Last year marked the one hundredth anniversary of the death of Florence Nightingale, whom most people know only as the iconic nurse caring for British soldiers during the Crimean War. Certainly, if she had done nothing more in her long life, those twenty-one months in the Crimea and Turkey earned her a rightful place in history. However, her influence extended far beyond nursing: she reformed hospital management and military medicine, improved sanitation and hospital architecture, and transformed public health policy. Although largely overlooked today, Florence Nightingale, more than a compassionate caregiver, was a first-class scientist and a pioneering biostatistician.

Childhood and Education

Florence Nightingale was born into a wealthy, progressive British family. Her father, William, had inherited lucrative farmlands, coal mines, textile mills, and investment income from both sides of his family. Her mother, Fanny, had been raised surrounded by intellectuals including Joseph Priestley, Erasmus Darwin (Charles’s grandfather), Charles Babbage, and Samuel Taylor Coleridge. The Nightingales were well educated, well bred, and widely traveled, and they raised their two daughters the same way (1, 2).

Florence, the younger daughter, was born on May 12, 1820, while her parents were on an extended European
tour and was named for the city of her birth in Italy. Girls of Florence’s social class did not attend university and did not pursue professional careers, but William Nightingale believed that women should be educated as well as men. He personally taught Florence Latin, Greek, Italian, philosophy, history, and mathematics. Fanny Nightingale, the epitome of social grace and domestic decorum, taught her daughter social and leadership skills (1–4).

Florence was also tutored in French, German, and astronomy, but she was especially drawn to mathematics, economics, and science. She began a lifelong habit of collecting data. Her schoolgirl “Compendium of Useful Facts” chronicled quantitative data on eclectic topics such as the mean temperatures of cities around the world, dates of major inventions, heights of major structures such as St. Peter’s Cathedral and the Pyramids, the length and water volume of the world’s great rivers, and comparative monetary units calculated in English pounds (2–5).

As a teenager, Florence began attending regular meetings of the British Association for the Advancement of Science and once assisted Michael Faraday in his legendary demonstrations of electromagnetism—recording what she learned in her fact book. Her father allowed her free access to his extensive library, and she read widely, not only the classics but also contemporary novels, poetry, scientific articles, and the statistical reports of William Farr and Adolphe Quetelet (1, 2, 4, 5).

In 1837, William Farr, assistant registrar general, began systematically collecting data on births, deaths, and marriages in Great Britain. His annual morbidity and mortality reports permitted analysis of cause-and-effect relationships, which became the foundation for a new discipline, medical statistics (2, 4, 6). In 1841, Lambert-Adolphe-Jacques Quetelet, a Belgian astronomer-statistician, organized Belgium’s central statistical bureau, which became a model for similar agencies in other countries. He applied the mathematical theory of probability to analyze data gathered by governmental agencies and, like Farr, determined cause-effect relationships (1, 5). In the margins of her copy of Quetelet’s book, Essai de Physique Sociale, Florence wrote, “all Sciences of Observations depend upon Statistical methods...Make your facts comparable before deducing causes” (7).

**Nightingale and Nursing**

Florence clearly remembered the February day, short of her seventeenth birthday, when she felt an unequivocal calling to public service. Deeply religious, in the mold of her Unitarian parents, Florence initially struggled to reconcile the Victorian ideal of womanhood with her determination to apply her considerable intellect. She had a wide circle of friends and several persistent suitors, but after this date Florence never deviated from her full time commitment to improving public healthcare (1, 2).

Florence had all the qualities of a great clinician, but instead she aspired to be a nurse. With her natural wit and easy manner, she instinctively knew just the right thing to say or do to make people feel at ease. When members of her extended family fell ill, they asked for Florence, and she quickly recognized her ability to comfort them. She grew up knowing more about disease, death, and dying than most young women (2).

The Nightingale family was less than pleased with her choice. Nurses in those days lacked training, were almost always coarse and ignorant women, and usually promiscuous. Florence aimed to change all that and make nursing respectable. She read voraciously on medicine and health care, spent time inspecting hospitals in London, and worked with children in the slums (1).

