visualizing health and healthcare data

Creating clear and compelling visualizations to "see how you're doing"

katherine **rowell**
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Preface

We understand the challenges you face when trying to communicate health and healthcare data. We wrote this book to share our deep experience and expertise in creating clear, compelling, and actionable displays of health and healthcare data that empower people to "see how they're doing."

As a group, we've spent the last 30 years working on this book—29 conducting the research, and one writing it. Our research can be categorized into three areas: formal education, work experience, and self-education.

We've each had the privilege of a formal education delivered by recognized health and healthcare experts and thought leaders. This education is foundational to our ability to think critically about the various aspects of what health is, how health and healthcare systems operate, and the structures and policies that influence it all.

We've played a role in the development, capture, and analysis of just about every type of health and healthcare data imaginable—from administrative claims data to risk-adjusted clinical outcomes data to complex public health survey data. We've deciphered the inner workings of innumerable transactional systems and untangled databases created by evil geniuses.

Each of us can describe the moment we were bitten by the data visualization bug and set on a path of self-education. We sought out thought leaders in the field—some we know only through their books and blogs; others we have developed lifelong professional and personal friendships with. We learned and honed our viz skills through deep practice—stretching ourselves outside our comfort zone, stopping to reflect on successes and errors, making adjustments, and continuing the process over time. As a result, we have proudly joined the ranks of recognized data visualization experts, and we work with leading health and healthcare organizations throughout the world. And now, we have written this book to share our experience and expertise with you.

This book is organized into three sections. Section I is focused on understanding different types of data to be displayed, and requirement-gathering methods. All too often teams want to jump directly to creating displays, but this is a mistake to be avoided. Before you can determine how to display data and information, you must understand what will be displayed and for whom.

Section II provides an overview of the research that informs the best practices of table and graph design. Included in this chapter are the four fundamental shapes you can use alone or in combination to create clear and compelling displays of data. This section also includes detailed examples of the most common mistakes people make in selecting a chart type, with explanations about why they don't work, and examples of what works better and why.

Section III of the book defines and describes the characteristics of dashboards, reports, multidimensional exploratory displays (MEDS™) and infographics. It includes examples of each type of display and tips and tricks to designing and building them.

We ardently believe that making the message and the story in the data clear will improve health and healthcare systems. We hope this book will help you to join in our efforts.

SECTION ONE

Establishing a Framework and Process

"If you can't describe what you're doing as a process, you don't know what you're doing."

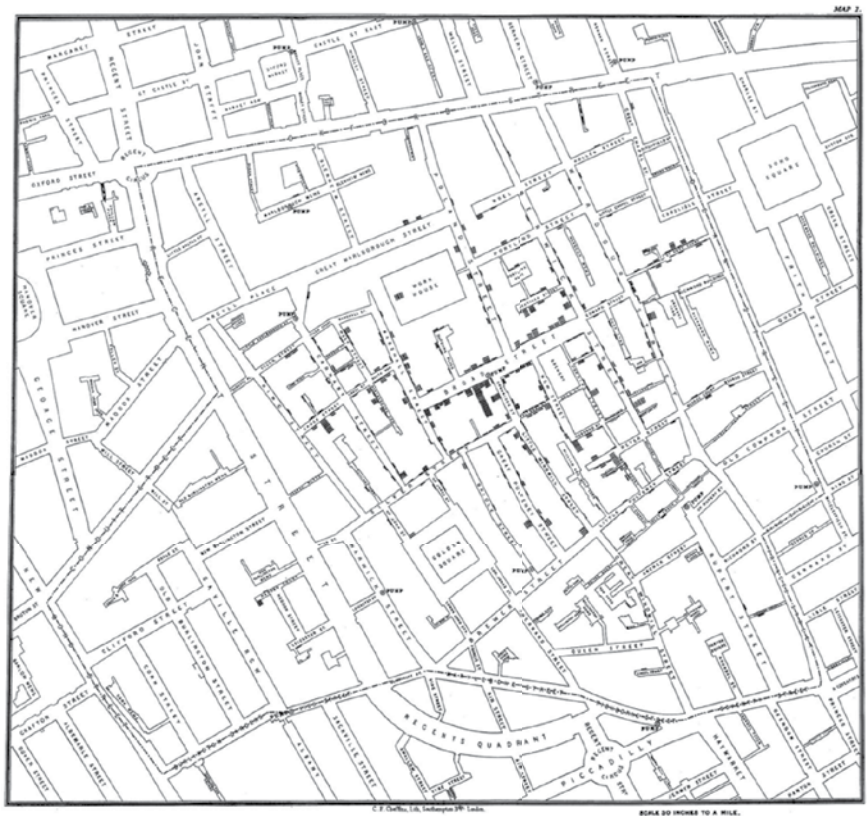
—W. Edwards Deming,
American engineer,
statistician, and leading quality
management thinker

