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Coping with Danger in the Air: BCG Vaccination in the Republic of China and International Projects of Postwar Tuberculosis Control, 1930–1949

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Abstract

In the early twentieth century, while smallpox, cholera, and other diseases caused temporary but urgent health crises in China, pulmonary tuberculosis remained a leading cause of mortality. This article investigates efforts to prevent and control tuberculosis in Republican China, especially efforts to implement the Bacille Calmette-Guérin (BCG) vaccine as a preventive measure against the disease. Published materials show that efforts to introduce this vaccine during the early 1930s met with skepticism on the part of Chinese physicians and inaction on the part of the state. Although the outbreak of the Second Sino-Japanese War (1937–1945) presented an obstacle to BCG research and development, it also provided new opportunities for members of China's biomedical research community—many of whom had moved with the Nationalist government to the nation's western hinterlands—to learn about new methods of producing vaccines and study methods of epidemic control. In the case of BCG, these processes bore fruit only in the years after the war ended, when a review of medical literature suggests that in the tumultuous years of civil war between 1945 and 1949, health administrators began to plan for implementation of the BCG vaccine on a large scale for the first time. But questions of the ability of this biochemical method to prevent an airborne disease, and the role of environmental and social factors in causing tuberculosis, lingered throughout this period.

Keywords: tuberculosis, Bacille Calmette-Guérin, BCG, Republic of China, public health, bacteriology, vaccine, immunization, epidemic

Introduction

During the early twentieth century, a host of epidemic diseases presented a crisis for the nascent Republic of China. Some were passed by the touch of humans or animals, others infected water and food supplies, and perhaps the most fearsome spread through the air. Pulmonary tuberculosis fell into the last category, and was a leading cause of mortality in China; by 1935, tuberculosis caused approximately 1.2 million deaths per year and accounted for 400 of every 100,000 deaths in the nation

(Core 2014, 128). However, after its establishment in 1911, the Republican government did not prioritize tuberculosis in its epidemic control policies, focusing its efforts instead on programs that sought to control smallpox, cholera, plague, and other *fading chuanranbing* 法定傳染病 (notifiable infectious diseases) that caused swift-moving, devastating epidemics. In the first decades of its rule, the government of the Republic of China deprioritized tuberculosis because it was a social disease: a consequence of poverty and urban labor conditions that could not be controlled with public health programs, especially given constraints of time, money, and human resources (Lei 2010, 254–255). Then, in the 1920s and 1930s, the development of a vaccine for tuberculosis and its introduction to China challenged these assumptions.

This article investigates efforts by the Republican government to prevent and control tuberculosis using the Bacille Calmette-Guérin (BCG) vaccine, focusing on the period after the Nationalist Party consolidated its power in 1927. Whereas most accounts of the introduction of BCG to China focus on the rapid expansion of immunization programs under the People's Republic in the early 1950s, physicians and researchers working for the Nationalist administration actually laid the groundwork for these programs well before 1949. As early as 1929, Chinese physicians traveled to Paris to acquire samples of BCG, launched urban pilot programs, and discussed the BCG vaccine in medical textbooks and handbooks—yet medical discussions of the vaccine in the 1930s remained tentative, casting it as a foreign pharmaceutical intervention of unclear efficacy and technical complexity, thereby preserving the identity of tuberculosis in China as a social disease best controlled through transformations of personal and environmental hygiene.

The Second Sino-Japanese War (1937–1945) interrupted these efforts, but the war was not a simple obstacle to research and development.[1] It provided new opportunities for members of China's biomedical research community—many of whom had moved with the Nationalist government to the nation's plague-prone western hinterlands—to develop new methods of producing and distributing vaccines and controlling epidemics. After Japan's surrender, in the tumultuous later years of the Chinese Civil War (1945–1949), health administrators began to plan the implementation of BCG vaccination on a large scale in China for the first time. Although this may seem like curious timing, given the chaotic state of postwar China as Nationalist and Communist forces resumed the civil war that the Japanese invasion had disrupted, I argue that the economic crisis that China faced after 1945, combined with wartime transformations in epidemic control that emphasized vaccination, actually encouraged physicians to promote the BCG vaccine as a means of resolving the tuberculosis crisis that did *not* require long-term transformations of environment or society. Although physicians continued to discuss the value of combining BCG vaccination with environmental and social measures, they gave new prominence to immunization as they stressed the potential of BCG to make the Chinese population healthier and more productive. The vaccine itself proved difficult

[1] This conflict between China and Japan is also known as China's War of Resistance with Japan or sometimes simply the Pacific War.

to produce and implement, but its promotion reflected the transformations that war had wrought in China's public health system, as well as the particular meaning that physicians gave to the economic implications of the tuberculosis crisis and their engagement with global networks of bacteriology.

Tuberculosis in Republican China

During the late nineteenth and early twentieth centuries, urbanization and the rise of factory production in cities created crowded, unsanitary conditions that permitted infectious diseases like tuberculosis to spread rapidly in China. Tuberculosis is caused by the tubercle bacillus (*Mycobacterium tuberculosis*), discovered in 1882 by German physician and microbiologist Heinrich Hermann Robert Koch. This bacterium is resistant to heat and can survive in dark spaces for six to eight months, so tuberculosis infection rates tend to correlate with dark, damp, stuffy, and crowded spaces. Tuberculosis typically spreads when one inhales an infected droplet that a tubercular person has exhaled. Because the tubercle bacillus reproduces slowly, it is possible for infected persons to become disease vectors without displaying any obvious symptoms or realizing the extent of their illness. Those who catch the disease may therefore live for many years, and transmit the disease to others, before developing the characteristic symptoms—such as cough expelling sputum or blood (or both), night sweats, fatigue, fever, and weight loss—that indicate the contraction of tuberculosis. The disease particularly threatened Chinese industry because it spread so easily through the urban workforce (Zhang and Elvin 1998, 530–535).

Although historians of medicine have begun to understand the modern history of tuberculosis in global terms (McMillen 2015), China's place in those narratives has remained unclear. The dominant narratives examine the emergence in Europe of the fields of bacteriology and germ theory and subsequent work by Koch and others on the etiology of tuberculosis, as well as the range of therapeutic measures developed in Europe and North America to attempt to control the disease. For example, British and American patients who developed "consumption" typically entered sanatoriums or migrated to more favorable environments (Bryder 1988; Rothman 1995). In the late nineteenth century, European and American bacteriologists suggested preventive tactics that altered individual and collective behavior. In the United States, these strategies became intertwined with Progressive Era social reforms and resulted in the establishment of sewers, water purification, garbage collection, and food inspection systems by the early twentieth century (Tomes 1999, 5–10).

