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People of Data

Florence Nightingale (1820–1910): An Unexpected Master of Data

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Florence Nightingale is known for her nursing skills in the Crimean War. This article shows how she used her mathematical and statistical knowledge to advise the British Army and government on the best approaches for medical data collection and management, thus significantly reducing mortality rates. Many of the problems she described are just as relevant today.

Although best known by the general public as a nurse in the Crimean War, Florence Nightingale spent most of her life analyzing data and using them to inform decision making in the British Army and government. She could be described as doing the work of a modern data scientist but using smaller quantities of data and manual calculations.

Born 200 years ago in Florence, Italy, she grew up with her sister in Derbyshire and Hampshire, where her father, William, took charge of the girls' education, ensuring that they learned several modern and ancient languages alongside the more traditional female subjects of painting, music, and needlework. However, their parents still expected them to marry rather than to seek employment.

Fascinated by mathematics, Nightingale subsequently became interested in statistics, reading and commenting on the work of the Belgian statistician Quetelet. Being wealthy, she was fortunate to take several long trips to Europe with family and friends where she learned how to nurse in a hospital in Kaiserwerth, Germany, and also met influential people like Sidney Herbert, who went on to become the secretary of state for war.

Eventually her parents allowed her to take up the position of superintendent at a nursing home for gentlewomen in Harley Street. Soon after this, the Crimean War broke out, which changed Florence's life.

It was on her return that she used her statistical knowledge to full effect. She became fascinated that the mortality rate among soldiers stationed at home was higher than the mortality rate of ordinary British men, despite soldiers being healthier at the start of their careers. She used data to examine the cause, concluding that the problem was poor sanitation and over-crowding of military barracks, encampments, and hospitals that exacerbated the spread of disease. She drew many graphs depicting this, including Figure 1, which shows five circles filled with hexagons representing the space between people. The first three circles show how closely packed the army would be in the Quartermaster General's camp plans, while the last two circles show how densely packed the inner city of London currently was and the population of London in general. This comparison made it obvious to anyone that the Quartermaster General's proposition for encampment was going to be problematic given how unhealthy densely populated areas of London were.

She went on to forecast the efficiency of the army if the soldiers were as healthy as the rest of the men in the UK. This graph was way ahead of its time (Figure 2). On

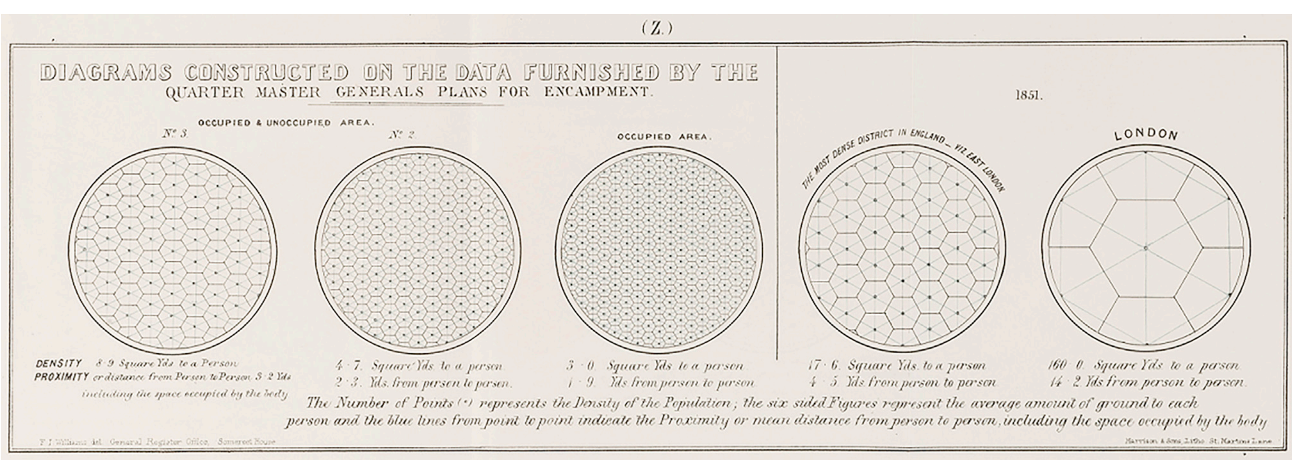

Figure 1. Diagrams Constructed on the Data from the Quartermaster General's Plans for Encampment
Credit: The RAMC Muniment Collection in the care of the Wellcome Library.