In 1849, she travelled abroad to study nursing and hospital systems at the Institute of Saint Vincent de Paul in Alexandria, Egypt; the Institute for Protestant Deaconesses at Kaiserworth, Germany; and the Maison de la Providence in Paris (Figure 1). At every stop, she collected hospital reports, statistical forms, and general information on hospital construction and sanitation (1, 4, 5).

In 1853, she became the unpaid superintendent of the Hospital for Invalid Gentlewomen in London where she was responsible for supervising the nurses, overseeing the physical plant, and guaranteeing the purity of the medicines. During the cholera outbreak of 1854, she also volunteered as a nurse at the Middlesex Hospital in London (1, 4, 7).

Her collective experiences on the fever wards (where patients suffered from fever-producing infections such as typhoid, typhus, dysentery, and cholera) convinced her that the so-called heroic medicine of the day, which was based on bleeding and infusions of arsenic, mercury, and opiates, hastened the deaths of many more patients than it saved. Florence believed that by keeping patients well-fed, comfortable, and above all clean, nursing could save more patients than nineteenth century medicines (1, 7, 8).

![Figure 1. Portrait of Florence Nightingale taken during her European tour of nursing facilities.](Photo credit: Wellcome Library, London)
Florence had worked barely a year in London when she began reading graphic reports in *The Times* from war correspondents describing the suffering of British casualties in the Crimea. On October 14, 1854, she wrote her friend, Elizabeth Herbert, explaining that she was planning to lead a group of nurses to aid the wounded. A letter from Minister at War Sidney Herbert, Elizabeth’s husband, was simultaneously on its way to Florence. Her nursing accomplishments were well recognized in influential circles, and on behalf of the government, he implored her to recruit and lead a corps of nurses for the army (1, 2).

On November 5, 1854, Florence arrived at the British army’s base hospitals in Scutari, Turkey (near Istanbul), with thirty-eight nurses (Box 1). As “Superintendent of the female nursing establishment in the English General Military Hospitals in Turkey,” she had the official backing of the government and the private support of a special fund raised by *The Times* (1, 2).

**Crimea**

Infectious diseases were rampant in the army hospitals, killing many more soldiers than bullets, saber thrusts, or shells. Even so, British field surgeons concentrated their efforts on combat injuries, which they could effectively treat through amputation and debridement, and those soldiers had a reasonable chance of survival (7, 9, 10).

Unfortunately, the surgeons could do little to treat fevers and merely segregated infected patients from their healthy compatriots. Feverish soldiers were evacuated from the Crimean war zone to the Scutari base hospitals not so much to be healed as to die, and those patients were the only ones Florence and her nurses were allowed to care for (7).

Florence had closely followed the work of Edwin Chadwick, the author of the British Public Health Act of 1848, and was aware of John Snow’s landmark epidemiology study in 1854 showing a causal link between cholera and polluted water from London’s Broad Street Pump. Although these events predated knowledge of bacterial and viral infections, Florence clearly understood contagion and saw the relationship between the diseases killing her patients and the dirty hospital wards with their contaminated drinking water, poor quality food, and foul air (7, 10, 11, 12).

Florence had always been a person who made an impression. Her voice, manner, and conversation were striking, and though far from beautiful, she remained in people’s memories. She had charisma, and now everyone noticed (2).

Florence worked diligently at individual nursing, assigning herself the most serious cases. But increasingly she was forced to face the fierce resistance of the local military hierarchy. The line and medical officers resented her government-mandated authority (which circumvented their chain of command), feared she might expose their errors or incompetence, and fumed that she was not only a civilian but also a woman (1, 2). She cajoled, persuaded, negotiated, bartered, appeased, and flattered—often making more concessions than progress.

Her success in improving patient outcomes only exacerbated senior military resentment; however, it also earned her the deep adoration of the rank-and-file soldiers, for whom she always made time despite her administrative workload. Late at night, when the other nurses had gone to bed and the night duty orderlies were usually asleep, Florence walked the four miles of wards with a small lamp in her hand, stopping to talk here and there to suffering soldiers (1, 2, 7). What began as an exploratory tour of inspection became a routine and then a ritual. Her nightly rounds captured the public’s imagination, and Longfellow immortalized her as the “lady with a lamp” (13).