Chapter One

Health and Healthcare Data Visualizations of Historical Importance

Even before modern-day visualization research validated the direct and powerful relationship between the way information is presented and the way we see and understand it, pioneering healthcare statisticians and caregivers like John Snow (1813–1858) and Florence Nightingale (1820–1910) understood that visual display could be a highly effective method for grasping and communicating the messages buried in data. No one who has ever taken an epidemiology course can forget Dr. John Snow's classic work, *On the Mode of Communication of Cholera*. By mapping the London street addresses of residents who had become sick (and in many cases died) and their distance from City water pumps, Snow could visually and effectively communicate the relationship between a single pathogen-tainted water source and the homes of people who contracted the disease. Most people who had fallen ill, it turned

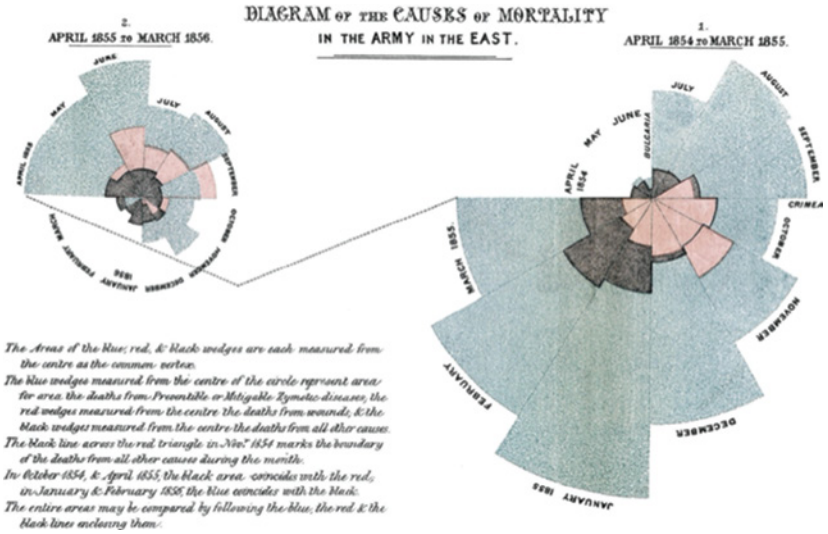
out, lived near the Broad Street pump. Snow persuaded the town council to remove the pump's handle, and the outbreak abated.



In 1868, British nurse Florence Nightingale—distressed by the alarmingly high mortality rates in the Crimean War—began to compile statistics on causes of death. Her analysis revealed that of the 900,000 soldiers who died during the war—more than half of 1,650,000 combatants from all countries involved—most had succumbed to preventable diseases arising from unsanitary conditions in the hospitals where they were treated, and not as a direct result of battlefield wounds. Nightingale recognized the buried message: better hygiene could have saved—and could still save—thousands of lives.

