

## Lessons from the 1800s: tuberculosis control in the new millennium

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At the end of the 19th century, Hermann Biggs of the New York City Department of Health remarked that, compared with tuberculosis, “all other communicable and preventable diseases sink into relative insignificance”.<sup>1</sup> With WHO’s declaration of a “global emergency” regarding tuberculosis,<sup>2</sup> and the calculation from the World Bank that the disease accounts for about 26% of all avoidable adult deaths in less-developed countries,<sup>3</sup> it seems that little has changed. HIV and multidrug-resistant tuberculosis have the potential to again make the disease what it was in Biggs’ time: “the captain of all these men of death”.<sup>4</sup> Against this persistent foe, the approaches taken by the turn-of-the-century New York City Department of Health and the current recommendations of the International Union Against Tuberculosis and Lung Disease and the WHO reveal striking similarities. We review the parallels between key features of modern tuberculosis control and Biggs’ programme, and point to lessons that can still be learned from Biggs’ remarkable efforts.

### Epidemiological parallels

Biggs developed his programme in response to the epidemiological context in New York at the turn of the 20th century, when tuberculosis was the leading cause of death in the city. The disease caused roughly 10 000 deaths per year at this time, with a mortality rate of 280 per 100 000 population.<sup>5</sup> Individuals succumbing to tuberculosis 100 years ago were primarily young men; 57% of all tuberculosis deaths in New York occurred in individuals who were aged 25–45 years, and the ratio of male-to-female tuberculosis mortality approached 2:1.<sup>6</sup> The poor were disproportionately affected: members of five blue-collar professions made up half of the tuberculosis mortality, whereas those in white-collar professions, such as finance, law, and medicine, made up less than 1%.<sup>5</sup>

Although mortality from tuberculosis has declined during the 20th century in industrialised nations, mortality in less-developed countries remains high. In the lower income countries of Asia, the mortality rate from tuberculosis exceeds 50 per 100 000 population.<sup>7</sup> This rate represents an epidemiological picture closer to Biggs’ era than to industrialised contemporaries—the mortality rate in New York City in 1998 being 0.7 per 100 000

population.<sup>8</sup> Today, as in turn-of-the-century New York City, young adults make up a disproportionate number of cases in less-developed countries, and more men are affected than women.<sup>9</sup> In addition, most tuberculosis deaths in today’s less-developed countries occur among the poor. Unskilled industrial workers have much higher rates of disease than the general population.<sup>10</sup> One important difference between Biggs’ New York and the modern context is the presence of HIV, which has led to a doubling of tuberculosis in some countries in Africa.<sup>11</sup>

### The antituberculosis movement

The impetus for Biggs’ efforts came in 1882, when Robert Koch showed that tuberculosis was a communicable disease caused by a bacterium. Beginning in 1889, more than 50 years before the availability of antituberculosis agents, Biggs proposed a systematic approach to tuberculosis control that comprised five main elements. First, he instituted mandatory notification of all tuberculosis cases. Second, he made free sputum examinations available from the bacteriology laboratory of the New York City Department of Health for both public and private patients. Third, he established individual nursing follow-up of all reported infectious cases, with isolation of patients if necessary. Fourth, he promoted awareness of the communicability of tuberculosis by public education. Fifth, he strengthened political will to gain financial and administrative support for his programme. He worked with a succession of city governments, ranging from corrupt Tammany Hall political bosses to reformist mayors.<sup>12–14</sup> Each of these five areas remains relevant today; they embody key features of the DOTS (Directly Observed Treatment, Short-course) strategy recommended by the WHO and the International Union Against Tuberculosis and Lung Disease.<sup>15</sup>

#### Mandatory notification

“It shall be the duty of every physician in this City to report to the sanitary body in writing the name, age, sex, occupation and address of every patient suspected of tuberculosis.”