Florence brought to Scutari not only her nursing knowledge, a deep faith in the sanitation movement, and impressive managerial skills but also an obsession with meticulous record keeping. On her arrival, she found three separate military registries with different accounting procedures, making it impossible to tabulate deaths accurately. While she worked to improve sanitation and nutrition for the patients, she kept detailed records on their sickness and death rates (1, 4, 5, 7, 9).

In response to her unrelenting stream of letters to Sidney Herbert and the bleak daily dispatches filed by *The Times*’s
war correspondents, two royal commissions were deployed in March 1855. One commission examined the provision of supplies in the Crimea. The other was the Sanitary Commission headed by Dr. John Sutherland. The commissioners’ authority trumped the military command in the war zone and extended far beyond Florence’s influence and authority (2, 8).

Florence and the commissioners became firm allies. Together, they tackled the fetid conditions and transformed the Scutari hospitals into model institutions, which foreign visitors toured with admiration and envy (2, 8). The close alliance Florence fostered with the commissioners continued to advance British healthcare reforms for many years after the war.

Everything Florence did in Turkey and the Crimea was reported and embellished by the British press. Thanks to the war correspondents’ dispatches and the elder Nightingales’ injudicious leaks of her private letters to the press, Florence’s activities were constantly front page news. Everyone from the queen to cockney fishmongers breathlessly followed her progress and setbacks, which read like a Victorian dime novel. When she returned to England in July 1856, Florence Nightingale was the most famous woman in Europe, perhaps in the world (1, 2).

But she was also gaunt, exhausted, and aged far beyond her thirty-six years. Florence stepped off the world stage, and for the next forty-five years, she rarely left her home or admitted visitors. But she continued to work hard. Privately, persistently, and through prolific correspondence, she would make contributions in statistics of far greater impact than her very public performance during the war.

### Applying Statistics

Nightingale’s activities in statistics fall into three broad categories: safeguarding the health of British soldiers, reorganizing civilian and military hospital administration, and reforming sanitation practices in India (5).

Shortly after her return to England, Nightingale travelled to Balmoral Castle to brief Queen Victoria, who had closely followed her wartime exploits. During the audience, Nightingale pressed for creation of a new royal commission to examine the state of military health care (1, 2, 5).

Before reluctantly agreeing to the royal commission, Lord Panmure, the Secretary of State for War, asked Nightingale to write her own report detailing her experiences. She turned to William Farr, a physician as well as a professional statistician, to help her analyze the data she had collected. In six months, she produced the 830 page *Notes on Matters Affecting the Health, Efficiency, and Hospital Administration of the British Army* (Table 1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Publication</th>
</tr>
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<tbody>
<tr>
<td>1858</td>
<td><em>Notes on Matters Affecting the Health, Efficiency, and Hospital Administration of the British Army:</em> Founded Chiefly on the Experience of the Late War. Presented by request to the Secretary of State for War.</td>
</tr>
<tr>
<td>1858</td>
<td>Appendix 72 of <em>The Report of the Royal Commission on the Health of the Army</em></td>
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<tr>
<td>1858</td>
<td><em>Mortality of the British Army</em></td>
</tr>
<tr>
<td>1858</td>
<td><em>Subsidiary Notes as to the Introduction of Female Nursing into Military Hospitals in Peace and War.</em> Presented by request to the Secretary of State for War.</td>
</tr>
<tr>
<td>1859</td>
<td><em>A Contribution to the Sanitary History of the British Army During the Late War with Russia.</em></td>
</tr>
<tr>
<td>1859</td>
<td><em>Notes on Hospitals</em> (rewritten in 1863)</td>
</tr>
<tr>
<td>1860</td>
<td><em>Suggestions for Thought to the Searchers after Truth among the Artizans of England.</em></td>
</tr>
<tr>
<td>1860</td>
<td><em>Notes on Nursing: What it is, and What it is not.</em></td>
</tr>
<tr>
<td>1862</td>
<td><em>Army Sanitary Administration and its Reform under the Late Lord Herbert.</em></td>
</tr>
<tr>
<td>1864</td>
<td><em>How People may Live and not Die in India</em></td>
</tr>
<tr>
<td>1871</td>
<td><em>Introductory Notes on Lying-in Institutions. Together with a Proposal for Organizing an Institution for Training Midwives and Midwifery Nurses.</em></td>
</tr>
<tr>
<td>1874</td>
<td><em>Life or Death in India.</em></td>
</tr>
<tr>
<td>1876</td>
<td><em>On Trained Nurses for the Sick Poor.</em></td>
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</table>
Florence Nightingale's Statistical Innovations

