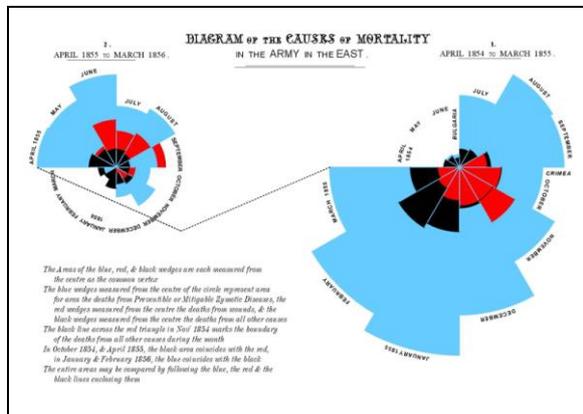


# Florence Nightingale's Hockey Stick

## The Real Message of her Rose Diagram

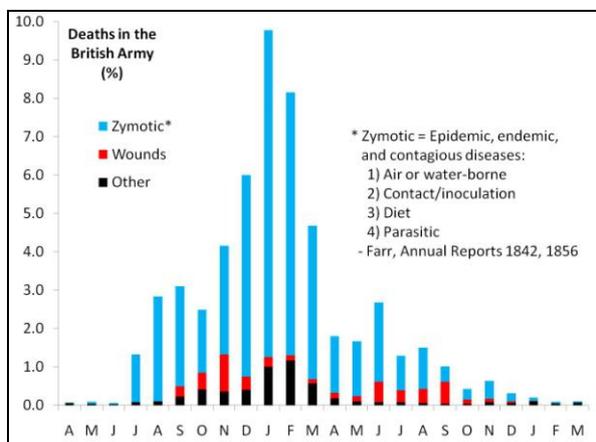
by Hugh Small

The passionate statistician: Florence Nightingale's use of statistics and links with statisticians Royal Statistical Society, London, 7 October 2010



I dare say you have all seen this diagram far too often; it is variously called the Rose Diagram, the Coxcomb, or (her name for it) the Wedges. What I want to do today is to put the diagram into its textual and political context and see what results Nightingale obtained from it.

Why didn't she make a column chart like the one below? Many people say it would have made the data clearer:



Incidentally, I've put here William Farr's definition of Zymotic, a term he coined in 1842 to mean epidemic, endemic, and contagious diseases. In his 1856 report he divided zymotic into four categories by mode of entry so to speak. Zymotic includes scurvy (in the diet category), a disease common in the Crimea.

Now, I drew this *column* chart when I was first investigating her post-war arguments. I had been taught by a graphics expert that rule number one in statistical graphics is 'time series data should be presented with time running on a horizontal axis from left to right', a rule which her Rose Diagram disobeys. But when I redrew her chart in this column format I could see that it didn't convey the message that Nightingale wanted. My graphics tutor had been a

data expert but in management consulting one tends to use graphics to present *messages*, not data, and there is a rule number zero which is that ‘your graphic should support the message, the whole message, and nothing but the message’.

So what message did Nightingale want to support? She first published this famous graphic in her *Contribution to the Sanitary History of the British Army* (1859), the text of which is not as famous as her diagram. The text contains two key passages:

“Let us now ask, how it was that our noble army all but perished in the East? And we shall at the same time learn how it has happened that so many hundreds of millions of the human race have by pestilence perished before their time.”

“[Mr John Simon, Chief Medical Officer of England] has been led to assert that the great mortality from important classes of zymotic disease is practically unavoidable.”

The first says that she wants to use the results of what she called ‘the Scutari experiment’ to save millions of lives back home in England and throughout the world. The second says that England’s Chief Medical Officer, John Simon, was obstructing her in this task. He wasn’t the only one, as we see when we look at the controversy that greeted her on her return from the Crimea, a controversy that led to a number of pro- and anti-sanitarian books and pamphlets:

*Anti-sanitarian publications:*

- **Observations of Sir John Hall**, (September 1857, rebutting Sutherland’s report of his Sanitary Commission in the Crimea).
- **Sir John Hall’s Rejoinder to Dr. Sutherland’s Reply to Sir John Hall’s Observations**, (February 1858).
- **By a Non-Commissioner**, (anon., 1858, attributed to Mapleton, Mouat, Taylor et al., rebutting Nightingale’s Royal Commission report).
- **Sanitary State of the People of England**, (John Simon, Chief Medical Officer, 1858)

*Nightingale’s sanitarian responses:*

- **Notes on Matters Affecting the Health of the British Army**, (Oct. 1858)
- **Sanitary History of the British Army**, (January 1859 – first pub. of Rose Diagram)
- **England and Her Soldiers**, ( Harriet Martineau, July 1859)
- **Notes on Nursing**, (January 1860)