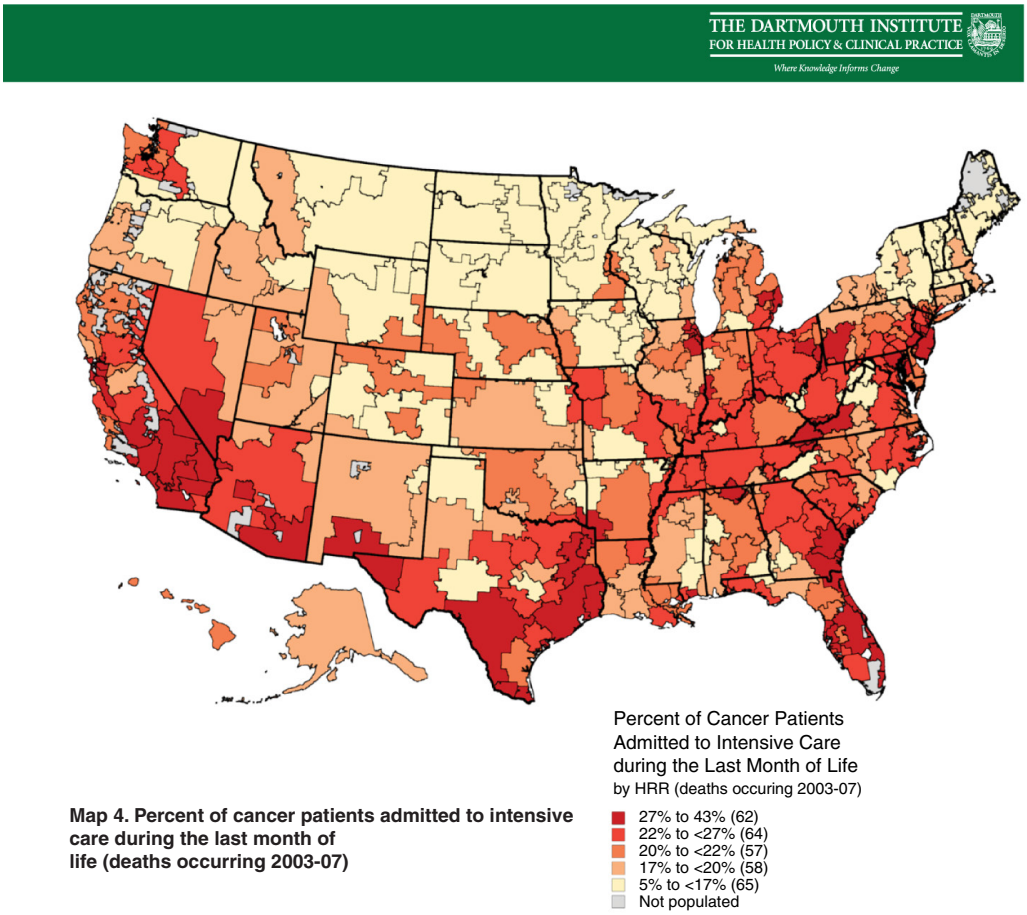
As impressive as her statistics were, Nightingale worried that the tables she presented to Queen Victoria would seem tedious,

even incomprehensible, and feared that members of the British Parliament were unlikely to be swayed by numbers lying flat on a page. So Nightingale devised ingenious ways of presenting the information in charts.



In the now-famous "Diagram of the Causes of Mortality in the Army in the East," each month is represented as a twelfth of a circle. The months with more deaths are shown with longer wedges so that the area of each wedge represents the total number of deaths. Preventable deaths are blue, deaths due to wounds are red, and deaths from all other causes are black. Over the months after March 1855, when members of the Sanitary Commission began repairing, cleaning, and otherwise improving field hospital conditions, the blue wedges shrank dramatically. Showing incredible insight into the power of displaying the data in this way, Nightingale said her graph was designed "to affect thro' the Eyes what we fail to convey to the public through their word-proof ears."

More recent efforts by healthcare researchers like those led by Dr. Jack Wennberg at the Dartmouth Atlas Project have documented glaring—and, for the most part, inexplicable—variations in how medical resources are apportioned and delivered in the United States. The project builds on Medicare data to provide



Map 4. Percent of cancer patients admitted to intensive care during the last month of life (deaths occurring 2003-07)

Source: The Dartmouth Institute: *The Dartmouth Atlas of Healthcare*

comprehensive information and analysis about national, regional, and local markets, as well as individual hospitals and their affiliated physicians.

Consider the map reproduced from the Dartmouth Atlas Report: "Quality of End-of-Life Cancer Care for Medicare Beneficiaries." It displays the percent of cancer patients admitted to intensive care during the last month of life compared by hospital referral regions. About 24% of cancer patients nationwide were admitted to intensive care at least once during that last month. However, the percent thus admitted varied more than sevenfold across those regions (dark red versus light yellow areas on the map). This map leads the viewer to ask, "Why are these rates so dramatically different across the country?," and perhaps to add an even more significant question: "What should the rate be?"

Geospatial displays of data like this one make the variation in end-of-life care jump off the page in a way that it never would if the data were buried in a table or report narrative. Such geospatial maps and accompanying reports, coupled with the underlying research, have helped policymakers, the media, healthcare analysts, and others improve their understanding of the efficiency and effectiveness of our healthcare system. As with the map created by John Snow, the visualizations built for the Dartmouth project make the story easy to see and understand and have formed the foundation for many of the nation's ongoing efforts to improve American health and healthcare systems.

Throughout history the power of data visualizations to help us see and consider the stories buried in our health and healthcare data has resulted in profound insights and often changes and improvement in our health and healthcare. And now with the advent of technology that allows us to amass data and quickly explore it, we are on the cusp of revolutionary insights and improvements. It is an exciting time indeed.