La Medicina del Lavoro Med Lav 2013; *104*, 4: 000-000

"Phthisiophobia": the difficult recognition of transmission of tuberculosis to health care workers

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Key words
Tuberculosis; health care workers; Luigi Devoto

Parole chiave
Tubercolosi; operatori sanitari; Luigi Devoto

Summary
Background: *Even if the contagious nature of tuberculosis was universally accepted during the nineteenth century, its transmission to health care workers (HCWs) was initially denied by the scientific community. Working among TB patients was not considered dangerous for healthy adults, so the potential risks for HCWs were branded as unwarranted "phthisiophobia" (fear of contracting tuberculosis).* **Objectives:** *This study aims at analyzing the problem of tuberculosis transmission among health care workers from an historical perspective, particularly highlighting the contribution made by the Italian Occupational Medicine community.* **Methods:** *Scientific literature and historical sources on different theories regarding tuberculosis transmission were investigated, specially focusing on the period at the turn of the 19th and 20th centuries.* **Results:** *At the beginning of the twentieth century, Luigi Devoto (1864-1936), an Italian pioneer in the field of Occupational Medicine, was one of the first scientists to conduct research on the transmission of tuberculosis among nurses. Since the 1920s several studies, conducted mainly on medical and nursing students, confirmed the risk for HCWs. However an international consensus on this issue was only achieved during the 1950s, when the institution of mandatory chest radiographs on admission for all patients significantly decreased the cases of tuberculosis among HCWs.* **Conclusions***: Devoto was one of the first scholars who postulated the transmission of tuberculosis to HCWs. He also theorized that hospital personnel with active disease could also be a source of contagion to patients. Nowadays, "third party risk" and latent tuberculosis infection pose a new challenge for occupational physicians in hospitals.*

Riassunto
«"Tisiofobia": il difficile riconoscimento della trasmissione della tubercolosi agli operatori sanitari». **Introduzione:** *Nonostante la natura infettiva della tubercolosi sia stata riconosciuta nel XIX secolo, la sua trasmissione agli operatori sanitari (OS) è stata inizialmente negata dalla comunità scientifica, soprattutto nel Nord Europa e negli USA. Il lavoro a contatto con pazienti affetti da tubercolosi non era considerato pericoloso per individui adulti in salute, pertanto l'ipotesi di un rischio per gli OS era ritenuto ingiustificato e bollato come "tisiofobia".* **Obiettivi:** *Questo studio ha come scopo quello di analizzare il problema della trasmissione della tubercolosi negli OS attraverso*

Pervenuto il 5.1.2013 - Revisione pervenuta il 21.4.2013 - Accettato il 9.5.2013
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una prospettiva storica, focalizzandosi sul contributo offerto dalla Medicina del Lavoro italiana. **Metodi:** *E' stata condotta un'analisi della letteratura scientifica e delle fonti storiche, con particolare riferimento al periodo a cavallo tra Ottocento e Novecento.* **Risultati:** *Agli inizi del XX secolo, Luigi Devoto (1864-1936), pioniere della Medicina del Lavoro italiana, fu uno dei primi scienziati a condurre ricerche sulla trasmissione della tubercolosi tra gli infermieri. A partire dal 1920 diversi studi, condotti principalmente su studenti di medicina e infermieristica, hanno confermato il rischio. Tuttavia, un consenso internazionale su questo tema è stato raggiunto soltanto negli anni cinquanta, allorché la radiografia del torace obbligatoria per tutti i pazienti ha determinato una riduzione significativa dei casi di tubercolosi tra gli OS.* **Conclusioni:** *Devoto fu uno dei primi ad ipotizzare la trasmissione della tubercolosi agli OS, teorizzando anche che quest'ultimi potessero costituire fonte di contagio per i pazienti. Oggi, il "rischio verso terzi" e l'infezione tubercolare latente rappresentano una nuova sfida per i medici del lavoro negli ospedali.*