Jan 19, 1897, statute of the New York City Board of Health<sup>1</sup>

Biggs proposed mandatory notification of all suspected cases of tuberculosis. This proposal was highly controversial. Members of the New York Academy of Medicine attacked it as “mistaken, untimely, irrational, and unwise”,<sup>16</sup> and condemned the “aggressive tyrannies of the Health Board”, terming the new requirement “offensively dictatorial”.<sup>17</sup> Fearing for the autonomy of its members, the Academy also complained that the Board of Health “had only to declare a disease infectious in order to take charge of it”.<sup>18</sup> Such outcries had both scientific and social origins. Some physicians objected because

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they continued to question the communicability of tuberculosis; an even greater number were concerned that the new policy threatened the livelihoods of physicians and patients by violating the confidence of the doctor-patient relationship.

To reduce opposition, Biggs emphasised the need to ensure that reporting of tuberculosis was confidential: "Notification to sanitary authorities does not involve notification to the city at large".<sup>1</sup> However, opposition to Biggs' proposal remained vehement, and, at one point, wrote Winslow, "Biggs stood virtually alone".<sup>1</sup> In 1897, the Medical Society of the State of New York (the physicians' association) even introduced legislation reducing the Department of Health's statutory authority.<sup>1</sup> This step proved unsuccessful after Biggs convinced state lawmakers that control of infectious patients was necessary to reduce the spread of tuberculosis. In doing so, Biggs accepted the responsibility of "official control of the cases once they have been reported".<sup>1</sup>

Private physicians initially reported few cases. In 1903, Biggs estimated that more than half of the active cases of tuberculosis in New York were still unreported.<sup>12</sup> Despite this, only six physicians were fined for failure to report cases during the first decade of compulsory notification.<sup>17</sup> Limited initial enforcement of the new statute constituted one of Biggs' rare compromises to organised medicine. Nevertheless, the requirement for notification had established the principle that the Department of Health was legally and ethically responsible for ensuring the proper care of all tuberculosis patients in the city.

Mandatory, confidential notification of tuberculosis cases to public-health authorities could potentially facilitate improved tuberculosis control in many less-developed countries. The WHO estimates that less than half of all tuberculosis cases were reported in 1997 and only 16% were treated by the WHO-recommended strategy.<sup>9,19</sup> This case-detection rate falls far short of the global target of 70%.

#### *Provision of sputum microscopy*

"A physician could leave a throat culture at a drug store in his neighbourhood at 5 pm and be sure of receiving a result by phone at 10 o'clock the next morning . . . You have done marvelous work."

Letter from Robert Koch to Hermann Biggs, 1907<sup>1</sup>

Although the battle to establish the principle of mandatory notification had brought Biggs into conflict with the medical establishment, at the same time he established one of the leading microbiology laboratories in the world and he made the services of this laboratory available to private physicians. This policy had several benefits. First, it encouraged the use of a highly effective diagnostic tool—the acid-fast bacillus smear. This smear, developed by Koch and later refined by Ziehl and Neelson,<sup>20</sup> was a rapid way of confirming the diagnosis of tuberculosis and of monitoring progression of the disease. Biggs had first done the smear in 1882, and he quickly recognised its potential. Second, the provision of free smears facilitated notification of cases from the private sector.<sup>14</sup> By providing high-quality laboratory services, Biggs helped to ensure that he would learn about all smear-positive patients. Biggs wrote that,

"In its relation to the medical profession, [the Department of Health] aims to give every assistance which the latest scientific developments can place within its power, in the treatment and management of communicable and infectious diseases, while not

interfering in any way with the privileges or prerogatives of the medical attendant, unless such interference becomes necessary for the protection of other persons from infection."<sup>21</sup>

Use of smears was initially resisted by many physicians, who, preferring to diagnose tuberculosis by physical examination, termed the use of the smear "absurd".<sup>1</sup> Opposition was especially strong to policies that were seen as "unduly magnifying the importance of [the] bacteriological department".<sup>1</sup> This perceived slight to the traditional domain of the clinician was intolerable to physicians at the end of the 19th century. They felt that "when it is a question as between the clinical and the bacteriologic showing . . . the clinical diagnosis should stand."<sup>16</sup>