Scholars of modern China have discussed the role of tuberculosis as a major cause of mortality, as well as its significance in efforts by medical missionaries to translate foreign medical texts into Chinese (Andrews 1997; Zhang and Elvin 1998). As physicians in China discussed tuberculosis—associated with a traditional pathology called *laobing* 痨病 (wasting disease)—using terms that had originated with European bacteriology, they also considered ways of adapting foreign methods of controlling the disease to the Chinese context. In China, physicians trained in Western medicine selectively assimilated germ theory into Chinese medical, political, and social spheres (Andrews 1997). This development coincided with the rise of practices associated with *weisheng* 衛生 (hygiene), which sought to bring street sweeping, sewer sanitation, trash collection, and other reforms similar to the transformations of the U.S. Progressive Era to China's treaty-ports (Rogaski 2004). Sean Hsiang-lin Lei has shown that, in the 1930s, tuberculosis was framed as a familial disease, so that physicians of Western medicine advocated behaviors of personal hygiene as a means of reforming traditional Chinese family structures in a process he calls "habituating individuality" (Lei 2010, 248–249). Li Hengjun also argues that Chinese physicians and administrators who sought to treat and prevent tuberculosis selectively integrated Western medicine into traditional social, cultural, and medical systems (Li 2014, 3–4).

The framing of tuberculosis as a chronic, social, familial disease clashed with the financial and epidemiological priorities of the Republican government, even after the Nationalist Party rose to power in 1927 and established a Ministry of Health in 1928 that sought to expand and modernize medical administration in China. The Republican government classified certain illnesses as *fading chuanranbing*, and these diseases merited extensive investments of personnel and money. They included the traditional scourges of cholera, plague, typhoid fever, smallpox, and other infections—but not tuberculosis. Because it was a disease with social causes, and not easily treatable or preventable, public health programs with limited resources did not target tuberculosis (Lei 2010, 251–254). Only after 1930 did organized anti-tuberculosis work in China begin in earnest, and it happened largely outside governmental spheres until the 1950s.

In the 1930s, efforts to control tuberculosis generally consisted of educational, diagnostic, and isolation programs and were centered primarily, but not exclusively, in Shanghai. As a means to compensate for the absence of government efforts to establish programs to control tuberculosis, Yan Fuqing, Wu Liande, and other prominent physicians of Western medicine established the Chinese Anti-Tuberculosis Association (Zhongguo fanglao xiehui) in Shanghai in 1933. The association sponsored public lectures, posters, and programs to educate the public about the dangers of tuberculosis, albeit with limited success. It also established treatment facilities and sanatoriums outside urban areas, focusing its efforts on Shanghai, where a branch of the organization was established in October 1938 (Core 2014, 129). In Beiping—as the city of Beijing was known from 1928 to 1949—physicians at Peking Union Medical College, the leading school of Western medicine in China established and run by the Rockefeller Foundation, established the Beiping jiehebing xueshe (Beiping Tuberculosis Study Society) in October 1932. With the physician Lu Yongchun at its head, they raised funds to build a tuberculosis hospital that would include a sanatorium and public health department. Several years later, in 1935, the Beiping Number One Health Station (Beiping di yi weisheng shiwusuo)—a pioneering public health project of Peking Union Medical College in collaboration with a local police department—established a clinic dedicated to tuberculosis treatment and prevention that became a model for future programs. It conducted epidemiological surveys and focused staffers' efforts on diagnosis, quarantine, and disinfection (He 2011, 131–132).

By the early 1930s, tuberculosis was identified as a crisis of Chinese health, society, and family. Yet it lay beyond the capacity of state programs to manage, and urban associations focused their efforts on funding diagnosis and treatment facilities, public education, and the development of practices and infrastructures associated with *weisheng* that could make urban environments safer and less conducive to disease transmission. When a vaccine for the disease was developed and publicized in Europe, then, such a pharmaceutical intervention did not automatically fit into these objectives of transforming environment and society.

Shanghai to Paris, Paris to Chongqing: The Introduction of BCG to China

If efforts to control tuberculosis in China during the Republican period were largely characterized by official neglect and professional concern, then the emergence of the BCG vaccine for the disease changed this calculus. To its promoters in the 1930s, BCG vaccination offered China a practical opportunity to prevent tuberculosis on a mass scale, relying on technical, biochemical methods rather than extensive and long-term social transformation. Yet physicians hesitated to offer a ringing endorsement of the BCG vaccine. They claimed that the global medical consensus on the vaccine was not clear and indicated that its identity as an immunization was not stable; it coexisted alongside a variety of other similar *xizhuang ji* 菌裝劑 (bacterial preparations) used for therapeutic as well as preventive purposes. These persistent qualms about BCG spoke to broader concerns about the use of *xizhuang ji* to deal with a disease that was historically intractable to biochemical interventions.

The Bacille Calmette-Guérin or BCG is the oldest vaccine still in widespread use today and the only extant immunization that offers some protection against tuberculosis (Liu et al. 2009, 70; Fine 1989, S353). First developed in the 1920s, the vaccine began to be used widely around the world only after 1930. On December 28, 1908, in the French city of Lille, physician Albert Calmette and veterinarian Camille Guérin announced that they had developed a weakened form of the tubercle bacillus (Gheorgiu 2011, 47–49; Plotkin, Orenstein, and Offit 2012, 797). In July 1921, the pediatrician Benjamin Weill-Hallé successfully gave an oral vaccine using live, attenuated tubercles to a Parisian infant (Gheorgiu 2011, 50; Liu et al. 2009, 72–75). In 1924, the Paris Pasteur Institute began to distribute the BCG strain around the world. In 1928, after a 1926 Norwegian clinical trial found the vaccine to prevent tuberculosis in 80 percent of human subjects (Flower 2008, 45), the League of Nations declared that the oral BCG vaccine was safe. The announcement was premature. A year later, authorities immunized 250 babies in Lübeck, Germany, but the vaccines were contaminated with virulent bacilli and seventy-two infants died. The Lübeck incident led health departments in English, Scottish, Irish, and American cities to avoid implementing the vaccine, but France, the Netherlands, Norway, and the League of Nations maintained their support for BCG (Petroff and Branch 1928; Feldberg 1995, 149–150; Hoft and Gheorgiu 1996; Plotkin, Orenstein, and Offit 2012, 808).

The Lübeck incident also shaped Chinese attitudes to the BCG vaccine. Although BCG vaccination in China is often dated to the 1950s, when the government of the People's Republic of China expanded a number of mass immunization programs (Zhang and Elvin 1998, 524), He Ling shows that it actually began much earlier, in the 1930s. In 1928, the nascent National Health Administration adopted a policy to introduce the BCG vaccine to China. Under these auspices, Song Guobin, a former student of Calmette and professor of bacteriology at Fudan University Medical School —best known today for his role in establishing the field of medical ethics in China—received and preserved a shipment of the BCG strain as early as 1929. Yet after news of the Lübeck incident spread to China, concerns about the safety of BCG forestalled its production and implementation, despite Song's promotion of the vaccine in medical literature (He 2011, 117).