Introduction

Tuberculosis (TB) is a disease whose origins are lost in the mists of time. Modern paleopathology has never ruled out the possibility that this disease started spreading since the very beginning of human civilization, although the presence of tuberculous lesions is not documented with certainty in the oldest human remains (11). Overshadowed for centuries by more contagious infectious diseases such as plague and smallpox, in the nineteenth century tuberculosis became a widespread condition, characterized by high mortality rates. The "great white plague" was spreading very rapidly in the cities of the Industrial Revolution, especially in overpopulated districts and insalubrious factories, where the infection was made easier by promiscuity and poor working conditions (11). Overworked, underpaid workers toiled in harsh, dark and crowded workplaces and they were thus susceptible to infection by a bacillus that prospered under unhealthy conditions (45). The prevalence of tuberculosis was very high in mines due to exposure to silica dust (19), as well as in cotton manufacturing due to "shuttle kissing", i.e., the practice of loading new bobbins of cotton by sucking the thread through the hole of the weaving shuttle; since these shuttles were rarely used by one single worker, other weavers might also "kiss" the shuttle, thus transmitting respiratory tract infections, particularly tuberculosis (the so-called "kiss of death") (4, 25). During the twentieth century the improvement in hygienic conditions (also at workplace) and the introduction of new prophylactic and therapeutic measures led to a substantial reduction in the number of cases of tuberculosis in Western countries, especially when, after World War II, selective antibiotics became available (streptomycin first of all, discovered in 1944) (43).

In recent decades a resurgence of this contagious disease has been witnessed worldwide and the increasing number of TB patients in hospitals has reopened the issue of transmission of this infection from patient to Health Care Workers (HCWs). Consequently, tuberculosis is now re-emerging as an Occupational Health problem, especially for the occupational physicians responsible for health surveillance of hospital personnel. Nowadays the scientific community agrees that the risk for tuberculosis in this category of workers is consistently higher than in the general population (2), but at the beginning of the last century, as opposed to what happened in miners and weavers, the majority of scientists still did not believe in the potential transmission of this disease to hospital personnel. In that period, this theory was only supported by a few scholars, among whom Luigi Devoto (1864-1936), the founder and the first Editor of the journal "*La Medicina del Lavoro*" (44).

This paper aims to report and describe the scientific debate on the contagiousness of tuberculosis to HCWs at the turn of the nineteenth and twentieth centuries, shedding light on the often forgotten contribution to this issue provided by the Italian Occupational Medicine community, particularly by Luigi Devoto,

First recognition of contagiousness of tuberculosis

The contagious nature of tuberculosis was suggested for the first time by Aristotle, the Greek philosopher and naturalist (384-322 BC), according to whom the disease originated from exposure to an undefined substance floating in the air and transmitted from an individual who was already sick (47). In the classical world and in the Middle Ages the dissemination of leprosy (caused by *Mycobacterium leprae*, in biological competition with *M. tuberculosis*) (26) and the recurrent epidemics of plague limited the spread of the *phthisis,* that was slower in its manifestation and in ultimately causing the death of the affected person. As a result, the debate on the infectiousness of tuberculosis remained dormant until the Renaissance, when the transmissibility of the disease was again supported by the physician and humanist Girolamo Fracastoro (1483-1553). In particular, in his famous work *"De contagionibus et contagiosis morbis"* (1546), Fracastoro said about tuberculosis that "people [...] even though they are usually very healthy, contract the disease for life in common with consumptives or touching objects that belonged to them. [...] Therefore, it can be assumed that inside these objects remain contagious seeds" (10).

In the following century, the problem of tuberculosis and its treatment continued to emerge very slowly, even if there were some innovations, although isolated, in the hygiene and epidemiology fields. In Italy, for example, the city of Lucca enacted a decree in 1699, requiring the destruction of all objects belonging to a person who died of tuberculosis. In addition, physicians in Lucca were obliged to report the names of all persons with known or suspected TB disease, regardless of the social status of the infected person (10). In the following decades, similar measures were taken in several regions of Spain and Italy (e.g. the Grand Duchy of Tuscany, Republic of Venice, Papal States, Kingdom of Naples) (49). Among the scientists, the Italian pathologists Antonio Maria Valsalva (1666-1723) and Giovanbattista Morgagni (1682-1771) supported the thesis of the contagiousness of tuberculosis; they usually avoided performing necropsies on patients with this disease, knowing the high risk of infection. Morgagni, in particular, did not allow his students to participate in autopsies on suspected cases of tuberculosis, to safeguard their health (8). However, the "contagionist" legislation, perceived as an expression of conservatism and scientific backwardness, did not survive through the Enlightenment ideas and the revolutionary wave of the end of the eighteenth century (49).

