Chapter Ten

Immunology and Cholera in New York City

"Since the summer of 1885 Sternberg's professional pace had been tiring, if not grueling, and not completely as satisfying as he would have liked. On the home front, his mother died December 7, 1888, in Ellsworth. Levi wrote to his oldest son: "Ma left us at 12 PM today. Her death was quick & easy. She had her mind clear to the last. She was very anxious to go. She was reduced to a mere skeleton. Her last message to her children was, 'Meet me in Heaven.' I had hoped to keep up as long as she needed me. But I broke down completely…The world seems very lonely to me without Ma."[1] Margaret Sternberg's apparently debilitating and wasting illness probably resulted from her earlier stroke or strokes. Although Sternberg knew that such a letter could come at any time, the knowledge did not soften the blow. Sixteen month later, in the spring of 1890, another letter informed him that his sister Emily, Mrs. Frank Humlong, had succumbed to cancer in Albion, Iowa."[2]

The summer of 1890 appears to have been a relatively slow one for Sternberg; it was a refractory period in which he recovered physically, mentally, and emotionally from the rapid and intense pace that he had established for himself over the past three years and the recent family losses. It gave him time to put professional disappointment in perspective and philosophically reflect on the nature of life, death, and the will of God. The official army duties Mrs. Sternberg claimed always interrupted his research now furnished time for Sternberg to rest and refocus his scientific and military sights on future endeavors. He was still attending surgeon and examiner of recruits in Baltimore and served on numerous examining and promotion boards, and in July he assumed additional duty as post surgeon at Fort McHenry.[3]

In June, a letter from Major Charles R. Greenleaf to the surgeon general in reference to the ongoing revision of *Personal Histories of Medical Officers of the Army* set the bureaucratic wheels in motion that resulted in Sternberg being awarded another brevet commission for gallantry. Greenleaf's story began in Montana in 1882. In

his travels he met an old friend, a retired army packer with one leg whom Sternberg had saved by candlelight on the dark and dangerous Clearwater battlefield in 1877. The crippled veteran related the story once again of how Sternberg stopped the bleeding in dim light and under fire, and nursed him carefully on the trek from battlefield to Fort Lapwai, and also how he had stubbornly refused amputation until he nearly bled to death again in the post hospital. The packer told Greenleaf that no other officer was there that night on the Idaho plateau, which accounted for the story being unknown to the Medical Department. Greenleaf apparently did not take notes during the interview because in his letter to the surgeon general he described the event correctly, but placed it on the trail to Fort Lapwai rather than on the battlefield. Sternberg was eventually asked to relate the facts of the episode that resulted in a brevet lieutenant colonelcy.[4]

The impending retirement of Surgeon General Moore in August generated the usual scramble among medical officers to present their credentials for review. Sternberg submitted his packet, which was more impressive because it contained a letter of endorsement from Army Commanding General John M. Schofield: "Surgeon Sternberg is one of the most eminent medical scientists of the age, and has contributed very greatly to the advancement of that science. He has also performed ably and bravely every variety of duty devolving upon a medical officer of the army, with an Army in the field in time of War, in campaigns against hostile Indians, and in the midst of epidemic diseases. Not only his medical and surgical skill, but also his administrative ability is of the highest order. He is thoroughly qualified to administer the affairs of the Medical Department of the Army. On no other ground but that of seniority in rank and greater length of service in the varied duties of a surgeon in the army could, in my judgment, any other officer be considered more worthy of appointment to the office of Surgeon General."[5] Those eager applicants for the Medical Department throne, however, need not have bothered. Colonel Jedidiah H. Baxter, senior ranking medical officer, chief medical purveyor since 1872, and perennial candidate for the office, was the clear choice well before Moore's term as surgeon general ended. Secretary of War Redfield Proctor was a strenuous supporter, and President Benjamin Harrison was an old friend and patient. Baxter had a reputation as a volatile personality with strong opinions, but he was also known to have outstanding administrative ability. On August 16 he became surgeon general with plans for extensive and comprehensive improvements throughout the Medical Department. His ascension created a vacancy in the colonel's ranks, thereby allowing each senior officer in the lower ranks to be promoted in turn. As Sternberg was the senior major in the corps, he was promoted in October to lieutenant colonel. He was 52 years old.[6]

