Cholera and TB Now and Then

Revisiting the Determinants of Two 19th Century Diseases

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Introduction and Goals

19th century Europe was infested with diphteria, tuberculosis (TB), cholera and multiple infectious diseases. Cholera and TB are examples of diseases that had been deadly in the 19th century and declined rapidly independently of the discovery of medication. In particular, in the UK there was a shift from ubiquitous mortality to extremely low mortality from the mid-19th to the mid-20th century.

The goals of this paper are:
(i) to survey the prevalence of two diseases, cholera and tuberculosis, in 19th century London;
(ii) to assess the decline of each in relation to its determinants;
(iii) to present original data using modern software.

Determinants of diseases

The determinants of population health influence the likelihood of contracting the disease, the symptomatology, the mortality rates, etc (CDC, 2014).

- Genes and biology
- Health behaviours
- Physical environment or total ecology
- Health services or medical care
- Social determinants

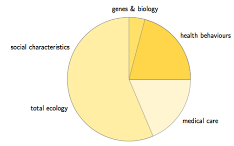


Figure: Re-drawn from Tarlov, 1999

19th Century London

- Slums arose in response to the rapid population growth (due to the flow of people from the countryside) in industrial cities (Birmingham, Liverpool, London, Manchester).
- The Victorian Era mortality and conditions have been paralleled with those today in Africa, Asia and Latin America (Woods, 2000).
- London slums: Whitechapel, Spitalfields, Bethnal Green and The Old Nichol – disappeared with the clearance programmes of the late 19th and early 20th century.

Chadwick is considered the **father of the public health system** and believed that diseases were "caused, or aggravated, or propagated chiefly amongst the labouring classes". His *Public Health Act* (1848) fixed a maximum number of lodgers per house and shed light on the need for ventilation and sanitation, and from this point onwards any upsurge in diseases had to be notified to the local authorities.

The **Miasma theory** sustained that *bad smell* was the cause of diseases. Most social reformers (e.g. Chadwick) were miasmatists but this theory was questioned by John Snow.

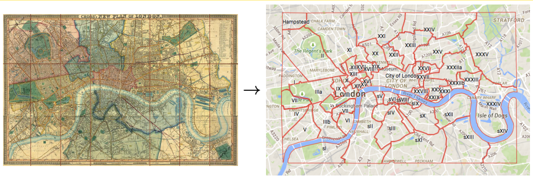


Figure: Cross' map from 1850 (left) and my computerised map (right)

CHOLERA *Vibrio cholerae*

- First noticed in Madras, 1769
- First pandemic originated in the delta of the Ganges, 1817
- Hits Britain, 1831
- There was already some evidence suggesting that cholera couldn't be transmitted with the wind/miasma, but rather: (i) it was communicated *from person to person* (i.e., something had to be passed from one to the other), (ii) someone didn't necessarily contract cholera just by being near a sick person, (iii) cholera could be contracted even without being physically near a cholera patient.

Year of epidemic	Number of fatalities
1831-1832	20 000
1848-1849	53 000
1853-1854	14 137
1866	10 738

Figure: Table of the four epidemics of cholera in Britain

On the Mode of Communication of Cholera (1855)

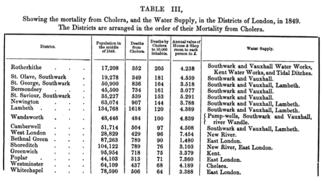


TABLE III,
Showing the mortality from Cholera, and the Water Supply, in the Districts of London, in 1849.
The Districts are arranged in the order of their Mortality from Cholera.

District.	Population in the middle of 1849.	Deaths from Cholera.	Deaths by Cholera to 10,000 inhabits.	Annual value of House & Shop room to each person in £.	Water Supply.
Rotherhithe	17,208	352	205	4.238	Southwark and Vauxhall Water Works, Kent Water Works, and Tidal Ditches.
St. Olave, Southwark	19,278	349	181	4.559	Southwark and Vauxhall.
St. George, Southwark	50,900	836	164	3.518	Southwark and Vauxhall, Lambeth.
Bermondsey	45,500	734	161	3.077	Southwark and Vauxhall.
St. Saviour, Southwark	35,227	539	153	5.291	Southwark and Vauxhall.
Newington	63,074	907	144	3.788	Southwark and Vauxhall, Lambeth.
Lambeth	134,768	1618	120	4.389	Southwark and Vauxhall, Lambeth.
Wandsworth	48,446	484	100	4.839	Pump-wells, Southwark and Vauxhall, river Wandle.
Camberwell	51,714	504	97	4.508	Southwark and Vauxhall, Lambeth.
West London	28,829	429	96	7.454	New River.
Bethnal Green	87,263	789	90	1.480	East London.
Shoreditch	104,122	789	76	3.103	New River, East London.
Greenwich	95,954	718	75	3.379	Kent.
Poplar	44,103	313	71	7.360	East London.
Westminster	64,109	437	68	4.189	Chelsea.
Whitechapel	78,590	506	64	3.388	East London.