As mentioned above, the following century was the period of maximum spread of tuberculosis. The increase in the number of patients admitted to hospitals led to a greater prevalence of the disease among HCWs. This period registers many examples of doctors who died from tuberculosis contracted in hospital wards or while performing autopsies. Among the victims, Marie Francois Xavier Bichat (1771-1802), a theorist of tissue pathology, and his pupil René Laennec (1789-1826), best known for the invention of the stethoscope, should be mentioned. Laennec, initially opposed to the infection thesis, was forced to change his mind when he contracted the disease while performing necropsies on patients who had died of tuberculosis (47).

Contagionists and anti-contagionists: the contribution of Luigi Devoto

During the following decades an international scientific debate opened about the significant hazard for HCWs of contracting tuberculosis during the care of infected patients. Although Robert Koch (1843-1910) had discovered the bacillus responsible for the disease in 1882, making it possible to officially classify tuberculosis among other infectious diseases, there were many doubts about the transmission of the pathogen from patient to physician or nurse, especially when they were in good health. In the same year when Koch discovered *Mycobacterium tuberculosis*, Charles Theodore Williams (1838-1912) from the "Brompton Hospital for Consumption", the main institution for the treatment of tuberculosis in London, published an article in which he claimed that he had never detected any case of tuberculosis amongst HCWs

in his own hospital (52). Starting from the article by Williams, two schools of thought developed in the international scientific community: the "contagionists", mainly concentrated in southern Europe (notably in Spain and Italy) and the "anti-contagionists" in northern Europe and the United States (47).

Among the followers of "tuberculosis contagionism" we must recall the figure of the Italian physician Luigi Devoto, a pioneer in the field of Occupational Medicine and founder of the first institute in the world entirely devoted to the diagnosis and the treatment of occupational diseases, the "Clinica del Lavoro" in Milan. A pupil of the great Genoese clinician and phthisiologist Edoardo Maragliano (1849-1940), Devoto stated that he first approached the themes of social medicine and occupational medicine by studying tuberculosis as an occupational disease of HCWs. As reported by Devoto himself, while still a young student at the Faculty of Medicine in Genoa, the day he attended his first lesson by Maragliano on 11 November 1882 [this year apparently recurs in the history of tuberculosis] he "heard for the first time the name of Bernardino Ramazzini. "[...] Thoughtful I went out of the classroom, also because my humble native town provided immediate recollections; there was a spinning mill which made the healthy peasants sick, [...] there was the production of wool in the home, and the people working on it getting sick from tuberculosis, and the same happened to the people employed in slate mines, which were very common in those times in Chiavari". (13). On the occasion of his twenty-fifth anniversary of teaching, the founder of the "Clinica del Lavoro", and also editor of a hugely successful treatise on tuberculosis at the time (14), pointed out the problem of tuberculosis infection among healthcare workers. "In the years I went to Maragliano's clinic [...] my attention was powerfully attracted to tuberculosis in all types of patients, in particular in hospital nurses. During my last years in Genoa I became interested in the problem of tuberculosis among nurses, which was a source of more acute concern since it spread among [their] healthy families and among non-TB patients" (13). Devoto had a very clear view of the "third party risk" problem, linked to the possibility that TB-infected nurses could transmit the disease to their own relatives and patients. So, the young Italian clinician approached the problem of work-related diseases starting with an analysis of the diffusion of "pulmonary tuberculosis in hospital nurses", which was his first work on occupational medicine, given as a lecture at a conference on tuberculosis in 1901 (12).

