Data visualization in health care

Data visualization in healthcare: the Florence effect

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Data visualization in healthcare: the Florence effect

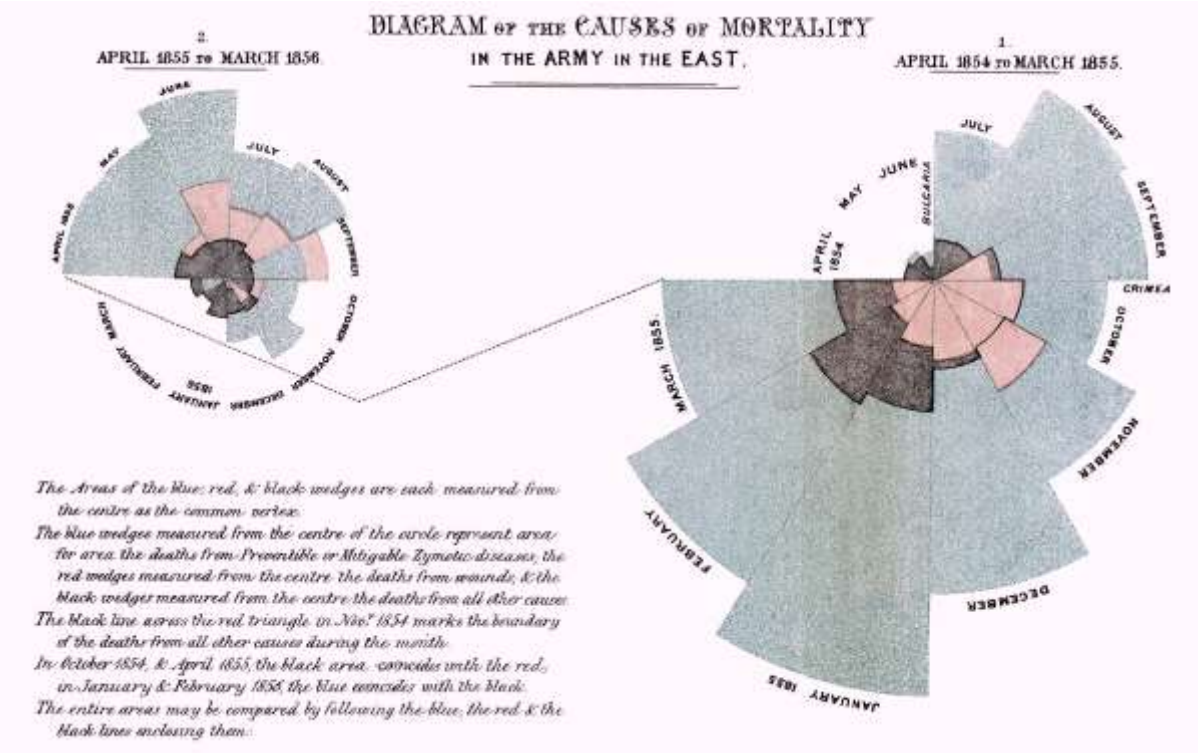
Healthcare is becoming more data driven than ever before. The rise of evidence-based practice requires information to be utilized quickly and effectively to improve patient outcomes. This is a challenge for clinicians, health service managers, and researchers who routinely obtain and process data from an array of sources. Insights gained can be highly informative in enhancing planning and policy in healthcare. Advances in computing have enabled vast amounts of digital health data to be collected and analyzed in developed nations and emerging economies (Kuan et al., 2019). From electronic medical records that hold clinical and administrative datasets, to telehealth systems that monitor people with long-term conditions, and health apps and wearable devices that track diet and exercise among other behaviours, a wealth of digital health data is now available. These can also be combined with data from transport, agriculture, education, and other sectors to improve human health.

One difficulty with understanding complex datasets is communicating the results of analysis in coherent ways to a range of stakeholders, necessary to aid individual and organisational decision making. A 2012 Institute of Medicine report highlighted that, "*Designing information presentation to minimize safety risks with minimum effort is still an unsolved problem. Information visualization is not as advanced in parts of clinical medicine as compared with other scientific disciplines*" (Institute of Medicine, 2012pg. 172). A new science, that of data visualization, has evolved which examines how to create visual representations of complex data to help people quickly assimilate large amounts of information (Caban & Gotz, 2015). This can take numerous forms such as visualizing genomic and clinical data to track infections in hospitals (Smith et al., 2017) or displaying personal health data from self-monitoring technologies via graphs and other infographics (Almalki, Gray, & Sanchez, 2015).