A similar situation occurs in much of the world today, where physicians overemphasise clinical and radiographic diagnosis of tuberculosis. Given that private-sector physicians treat most patients in some less-developed countries, Biggs' approach has great modern relevance. By providing high-quality, convenient laboratory services to physicians, the health authorities in these countries could learn about infectious patients and work with physicians to ensure appropriate and complete treatment of all such patients. Laboratory facilities are currently inadequate in many less-developed countries, even though the acid-fast bacillus smear remains a reliable diagnostic tool that is useful for the monitoring of patients with tuberculosis. The WHO estimates that one reliable sputum microscopy facility is necessary for every 50 000–150 000 individuals in a population.<sup>21</sup>

#### *Case management*

"The purpose of [the Board's] procedure is to keep under more or less constant supervision those cases of pulmonary tuberculosis which . . . are most likely to be dangerous sources of infection to others."

Hermann Biggs<sup>22</sup>

Biggs recognised that the purpose of surveillance in tuberculosis was not simply to count the number of cases, but to reduce the spread of disease. Effective treatment exists today, but even before antibiotics, the chain of transmission could be halted if patients ceased to spread disease, either by gradual healing of their lesions or by physical isolation. Through the provision of nursing follow-up in private homes, clinic services, and public sanatoria, Biggs ensured that diagnosis was followed by the best treatment available at the time: bedrest, fresh air, and nutritional support.

Although New York City opened several public sanatoria by 1910, most patients with tuberculosis were monitored at home and in outpatient dispensaries. Beginning in 1903, public-health nurses visited the homes of those diagnosed with tuberculosis to monitor their progress. Nurses educated patients and family members about proper isolation techniques and monitored patients to ensure that they covered their mouths when they coughed and disposed of their sputa as instructed. The nurses served as information agents of the Health Department. When hygienic measures were disregarded, nurses could recommend that patients be transferred to sanatoria.<sup>23,24</sup>

Lacking a reliable cure, Biggs promoted the need for selected patients with smear-positive tuberculosis to be admitted to hospital. Biggs campaigned for years to create specialised institutions for tuberculosis treatment.

**Comparison of WHO-recommended approach to tuberculosis control (1994) with that recommended by Hermann Biggs (1889)****WHO<sup>25</sup>**

Diagnosis by microscopy of patients attending health facilities

Adequate supply of drugs to allow treatment and stop transmission

Best available treatment (short-course chemotherapy) under appropriate case management (directly observed treatment)

Systematic monitoring and supervision with analysis of each cohort of patients put on treatment

Political will

**Hermann Biggs<sup>1</sup>**

Provision of free microscopy to private physicians and at public clinics

Creation of hospital beds to allow isolation and stop transmission

Best available treatment (nutritional support, cough etiquette, and isolation) under appropriate case management (nursing supervision)

Mandatory reporting and systematic follow-up of all patients reported

Political will: "Public health is purchasable"; creation of a social movement for control of tuberculosis

As a result, the Department of Health opened tuberculosis hospitals in and around New York City. Admitting patients to hospital served the dual purpose of providing a therapeutic environment for patients, while also removing infectious individuals from the general population. Admission thus removed patients from society, stopping tuberculosis at the source, as is the goal of modern treatment. Patients sent to sanatoria generally remained there for months or even years. Those who survived until discharge underwent follow-up in the clinics.

Supervised therapy remains the basis of tuberculosis control today. Biggs implemented the best available measures (nutrition, rest, cough etiquette, and physical isolation) under appropriate case management (nursing supervision) to stop the chain of transmission. Similarly the WHO-recommended DOTS strategy is to provide the best available treatment (short-course chemotherapy) under appropriate case management (directly observed treatment) to achieve chemical isolation of patients and stop the chain of transmission.<sup>15</sup> Lack of effective case management remains a major problem in many parts of the world. In many countries, more than 50% of patients treated for tuberculosis are lost to follow-up, many during the intensive initial treatment period.<sup>9,25</sup> Among patients not treated according to the WHO guidelines, less than half were successfully treated;<sup>9</sup> stronger public-health supervision is urgently required.