This controversy broke out after Dr. Sutherland published the report of the Sanitary Commission that he had led to Scutari and the Crimea. The Army medical establishment in the person of Sir John Hall quickly went into print to denounce it. Sutherland replied with a pamphlet rebutting Hall, who then replied with a pamphlet refuting Sutherland’s rebuttal; the exchange could have gone on for ever except that Nightingale’s Royal Commission report came out and the Army doctors then ganged up on her instead, in *By a non-Commissioner*. The Army doctors claimed that sanitary measures had *not* caused the famous decline in the death rate from 42 per cent to 2 per cent during the war. Nightingale responded in print between late 1858 and early 1860, beginning by leaking the suppressed material from her Confidential Report (which did contain the Rose Diagram but does not count as a publication), then by publishing the *Sanitary History*, then by arranging for a popular account to be written for her by Harriet Martineau, which also contained the Rose Diagram, and finally by publishing *Notes on Nursing*. All this activity, by the way, when she was claiming

she was far too ill to have anything to do with hospitals. She was having the fight of her life trying to get her sanitarian message across, and her Rose Diagram was one of her weapons.

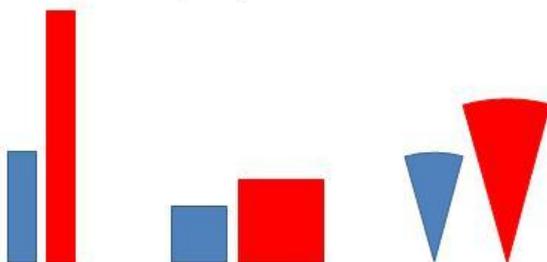
Nightingale wanted to use the Rose Diagram to convince people that the Chief Medical Officer, John Simon, was wrong because deaths from epidemic disease *were* avoidable, using her evidence that deaths from sickness had been reduced during the war. So looking at the column chart which I drew in an attempt to ‘improve’ Nightingale’s chart, what is wrong with it as far as supporting Nightingale’s sanitarian message? It has 3 defects:

- 1) The war lasted exactly two years, and fortuitously the Sanitary Commission and the death rate reduction arrived exactly in the middle; she wanted to compare the two years to show the situation ‘before and after’, but the column chart simply contrasts each month with preceding and succeeding months. Obviously the answer was to split the two years in some way;
- 2) As well as obscuring the comparison of years, it obscures the comparison of seasons. You have to hunt for the month letters on the horizontal axis. The answer here would be to line up the years with each other after you’ve split them.
- 3) The staggeringly high mortality in the first January (decimation of the army in a single month) gives the impression that ‘General Winter’ was to blame, or at least distracts the viewer from the intended ‘before and after’ message. Her answer to this was downplay month on month variation by doing a *square root transformation*, using *areas*.

On the slide below the blue area is always 4/9 of the red one. Using rectangular columns therefore the red one is more than twice as high as the blue. Using square columns would de-emphasise extreme values, but it would be hard to line up the two years because the intervals on the x-axis would vary. Her answer: use the ‘wedges’ on the right and make a circular x-axis for each year. (I’ve checked against the original table of data by the way and it *is* the area that is proportional to the mortality although some commentators have said that it is the length of the radius).

How to reduce visual impact of month-on-month differences:

Use areas to give a square root transformation



Each blue area is 4 cm<sup>2</sup>, each red area is 9 cm<sup>2</sup>

Why has she made the first year on the right in disobedience to the rule that time should go from left-to-right? I think it might have had something to do with printing limitations. If you wanted to show time going left to right and align the months going clockwise in each year *and* join up the two years with the dotted line you’d have to rotate the Rose Diagram through 180 degrees. This is the only improvement I can suggest, except that I would punchily summarise the message by a headline above the graphic as well as putting it in the text, e.g.: “We *can* control epidemic disease”.

So that was why she needed the Rose Diagram to be the way it is: to convey her ‘before-and-after’ message without distractions.\*

Now, have I exaggerated the strength of the opposition in 1858? History said that her battle for sanitation had been won in 1854/55. How can it then be true that John Simon was saying after the war that we *can't* control the epidemics which were ravaging Britain and killing half of all urban children before their fifth birthday? Sir John Hall and the Army Medical Department were not heavyweight movers and shakers, but England's Chief Medical Officer controlled all national public health strategy and funding. I looked up what John Simon said, and compared it to what Nightingale accused him of saying. The easiest place to find John Simon's paper is in the volume of his collected papers which he published in 1887. He left the date 1858 on the paper, and it says “*A further, in some degree unavoidable, [my underlining] cause of premature death in every civilised country is the risk of its current contagions*”.