Nightingale devoted two sections of Notes to a comparison of the mortality among civilians versus soldiers. Combining her data with Farr’s tables on civilian mortality, she found that in peacetime, soldiers in England had a mortality rate nearly twice that of civilians. In 1857, she wrote to Sir John Hall, “With our present amount of sanitary knowledge, it is as criminal to have a mortality of 17, 19, and 20 per 1000 in the Line, Artillery, and Guards in England, when that of Civil life is only 11 per 1000, as it would be to take 1100 men per annum out upon Salisbury Plain and shoot them” (1, 2, 5). (The 1100 men represented 20 per 1000 of the current enlisted force of 55,000.)

Nightingale’s analysis in Notes was soon challenged. An anonymously published pamphlet (attributed to Sir John Hall, who had been the army’s chief medical officer in the Crimea) claimed that she had exaggerated the number of war deaths (15). She immediately prepared a reply, A Contribution to the Sanitary History of the British Army during the late War with Russia, also published anonymously, in which she used the army’s own, just-released data to show that, on the contrary, her original data had actually underestimated mortality (5, 6).

Despite the consternation of the War Office, the queen officially established the Royal Commission on the Health of the Army on May 5, 1857 (5). In that era, it was inappropriate for a woman to serve on such a board, but Nightingale nevertheless strongly influenced the commission’s work. Some of the commissioners, including Sutherland, Farr, and Sidney Herbert, were her friends, and they relied heavily on her data, statistical expertise, and skills as a strategist. She planned most of the commission’s interviews, organized most of the data, and wrote much of the testimony submitted to the commission (1, 2).

The Royal Commission’s report was issued in August 1857, and made public in January 1858 (5). Although Nightingale’s signature does not appear on any commission document and she never testified in person before the board, the final report was largely written by her and based upon her Notes. The commission’s main conclusions were: mortality among the troops during the Crimean War had risen by the beginning of 1855 to unprecedented heights and then plummeted even more rapidly in the spring once basic sanitary measures were enacted, saving lives by taking precautionary sanitary measures was cost-effective for an army at war because there were more healthy soldiers to do the fighting, and the peacetime mortality rate for men in the army was almost double that of civilians (2).

Nightingale’s mortality data also dramatized the impact of improved sanitary conditions. In March 1855, her sanitary reforms began lowering hospital mortality, and by the end of the war, with the aid of the Sanitary Commission’s improvements, the annualized mortality rate had dropped to 13 per 1,000 (1, 14).

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William Farr called Nightingale’s Notes the best thing that was ever written either on the presentation of statistics or on the army (1). The introductory chapter gave a history of health in the British armies. The main cause of death in war had always been disease, and the Crimean War was no exception. But Nightingale’s shocking statistics showed that early in the war the mortality from disease alone exceeded that of the Great Plague of 1665 (1, 5).

Six of the twenty sections of Notes were devoted to medical data from the Crimean War. In January 1855, almost 12,000 of the 25,000 British soldiers deployed in the war zone were on the sick lists, but only about 150 of them suffered from wounds. That month, the noncombat mortality rate peaked at an annualized rate of 1,174 per 1,000. That is, if the dead soldiers had not been replaced, disease alone would have wiped out the entire British army in the Crimea (1, 2, 5, 14).

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that of her fellow statisticians was her innovative use of graphic illustrations and diagrams. Her audience was the queen, cabinet ministers, and other governmental leaders who were not educated in statistics, and she feared their eyes would glaze over if faced with endless tables of numbers. So, Nightingale devised clever ways of presenting her data in simple, colorful charts that decision makers without a statistical background could understand and act upon (1, 5, 6, 8). She displayed some of the data in “100% area” graphs similar to those previously published by Farr. One figure, for example, shows the loss of manpower in the British army due to mortality and “invaliding” over the recruits’ twenty-year career (1, 6) (Figure 2).