Tied to the promotion was a permanent change of station. Sternberg was detailed as medical purveyor at San Francisco in early October. This order, Mrs. Sternberg declared, "caused them no little regret" as army duties and the well-known dearth of laboratory facilities on the west coast would interfere with experimental bacteriology.[7] Her husband, in his usual aggressive and optimistic manner, had already begun planning what scientific goals could be practically pursued in conjunction with the large logistic responsibilities he would assume in California. Sternberg

set his sights on the completion of *Manual of Bacteriology*. Exactly when he determined to produce what would become the American gospel of bacteriology for many years is unknown, but why he did is obvious: it was the logical sequel to—and much needed revision of—*Bacteria* published in 1884.[8]

Between October 3, when he received his orders, and October 7 when he and Mrs. Sternberg boarded the train for their fifth transcontinental trek together, the Sternberg home was a flurry of activity. In that time, he put his laboratory corner at Johns Hopkins in order. The Sternberg's household was packed up or disposed of at auction once again, and they said good-bye to many friends and colleagues. They arrived in San Francisco a week later, and Sternberg immediately began inventorying the medical and hospital property at the purveying depot with the outgoing purveyor, Colonel Bernard J. D. Irwin. He also—with a great deal of regret—tendered his resignation as director of the Hoagland Laboratory. However, the facility's trustees were not disposed to let him sever his connections so easily with the laboratory merely because he now resided 4,000 miles away. The resignation was tabled, and a year's leave of absence was granted.[9]

As medical purveyor at San Francisco, Sternberg was responsible for medical logistics support to 34 posts that comprised the Departments of California, Columbia, and Arizona, essentially every fort and barracks west of the Rocky Mountains. He contracted for every drug, chemical, dressing, instrument, and hospital furnishing used by the Medical Department, then received and stored these items, assembled them for unit issue, and shipped them to their final destination. Although the army was small in 1890, the job still demanded indepth knowledge of the army formulary and medical equipment required in the garrison and field environments, as well as foresight, planning, and attention to detail.[10]

That Sternberg dedicated nearly every waking moment to his logistic responsibilities and the compilation of his textbook are reflected by the minimal contributions he made to the professional literature over the next year. He did read Finlay's report on yellow fever inoculations made with infected mosquitoes in the *Medical Record* and felt compelled to respond to his old friend and colleague in a professional forum. Finlay claimed to have successfully inoculated 92 percent of the 52 volunteers in his study against yellow fever. Of these, only 12 developed disease symptoms in the 3- to 25-day incubation period Finlay allowed. Twenty-four of the remaining 40 volunteers had mild symptoms later on, four had severe yellow fever, and one died. Sternberg took issue with his friend's experimental methods and presumed results. He commented "that 12 out of 52 unacclimated persons arriving in Havana should suffer mild attacks of fever…is not surprising; and inasmuch as 40 other persons inoculated did not suffer similar attacks within twenty-five days after the supposed inoculation, we see no reason for ascribing the slight attacks of fever suffered by these 12 to the application of a mosquito by Dr. Finlay."[11] He also noted Finlay's incubation period was five times longer than the generally accepted timeframe, and the fact that 24 of his volunteers developed mild attacks of the disease later provided little support as such fevers were common in Havana. Moreover, although it could not have been known at the time, many of Finlay's infected mosquitoes were not infectious at the time of application.

Sternberg concluded kindly: "I esteem both of these gentlemen [Finlay and Delgado] very highly, and I would welcome most gladly a demonstration of the value of the method which they faithfully endeavored to test. But a justifiable scientific skepticism makes it necessary to demand more direct and satisfactory proof that the so-called inoculations produce any pathogenic effect before any great importance can be attached to the results of Dr. Finlay's laudable efforts to discover a method of prophylaxis in yellow fever."[12]

Sternberg's main endeavor at the time was to gather and read the most current literature in bacteriological research, and then extract and concentrate the essence of these data for his textbook. His bibliography for the manual eventually encompassed more than 2,000 references, many of them in French, but the majority in German. He could read the French technical literature without difficulty, but without a translated text it was impossible for him to struggle through the overwhelming number of German articles with accuracy and efficiency. With a tutor's help, Sternberg taught himself to read German between 1889 and 1892. It is a small and obscure episode in his life, but one that impressed Alexander Abbott with Sternberg's "will and energy."[13] He probably engaged this academic goal with the same zeal as he did all other professional and scientific pursuits, leading Mrs. Sternberg to lament the fact that while in San Francisco "he scarcely gave himself an hour's leisure."[14] An insightful woman, she realized the world of academia—in any form—was sustenance, not stress, to her husband. But she was also a devoted and caring wife in an era when 50 years was considered well past middle age and too much studying was detrimental to both mind and body. She also seems to have entertained the idea that Sternberg's near fatal bout with yellow fever in 1875 had reduced his stamina and endurance, the Clearwater Campaign notwithstanding. Furthermore, and perhaps more to the point, she found herself once again vying for her husband's attention. "It devolved upon me," she asserted, "to plan diversion for his mental and physical welfare. His interest in botany gave me excuse to suggest short trips to Monterey and other coastal resorts, to the beautiful Santa Clara Valley and to San Jose. Many times we drove to Golden Gate Park, a magnificently cultivated tract of one thousand acres fronting the ocean."[15]