Song was the first, but far from the only, physician to bring BCG cultures to China. While some physicians were reading translated texts about BCG and discussing the new vaccine in the pages of journals and books, others sought to begin producing the vaccine domestically. In 1933, the physician and researcher Wang Liang succeeded in a second transfer of the BCG strain, this time to Chongqing from Paris. A native of Chengdu, Wang had trained at the medical school at Hanoi established by the French colonial government of Indochina, then pursued medical studies in France before taking up a position as chief physician at the Ren'aitang yiyuan (Ren'aitang Hospital) in 1913. Having seen news of BCG in French medical literature, in 1931 he arranged to undertake research in Calmette's laboratory at the Pasteur Institute. In 1933, Wang carried the original BCG strain back to China from France, set up a small laboratory, and used it to immunize 248 children (He 2011, 117–118). Wang claimed that none of those immunized fell ill with tuberculosis. In retrospect, Wang presented his research in France as a fundamentally patriotic endeavor: "Thinking of the needs of our nation to fight tuberculosis," he wrote in 1948, "I traveled across the oceans, and went to Calmette's laboratory" (Wang 1948, 13).[2]

Wang's work—as well as that of Calmette, who had established the Pasteur Institute in Saigon before undertaking work on BCG—speaks to the importance of the medical networks that connected China, Southeast Asia, and France, especially the role that medical schools in French Indochina played in training Chinese physicians in Western medicine (Bretelle-Establet 2000). This point complements He Ling's suggestion that although knowledge about tuberculosis was most often translated from Japanese, most tuberculosis specialists in China were trained in the European and North American tradition (He 2011, 5, 79–102). Yet Wang appears to have remained relatively isolated in his work in Chongqing, while private research institutes in Shanghai also sought to cultivate the BCG strain. At the Henry Lester Institute, the microbiologist Tang Feifan conducted animal experiments with BCG in 1934 and 1935, but the results made him hesitate to attempt experimentation with human subjects. In 1936, the Shanghai Pasteur Institute created a special department for anti-tuberculosis work with a BCG production section that produced vaccines using a strain mailed directly from the Paris Pasteur Institute; the Shanghai Institute also sent its researcher Liu Yongchun to Paris to study BCG production (He

[2] Original source: "念我國防癆之需要，遠遠涉重洋，逕赴巴黎入巴斯德研究院卡爾默特實驗室."

2011, 118). By 1937, the Institute was preparing BCG once a week and supplying private doctors and local hospitals in Shanghai with the vaccine (Wang 1948, 16). By 1948, it had distributed 7,500 BCG vaccines in Shanghai (Chen, Wei, and Zhu 1982, 437). Yet the vaccine did not receive widespread acceptance or support beyond these significant urban efforts.

"The Most Interesting Vaccine in the World": Chinese Concerns about BCG in the 1930s

The hesitation of Chinese authors to wholeheartedly endorse BCG is apparent in medical texts of the 1930s, when books and articles about tuberculosis treatment and prevention began to appear more frequently. Many were translated from foreign authors (Lomisch 1939; Hawes 1930; Jacquerod 1933), whereas others were written by Chinese physicians (Ren 1935; Liu 1932; Ding 1936). Mostly printed in Shanghai, as was typical for the time, these works were pitched at a diverse range of readers, from medical students to the general public. If these accounts mentioned BCG, or any immunization against tuberculosis, they often stressed the incomplete nature of current knowledge and the uncertain efficacy of the vaccine, especially in a context of diverse pharmaceutical interventions for tuberculosis that confused therapeutic and preventive functions. They also discussed BCG only in terms of injection, not the oral form of the vaccine—perhaps as a result of the Lübeck incident, in which the latter had been employed.

In introducing the BCG vaccine, authors commonly invoked the concept of a global consensus on a vaccine and noted that such a consensus was lacking in the case of tuberculosis. For example, a 1935 book by the Japanese researcher Imamura Arao in Chinese translation, titled *Feijiehe zhi changshi* (General knowledge of tuberculosis), discussed treatment and prevention of the disease. Imamura introduced the BCG vaccine at the end of a section on preventing tuberculosis that first discussed methods of disinfection and nursing care. A vaccine against tuberculosis could not be like its more famous counterparts against smallpox or typhoid fever, Imamura suggested. The immunity produced by contracting tuberculosis was not strong, and reinfection was relatively easy, so a vaccine—which generally worked by introducing the disease pathogen in an attenuated form to the body—would not be very strong, either. Because of this, Imamura thought it unlikely that any vaccine for tuberculosis could work very well (Imamura 1935, 172). However, Imamura introduced the BCG vaccine in glowing terms, noting that Calmette had reported a successful experimental trial with four hundred thousand human subjects. "It has really produced extraordinary efficacy, and furthermore it is not at all dangerous," he reported. Despite this enthusiasm, Imamura went on to reserve final judgment, saying that "now it is just the problem of quality [literally, *chengji* 成績 (grades)], which still has not reached a definite judgment." He concluded ambiguously, "It's the most interesting vaccine in the world" (Imamura

1935, 173).[3] Imamura claimed that the BCG vaccine was not very effective in terms of prevention, so it would be important to combine getting the vaccine with careful maintenance of personal and environmental hygiene. This opinion supported the view that only social change over long periods of time could adequately control tuberculosis.

Awareness of the lack of consensus about BCG in the global medical community can also be seen in the physician Cui Guchen's 1936 text *Fei jiehe bing (feilao) wenda yiqian ze* (A thousand questions and answers about tuberculosis), which intended to provide a comprehensive but readable encyclopedic guide to the disease. In a section on the immunology of tuberculosis, Cui posed a series of basic questions and detailed answers about vaccination (Cui 1936, 17–19). Cui gave a stock answer to the question of what a vaccine was and what it did—it involved injecting killed or nontoxic pathogens into the body and increased the strength of resistance to infection by producing a strong reaction to the invading tubercle. But in response to the question "How many different methods of vaccination to prevent tuberculosis are there?" Cui hinted at the existing diversity of vaccines and treatments for tuberculosis at the time. He first discussed the BCG vaccine, describing it simply as "French" and that it "used a kind of special method" to produce an attenuated bovine tubercle bacillus suitable for inoculation of infants younger than one week. But he added that there were other vaccines, produced in England and Japan, using human tubercle bacilli that were nontoxic. "They all have the same efficacy, and have not yet elicited attention from the medical community," he concluded (Cui 1936, 19).[4] This brief, simple account not only supported the consensus in China that there was, in fact, no global consensus about BCG; it also suggested that BCG was not seen as unusual, but instead was interchangeable with other pharmaceutical products.