Nightingale also introduced two diagrams that are so different from any previously published that they have been attributed to her as original inventions. She used the polar-area diagram—perhaps her most innovative contribution—to show the chronology of mortality in the Scutari hospitals (Figure 3). By dividing a circle into twelve sectors, she represented a month of data in each sector, wherein the area of the wedge was proportional to the number of that month’s deaths from wounds, disease, or other causes. For months during the first part of the war, the blue wedges (representing disease) are far larger than either the red ones (for wounds) or the black ones (for other causes). In the months following March 1855, when the Sanitary Commission arrived, the blue wedges become dramatically smaller (1, 3, 5, 6).

Prior to Nightingale, most statisticians merely tabulated data into descriptive categories. Nightingale’s diagrams displayed data to emphasize correlations and causal relationships. The polar area diagram, for example, showed not only that most of the fatalities during the war were from noncombat sickness but also—and more importantly—that improvements in hygiene dramatically reduced the death rate (1, 4–6).

In addition to Notes, Nightingale republished Appendix 72 of the Royal Commission’s report, which included her original morbidity and mortality tables, as a private edition pamphlet, Mortality of the British Army. It had the same content as Appendix 72 but a better layout than that used by the government’s printers. As with her Notes, she widely distributed copies of Mortality to members of Parliament and the army. She also framed a few copies of the diagrams and presented them to officials in the War Office and the Army Medical Department (1, 5, 6).

Her publications, supplemented with easy-to-understand graphics, made a profound impression on the British public, who pressed for reforms. Despite opposition from an unsympathetic government and the military hierarchy, the statistical data that she compiled were sound and proved to be a powerful weapon. Rather than dwelling on the causes of failure, Nightingale and the commissioners wished to highlight ways that the health of British troops could be improved in future wars (4).

Within a few years, the commission’s recommendations were implemented. The training, professional advancement,
and institutional organization of the British Army Medical Department were restructured. An army medical school and an army statistics department were established. The construction and maintenance of army barracks and posts were redesigned. And as a result, mortality at the army bases in England fell sharply (1–4). Nightingale’s contributions to medical statistics were readily acknowledged, and she was elected to membership in the Royal Statistical Society in 1858. In 1874, the American Statistical Association elected her an honorary member (3–5).

Illness
Nightingale’s accomplishments during and immediately after the Crimean War are all the more impressive, considering the precarious state of her health. While on a visit to the field hospitals near the front lines in the Crimea in May 1855, Florence fell seriously ill from what was diagnosed at the time as Crimean fever. For weeks, she was too weak to feed herself or speak above a whisper, and her subsequent recovery was slow (2, 16). She finally returned to work at the Scutari hospitals in October 1855, noting, “I have now had all that this climate can give, Crimean fever, Dysentery, Rheumatism” (16).

After her return to England in 1856, she suffered several relapses, and both she and her physicians thought she was dying. The range of symptoms baffled her doctors, but her ailment has now been provisionally diagnosed as chronic brucellosis (16) (Box 2). During one serious relapse in 1861, she was unable to walk and remained bedridden for the next six years. From 1863 to 1866, she complained bitterly of spinal pain, most likely resulting from spondylitis. At times the pain was so severe that she was unable to have her position changed for intervals up to forty-eight hours (16).

Today, antibiotics effectively prevent serious complications from chronic brucellosis. But in her day, the insidious infection condemned Nightingale to decades of painful confinement. Her only relief came from subcutaneously injected opium, which attenuated the pain. The last of her symptoms finally faded in 1880, when she was 60, and she was once again able to resume something of a normal life (16).

Hospital Statistics
Despite her infirmity, or perhaps because of it (thinking she would soon die), Nightingale worked all the harder, against the advice of her family, friends, and physicians (2). Having analyzed and reported on the conditions in military hospitals, she turned her attention to civilian hospital statistics. As with the army’s data, she found a lack of uniformity. Each hospital used its own nomenclature and classification of diseases, making it impossible to compare the statistics of one hospital with another. With the assistance of William Farr and other physicians, she standardized a list of diseases and created a set of hospital forms for data gathering. In 1859, she persuaded a few London hospitals to use the forms on a trial basis, and these became the foundation for today’s hospital statistics standards (4, 5).