In December 1890, a little less than four months after taking office, Surgeon General Baxter contracted pneumonia and died. Baxter's untimely demise caught all contenders for his vacant chair—except those in Washington—completely off guard. Army Commanding General Schofield was looking after Sternberg's interests, however. He and a contingent of senators, numerous physicians, and public health officials across the country, and prominent businessmen Andrew Carnegie and Enoch Pratt endeavored to have Sternberg installed as surgeon general. Moreover, Schofield, a strong advocate of the seniority system of promotion, worked diligently to ensure that politically connected junior ranking medical officers, such as Billings, did not obtain a prize that they could keep until the turn of the century. Part of the reason that this august group of supporters did not achieve their objective was not so much a failure on their part to present a worthy candidate as it was a reflection of the personality of the president. The dogmatic Benjamin Harrison ignored

the proffered advice and selected Charles Sutherland, the senior Medical Corps officer. Schofield wrote to Sternberg after the decision was made in December: "Your position in the matter has been thoroughly understood both by me and the Secretary of War. I have watched the matter very carefully with the end in view that has finally been reached, and which will, I think, be gratifying to all, except the few who may have been more or less disappointed in their own personal ambition. I am glad to see that you are satisfied with the selection of the senior head of the corps, as indeed I knew you would be."[16] Sternberg, although undoubtedly disappointed, breathed a sigh of relief because Sutherland would retire for age in three years. He still had time to win the race.

It is unclear just when and how Sternberg developed this close relationship with Schofield, but it appears it was genuine friendship and mutual admiration that transcended army politics. Schofield was a strong advocate of increasing professionalism in the army through appropriate initial and continuing education. He not only appreciated Sternberg's research in the abstract, but also was interested enough to visit Sternberg's office during a trip to San Francisco, where the doctor showed him some of his bacteria and gave him "an idea of our methods of cultivating these minute plants."[17] As Sternberg neared the completion of his manual, he once again contacted Schofield concerning his future and his pressing need to be on the east coast: "You will remember…when you were here I spoke to you with reference to my reasons for desiring an eastern station. I have been devoting all of my spare time…to writing A Manual of Bacteriology, and the work is now approaching completion. In order to arrange for its publication & to see it through the press in good shape it is important that I should be on the eastern seaboard. Then, as you know, I am anxious to continue my bacteriological studies, and can only do so to advantage when stationed within reach of a well-equipped laboratory, such as the Hoagland laboratory…or the laboratories of Johns Hopkins University…I do not propose to allow these studies to interfere in any way with the duties to which I may be assigned, but by persistently devoting my spare time to this special department of research I hope to add something to the progress of scientific medicine & hygiene. I have had comparatively little duty on the eastern seaboard during my 30 years of service unless the department counts against me the time when I have been on detached service engaged in the study of yellow fever under the orders of the President. I look upon this duty as 'field service' & think it should be placed to my credit rather than charged against me…I have had more frontier service than many medical officers of my rank & have had an exceptional experience in encountering epidemics, which for medical officers are trying & protracted campaigns against an invisible but deadly foe…. I write to you because I feel assured of your friendship & kind interest in my efforts to accomplish something of value in my chosen field of scientific research. I wrote to the Surgeon General several months since telling him of my desire & the reasons for it, and as he has heretofore been friendly to me. I hope that he will be disposed to give me such a detail as I have suggested whenever a vacancy occurs."[18]