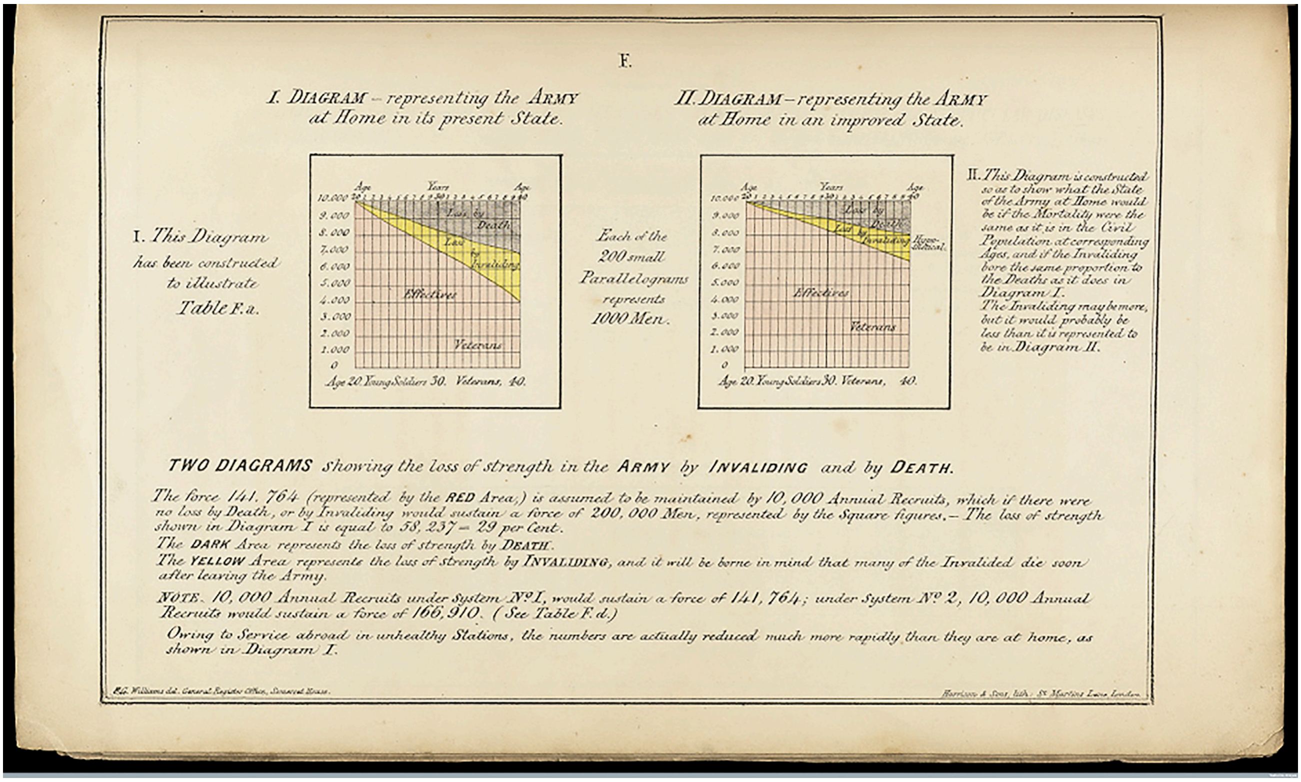

Figure 2. Diagrams Showing the Loss of Strength in the Army by Invaliding and by Death
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the left she displayed the current situation, showing the effectiveness of the British Army in terms of the numbers who were ill, invalided, etc. On the right she graphed the potential effectiveness of the army if the soldiers were as healthy as the general male population. By forecasting this potential effectiveness, she emphasized how the army at rest were experiencing higher degrees of mortality that the general male population. Nightingale's use of data visualization was unusual as many statisticians in England did not use graphs at all, and when they did, they only used them sparingly, unlike the statisticians in Europe who used graphs, particularly polar area diagrams, prolifically. Her well-known polar area diagram on the front cover shows the causes of mortality among the soldiers in the Crimea (Figure 3).

Nightingale also made many pertinent comments on the misuse of statistics and data, some of which are still relevant today. She was frustrated by discrepancies between datasets, commenting "I have carefully compared the statistics from six different official sources, and none of them agree."[1] She acknowledged that this "shakes [one's] confidence" in their accuracy.

This discrepancy was probably down to an inconsistency in record keeping that Nightingale also observed. In a letter to John Henry Lefroy, scientist and military reformer, in June 1856, she described the data from the Land Transport Corps (a branch of the army that transported military supplies) as being in "a state of great confusion" and asserted that they had "an extraordinary method (or no method) of keeping statistics," with one of the problems being that sometimes local people were included in the data and sometimes not, so there was no consistency.[2]

Nightingale also struggled with inaccuracy in recording details of patients. She pointed out that by only counting the soldiers in hospital on one day of each week, many soldiers were missed from these returns. Soldiers who were admitted and died between counts were not registered as being there at all. Consequently, she estimated that hospital records in the Crimea may have only shown one-seventh of the true number of deaths. She called for a standard measure of time, and numbers under observation, to enable accurate comparison.

Later, in India, she noticed that some causes of death were left out of data returns and concluded that if this continued, it would lead to a zero rate of death!