Indeed, in the 1930s, biochemical interventions for tuberculosis appear to have been numerous in kind and origin—and not always trustworthy. The fact that vaccines occupied an often-blurred line between prevention and treatment of disease, combined with this large pharmaceutical marketplace, meant that physicians were hesitant to uniformly endorse the BCG vaccine. In the case of tuberculosis, the ambiguous status of another biochemically produced substance, tuberculin (*jiehe jun su* 結核菌素), complicated acceptance and understanding of the BCG vaccine. In the decades after Robert Koch's 1890 failed attempt to use this extract of tubercle bacillus as the basis for a tuberculosis vaccine, the activity and toxicity of the bacillus remained poorly understood in Europe. Tuberculin was primarily used for diagnosis—then as now, a positive reaction to an injection of tuberculin indicates infection with the disease—but researchers continued to search for ways to use a modified form of bacillus extract to halt the spread of the disease. Consequently, a variety of substances related to tuberculin appeared on

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[3] Original source: "頗奏奇效，而且絕沒有危險...現在就是成績問題，還不得決定的批判....現在世界上這種 BCG 疫苗是最有興味的疫苗."

[4] Original source: "至於他們的效力同功用，尚不能引起醫界的注意力."

pharmaceutical markets and made standardization of the BCG vaccine extremely difficult, since "tuberculin was seen essentially as a vaccine" (Bonah 2008, 281). In the early twentieth century, in Western languages, the term "vaccine" referred to a microbiological substance in which a pathogen was somehow weakened, but there was some debate over whether a vaccine was necessarily prophylactic in nature. Advocates of "vaccine therapy," developed in the early 1900s by British immunologist Almroth Wright, suggested that in some cases, the vaccine could be used for therapy as well as prevention of bacterial diseases like staphylococcus (Keating 1988, 276–288).

This ambiguity presented difficulties for the authors and translators of texts about tuberculosis in China, since the BCG vaccine was often discussed in the context of injected bacterial preparations that could prevent or treat disease. After discussing BCG, for example, Imamura noted the existence of a method of using two or three "preventive injections" to prevent the onset of tuberculosis, saying, "This is not at all the idea meant by 'immunization.'" Yet Imamura went on to say that because such "preventive injection" did prevent the onset of disease by healing lesions, it "could only be termed, in contrast to immunization, a kind of vaccine therapy [*yimiao liaofa* 疫苗療法]." He stressed that vaccines were the only kind of injection that could prevent disease, and any "substitutions" (*daiyongpin* 代用品) were not dependable, suggesting a concern with reliability and quality of vaccines for the time (Imamura 1935, 174).

Although Cui, writing for a broader audience than Imamura, did not delve into the technicalities of immunology, he referred to multiple versions of an anti-tuberculosis vaccine, specifically versions produced in England and Japan. The latter might have been a preparation developed by the bacteriologist Shiga Kiyoshi; in 1924, Shiga had taken samples of BCG from the Paris Pasteur Institute to the Institute for Infectious Diseases in Tokyo (Yongue 2017, 212). Shiga's work appears in another Chinese text about tuberculosis from 1933, originally in Japanese: Hara Sakae's *Feibing yufang liaoyang jiao ze* (Instructions for prevention and treatment of lung diseases). This technical textbook did not mention the BCG vaccine in its section on prevention, where it instead focused on social means of preventing the disease. The question of injecting microbiological preparations did, however, come up in a section on therapy titled "Injecting tuberculin and related kinds of bacterial preparations." The bulk of the section discussed tuberculin, but did not draw a strong distinction between tuberculin and a vaccine meant to prevent tuberculosis infection. Hara wrote, "The effectiveness of tuberculin and other bacterial material preparation therapies (for instance, Bailai serum, Shiga's sensitized tuberculosis vaccine material, and so on—they are all a kind of tuberculin and their use is not different), has not yet been widely accepted. There are many patients who misunderstand this treatment's fundamental nature" (Hara 1933, 127).[5] Hara's text,

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[5] Original source: "世上對於結核菌素及其他菌裝劑療法 (例如百瀬氏液或志賀氏感作結核苗裝等。均為結核菌素之一種。 其作用並無異點)." I have translated 苗裝 (*miao zhuang*) as "vaccine material" because in the context of microbiology, 苗 (*miao*) is a term

aimed at medical students, again indicated the complex nature of the medical marketplace, the lack of international consensus on a bacteriological approach to controlling tuberculosis, and the fear that patients could easily misunderstand the nature of their disease and how best to treat or prevent it.

These sources suggest that in Japan and China, as in Europe, prevention and treatment of tuberculosis were not always clearly separable; moreover, in the 1930s the BCG vaccine lacked a stable, standardized definition (Bonah 2008, 279). There was a variety of biochemical preparations, many of which were loosely associated with the extract tuberculin and sought to use an attenuated form of the tubercle bacillus for therapeutic as well as preventive ends. In this context, and given the clear lack of transnational consensus on its efficacy, the BCG vaccine was not an intervention that most physicians and other medical authorities wholeheartedly endorsed. Their hesitation—often expressed in the assertion that preventive measures might include BCG but certainly ought to continue to stress social measures—also supported broader, environmental efforts to control tuberculosis by transforming local health infrastructures and personal, familial behaviors.

Airborne Enemies: The Second Sino-Japanese War and the Interruption of BCG Work

The outbreak of formal war with Japan in 1937 initially disrupted, but ultimately facilitated, efforts to introduce BCG. Recent scholarship has shown that the Second Sino-Japanese War was a key period for medicine in China. Especially after the Nationalist government—and with it a host of medical administrators, physicians, and researchers—relocated to southwest China to make its headquarters at Chongqing, new institutions were built, expertise in Western and Chinese medicine was remade, and groups like women and the overseas Chinese became prominent actors in spheres of medicine and public health (Watt 2014; Barnes 2018; Soon 2016).

Throughout these transformations, and amid new outbreaks of infectious diseases, tuberculosis continued to present a major threat to the Chinese population. Under Japanese occupation, Shanghai, previously the epicenter of anti-tuberculosis work, saw a substantial rise in infection rates as refugees flooded into the region and air raids destroyed sanatoriums and clinics. Although the Shanghai branch of the Chinese Anti-Tuberculosis Association established its own treatment facilities, the epidemic worsened during the early years of the war (Core 2014, 131–132). The Shanghai Pasteur Institute continued to distribute BCG vaccines after the city fell to the Japanese in 1937, and vaccinated a total of 5,661 people between 1937 and 1946. Research, too, continued: Liu Yongchun conducted trials of novel methods for intradermal injection of BCG (He 2011, 118). Procedures for manufacturing the vaccine generally followed international norms—using a solution called Sauton's

strongly associated with immunizations—i.e., *Doumiao* 痘苗 (Vaccinia), *yimiao* 疫苗 (vaccine), etc.

medium—but the wartime institute changed these methods to adapt production to wartime scarcity. For example, in 1942, staff members at the institute replaced asparagine, an ingredient in Sauton's medium, with sodium glutamate, a common ingredient in Chinese cuisine (Liu and Guo 1949, 276).