Orders relieving Sternberg from duty in San Francisco were issued February 2, 1892. As soon as his replacement, Lieutenant Colonel Joseph P. Wright, arrived from Fort Leavenworth and an equipment inventory was completed, Sternberg proceeded to New York City to assume duties as attending surgeon and examiner of recruits. According to Eggerth, in his *The History of the Hoagland Laboratory*, Sternberg did not resume an active role at the laboratory, with a tidy annual salary of $1,000, until September. But he was very much engaged in trying to define the practical value of the most recent bacteriologic discovery—the presence of antitoxins in blood sera—from the moment he arrived at his new station. As his research moved into the enigmatic realm of natural and acquired immunity, he again became a pioneer in a new science, one of America's first immunologists.[19]

Immunity to certain diseases, such as smallpox and yellow fever, derived naturally by surviving an attack of the disease had been an accepted fact for generations. It was not a new phenomenon either that immunity could be induced artificially, or acquired, by deliberate exposure to a disease agent. Smallpox variolation and vaccination were examples of artificially acquired immunity, as were Louis Pasteur's attenuated anthrax and rabies vaccines. Both of these vaccines resulted from the natural loss of virulence, known as attenuation, by these organisms when exposed to dry air over a given time period. Attenuation was a well-known phenomenon to bacteriologists. Sternberg and others had encountered it during their work with the pneumococcus, and he also found he could attenuate certain bacteria with disinfectants. What caused the organism to attenuate, how these less virulent strains induced an immune response, or how natural immunity was generated were unknown, but explanatory hypotheses were soon forthcoming.[20]

Based on observations of in vitro cultures of chicken cholera and other organisms, Pasteur offered the "depletion theory" that stated a disease organism obtained the vital material it required for life from its host just as it did from artificial culture media in flasks. Pasteur assumed the supply of this material in the chicken—just like artificial media—was exhaustible, and once consumed the organism inevitably died. Hence, multiple injections of attenuated organisms into chickens over time consumed this nutritional substance without causing disease, and thereby induced immunity. Pasteur also suggested waste products generated by the organisms may produce an environment ill suited for their continued growth. Hypotheses proposing that bacteria essentially poisoned themselves to death and, in the process, established immunity abounded. Jean Baptiste Chaveau's "retention theory" held that toxic metabolic by-products did this very thing. Paul Baumgarten's "osmotic theory" and Emil von Behring's "alkalinity theory" were variations on this theme.[21] In April 1881, Sternberg gave a critical appraisal of these theories in the *American Journal of the Medical Sciences*. The assumption that the human body produced and stored nutritional substances unique to each of the wide variety of infectious diseases it was subject to—without new production of the same—did not make biological sense to him. Neither did the idea that microbial metabolic waste products were somehow retained when the human economy provided so well for the elimination of toxic substances. Sternberg believed the explanation for

immunity was to be found in the "peculiar properties of the protoplasm, which is the essential framework of every living organism."[22] He explained this by stating that "during a non-fatal attack of one of the specific diseases the cellular elements implicated which do not succumb to the destructive influence of the poison, acquire a tolerance to this poison which is transmissible to their progeny, and… is the reason of the exemption…the individual enjoys from future attacks of the same disease."[23] He was essentially advocating what was known as the "adaptation theory," by which the body adapts to pathogenic toxins during an illness similar to the way in which it adapts to the effects of narcotics or alcohol with increasing doses. Over the next decade, all of these theories were rendered untenable.[24]

At the American Public Health Association meeting in Memphis in 1887, Sternberg was appointed chairman of the committee on protective inoculations in infectious diseases. The final report of this committee was not presented until the annual meeting in 1892. He commented the tardy report was due "…partly to the pressure of other engagements…the magnitude of the subject, and…to the fact that experimental evidence…has been constantly accumulating during the past five years, and the fundamental question concerning the explanation of acquired immunity has not been answered in a satisfactory manner until very recently."[25] Great strides were made in humoral immunology during this time. In 1886, D. E. Salmon and Theobald Smith induced immunity in pigeons by injecting them with heat-killed hog cholera cultures. Two years later, George H. F. Nuttall discovered blood had bactericidal properties, and Hans Buchner confirmed this bactericidal blood component was a protein—which he named alexin—unrelated to cellular blood elements. In Berlin in 1890, Emil von Behring and Shibasaburo Kitasato, working with diphtheria and tetanus, respectively, reported results that would have a profound impact on the practical application of acquired immunity against human disease. They demonstrated that blood sera from laboratory animals made immune to these diseases protected nonimmune animal subjects from fatal outcomes.[26]