Nightingale actively promoted the use of her standards for hospital data in a series of presentations, made on her behalf by physicians and scientists at various international conferences (Table 2). The data she collected on her forms showed, among other things, that hospital nurses and attendants suffered a much higher mortality from communicable diseases than the general population. Subsequent improvements in hospital architectural design and sanitation relied heavily on her statistical analyses (5).

India and Later Reforms
Nightingale next turned her attention to India, Britain’s largest and most important colony (which encompassed the entire subcontinent of modern day India, Pakistan, and Bangladesh). For eight months in 1858–1859, Nightingale lobbied for the appointment of a Royal Sanitary Commission that would do for the armies in India what the 1857 Royal Commission had done for the armies in Britain. In parallel, she drafted questionnaires, initiated an active correspondence with the governors in the various colonial offices in India, and began tabulating and interpreting the data. She and Farr also studied the morbidity and mortality records of the government’s India Office. At that time, the average annual death rate of the British armies in India was 69 per 1000 (1, 2, 5).

In 1861, Nightingale submitted her analysis to the Royal Sanitary Commission, describing the conditions that were causing a sixfold higher death rate among the troops in India compared to that among civilians in England: defective sewage systems, overcrowded barracks, lack of exercise, and inadequate hospitals, among other things. When the

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**Box 2. Chronic Brucellosis**

Brucellosis is a disease caused by *Brucella*, an aerobic, gram-negative bacterial organism. It penetrates reticuloendothelial cells and persists as an intracellular parasite. Brucellosis begins as an acute fever, with few or no other signs, and progresses to a chronic stage with relapses of fever, weakness, musculoskeletal pain, septic arthritis, sweats, and vague aches and pains. It is effectively treated with a combination of streptomycin and doxycycline.
Reflections

Treasury balked at the printing costs, Nightingale personally paid to publish Observations on the Evidence Contained in the Stational Reports Submitted to the Royal Commission on the Sanitary State of the Army in India and sent copies to the queen and influential government officials. In 1863, the Royal Sanitary Commission issued its report. Most of the accumulated evidence and statistical work in its 2,028 pages were contributed by Nightingale (1, 2, 5).

As with her earlier works, Nightingale publicized the commission’s achievements in improving sanitation in a summary report, How People may Live and not Die in India, which she published for the general public in 1864. For ten years, she edited the annual reports issued by the sanitary department of the India Office, and in 1873, she summarized her decade of analysis in an invited paper presented to the National Association for the Promotion of Social Science, “How Some People have Lived and Not Died in India.” By the end of the nineteenth century, the mortality of the British armies in India had dropped to 5 per 1000 (2, 5).

Nightingale’s Influence

Throughout her life, Nightingale collected an immense number of pamphlets and reports, which she skillfully analyzed, making her a widely sought expert (5). She knew how far it was possible to travel on a winter day in Canada by sled, how to make a self-contained kit for easy assembly of canvas beds in a war zone, the number of inches there should be between hospital beds, and the recipe for an economical, nutritious soup (2).

When civil war broke out in the United States in 1861, federal officials asked Nightingale for advice on military hospitals. During the Franco-Prussian War in 1870, she was deeply involved with the efforts of the newly formed Red Cross organization to bring good medical care to the wounded on both sides. She responded to a British War Office request for advice on army medical care in Canada, including how to transport the sick over immense distances by sledge. Successive viceroyos of India, before departing to assume their posts, conferred with her, because she appeared to know more about India than anyone else (2, 3).

In parallel with all these activities, Nightingale wrote the classic Notes on Nursing, which is still in print. In the 1870s, she finally took a personal interest in the Nightingale Fund, which had been launched while she was in the Crimea and raised money to found an institution for training nurses in England. The “Nightingale Nurse” became established as a model of trained, disciplined, and dedicated professionalism.