The interventions and strategies developed by Devoto and his pupils in the 1920s and 1930s to limit the spread of tuberculosis among workers were well incorporated in the fight against tuberculosis carried out by the fascist regime. Compulsory insurance against tuberculosis, announced in section XXVIII of the "Labour Charter" (1927), was the key measure of this effort. It was implemented "in favour of the insured people and their families, to provide admission to special sanatoriums, hospital-sanatoriums and post-sanatoriums and in legally recognized hospital institutions, which must have special and separate spaces to ensure a convenient level of isolation" (22). In addition, compulsory insurance against silicosis and asbestosis (1943) also served to protect against the tuberculosis complications of these occupational diseases (5).

Contrary to what was happening in southern Europe, in the English-speaking countries the thesis of the anti-contagionists prevailed and the arguments against it were strongly criticized and presented as the result of a senseless and unreasonable "pthisiophobia" (fear of [contracting] tuberculosis). In the early years of the twentieth century, Fishberg and Dublin, by means of a kind of meta-analysis of studies on over 18,000 workers in European sanatoriums, claimed the absence of risks to HCWs (15, 21). Thus, in many US hospitals the risk of infection began to be underestimated; in some cases, nurses and doctors stopped wearing face masks when assisting patients with tuberculosis. In northern Europe, however, there were also dissenting voices; in 1889 Georg Cornet (1858-1915) noted an excessive mortality rate from tuberculosis amongst Catholic nuns working in hospitals in Germany, concluding that a 17-years old nurse lived on average 21½ years less than a girl of the same age in the general population (33). In 1925,

Britton and Bollman showed that 2.2% of all nurses in Chicago suffered from tuberculosis, and five years later Steidl argued that tuberculosis could be rightly looked upon as an occupational risk for HCWs, noting that 10% of medical students generally developed a form of tuberculosis within one or two years after their graduation (48).

BELATED RECOGNITION

In the first decades of the twentieth century two factors favoured the recognition of the risk of tuberculosis transmission to HCWs. In 1907, the French physician Charles Mantoux (1877-1947) introduced a new method for the diagnosis of tuberculosis by intra-dermal injection of a purified preparation. Tuberculin Skin Test (TST), which was cheaper than a chest X-ray (CXR), made it possible to detect tuberculosis among hospital personnel via a reproducible, standardized and inexpensive method and observing the working population over time (47). Secondly, the improvement of hygienic conditions resulted in a decreased diffusion of tuberculosis in the general population, but it also led to a lowering of the defenses against this disease in future generations. Consequently, at the beginning of the twentieth century nursing and medical students were more susceptible to infection, since they were not exposed to the mycobacteria when they were children (47). Pioneering studies conducted in 1924 by Johannes Heimbeck (1892–1976) at the Ullevaal Hospital in Oslo showed that 220 out of 240 nursing students who were skin-negative at school, became positive by graduation, and 48 of them had also experienced a clinically demonstrated tuberculosis (3, 29, 30). These results were confirmed by other investigations (31, 32), including a study in 1939 which postulated that the risk of contracting tuberculosis in a nurse was 500 times higher than in the general population (6). Similar investigations showed skin-conversion among medical students who assisted at autopsies (28, 34).

Despite much scientific evidence in the first decades of the twentieth century, the risk of tuberculosis transmission from patient to HCWs was accepted only in the 1950s. Several hypotheses may explain the reasons for such a late recognition. First of all, knowledge of the transmissibility of the disease to hospital staff was believed would lead to a situation where private hospitals would refuse to admit TB patients because these hospitals would be afraid of the disease spreading among their workforce with consequent economic retaliation for the hospitals themselves (47). Moreover, a possible fall in enrollment of young girls in nursing schools scared of contagion was feared (47). Therefore some scholars continued to support the thesis of the anti-contagionists, often *bona fide*, believing that higher incidences of cases among workers was due to greater control and surveillance rather than to a real increase in the disease (7, 8, 41). According to this hypothesis, it was simply more likely to diagnose a mild form of tuberculosis or skin-conversion among HCWs since they often underwent CXR and TST (47).