Figure: Snow's table of the 1849 epidemic and a portrait of Snow. Credit: R G Snow. Source: `https://www.york.ac.uk/`

- **1832** Mortality of cholera was highest in the districts supplied by very bad water
- **1848-1849** Snow links water supply with cholera

Company	Source of water	Quality of water	Mortality	Quality code
Lambeth	Thames	Bad	Very high	1
Southwark and Vauxhall	Thames	Very bad	Very high	1
Chelsea Water Works	Thames	Good*	Low	4*
New River Company	Various springs & River Lea	Good	Low	2
East London Company	River Lea	Good	Low	2
West Middlesex Company	Thames at Hammersmith	Good	Low	3
Grand Junction Company	Brentford	Good	Low	3

The code from Bingham *et at* (2004) is used, except for Chelsea Water Works, where because the water they supplied came from the Thames but was filtered I have assigned it a *4* and not a *1*.
* Filtered water.

In the south there was a high mortality that bore a direct relation to the **water supply**.

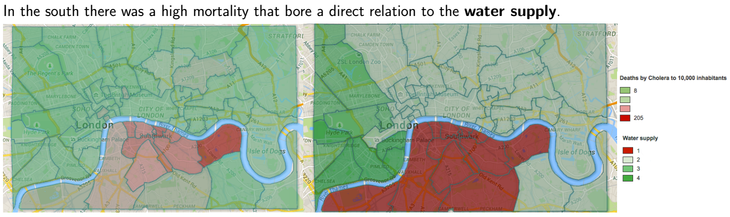


Figure: Maps of dealth by cholera to 10,000 inhabitants (left) and water supply (right) drawn directly from Snow's data

- **1854** Dire local outbreak in **Broad Street, Soho**, which Snow believed was caused by contaminated water emanating from a pump. The evidence that supported his hypothesis could be grouped into (1) mortality of those who lived away from the pump but drank its water (with the reputation of producing good water), and (2) survival of those who lived near the pump but didn't use it (there were no deaths in a workhouse that had a pump of its own, nor in The Lion Brewery where they had a private pipeline and mostly drank beer rather than water).
  The Broad Street Pump's handle was removed. John Snow was acknowledged as the **father of Modern Epidemiology**.

The spread of cholera in the four 19th-century London epidemics was largely driven by the **lack of infrastructure** (Hamlin, 2009) and terminated by separating contaminated from non-contaminated water. There was a will to change the whole of the sewage system –

- 1846 The Nuisances Removal and Diseases Prevention Act that encouraged the cleaning of houses and the coupling to a sewer
- 1870 new sewage system created by Bazalgette (The Metropolitan Board of Works)

– taken for the **city as a whole**, and not for separate neighbourhoods. There have been no indigenous cases of cholera since 1893 (PHE, 2013).

In the present day deaths from cholera are confined to Africa and some Asiatic and American countries in the Tropic of Cancer. There are only isolated imported cases in the United Kingdom (WHO, 2014).

TUBERCULOSIS *Mycobacterium tuberculosis*

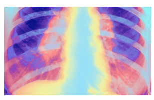
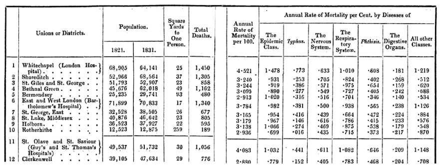


Figure: Barts Hospital/Getty Images

- Epidemics of tuberculosis in the 18th and 19th centuries in Europe and North America
- *M. tuberculosis* is the pathogen that has claimed more deaths in history.
- Clear correlation between poverty and likelihood of infection, mainly due to **poor nutrition, overcrowding and insufficient ventilation**.
- The disease creates a positive feedback loop, where poverty increases the chances of contracting tuberculosis and the presence of tuberculosis makes the individual and the community poorer (UNOPS, 2002).