While Chinese institutions in occupied territory continued their work under dramatically altered circumstances, the Japanese occupation regime made medical interventions of its own. During the war, Japan's Meiji government assumed a strong role in developing programs to control tuberculosis (Johnston 1995). Yet such changes in priority for the central Japanese state did not necessarily translate to colonial settings, especially during the war, and were often articulated in different configurations of personnel and institutions (Liu 2008). Cities under Japanese occupation generally emphasized public health programming and, at least in the case of Tianjin, distributed vaccines against cholera, smallpox, and typhoid fever (Rogaski 2004, 272–273), but the BCG vaccine against tuberculosis does not seem to have been typically considered part of these interventions.

In regions under Nationalist control, the war was also a key period for the state development and large-scale manufacturing of immunizations against infectious diseases. Plague, smallpox, cholera, and malaria were endemic to the subtropical southwest, and their transmission was all the swifter in the context of wartime migrations and poverty. Tuberculosis was counted among these epidemics. "Malnutrition due to economic stringency affected the health of the teachers and quite a number fell victims to tuberculosis," wrote Hengbi Zhu, director of Shanghai National Medical College, which moved to Kunming in 1937 and then Chongqing in 1938 (Zhu 1946, 18–19). During the deprivations of war, the link between poverty and illness was starkly apparent; Zhu continued, "Once [the teachers at Shanghai National Medical College] fell ill, there was no one to care for them at home, and the expensive fees of hospitalization were well beyond the reach of their puny incomes" (1946, 19). Zhu claimed that the incidence of tuberculosis among medical students crept up to 10 percent, due in no small part to crowded and vermin-infested housing situations that encouraged the spread of infection. "Their living quarters were so crowded that when one person became ill, the rest were exposed to danger of infection," he said, noting grimly, "Students not infrequently succumbed to disease and death before they could finish their course" (1946, 19).

In a region where so many fast-moving, deadly infectious diseases were endemic and widespread, public health administration continued to deprioritize tuberculosis. Although the BCG vaccine was a low priority for the Nationalist government during the war, immunization as a means of preventing disease was not. Between 1937 and 1945, the National Health Administration supported extensive efforts to develop immunization research, development, and distribution of vaccines across large sections of the regional population against cholera, smallpox, plague, and a number of other severe infectious diseases. This work was centered chiefly, but not exclusively, in Kunming, where the National Epidemic Prevention Bureau (Zhongyang fangyi chu)—the chief governmental agency that took responsibility for manufacturing biological products in China—made its wartime headquarters. The immunization programs sponsored by the bureau laid the foundations for national disease control programs in the postwar and post-1949 periods, and brought together Chinese microbiologists with foreign colleagues involved in medical aid programs sponsored by groups like the League of Nations Health Organization and the American Bureau for Medical Aid to China (ABMAC) (Brazelton forthcoming 2019).

Some of these physicians and researchers—notably Tang Feifan, wartime head of the National Epidemic Prevention Bureau—had been involved in BCG research before the war broke out. Yet although the bureau occasionally produced a small amount of tuberculin, probably for diagnostic use ("Biao san" 1939, 18), it did not attempt to manufacture BCG vaccines during its extensive wartime work, instead focusing on producing immunizations for smallpox, plague, cholera, and typhoid fever. Likewise, ABMAC and the League of Nations Health Organization focused their interventions on supporting the development of immunizations against urgent infectious diseases and new therapeutics like penicillin. Wang Liang continued to vaccinate with BCG in Chongqing, immunizing in total about eight hundred children there (Liu and Guo 1949; Chen, Wei, and Zhu 1982, 437). Although tuberculosis continued to spread across wartime China, then, BCG vaccination was generally not a part of wartime medical work, probably because the immediate risks posed by severe infectious diseases were much greater and demanded the bulk of available resources.

Global Dissemination and Chinese Promotion of BCG

After the war with Japan, although infectious diseases and tuberculosis continued to threaten China, the Republic could not afford to invest in anti-tuberculosis work any more than it had before the war. In 1945, Nationalist government revenues amounted to only about one-third as much as its expenditures (Pepper 1999, 95). It was in this context of a bankrupt state that scientists, physicians, and members of the public turned to the belief that BCG vaccination could save public health and, by extension, the Chinese economy. After the Second Sino-Japanese War, as Nationalist and Communist forces lurched toward a renewal of civil war, physicians and medical researchers promoted BCG vaccination as an effective, cost-efficient means of preventing tuberculosis transmission that could save China from economic ruin. This campaign for BCG suggests the lasting impact of wartime vaccination work upon public health. A survey of medical research and writing shows that Chinese researchers and physicians participated actively in global efforts to promote the BCG vaccine in the immediate postwar era, when the disease swept Europe. A variety of actors—from clinicians to researchers and administrators—mobilized in support of one vaccine. They took the United States, rather than Japan, as a model of immunization practice, and they participated in transnational anti-tuberculosis health programs. These activities had shaped the experiences of many biomedical researchers and doctors during the war with Japan, and they also shaped the enthusiastic support for BCG that emerged from 1945 to 1949, along with the emergence of a global endorsement for the vaccine.

Indeed, concerns about treating and preventing tuberculosis were not limited to China during this period. After the Second World War (1939–1945), the disease provoked a global crisis. The international health organizations that emerged in the wake of that war promoted BCG as a solution to this emergency. The typical ways of controlling the disease via diagnostic chest radiography and systemic isolation of patients were sorely absent in the wreckage of war-torn Europe. In the absence of such infrastructure, an international intervention to vaccinate with BCG provided a means of controlling the spread of tuberculosis. In May 1947, the Danish Red Cross commenced a pilot program in Poland to test children for tuberculosis, immunize those who tested negative with the BCG vaccine, and train local doctors, nurses, and medical students in diagnosis and vaccination (Comstock 1994, 528–529). In 1948—the year the First International BCG Congress was held, in Paris—the success of this program led the nascent United Nations International Children Emergency Fund (UNICEF) and the World Health Organization (WHO) to fund a joint pan-European enterprise (Plotkin, Orenstein, and Offit 2012, 797; Comstock 1994, 528–529). The International Tuberculosis Campaign established an International Tuberculosis College to train epidemiologists, physicians, and laboratory staff; a research unit to evaluate data collected by fieldworkers; and field units that distributed BCG vaccines from laboratories in Denmark, Sweden, Paris, India, and Mexico. The campaign lasted until 1951 and eventually reached beyond Europe to India, the Middle East, and even Mexico and Ecuador. In total, its agents vaccinated almost fourteen million people with BCG (Comstock 1994, 533–534).

The International Tuberculosis Campaign did not directly sponsor tuberculin testing or BCG vaccination work in China, yet Chinese participants were involved in the project's formation and evolution. When UNICEF deliberated over the funding and nature of the campaign in March 1948, it was China that formally proposed to extend the work from Europe (as it had originally been conceived) to activities in Asia, Latin America, and Africa (Brimnes 2007, 411). Although the campaign originally earmarked $500,000 for work in China, it ultimately spent only $27,191 there—yet most of this sum went toward a donation of laboratory equipment for production of BCG, in a departure from typical spending patterns on non-European countries that participated in the campaign (International Tuberculosis Campaign 1951, 19, 30–32). The campaign's final report noted that in the spring and summer of 1948 it had shipped equipment and chemicals to establish a vaccine production facility in Beijing in preparation for a BCG campaign in China; in the same year, it had also sponsored the training of Chinese bacteriologists in BCG production. Yet the report concluded that the upheaval of civil war meant that "it was not feasible to start the usual kind of ITC-aided BCG programme in China" (International Tuberculosis Campaign 1951, 46).

