better able to control this health concern.

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