Sternberg was fascinated with these discoveries, the results of which he called "so novel and so unexpected," and he waded into this new science with gusto.[27] By the end of June 1892, he had initiated his own immunological research and presented two papers, "Practical Results of Bacteriological Researches" and "Infectious Diseases, Causation and Immunity," to the Association of American Physicians and the medical department of Yale University, respectively. It appeared to Sternberg that the morbid phenomena that resulted from ricin poisoning or infection with tetanus or diphtheria were "due to the specific toxic action of substances resembling the toxalbumins [antigens] already discovered, and that acquired immunity…results from the formation of an antitoxine [sic] [antibody] in the body of the immune animal….Evidently the production of antitoxine [sic] during an attack…would account for recovery in non-fatal cases; and it may be that this is the true explanation of self-limitation in this disease class. If nature adopts this method of cure, we but follow her if we seek to introduce more…antitoxine for the purpose of arresting the progress of cases of unusual severity and fatal tendency."[28]

Referring to the attempts by German scientists to treat croupous pneumonia and tetanus with immune serum, Sternberg commented, "Although the production of these antitoxins…for therapeutic use will be attended with difficulties…methods will be devised for obtaining them on a large scale as soon as it is…established that they may be successfully used as specifics in the treatment of infectious diseases."[29] How would sufficient quantities be produced for strictly human maladies such as smallpox? While Sternberg admitted transfusion of a moderate amount of blood from immune to nonimmune humans was worth consideration, he sought a more practical and universal solution.[30]

Calves were used to produce cowpox virus for human vaccination. If these animals could be used as vaccine factories, could they also be used as smallpox immune serum factories? Sternberg contacted Dr. William E. Griffiths, a producer of vaccinia quills in Brooklyn, to assist him with an experiment to determine whether the calf did produce neutralizing antitoxin to vaccine virus. Sternberg and Griffiths combined serum from a recently vaccinated calf with fresh vaccine lymph in one test tube and with a fresh vaccine crust from a child's arm in another. After these mixtures sat for 24 hours, they shaved and scarified the thighs of a nonimmune calf and rubbed the contents of both tubes into each of the scarified areas. Nine days later, the calf was noted to have had an entirely negative reaction to the vaccinations. An experiment using a nonimmune calf was performed as a control and verified that "the blood serum of an immune calf contains something which neutralizes the…virulence of vaccine virus, either bovine or…lymph-crust from the arm of a child."[31] Although he could not know it at the time, Sternberg had performed the first viral neutralization test. The Association of American Physicians received his results with caution. William H. Welch commented, "There can be no doubt… the blood-serum of immunized animals may possess powerful therapeutic effects. As regards the practical application of this principle to the treatment of human beings, it does not seem to me that we…possess positive results entirely free from doubt as to the correctness of the interpretation put upon them."[32] Dr. Sewall, who had shown immunity to rattlesnake venom could be obtained by multiple small injections of venom components in 1887, questioned "whether this is not simply establishing a tolerance for the poison, instead of a true vaccine action," and added that no pure toxalbumin had ever been distilled.[33] Victor Vaughn remarked: "I wish to express my high appreciation of Dr. Sternberg's paper, and especially of his own experimental work with regard to vaccine. Of course, the number of experiments is too limited…for positive conclusions to be drawn…we must be very slow to conclude…all of this is going to be of special benefit in medicine."[34] Dr. Lyman concluded, "we are not so very near, as some enthusiasts think, to the time when we shall be able to protect our patients from diseases."[35] Sternberg admitted he "admired conservatism and skepticism, but why Dr. Kitasato should be so very conservative about the results obtained upon a man when they correspond so entirely with the results which he and others have obtained on the lower animals I do not understand. When I see carefully reported cases…in which all the symptoms are carefully detailed and the results of treatment seem to be…definite, I feel like

giving considerable credit to it without admitting that the thing is proved. I am… free to say that I think the future of scientific medicine is in this direction, and that we have entered upon a field that is to be cultivated vigorously, and…will give you results that will knock the conservatism from under your feet before many years."[36] Sternberg also told the association it was his intention to isolate the antitoxin of vaccinia and test whether it could neutralize smallpox virus in infected patients. However, before he could do so he was called on to assist with a public health crisis that had the potential to devastate not only New York City, but also the nation.[37]