Although the two bacteriologists who received training from the campaign went unnamed in its final report, as plans for the Campaign were coalescing in 1947, the WHO funded a scholarship for three Chinese researchers—Chen Zhengren, Wei Xihua, and Zhu Zongyao—to visit Denmark's State Serum Institute and Anti-Tuberculosis Dispensary in November 1947. Over six months in Copenhagen, these researchers studied BCG vaccine production, standardization, and distribution. After completing their studies, the trio toured anti-tuberculosis projects in Norway, Switzerland, Italy, France, England, and the United States. In October 1948, they returned to China with freeze-dried samples of the Danish strain of BCG. Chen set up a laboratory at the National Vaccine and Serum Institute in Beijing to produce the vaccine, and Wei did likewise at the Shanghai branch of the Vaccine and Serum Institute (Chen, Wei, and Zhu 1982, 437–438).

Chen and Wei's efforts were accompanied by a new focus by the Chinese medical press on tuberculosis, the dangers it posed to the population, and the potential for BCG to provide an economical means of controlling the disease. A series of articles in the *Chinese Medical Journal* and other medical publications presented financial imperatives for adoption of the vaccine, exploiting popular (and legitimate) concerns about China's economic collapse in the face of hyperinflation and civil war (Fan 2011, 32–33). In September 1947, physician Shaoqing Wu wrote that BCG vaccines represented a chance to break pernicious cycles of tubercular infection that had weakened China's labor force: "More ignorance and poverty, more tuberculosis! More tuberculosis, more poverty!" Wu stressed the effectiveness of the vaccine, commenting, "BCG vaccine, as an immunological agent used in conjunction with general measures of socio-economic improvements, will greatly hasten the process and bring tuberculosis under control much faster" (Wu 1947, 383). A year later, Shumin Qiao, at National Lanzhou University, also advocated for widespread BCG use. Qiao pointed out that mass immunization would cost "but an infinitesimal fraction of the millions of dollars it costs to run sanatoria [*sic*]" (Qiao 1948, 568). As an alternative to costlier environmental means of tuberculosis prevention, vaccination with BCG provided a feasible practical means of prophylaxis that could save China's labor force from consumptive collapse. Another 1948 article suggested that the implementation of BCG immunizations in China would be as transformative as the introduction of Jennerian vaccination: "Just as our nation's hygiene authorities…began to vaccinate to prevent smallpox, so [BCG] may have an outstanding and unlimited influence on citizens' health and the nation's economy" (Liu 1948, 209).[6]

The complex technical requirements of BCG demanded special consideration in planning for its production on a large scale, and authors' willingness to consider these issues indicated their commitment to the project, as well as their wartime experiences in setting up large-scale immunization programs. Qiao laid out a stepwise plan to roll out BCG vaccination across the country. He proposed the use of the National Vaccine and Serum Institute (formerly the National Epidemic Prevention Bureau until it was renamed in January 1946) as the first site for BCG vaccine production, and the establishment of a center for training technical personnel in production methods, followed by mobile laboratory units that could help distribute the vaccine in China's interior. He suggested vaccinating all infants at birth, as well as children and adults who had not already contracted the disease, "because the risk of exposure to cases of tuberculosis in China is so ubiquitous" (Qiao 1948, 571–573). Qiao discussed the mechanism of the vaccine and possible means of manufacturing it, noting that the nature of BCG as an attenuated vaccine mandated domestic production in an unusually lengthy process of fifteen to twenty days during which the vaccine had to be preserved in heat as it developed.

[6] Original source: "如我國衛生當局，經專家檢定標準接種方法後再努力推行，始種牛豆 [sic] 以防天花，則於國民健康和國家經濟殊有無限之影響."

The distribution of the vaccine on a national level also posed many logistical issues, which Wang Liang discussed in a 1948 article in the journal *Xin Chongqing* (The new Chongqing). After such a long period of cultivation, the live vaccine had a fleeting window of only fifteen days. “One cannot transport it to far places for use,” worried Wang, “and if it stays local, one must abandon lots of expired vaccines, so it is really not economical” (Wang 1948, 15–16).[7] Qiao suggested the potential for Soviet manufacturing methods, which used a dry glucose vaccine easily stored at room temperature, to work in China’s less accessible borderlands. The dry vaccine was not as fresh, nor as effective, as the vaccine prepared in suspension, but to Qiao, its capacity for long-term storage was worth the trade-off. This attention to means of employing vaccines in China’s distant borderlands likely reflected the experiences of microbiologists in the wartime hinterland, and indicated that microbiologists like Qiao were now thinking about vaccination on a national scale.

In advocating for the adoption of BCG as a critical preventive measure, authors discussed the precedents that other nations had set in producing and distributing the vaccine. Shaoqing Wu cited Denmark, Norway, Sweden, Canada, Russia, the United States, and even the former enemy state, Japan, as models that had already begun planning and instituting regular BCG immunizations (Wu 1947, 382).[8] In 1948, an article by a Russian contributor named S. A. Abolnick appeared in the *Chinese Medical Journal* discussing BCG vaccination in the Soviet Union. The success of trials in the Ukraine and Russia during the 1920s resulted in a larger campaign in 1934 and a nationwide movement in 1937. Abolnick concluded that BCG immunization had significantly lowered infant mortality in large cities (Abolnick 1948, 564–567). Wang Liang presented an overview of the efficacy of BCG vaccination programs in European countries, Canada, Brazil, and Uruguay, as well as the United States. To emphasize the reliability of BCG, Wang discussed its acceptance by the international immunological community. “If BCG was not effective, it would have been abandoned a long time ago,” he claimed, “and would not have reached a point today where American scholars plan to establish manufacturing offices to produce the vaccine for American children” (Wang 1948, 15).[9] This statement is odd, given that BCG vaccination was never widely implemented in the American population. It seems likely that he was drawing on scientific evaluations of BCG in medical journals.[10] Nevertheless, the fact that Wang

[7] Original source: “不能運至遠處施用，即在本地施用，必至拋棄甚多失效菌苗，大不經濟.”

[8] It is curious that Wu cited the United States as a model, even though it never adopted BCG vaccination on a large scale. He refers to scholarship by American biologist Joseph Aronson promoting the BCG vaccine in the United States on the basis of experiments distributing it in Native American communities (Aronson, Parr, and Saylor 1941; Aronson and Palmer 1946; Aronson 1948).

[9] Original source: “假令卡介苗毫無功效，則早已棄置不用，不至使現今美國學者籌設製造機關以接種美國之小兒矣.”