To mediate between the anti-contagionists and contagionists theories, it was suggested that the high frequency of the TST-conversion did not necessarily mean that all operators were developing an active form of tuberculosis. Between 1931 and 1936 Amberson and Riggins at Bellevue Hospital in New York noted that only 8 out of 539 trainee nurses in their department had developed an active form of tuberculosis (1.5%), of which 6 had suffered from a mild and easily treatable form (1). Thus the concept of "latent tuberculosis infection" was developed, as already theorized by William Osler (1849-1919). In 1909 Osler had indeed claimed that "all who mix with tuberculosis patients became infected, but remained well so long as they [...] kept the soil in a condition unfavourable for the growth of the seed" (40). In fact, nowadays it is widely acknowledged that a person with "latent tuberculosis infection", although actually infected with the bacillus, is not affected by active disease and is not contagious, but presents a 5-10% risk of progression to an overt form throughout life, especially in the two years following infection (27).

In the 1930s, however, the mortality rate from tuberculosis was much lower among physicians than other occupational groups, possibly in part

due to earlier diagnosis in this category but also to higher income and better hygienic conditions, so physicians were still considered at low-risk of contracting the disease (16, 18, 50, 51). Only in the 1950s, the rapid decline of tuberculosis in all classes except among HCWs, rekindled the debate on the safety of these workers (42). To reduce the spread of the disease in this occupational category, already at the beginning of the 1930s Jay Arthur Myers (1888-1978) from Minneapolis had suggested five basic steps: 1) to require TST and CXR for all new employees in hospitals, 2) to follow up HCWs by TST and CXR every 6-12 months, 3) to exclude the presence of undiagnosed forms of tuberculosis in all admitted patients by CXR 4) to establish a tuberculosis department in all hospitals and 5) to observe the aseptic precautions as already introduced for other infectious diseases, such as diphtheria and scarlet fever (37). Other scholars suggested dietary recommendations (meals rich in carbohydrates and free beer in hospital canteens) or organizational solutions (reduction in work shifts, with a month's vacation per year) (17, 23, 24). The usefulness of anti-tuberculosis vaccination with the "Bacillus Calmette-Guerin" (BCG), tested for the first time in 1921, was controversial, since no significant differences in tuberculosis incidence were found in vaccinated rather than in non-vaccinated HCWs. So, at that time BCG vaccination was not recommended for this category of workers (38). The turning point for the control of tuberculosis in hospitals came, however, starting in the 1950s, only by carrying out CXR in all admitted patients (third point of Myers' protocol), a measure that drastically reduced the number of cases among HCWs (36).

Conclusions

This paper shows the often-forgotten contribution provided by the Italian Occupational Medicine community and, in particular, by Luigi Devoto to the identification of potential transmission of tuberculosis to HCWs. According to the founder of "*La Medicina del Lavoro*", this topic led him for the first time to take an interest in the aspects of social medicine and to study workers' diseases. Therefore, the study of biological risk (tuberculosis in particular) among HCWs may be rightly credited as one of the first subjects at the dawning of Italian Occupational Health, that found in Devoto one of the most distinguished and prominent figures at that time. It is noteworthy that his memorial bust (Figure 1), located at the "Clinica del Lavoro" of Milan, depicts the Italian physician holding a stethoscope in his right hand, not only demonstrating the primitive relationship between Occupational Medicine and Phthisiology, but also suggesting the importance of clinical semiotics in the daily practice of every occupational physician.