*Public education*

"I do not believe that the importance of [the Board of Health's] educational work can be overstated. Its value is incalculable in widely disseminating popular and scientific information with regard to the results of the latest studies of infectious diseases, and there have been constantly exhibited in New York the most gratifying indications of the influence of this information thus distributed, on both the general public and the medical profession."

Hermann Biggs<sup>22</sup>

Efforts to educate the public about preventing the spread of tuberculosis began in 1889. These tactics included several "measures to be taken to render the sputum innocuous", such as ensuring that tuberculosis patients coughed into handkerchiefs and disposed of sputum properly.<sup>1</sup>

Biggs publicised his disease-control strategies in many ways. The Health Department issued many circulars for physicians and patients. Information for patients and the public was made available to the most affected immigrant populations by translation into German, Hebrew, Italian, and other languages. There were unintended

consequences of the propaganda about tuberculosis. The noted New York physician S Adolphus Knopf described the entity of "phthisiophobia"—the irrational fear of tuberculosis.<sup>26</sup> At times, educational messages about the seriousness of the disease scared patients away instead of convincing them to use Department of Health's services. Thus, although Biggs meant to improve knowledge and behaviour by educating the public about the infectiousness of tuberculosis, these efforts sometimes had the inadvertent effect of stigmatising those afflicted.

New York City's educational programme was expanded in 1902 with the founding of the Committee on the Prevention of Tuberculosis of the Charity Organization Society of New York City (later the New York Tuberculosis and Health Association). Through innovative techniques such as public exhibits, parades, and the sale of Christmas seals, the Association and its nationwide affiliates zealously trumpeted the importance of hygienic behaviour.<sup>27</sup> These antituberculosis societies represented the first mass education campaign directed at a single disease, and they were integral to promoting the new bacteriological awareness among the public.<sup>28</sup>

Today public education remains important for several reasons: to emphasise that tuberculosis can be cured; to publicise the availability of free diagnosis and treatment; to reduce the stigma of tuberculosis patients; and, perhaps most importantly, to keep public attention focused on tuberculosis in order to foster political, administrative, and financial support. Public education and advocacy can play an essential part in forging new partnerships to control tuberculosis, and in reaching out to target populations.<sup>29,30</sup>

*Political will*

"Public health is purchasable. Within natural limitations a community can determine its own death rate."

Hermann Biggs<sup>1</sup>

Biggs lobbied effectively for increased funding. He was able to systematically expand diagnostic and follow-up activities because of this support, even in periods of financial difficulty for the city. Acting for the good of the public's health, Biggs was supremely confident in his ability to manipulate political power to his own ends. Even when he failed to sway politicians to his cause, Biggs found a way to maintain resources. For example, the large-scale sale of diphtheria antitoxin which he had begun in 1895 helped finance the Department of Health's activities for many years.<sup>14</sup> Biggs' effectiveness in garnering support stemmed from his tenacity. Colleagues noted that "his great genius lay in his capacity for hard work . . . no, constant work".<sup>1</sup> Unlike some public-health physicians, he remained clinically active, and was known

as a great clinician and teacher. This increased his credibility and influence within the medical profession. However, his greatest strength was his “mastery of the political process, the media, and public relations”.<sup>14</sup>

Biggs’ skill at public relations was at the heart of the Health Department’s success in fighting tuberculosis. He lobbied politicians about the economic value of public health and capitalised on the city’s fear of epidemics. Aggressive leadership in the interest of public health is as necessary today as it was at the turn of the century. Tuberculosis-control programmes have been plagued by inadequate budgetary outlays and ineffective direction; public-health leaders have not been able to focus resources on the huge burden of tuberculosis. Advocacy is required to create and sustain effective antituberculosis programmes.