[10] Wang may have been drawing on the same research by Joseph Aronson that Wu Shaoqing had.

was somewhat overstating the commitment of the United States to the BCG vaccine is indicative of how Chinese physicians built consensus around public health measures, and stands in contrast to prewar concerns over the lack of a global consensus for the use of a standardized BCG vaccine. Wang relied on global standards of assessment and especially on the authority of American biology to reassure Chinese readers that the vaccine worked.

Physicians and researchers who promoted BCG between 1945 and 1949 were enthusiastic about the vaccine, but pointed out that it did not exclude the role of other, social measures of improving public health, in part because concerns about its efficacy lingered. For example, Wu claimed that since the BCG vaccine had proven only partially effective, it should be combined with other preventive means like proper nutrition and quarantining active cases (Wu 1947). The new prominence of BCG in the medical world during the Civil War in China, then, did not indicate a rejection of long-standing approaches to tuberculosis as a familial and social disease, but rather a greater acceptance of biochemical methods for controlling the disease.

Conclusion

Although Chinese researchers and physicians promoted the BCG vaccine domestically in medical journals and in popular media, actual immunization rates remained very low between 1945 and 1949, and exact figures remain elusive. The widespread dissemination of BCG remained an ideal solution to medical and economic problems rather than a feasible plan for public health in China. Moreover, the economic, social, and military crises of the Civil War were not conducive to qualitative improvements in working and living conditions in China's cities and villages. The air still carried with it dangerous bacilli.

Actually implementing mass BCG immunization did not happen on a large scale until after the establishment of the People's Republic of China. Yet the vaccine's promotion in China before 1949, especially during the Civil War, was the result of attention to bacteriological research on a global stage, perceived connections between the prevalence of tuberculosis in China and its state of economic crisis, and a genuinely national vision for public health and immunization work. These factors were a function of wartime reconfigurations of medicine, as well as longer debates that had roots in the 1920s and 1930s. They reflected changing understandings of tuberculosis, bacteriology, and vaccination in China, and they resulted in the gradual acceptance of BCG immunization as a technical, pharmaceutical approach to a disease that had taken on a variety of social and cultural meanings, and one that could reasonably work alongside—not in place of—practices of *weisheng*.

References

<u>Primary Sources</u>

Abolnick, S. A. 1948. "BCG Vaccination in the U.S.S.R." *Chinese Medical Journal* 66 (10): 564–567.

Aronson, Joseph D. 1948. "Protective Vaccination against Tuberculosis with Special Reference to BCG Vaccination." *American Review of Tuberculosis* 58 (3): 255–281.

Aronson, Joseph D., Erma I. Parr, and Robert M. Saylor. 1941. "The Specificity and Sensitivity of the Tuberculin Reaction Following Vaccination with BCG." *American Journal of Hygiene* 33, section B (2): 42–49.

Aronson, Joseph D., and C. E. Palmer. 1946. "Experience with BCG Vaccine in the Control of Tuberculosis among North American Indians." *Public Health Report* 61 (23, Tuberculosis Control Issue no. 4): 802–820.

"Biao san: Zhongyang fangyi chu zhipin chanliang" 衛生，表三：中央防疫處製品產量 [Table 3: Biological products of the National Epidemic Prevention Bureau]. 1939. *Tongji yuebao* 38: 18.

Chen, Zhengren, Xihua Wei, and Zongyao Zhu. 1982. "BCG in China." *Chinese Medical Journal* 95 (6): 437–442.

Cui Guchen. 1936. *Feijiehe bing (feilao) wenda yi qian ze* 肺結核病 (肺癆) 問答一千則 [A thousand questions and answers about tuberculosis]. Shanghai: Heji yinshuguan.

Ding Huikang. 1936. *Shiyan liao fei xue* 实验疗肺学 [Study of the experimental treatment of lungs]. Shanghai: Yixue shuju.

Hara Sakae. 1933. *Feibing yufang liaoyang jiao ze (shang ji)* 肺病預防療養教則 (上集) [Instructions for prevention and treatment of lung diseases, volume 1]. Translated from the Japanese by Xie Yushou. Shanghai: Shehui yibao guan.

Hawes, John B. 1930. *Feijiehe zhi zaoqi zhenduan* 肺結核之早期診斷 [Early diagnosis of tuberculosis]. Edited and translated by Chen Wenda. N.p.

Imamura Arao. 1935. *Feijiehe zhi changshi* 肺結核之常識 [General knowledge of tuberculosis]. Translated from the Japanese by Zhang Jiaoran. Shanghai: Shangwu yinshuguan.

International Tuberculosis Campaign. 1951. *Final Report of the International Tuberculosis Campaign, July 1, 1948–June 30, 1951.* Copenhagen: Dyva and Jeppesens Bogtrykkeri.

Jacquerod, M. 1933. *Feilao gexue* 肺癆咯血 [Tubercular hemoptysis]. Translated by S. F. Silberbauer and Lu Yongchun. Beiping: Tianran liaoyangyuan.

Liu Qijing. 1932. *Feilao bing ziji liaoyang fa* 肺癆病自己療養法 [Methods of recuperating from tuberculosis oneself]. Shanghai: Guangda yiyuan.

Liu, Yongchun [Lieou Y. Ch.], and Chengzhou Guo [C. C. Kouo]. 1949. "B.C.G. Vaccination: Eleven Years of Experience." *Chinese Medical Journal* 67 (5): 275–278.

Liu Zhai. 1948. "B.C.G. yimiao jiezhong de xiaoguo" B.C.G. 疫苗接種的效果 [The effectiveness of BCG vaccination]. *Yiyao xinzhi* 1 (5): 209.

Lomisch. 1939. *Feijiehe zheng zaifa zhi yufang* 肺結核症再發之預防 [Prevention of the reoccurrence of tuberculosis]. Translated by Hong Shilü. Shanghai: Shangwu yinshuguan.

Petroff, S. A., and Arnold Branch. 1928. "Bacillus Calmette-Guérin (B.C.G.) Animal Experimentation and Prophylactic Immunization of Children: An Analysis and Critical Review." *American Journal of Public Health and the Nation's Health* 18 (7): 843–864.

Qiao, Shumin [Chiao Shu-min]. 1948. "Project on BCG Vaccination for China." *Chinese Medical Journal* 66 (10): 568–575.

Ren Yibi, ed. 1935. *Zenyang tong feibing douzheng* 怎樣同肺病斗争 [How to fight lung diseases]. Shanghai: Beixin shuju.

Wang Liang. 1948. "Lun BCG fanglao yimiao zhi xiaoyong" 論 BCG 防癆疫苗之效用 [Discussion of the efficacy of the BCG vaccine]. *Xin Chongqing* 2 (1): 13–16.

Wu, Shaoqing [S. C. Wu]. 1947. "Guest editorial: BCG Vaccination for Tuberculosis Control in China." *Chinese Medical Journal* 65 (9–10): 381–383.