Annual Report of the Registrar-General of Births, Deaths and Marriages in England (1839)



	Unions or Districts.	Population. 1821.	Population. 1831.	Square Yards to One Person.	Total Deaths.	Annual Rate of Mortality per 100.	The Epidemic Class.	Typhus.	The Nervous System.	The Respiratory System.	Phthisis.	The Digestive Organs.	All other Classes.
							Annual Rate of Mortality per Cent. by Diseases of						
1	Whitechapel (London Hospital)	68,905	64,141	25	1,450	4·521	1·478	·773	·633	1·010	·608	·181	1·219
2	Shoreditch	52,966	68,564	37	1,305	3·240	·931	·253	·705	·824	·402	·268	·512
3	St. Giles and St. George	51,793	52,907	23	858	3·244	·919	·386	·571	·975	·654	·159	·620
4	Bethnal Green	45,676	62,018	49	1,162	3·095	·890	·277	·549	·727	·405	·242	·688
5	Bermondsey	25,235	29,741	93	480	2·913	1·020	·316	·516	·704	·346	·140	·534
6	East and West London (Bartholomew's Hospital)	71,899	70,833	17	1,340	3·784	·982	·381	·500	·938	·565	·238	1·126
7	St. George, East	32,528	38,505	26	677	3·165	·954	·416	·439	·664	·472	·224	·884
8	St. Luke, Middlesex	40,876	46,642	23	805	3·179	·967	·146	·616	·786	·415	·233	·576
9	Holborn	36,523	37,927	22	595	3·138	1·066	·274	·469	·875	·538	·179	·548
10	Rotherhithe	12,523	12,875	259	189	2·936	·699	·016	·435	·715	·373	·217	·870
11	St. Olave and St. Saviour (Guy's and St. Thomas's Hospitals)	49,537	51,732	30	1,056	4·083	1·032	·441	·611	1·082	·646	·209	1·148
12	Clerkenwell	39,105	47,634	29	776	2·880	·779	·152	·405	·783	·468	·204	·708

The trend is

- low tuberculosis incidence in high annual-value districts
- high incidence in low annual-value (and, thus, poorest) districts (e.g. St George, Southwark; St Giles; St Saviour, St Olave; Whitechapel).

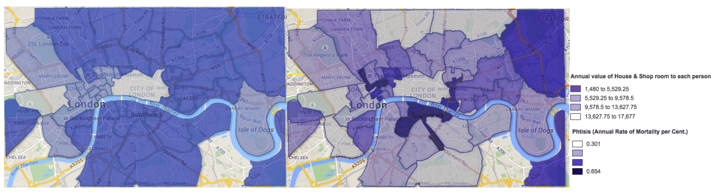


Figure: Maps of annual value (£) (left) and tuberculosis annual mortality per 100 (right)

- After provoking many deaths in the 18th and early 19th century tuberculosis mortality declined steadily in the 19th century, and continued to do so thorough the 20th century.
- The cause for the decline seems to be an improvement in nutrition – a position supported by Thomas McKeown (1976) and that had been reached by analysing the TB mortality data from the 19th and 20th century.
- However, because McKeown misread data (thus including under "death from tuberculosis" deaths by other pulmonary diseases) (Szreter, 1988), the hypothesis is widely disputed. Data from Glasgow (McFarlane, 1989) support the idea that it was the reduction of overcrowding and improvement of housing which was behind the decline of TB, as opposed to improved nutrition.
- The consensus at the moment is that multiple factors (ventilation, nutrition, decline in overcrowding) explain the decrease in mortality that was a trend in most diseases of the 19th and 20th century, including TB.
- These improvements in lifestyle were prior to the pharmacological development of treatment for TB.

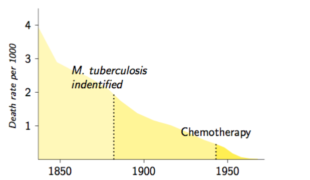


Figure: The decline of TB. Re-drawn from Gherardi, 2013 (data from McKeown, 1976).

There have been great advances in the pharmaceutical treatment of tuberculosis but resistance to treatment by drugs has also grown.

The incidence of TB is highest in Africa, followed by Asia and South America but it is present in every country, and is today the second greatest mortal infectious agent (behind HIV) (WHO, 2015). In the UK most cases affect Black and Minority Ethnic groups (especially Indian), as well as homeless people, prisoners and drug-users.

Conclusions

Reduction in the morbidity and mortality of cholera and tuberculosis was greatly facilitated by the discovery of their water-borne and air-borne nature. The problem with cholera was very much solved once it was discovered how it was transmitted and building the proper infrastructure to shun the contamination of water was a city-scale effort. Meanwhile, tuberculosis is still present within minorities in the UK, showing how, despite the great advances in medicine and biology, social inequalities still prevent diseases from being fully eradicated.

Cholera and TB are examples of diseases with different determinants or, to be precise, of diseases in which the relative weight of social factors and biological factors are at variance.

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