However, despite the pioneering studies conducted by Devoto and other scholars at the beginning of the twentieth century, the risk for HCWs of contracting tuberculosis from patients in their

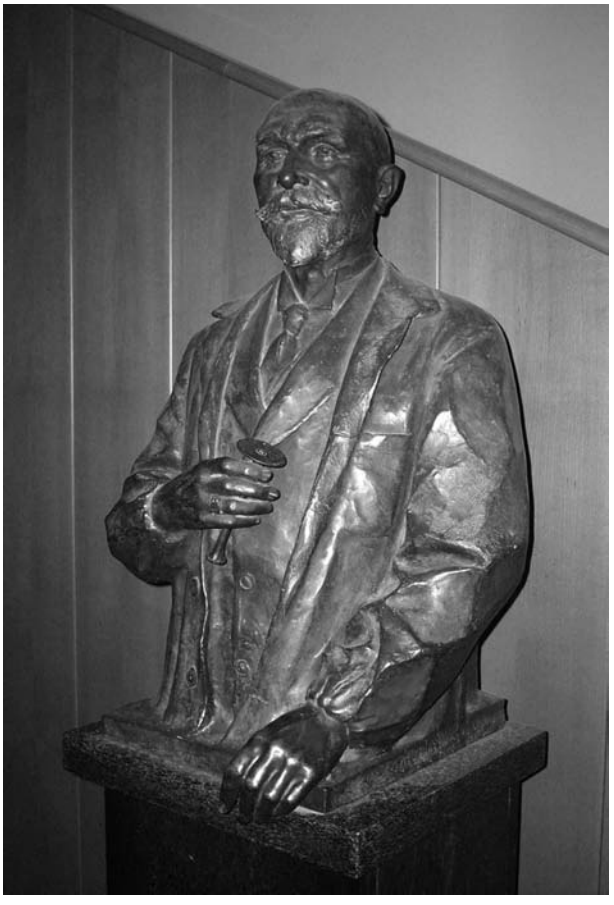

Figure 1 - Memorial bust of Luigi Devoto at the "Clinica del Lavoro" of Milan.

care was recognized very late by the international scientific community. This delay could be explained initially by the lack of knowledge about transmission pathways of *M. tuberculosis* and, subsequently, by the underestimation of risk, in part due to the successes of medicine in the field of infectious diseases, as a result of the introduction of antibiotics. By the early 1960s the problem of tuberculosis infection among hospital workers had significantly diminished in Western countries, simultaneously with the decrease in the number of patients hospitalized for this disease.

However, at the end of the last century, immigration from highly endemic areas and the emergence and rapid spread of AIDS led to a steady increase in cases of active tuberculosis in the general population. According to recent assessments by the World Health Organization (WHO), in 2010 there were an estimated 9 million new cases worldwide, most of them in Asia (59%) and Africa (26%) (53). Migration from these areas, Latin America and Eastern Europe have led to an increased incidence of the disease in industrialized countries, where it propagates mainly among the immigrant population (46). In particular in Italy, while the notified incidence of TB was stable at approximately 7 cases per 100,000 inhabitants annually, the proportion of immigrants with TB increased from 22% to 46% in the last decade (20). In addition, the diffusion of drug-resistant forms of mycobacteria ("Multi Drug Resistant" MDR, "Extensively Drug Resistant" XDR), especially originating in Eastern Europe and the former Soviet Union countries, and the circulation of this disease among patients co-infected with Human Immunodeficiency Virus (HIV), especially on the African continent, makes the treatment of this disease extremely difficult (46).

In the field of Occupational Medicine, the often delayed diagnosis due to non-specific symptoms and the inadequate use of personal protective devices re-exposed HCWs to high risks of contagion, stimulating the development of specific guidelines and precise protocols in hospitals to be used in the event of detection of a case of tuberculosis amongst patients, in order to safeguard the health of the employees (9, 27, 35, 39). Nowadays, besides the aforementioned problems of TB in migrants and in HIV-infected subject and the emergence of new drug-resistant forms, the numerous cases of latent tuberculosis infection among HCWs still registered and the possibility of infection of patients by HCWs with active tuberculosis ("third party risk"), already theorized by the young Luigi Devoto at the end of the nineteenth century, make the "historic" issue of tuberculosis an extremely modern challenge not only for clinicians, but also for all those who have to deal with hospital infections, clinical risk and health protection of hospital workers.

No potential conflict of interest relevant to this article was reported

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ACKNOWLEDGMENTS: *The authors would like to express their gratitude to Dr. Melania Favaro for linguistic review*