## Conclusions

In the early 1990s, 100 years after Hermann Biggs initiated comprehensive tuberculosis-control efforts in New York, both the city and the US saw a resurgence of the disease. Fuelled by poverty, a deteriorating public-health system, and the HIV epidemic, the outbreak included the emergence and spread of multidrug-resistant strains.<sup>31</sup> New York’s rejuvenated tuberculosis-control efforts were patterned after Biggs’ original model. Biggs’ mandatory notification policy was expanded to include reporting of all results of drug susceptibility testing, a measure that was essential to the coordination of control efforts with the private sector. This change became more palatable to physicians and laboratories when, in 1992, the city’s Department of Health offered private physicians laboratory services that included free, high-quality first-line and second-line drug susceptibility testing. Treatment of patients was improved by upgrading public clinics, improving the education of physicians who treated tuberculosis patients, and recruiting outreach workers to provide case management, particularly directly observed treatment, in clinics and in patients’ homes. Another echo of Biggs’ programme was the opening of specialised institutions for the care of tuberculosis patients, including a hospital ward for non-adherent patients as a last resort if all other efforts failed.<sup>13,32</sup> Thus, the pattern of developing an appropriate regulatory framework, providing laboratory and clinical services, and ensuring intensive follow-up of each patient was similar in the 1890s and 1990s. With the exception of short-course chemotherapy, which was established in the 1980s, Biggs’ approach included all the elements of WHO’s recommended programme of tuberculosis control (panel).

Biggs’ effort were not an unalloyed success. It took a decade for him to implement his programme, even partially. Some features of the programme, including mandatory confinement of uncooperative patients with tuberculosis, were considered authoritarian.<sup>33</sup> And the epidemiological impact of Biggs’ work is difficult to determine. The mortality rate from tuberculosis had already begun to decline when Biggs began his programme. It has been suggested that improvements in living conditions and nutrition, or selective genetic pressure—not public-health programmes—led to further declines in tuberculosis after 1900.<sup>34,35</sup>

Others have argued that specific interventions, including isolation in sanatoria, did reduce tuberculosis cases.<sup>36</sup> The epidemiological impact of prompt diagnosis and physical isolation is difficult to quantify but should

not be discounted. If isolation and education were effectively applied to only 40% of patients, and reduced the number of people infected by these patients by only one fourth, this would still reduce new infections by 10% and could result in a steady decrease in cases.

Application and adaptation of Biggs’ principles in recent years has been associated with significant declines in tuberculosis incidence in New York City—by 75% among US-born people and 60% overall in 6 years;<sup>8</sup> similar declines have been documented in Beijing, Baltimore, Cuba, and elsewhere.<sup>37–39</sup> As has been stated by Karel Styblo, the modern-day founder of DOTS, “Unlike many other infectious diseases in developing countries, tuberculosis can be controlled . . . under any socioeconomic conditions, because the infectious agent is almost exclusively in the diseased man, and simple and inexpensive means to eradicate tuberculosis are available.”<sup>40</sup>

In 1929, Winslow noted that, “[By] 1897 Biggs had completed the outline of machinery for the official administrative control of tuberculosis practically as it stands in the world today.”<sup>21</sup> The same can still be said in the year 2000. Biggs’ strategies continue to hold great potential for less-developed countries. Mandatory notification of cases based primarily on active surveillance of microscopy laboratories could substantially increase case-detection rates, but is generally not done in less-developed countries today. Provision of convenient, high-quality laboratory services to public and private sectors could further improve case-detection rates. Finally, creation of a social movement to stop the preventable illness and deaths from tuberculosis is as essential and urgent today as ever. Now, more than 100 years after Biggs’ initial efforts, the control of tuberculosis still depends on leadership and management—leadership, to ensure funding and administrative support, and management, to ensure accurate diagnosis of tuberculosis as well as accountability for cure of every patient diagnosed.

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