I could not help laughing at your critics who 'exclude' specific diseases such as "cholera," accidents "proving fatal," etc. It is very convenient indeed to leave out all deaths that ought not to have happened, as not having happened. And it is certainly a new way of preventing preventable mortality to omit it altogether from any statement of mortality, then they would "exclude" "deaths above 60." Their principle, if logically carried out, is simply to throw out all ages and all diseases and then there would be no mortality whatever."[3]

Nightingale was so perplexed by some of the official data and statistics that she ended up questioning the integrity of

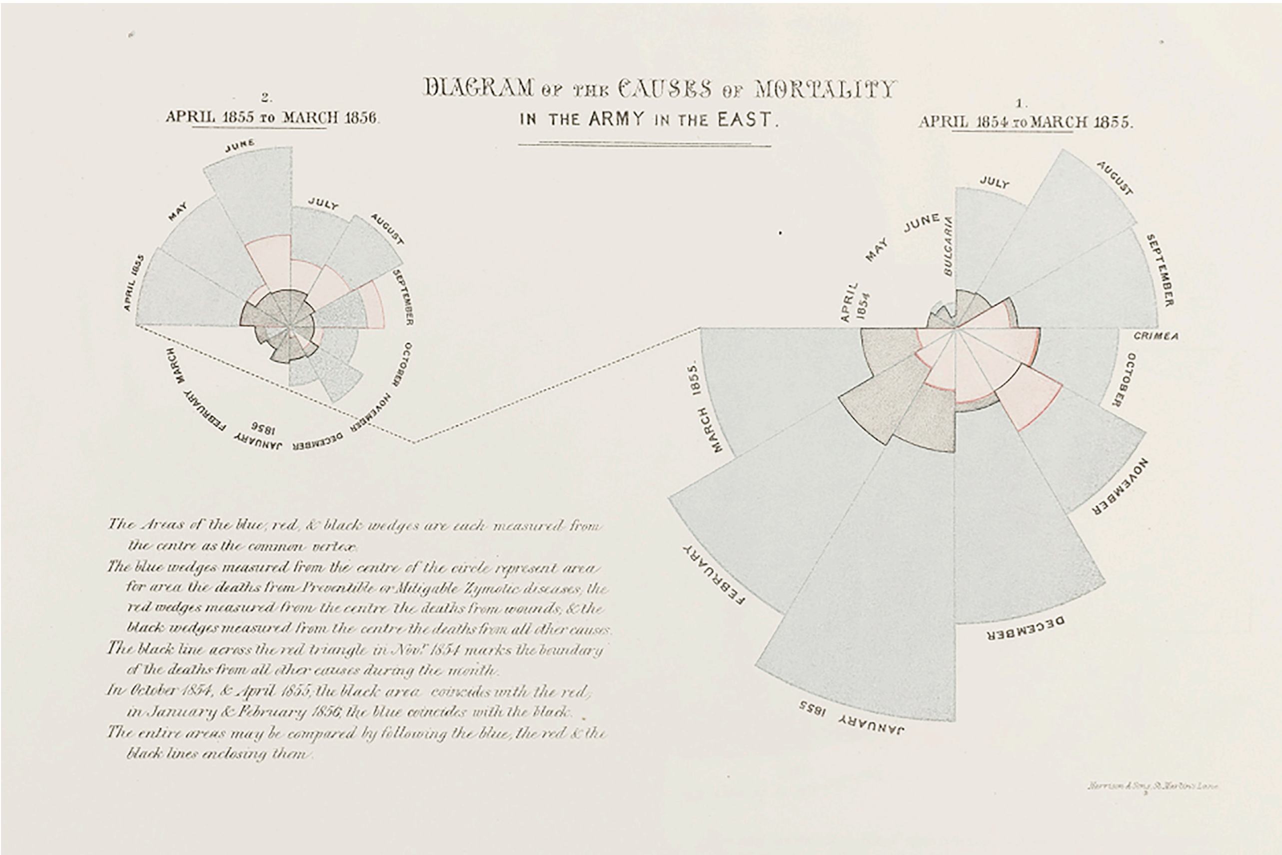

Figure 3. Cover Polar Area (or Rose) Diagram of the Causes of Mortality in the Army in the East
Credit: Wellcome Collection. Attribution 4.0 International (CC BY 4.0).

officials, suggesting that either they were incompetent and lacked understanding or they were guilty of willfully keeping back the truth.

Her criticism of army medical data and the process of data collection, as well as her suggestions of more rigorous methods, was pivotal in changing the way that British military data were gathered and recorded and led to her becoming the first female fellow of the Royal Statistical Society.

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About the Authors

Noel-Ann Bradshaw is currently Head of School of Computing and Digital Media at London Metropolitan University. She was previously Faculty Director Employability at the University of Greenwich, teaching data analytics to mathematics students. She has also worked as a data scientist for Sainsbury's Argos, where she soon appreciated that Nightingale's concerns regarding data are just as relevant today. Committed to encouraging more young people, especially girls, to take mathematics at A level and university, Noel-Ann is currently on the Institute of Mathematics and its Applications Higher Education Service Area committee and part of the Implementation Group of the Big Mathematics Initiative.