Cholera had reappeared in Central Asia. The disease spread from Afghanistan by railroad into the Russian heartland and reached Kiev by the summer. At that time, massive numbers of Jews were immigrating from Russia to the United States, a journey which took many of them—infected with cholera—to Hamburg where they secured passage in the cramped, filthy, and poorly ventilated holds of ocean liners. By August 14, the inadequate barrack latrines, chamber pots, and earth closets that were emptied into Hamburg Harbor and the Elbe River had seeded these waters with cholera. Less than a week later, contaminated river water had made its way into municipal reservoirs and was then pumped—without benefit of filtration—into city homes.[38]

Had the first few cases of cholera seen in the neighboring town of Altona been admitted for what they were by medical authorities, both Hamburg and Altona may have been spared a tragedy. Procrastination and prevarication by Hamburg civil and medical authorities not only allowed the epidemic to rage, but also allowed five cruise liners—the *Moravia*, *Rugia*, *Wyoming*, *Scandia*, and *Normannia*—to obtain clean bills of health and sail for New York.[39]

While the medical and political authorities in Hamburg were just beginning to feel the intensifying heat of public, professional, and international wrath for their stubborn complacency at the end of August, those in New York City were hoping their similar troubles were taking a cooler turn. Mayor Hugh J. Grant, a Tammany Hall Democrat, had systematically replaced almost all Republicans in municipal office, including the Board of Health, with loyal Democrats. This generated a hue and cry from the medical and lay press. Doctors T. Mitchell Prudden, Abraham Jacobi, Edward Janeway, and Stephen Smith resigned as consultants to the Board of Health in June, declaring it had lost all independence and become a haven for political hacks. Undaunted, Charles G. Wilson, President of the New York Board of Health, pompously commented, "We passed through the typhus and smallpox epidemics without calling on them for assistance, and can do very well without them."[40] New York politicians and health officers relied on the quarantine establishment in the lower harbor to accommodate, screen, and disinfect more than two-thirds of foreign imports and two-thirds of all immigrants into America, and to guarantee that no diseases would escape from Swinburne Island. This was a tall order considering the quarantine system in the United States had not improved substantially in the seven years since sanitarians had met in Rome to debate the issues that now faced the city. Furthermore, the same political and economic concerns that had stifled national quarantine legislation in 1879 and allowed the

National Board of Health to die of neglect continued to sway decisions in the office of the Port Health Authority. In late summer of 1892, it appeared all of these sins of negligence were coming home to New York City simultaneously.[41]

From August 24, the day New Yorkers learned that cholera was coming, public-minded citizens and the Board of Health worked aggressively to preclude it from gaining a foothold in the city. An emergency fund of $200,000 was established; special funds for the Health Department were appropriated; Health Commissioner Joseph Bryant began inspections of tenements, the Croton watershed, and reservoirs; and public areas were cleaned. The Chamber of Commerce created an advisory committee of physicians mainly composed of the same doctors that had resigned from the Health Department's advisory board only two months before. On August 30, the day before the *Moravia* arrived with cholera on board, a circular titled "Prevention of Cholera Easier Than Cure" was issued in six languages.[42]

Between August 31 and September 9, the five infected ships had anchored at the lower harbor quarantine station with their steerage decks teaming with passengers anxious to get to the mainland. Before they could be released, each had to undergo medical examination, including the sick and those suspected of incubating the disease would have to be hospitalized at facilities on Swinburne and Hoffman islands, and their clothes and baggage were disinfected. The magnitude of this public health crisis overwhelmed the resources on both islands as well as the capabilities of the Port Health Officer Dr. William Jenkins.[43]

The announcement by Board of Health President Wilson that cholera had been discovered in the city on September 14 and the arrival of another disease-ridden ship, the *Bohemia*, the following day only increased public fear and apprehension. There were now 5,300 immigrants being bathed and disinfected in a quarantine station fitted out for half that number, and a large amount of cargo also had to be disinfected. On September 16, the advisory committee of physicians of the Chamber of Commerce held a lengthy meeting to discuss the detention of passengers and the best method of disinfection to be employed at quarantine. The advisory committee was fully represented, and among others at the meeting were Jenkins; Dr. Joseph J. Kinyoun, representing the Marine Hospital Service; Dr. Edward O. Shakespeare, health officer of the port of Philadelphia; and Sternberg. This appears to be the first time Sternberg's counsel was sought during the crisis. Although Sternberg assisted Hermann Biggs and Prudden in confirming cholera cultures—and most assuredly had opinions on the conduct of the quarantine—he was specifically engaged for his expertise with disinfections. Jenkins requested Sternberg evaluate disinfection methods used on Hoffman Island, specifically, what articles needed disinfection and what method would be most expeditious and economical. The War Department temporarily assigned Sternberg as consulting bacteriologist at the quarantine station.[44]