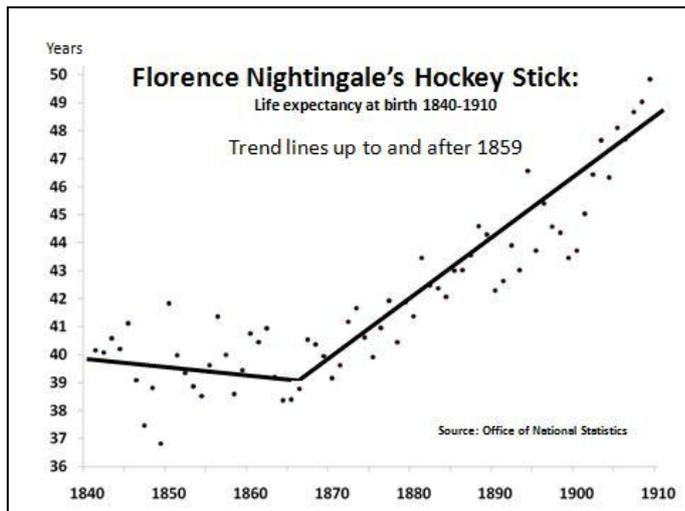
Well, this is not what Nightingale accused him of saying (“*practically unavoidable*”). One could hardly say that Simon was wrong to say that *not all* deaths from epidemics could be avoided. But I dug out Simon's rare original 1858 paper and found that he had written then “*A further, practically speaking, unavoidable, cause of premature death in every civilised country is the risk of its current contagions.*” So he *had* said, as Nightingale claimed, there was nothing that could be done about scarlet fever deaths. By 1887 he knew he had been wrong, and altered the record of what he had written. Nightingale had shadowed him throughout his career, briefing politicians against him and subverting his attempts to divert public health funds from sanitation projects into scientific research

I think I have shown you that the Rose Diagram was not just a pretty way of showing that there were more deaths from sickness than wounds in wartime. It is a *prescriptive* graphic that calls for controversial expenditure on sanitation against the advice, just issued, of England's Chief Medical Officer.

As Simon was effectively admitting his mistake in 1887, that makes it game, set and match to Miss Nightingale, I think. But what was the score, in terms of end results? Everyone knows that life expectancy increased during the Victorian era, and much of the credit is due to the sanitarian revolution. Not so many people realise that for several decades life expectancy was actually flat, held back by the increasing urbanisation of the industrial revolution. The sudden change to an upward trend on a graph is sometimes called a hockey stick. This configuration is common in optimistic predictions of economic upturn, but is rarely found in practice. Farr's life tables allow us to plot life expectancy at birth year by year to see the trend. [NB in response to comments at the RSS that some infant deaths were not reported, I have tried plotting the life expectancy at age one; there is a difference in the gradient but I have kept the ‘at birth’ data as simpler to understand.]

I have taken the liberty of calling this graphic *Florence Nightingale's Hockey Stick*.

I know you're going to say that correlation is not causation, and you could probably do a hockey stick around any point in the mid-century. A trend line is not data. And the data is extracted from Farr's Life Tables, which are just models. But I think it's worth illustrating the turnaround, because most people have seen the upward part of the graph but I've never seen the flat part plotted.



Her 1858 dispute with Simon was the most important battle of the sanitary revolution, perhaps one of the most important battles of the whole century, but has not received much attention. Only Simon's biographer and F B Smith even mention it; both show her as a crank slowing down the progress of medical science and neither examines the dispute to see the rights and wrongs or to understand what Simon actually said. The impression of crankiness is encouraged by the entry in the 1920 Dictionary of National Biography, repeating the earlier claim of E T Cook that she had convinced everyone in 1854-55 of the lifesaving effect of sanitation. If that had been true then her campaign after the war would have been trying to kick down an open door.

*Dictionary of National Biography (1920)*

*"The death rate rose in February 1855 to 42 per cent. At Miss Nightingale's persistent entreaties the War Office at home ordered the sanitary commissioners at Scutari to carry out at once sanitary reforms. Then the death rate rapidly declined until in June it had dropped to 2 per cent."*

Because it makes her later campaigns seem pointless, as if she were simply grandstanding her supposed earlier victory as Lytton Strachey maintained, this DNB entry should not just be forgotten but denounced as masking for a century her achievements as a leading politician of the 19th century. The new Oxford Dictionary of National Biography entry does not fill the gap, describing her only as a 'reformer of army medicine and nursing organiser'. It doesn't even mention William Farr or Edwin Chadwick in her entry, two national figures who were her principal collaborators in the sanitarian revolution.

One person can change the world, but it takes the world a long time to appreciate it.

-----  
 \* Updated 3 October 2012. The principal change made is to remove the implication that Nightingale used the Rose Diagram/Coxcomb as evidence that poor sanitation in the base hospitals near Scutari was the cause of the higher death rate there before April 1855 (right hand side of diagram). She had more convincing evidence of that, but was not allowed to publish it (see my biography of Florence Nightingale). She could only draw the more general conclusion from the Coxcomb that epidemic disease, contrary to the advice of John Simon, could be controlled by a variety of factors (nutrition, ventilation, shelter). In the end this general message may have been a more effective one.