The origins of data visualization in healthcare can be traced as far back as the 1800's, a primary example being Florence Nightingale ground breaking work examining the causes of hospital mortality in the Crimean War (1853-56). Based at the Barrack Hospital in Scutari, she witnessed first-hand the overcrowded and poor conditions wounded British soldiers were treated in. As a nurse, Florence worked tirelessly to improve hygiene, cleanliness, and the organization of equipment, staff, and other hospital resources. A dramatic reduction in mortality after improvements were made by the Sanitary Commission, greatly influenced her professional perspective. She became committed to hospital and public health reform and after the war acquired a wealth of data on injured soldiers who contracted infections and died in field hospitals (Bostridge, 2015). Florence realized that bringing this information to life in a simple and clear way was essential for it to be quickly understood and action taken to improve practice.

She employed her statistical expertise, with help from William Farr a well-known epidemiologist and medical statistician (Farr, 1864), to create a form of a pie chart known as a polar area chart, a novel approach to presenting data at that time. This scientific collaboration enabled Florence to plot the counts of death by month, with the area of each sector representing the number of deaths which was further subdivided using colour based on the cause of mortality. In her seminal diagram, it is clear that more soldiers died from preventable diseases which are shaded in blue, than from wounds represented in red, and other causes shown in black (see Figure 1). This figure is commonly referred to as a coxcomb or 'rose' diagram and enables multiple comparisons of data to be seen in a single illustration, a useful visual aid for those unfamiliar with statistical data and reports (Magnello, 2012).

Figure 1. Nightingale's coxcomb diagram on causes of mortality in the British army



Florence used this and other statistical graphics when reporting to the British parliament on the health of the army. Rooted in the belief that improving sanitary conditions and having adequate ventilation would reduce deaths from infections such as typhus, cholera, and dysentery, she continued to use data visualization to support the case for change. In 1858, Florence published a report on mortality of the British army that contained numerous forms of charts and tables explaining the health of soldiers at home and at military hospitals overseas (Royal Commission appointed to enquire into the Regulations affecting the Sanitary State of the Army, 1858). Her passion for statistics and representing the health of populations in a visual way helped persuade government officials to improve care for British armed forces active in India by introducing better drainage, clean water, and ventilation, saving the lives of thousands of soldiers (Report of the Royal Commission, 1863). In recognition of her contribution to the field of statistics, Florence was elected to the Royal Statistical Society in 1859 as the first ever female member. Using her notoriety, political connections, and

statistical prowess, Florence was a powerful voice for change and continued to lobby ministers in the British government throughout her life to bring about improvements in public health.

Since then, Florence Nightingale's work and that of others has paved the way for modern day approaches to visualizing data in healthcare. As digital data becomes the cornerstone of contemporary evidence-based practice, her work and its relevance should not go unnoticed. The increasing popularity of data visualization techniques has resulted in a systematic review of the literature, calls for evaluation frameworks that can be used in healthcare (Wu et al., 2019) and subsequent efforts to consolidate best practice (Khasnabish et al., 2019). Nightingale's pioneering work began a new trend, the implications of which can still be felt today as governments, organizations, and citizens use digital data and visual techniques to affect change in healthcare and across every area of society in both public and private spheres. Furthermore, interdisciplinary initiatives are generating ever more sophisticated data visualizations and incorporating machine learning to tackle some of the challenges faced by the volume, variety, quality, and connectedness of health data (Gotz & Borland, 2016). This means the value and impact of data visualization in healthcare will no doubt continue. As the 200th anniversary of the birth of Florence Nightingale approaches on the 12th May 2020, which coincides with the World Health Organization designated Year of the Nurse and Midwife, we should reflect on and celebrate the significant and wide-reaching impact she has had. Florence is an enduring role model not only for nurses working globally on the front lines of delivering patient care but also for researchers who collect, analyze, and disseminate new knowledge via digital techniques such as data visualization to bring about improvements in human health.

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