A symposium to educate community physicians on the science of cholera and quarantine administration was held in the main assembly hall of the New York Academy of Medicine on the evening of September 19. Sternberg presented a paper that reviewed the biological characteristics of cholera and described the

most appropriate cholera disinfectants, carbolic acid and chloride of lime, and how to use them. Two days later, Sternberg and Dr. Ezra Wilson, the new chief of bacteriology at Hoagland, began experiments at the disinfection facility on Hoffman Island.[45]

To test the reliability of steam disinfection chambers, Sternberg placed swatches of cotton soaked in cholera bouillon cultures deep into piles of blankets and clothing brought in from passengers aboard the *Scandia*. After disinfection, Wilson prepared liquid and solid cultures and controls at the Hoagland Laboratory, but neither grew anything indicating they had been destroyed by desiccation. Sternberg commented, "In view of this fact and of the experimental evidence heretofore recorded, the question arises as to whether the exactions made by bacteriologists and sanitarians with reference to the use of steam as a disinfecting agent are not extravagant, and whether there is not some better way of disinfecting clothing, etc., in cholera."[46] To determine whether simple drying was an effective disinfection method, Sternberg put small squares of a cholera-soaked woolen blanket in sunlight and in the darkness of a closet. No growth was obtained after four hours of exposure to sunlight and after 48 hours in the closet. Wilson also tested contaminated articles of clothing in a drying chamber at 60° Celsius for four hours with the same results. Sternberg concluded that "desiccation is a reliable method of destroying the cholera spirillum, and…the International Sanitary Conference of Rome was justified in the conclusion that 'disinfection of merchandise and of the mails is unnecessary' if the merchandise was clean and dry when received on shipboard for transportation, and if it arrives at our ports in the same condition."[47] Furthermore, "disinfection would be accomplished quite as effectually by the free exposure of woolen garments, blankets, etc., in a hot-air drying oven or chamber…"[48] Should disinfection facilities be overwhelmed by a large volume of articles for disinfection, as was currently occurring at quarantine, then Sternberg advocated sun drying as an adequate method, except for soiled undergarments and bed linens. The cholera scare, however, ended before Sternberg's findings could be put to extensive practical use. Bacteriological science did little to preclude the disease spread at quarantine or in the city. Although he and Wilson would continue experiments with cholera into December, Sternberg's special duty with New York Public Health Authorities ended on October 31. A month later, he headed to Madison Barracks at Sackets Harbor, New York, to conduct a thorough sanitary inspection of the post and investigate an outbreak of typhoid fever then in progress.[49]

Madison Barracks was on the shore of Black River Bay, just above the town of Sackets Harbor. Home to six companies of the 9th Infantry, it had a garrison of about 400 soldiers plus ancillary personnel. The barracks were crowded, and the plumbing and sewers were in very poor condition when the index case arrived from the enlistment station at Binghamton, New York, on September 18. It took 4 weeks for the second case to develop. From then until December 13, when the last case was reported, 25 more cases and two deaths occurred. Sternberg arrived on the evening of December 5 with his field bacteriological kit and conducted his investigation

over the next three days. This is the earliest example found by the author of what contemporary army preventive medicine physicians call an epidemiological consultation. Today an epidemiological consultation may be requested by a post commander or his preventive medicine officer when a disease or injury outbreak has occurred on his or her post that requires more expertise and resources than he or she can bring to bear or it may be directed by a higher command authority. Regrettably, when an epidemiological consultation is directed from a higher authority than the post commander, the consultation team is not always received with open arms. One wonders whether Post Surgeon Daniel G. Caldwell and Assistant Surgeon Frank T. Merriwether may have felt a bit under the gun upon the arrival of a deputy surgeon general so well versed in epidemiology and infectious diseases. If so, they worried needlessly. Merriwether, who was acting post surgeon when the first case was diagnosed, implemented all of the correct procedures to preclude the spread of *Salmonella typhi*. He directed all excreta from this patient to be disinfected before being discharged into the sewer, that water from the Black River Bay not be used for drinking, and all other water be boiled before consumption. In his report, Sternberg stated that because of the scattered cases across the post, indicating a common source of infection, he doubted if Merriwether's disinfection orders were carried out quickly enough to preclude contamination of Black River Bay. The fact that 74 percent of cases were in enlisted men also indicated that they disregarded the order to boil their water. Furthermore, even though the sewer discharge pipe was only 500 feet from the drinking water intake well in the bay, he suspected—from talking with local physicians—that contamination may have originated from typhoid cases across the bay and cases in the village of Watertown some 10 miles upstream.[50]