Zhu, Hengbi [H. P. Chu]. 1946. "Medical Education during the Anti-Aggression War." *Chinese Medical Journal* 64 (1–2): 17–23.

Secondary Sources

Andrews, Bridie. 1997. "Tuberculosis and the Assimilation of Germ Theory in China, 1895–1937." *Journal of the History of Medicine and Allied Sciences* 52 (1): 114–157.

Barnes, Nicole Elizabeth. 2018. *Intimate Communities: Wartime Healthcare and the Birth of Modern China, 1937–45.* Oakland: University of California Press.

Bonah, Christian. 2008. "Packaging BCG: Standardizing an Anti-Tuberculosis Vaccine in Interwar Europe." *Science in Context* 21 (2): 279–310.

Brazelton, Mary Augusta. Forthcoming 2019. *Mass Vaccination: Citizens' Bodies and State Power in Modern China*. Ithaca, NY: Cornell University Press.

Brimnes, Neil. 2007. "Vikings against Tuberculosis: The International Tuberculosis Campaign in India, 1948–1951." *Bulletin of the History of Medicine* 81 (2): 407–430.

Bretelle-Establet, Florence. 2000. "La santé en Chine du Sud à la fin de l'Empire et au début de la République" [Health in the south of China at the end of the Empire and the beginning of the Republic]. PhD diss., Université de Paris VII.

Bryder, Linda. 1988. *Below the Magic Mountain: A Social History of Tuberculosis in Twentieth-Century Britain.* Oxford: Clarendon Press.

Comstock, George W. 1994. "The International Tuberculosis Campaign: A Pioneering Venture in Mass Vaccination and Research." *Clinical Infectious Diseases* 19 (3): 528–539.

Core, Rachel. 2014. "Tuberculosis Control in Shanghai: Bringing Health to the Masses, 1928–Present." In *Medical Transitions in Twentieth-Century China*, edited by Bridie Andrews and Mary Brown Bullock, 126–145. Indianapolis: Indiana University Press.

Fan, Joshua. 2011. *China's Homeless Generation: Voices from Veterans of the Chinese Civil War.* New York: Routledge.
Feldberg, Georgina. 1995. *Disease and Class: Tuberculosis and the Shaping of Modern North American Society.* New Brunswick, NJ: Rutgers University Press.
Fine, Paul E. M. 1989. "The BCG Story: Lessons from the Past and Implications for the Future." *Reviews of Infectious Diseases* 2, supplement 2: S353–359.
Flower, Darren R. 2008. *Bioinformatics for Vaccinology.* Chichester, UK: John Wiley and Sons.
Gheorgiu, Marina. 2011. "Antituberculosis BCG Vaccine: Lessons from the Past." In *History of Vaccine Development*, edited by Stanley A. Plotkin, 47–55. New York: Springer.
He Ling. 2011. "Xiyi chuan ru zhongguo: jiehebing anli yanqiu (1900–1967)" 西医传入中国：结核病案例研究 (1900–1967) [The transmission of Western medicine to China: The case study of tuberculosis (1900–1967)]. PhD diss., Shanghai Jiaotong University.
Hoft, Daniel F., and Marina Gheorghiu. 1996. "Mucosal Immunity Induced by Oral Administration of Bacille Calmette-Guérin." In *Mucosal Vaccines*, edited by Hiroshi Kiyono, Pearay L. Ogra, and Jerry R. McGhee, 269–279. San Diego, CA: Academic Press.
Keating, Peter. 1988. "Vaccine Therapy and the Problem of Opsonins." *Journal of the History of Medicine and Allied Sciences* 43 (3): 275–296.
Johnston, William. 1995. *The Modern Epidemic: A History of Tuberculosis in Japan.* Cambridge, MA: Harvard University Press (Harvard East Asian Monographs 162).
Lei, Sean Hsiang-lin. 2010. "Habituating Individuality: The Framing of Tuberculosis and Its Material Solutions in Republican China." *Bulletin of the History of Medicine* 84 (2): 248–279.
Li Hengjun. 2014. "Jibing zhishi, yiliao wenhua yu weisheng xiandaixing: Jindai Zhongguo feijiehebing de shehui yu wenhua shi (1850–1940 nian dai)" 疾病知识，医疗文化与卫生现代性：近代中国肺结核病的社会与文化史（1850–1940 年代) [Knowledge of disease, cultures of healing, and hygienic modernity: The social and cultural history of tuberculosis in modern China (1850s–1940s)]. PhD diss., National University of Singapore.
Liu, Jun, Vanessa Tran, Andrea S. Leung, David C. Alexander, and Baoli Zhu. 2009. "Review: BCG Vaccines: Their Mechanisms of Attenuation and Impact on Safety and Protective Efficacy." *Human Vaccines* 5 (2): 70–78.
Liu, Michael Shiyung. 2008. *Prescribing Colonization: The Role of Medical Practices and Policies in Japan-Ruled Taiwan, 1895–1945.* Ann Arbor, MI: Association of Asian Studies.
McMillen, Christian W. 2015. *Discovering Tuberculosis: A Global History, 1900 to the Present*. New Haven, CT: Yale University Press.
Pepper, Suzanne. 1999. *Civil War in China: The Political Struggle, 1945–1949*, 2nd ed. Lanham, MD: Rowman and Littlefield.

Plotkin, Stanley A., Walter A. Orenstein, and Paul A. Offit, eds. 2012. *Vaccines*, 6th ed. Philadelphia: Elsevier Saunders.
Rogaski, Ruth. 2004. *Hygienic Modernity: Meanings of Health and Disease in Treaty-Port China.* Berkeley: University of California Press.
Rothman, Sheila M. 1995. *Living in the Shadow of Death: Tuberculosis and the Social Experience of Illness in American History.* Baltimore, MD: Johns Hopkins University Press.
Soon, Wayne S. 2016. "Blood, Soy Milk, and Vitality: The Wartime Origins of Blood Banking in China, 1943–45." *Bulletin of the History of Medicine* 90 (3): 424–454.
Tomes, Nancy. 1999. *The Gospel of Germs: Men, Women, and the Microbe in American Life*. Cambridge, MA: Harvard University Press.
Watt, John Robertson. 2014. *Saving Lives in Wartime China: How Medical Reformers Built Modern Healthcare Systems Amid War and Epidemics*. Leiden: Brill.
Yongue, Julia. 2017. "A Distinctive Nation: Vaccine Policy and Prevention in Japan." In *The Politics of Vaccination: A Global History*, edited by Christine Holmberg, Stuart Blume, and Paul Greenough, 209–235. Manchester, UK: Manchester University Press.
Zhang, Yixia, and Mark Elvin. 1998. "Environment and Tuberculosis in Modern China." In *Sediments of Time: Environment and Society in Chinese History*, edited by Mark Elvin and Cuirong Liu, 520–542. Cambridge: Cambridge University Press.

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