### Table 2. Nightingale’s Scientific Society Presentations

<table>
<thead>
<tr>
<th>Year</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860</td>
<td>International Statistical Congress (London): two presentations advocating uniform hospital statistics and referencing her uniform classification system and forms.</td>
</tr>
<tr>
<td>1861</td>
<td>National Association for the Promotion of Social Science (Dublin): proposed seven primary elements for tabulating hospital sickness statistics.</td>
</tr>
<tr>
<td>1862</td>
<td>Journal of the Royal Statistical Society: published statistics of the various hospitals adopting her forms.</td>
</tr>
<tr>
<td>1863</td>
<td>National Association for the Promotion of Social Science (Liverpool): two presentations on hospital construction and sanitation from her extensive experience in and study of hospital systems in Germany, France, Ireland, and the Crimea.</td>
</tr>
<tr>
<td>1863</td>
<td>International Statistical Congress (Berlin): outlined the minimum requirements of a report form for the nature and result of surgical operations, including hospital cost and practical end results.</td>
</tr>
<tr>
<td>1863</td>
<td>National Association for the Promotion of Social Science (Edinburgh): published statistics of the various hospitals adopting her forms.</td>
</tr>
<tr>
<td>1864</td>
<td>National Association for the Promotion of Social Science (York, England): an extension of the 1863 paper, examining mortality of the aboriginal races in Australia.</td>
</tr>
<tr>
<td>1873</td>
<td>National Association for the Promotion of Social Science: “How some People have Lived and Not Died in India,” a summary of 10 years of progress in instituting sanitary reforms in India.</td>
</tr>
<tr>
<td>1877</td>
<td>Nineteenth Century magazine: “The People in India” gave principal facts about the Indian famines, compiling statistics starting in 1874 on the effect of irrigation on life and health in India.</td>
</tr>
</tbody>
</table>

molecular interventions
and it transformed the role of nurses (2). One of the most
telling indicators of her impact on nursing is statistical: The
British census of 1861 found 27,618 nurses in Britain and
listed nursing under the occupation heading “Domestics.” In
1901, the number had increased to 64,214 and it was listed
under “Medicine” (1).

Statisticians have equated Nightingale’s impact on biostatis-
tics to that of Quetelet and Farr, who admired and accepted
her as a full-fledged colleague (5). In a time when collecting,
editing, and presenting data was still uncommon and when
women could not vote, hold public office, or own property,
Nightingale’s accomplishments were truly remarkable (1, 4, 10).

She pioneered what is now called evidence-based medicine,
collecting data on disease using a uniform classification system
that permitted comparisons in outcomes (10). Furthermore, she
ingeniously used statistics not only as a means of tabulating
data but also for determining the forces that caused disease
and suffering (4). The methods she used and the powerful
graphics she introduced became the foundation of applied sta-
tistics in many fields, including the biostatistical analysis now
required by regulatory agencies to demonstrate the efficacy
and safety of new drugs.

Until 1900, Nightingale kept in touch with people world-
wide, including sanitation experts, nurses, hospital architects,
and Indian politicians. In 1909, she became the first woman
to receive the Order of Merit, Britain’s highest civilian decora-
tion. When she died on August 13, 1910, a young woman
doctor signed her death certificate, and six veterans of the
Crimean War, still remembering her care of their compan-
ions, carried her coffin (2). doi:10.1124/mi.11.2.1

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References
Life of Miss Florence Nightingale, Random House, New York.
education in the life of Florence Nightingale. Newsletter of the
Association for Women in Mathematics 23:11-12.
Statistics and Probability, University of Minnesota Morris. Available from:
http://www.morris.umn.edu/~sungen/introstat/history/w96/Nightengale.
html
5. Kopf EW (1918) Florence Nightingale as statistician. Publications of the
at the Stats & Lamps Res. Conf., Florence Nightingale Museum at St.
Thomas’ Hospital. Available from: http://www.york.ac.uk/depts/maths/
histstat/small.htm
ined. CID 40:1799-1805.
genetic/activity/view/id/38937/title/Florence_Nightingale_The_passion-
ate_statistician
Understanding Uncertainty. Available from: http://understandinguncer-
tainty.org/node/204
10. McDonald L (2006) Florence Nightingale and public health policy:
Theory, activism and public administration. Presented at the Origins of
Public Health Policy CSAA Meetings, York University. Available from:
http://www.uoguelph.ca/~cwfn/Public%20Health%20Policy/theory.html
12. Cameron D and Jones IG (1983) John Snow, the Broad Street pump
node/214
15. Hall, J (and others), Observations of a Non-Commissioner, n.p., n.d.
[1858], a pamphlet published anonymously to refute FN’s commission
report.

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