The unexpected and hasty departure of Dr. B. Meade Bolton in early June left the bacteriology department at Hoagland without a chairman.[51] Wilson and a recent graduate of the Long Island College Hospital, then working as a pathologist at the Norwegian Hospital by the name of Richard Slee, applied for the position. Wilson got the job on a part-time basis. Slee, however, had spent a great deal of time as a student working in the lab and had taken the postgraduate course in bacteriology the previous year. He was eager to work with Sternberg and persuaded the director to accept him as a part-time unsalaried assistant. With staffing in place, Sternberg focused on obtaining new equipment, supplies, and sufficient laboratory animals for spring classes. He also submitted plans for the reorganization of the postgraduate course for medical students and a modified course for women at the Pratt Institute in Brooklyn. Women were introduced to bacteriology through an eight-week course, which included routine culture exercises, experimentation with animals, and instruction in photomicrography, an essential skill for any bacteriologist according to Sternberg. The tuition was $30 and the women worked with nonpathogenic cultures. As the Pratt plan matured, Wilson felt it was appropriate to have a knowledgeable female chaperone for the Pratt students and suggested Mrs. Sternberg. She could take the course with the others because she already knew the basics having been her husband's assistant for 20 years.[52]

Sternberg agreed and Martha proved to be not only a valuable resource for Pratt students, but also an astute laboratory technician. One day while examining drinking water samples, she found what looked like the tubercle bacillus. She realized this was an odd finding, made several cultures, and determined it was probably a contaminant from the inoculating needle. But the puzzle left her unsettled, and she mentioned it to her husband. Sternberg was certain her find could not be the tubercle bacillus, but he accompanied her to the laboratory one afternoon and watched as she prepared another slide of her discovery. He agreed that it did resemble the mycobacterium, but "cautioned against mentioning it lest all Brooklyn be wild to think that the water supply was contaminated."[53] The following day he determined that she had found a previously undescribed protozoa. She named the new organism after Cornelius Hoagland.[54]

All of these activities drew heavily on Sternberg's time, but, along with Wilson and Slee, he pressed forward with smallpox research. In a calf shed built behind the laboratory specifically for this work, Wilson pursued investigations with calf antisera upon smallpox virus while Sternberg and Slee worked to improve immunization techniques. The potency of vaccine lymph dried upon points of ivory, bone, or quill was always questionable and frequently contaminated with bacteria. In 1891, Sydney M. Copeman, working in the Institute Pasteur, discovered that the addition of glycerol to the lymph slowly killed any contaminating bacteria, and the shelf life of the vaccine virus lengthened. After reading this development, Sternberg sent Slee to Paris to determine the value of the new method firsthand. The young assistant soon verified both of these sensational results, and together they devised a similar method of lymph preparation at Hoagland.[55]

In December 1892, Sternberg received the first of many compliments on his recently published *Manual of Bacteriology*. The first came from William Welch, and Dr. William Osler called it "magnificent."[56] Walter Reed wrote from Headquarters, Department of Dakota in St. Paul, "I have your new work…How an Army medical officer, in the midst of daily routine work, could have written so excellent and so exhaustive a work, I can't understand…it must always stand as a monument to your energy and ability."[57] Colonel Charles Greenleaf wrote, "I rec'd yesterday from the publishers a copy of your great work on Bacteriology, and in congratulating you…wish to say that I am very proud of knowing as a friend the man who sheds such luster on our Corps & does so much for the advancement of our common interest."[58] These last laudatory comments from Deputy Surgeon General Greenleaf appear rather insincere when compared with the admonishment he gave two years earlier to budding army surgeon William C. Borden concerning the leisure time Borden spent staring into a microscope. Greenleaf saw no value in it and caustically remarked, "Look at Sternberg, over there in New York, spending all his time with a microscope. Can you tell me one earthly bit of good Sternberg is to the Medical Corps?"[59] Perhaps the deputy surgeon general had experienced a scientific revelation in regard to medicine during the intervening months. It was fortuitous for him if he had because events were transpiring that would require him—at least officially—to acknowledge the bit of good Sternberg was to the corps and medical science as well.