

Epidemiology (2) Pioneers in Epidemiology and Public Health

Minato NAKAZAWA, Ph.D.
<minato@sip21c.org>

Origins of public health

- Public Health: The community effort to protect, maintain, and improve the health of a population by organized means, including preventive programs, hygiene, education, and other interventions (cf. Winslow CEA, 1920, Science, pp.23-33).
 - Preventive medicine, health care + clean water, sanitation, housing, sex education, ...
 - Contributed by other disciplines (engineering, architecture, biology, social science, ecology, economics, ...), amongst epidemiology plays crucial role.
- Originated from the need caused by population aggregation (changed from nomadic band to settled communities).
 - Water supply system and sanitation system were features of ancient civilization.
 - Control of transmissible diseases. Microbial origin was not evident until 19C, but diseases like plague were considered as transmissible, which led community action to isolate patients from others. Quarantine is still effective measure to control communicable diseases like SARS in 2003.

From Hippocrates to Snow and the modern day

- Epidemiology developed as scientific discipline in 20C
- However, public health and epidemiology represented long-lasting important increments
- Review highlights from some of the key contributors to the foundation of public health

Hippocrates (460-370 BC)

- Greek physician
- Father of medicine (cf. <http://iv.iarjournals.org/content/23/4/507.long>)
- Many of his work may be authored by his students
- He caused paradigm shift about the cause of disease
 - Before him: Disease is the result of demonic possession or divine displeasure
 - After him: Disease has earthly causes
- "*Airs, Waters, and Places*" first stressed the influence of the environment on disease occurrence.
 - (citation) He noticed the seasonal difference of diseases
 - In the same book, he wrote the cause of malaria as bad air (mal-aria)
- He believed astrological sign related to body and theory of humors (When 4 humors – black bile, phlegm, yellow bile, and blood – was out of balance, disease resulted)

Avicenna (Ibn Sina) (980-1037)

- Persian philosopher, scientist, and physician during European "Dark Ages", golden age of knowledge in Islamic world.
- cf. <https://link.springer.com/article/10.1007/s00415-011-6219-2>
- Contributed to disease causation. "Canon of medicine" 14-volume book.
 - Translated to Latin in 1187
 - Affected to both East and West.
 - Used as primary medical text in Europe until 1650
 - He emphasized the need of experiment and quantification
 - He inferred from observations that some infectious diseases were spread by contagion, the use of quarantine could limit the spread of those.
 - (citation) He emphasized the importance of disease causation in medicine

Fracastoro (1478-1553)

- Renaissance physician, poet.
- Extended the concept of contagion by "*De contagione et contagiosis morbis et curatione*"
 - Described many transmissible diseases such as plague, typhus and syphilis.
 - Suggested a theory that disease was spread through self-replicating particles "*seminaria*" or seeds, too small to see.
 - Forerunners of "germ theory", but no concept that *seminaria* were alive.
 - Direct person-to-person contact, indirect contact with *fomites*, and transmission at a distance transmit *seminaria*
 - Atmospheric condition could influence the ability of *seminaria* to spread and cause epidemics
- Epic poem "*Syphilis sive morbus Gallicus*" is best known, Latin verse, referred the treatments of syphilis included mercury and *guaiacum* (New World treatment) cf. <https://link.springer.com/article/10.1007/s12138-003-0002-4>

John Graunt (1620-1674)

- World first epidemiologist and demographer
- cf. [https://doi.org/10.1016/S0140-6736\(96\)91562-7](https://doi.org/10.1016/S0140-6736(96)91562-7)
- cf. <https://www.jstor.org/stable/pdf/90480.pdf>
- "Bills of Mortality" summarized data (baptism and death by cause) collected in the parishes of London (later throughout England), originally to monitor the deaths from plague.
 - Since 15C (from 1603, continuous), until 19C
 - A tradition of epidemiologist, seeking to use already collected data, was set by him.
- "Natural and political observations mentioned in a following index, and made upon the bills of mortality" included
 - First observation that more boys are born than girls
 - First actuarial table (lifetable)
 - First time trends of various diseases, adjusted for population size
 - Some apparent changes of disease frequency were caused by the change of disease classification (first in the case of misclassification of plague)
- Graunt's work has several features of good epidemiologic work such as: Original findings, explanations for reasoning, repeated tests, invited readers to criticize his work, revision with new data, estimation based on quantitative approach

Bernardino Ramazzini (1633-1714)

- Polymath, a father of occupational medicine, physician
- cf. <https://dx.doi.org/10.2105%2FAJPH.91.9.1382>
- Used cinchona bark (a source of quinine) to treat malaria
- "De morbis artificum diatriba" (on artificially caused disease) was the first comprehensive work on occupational diseases and industrial hygiene published in 1700.
 - Detailed descriptions of specific occupational diseases
 - Existing knowledge, suggestions for prevention and treatment
 - Physical demands of specific occupations, repetitive physical works – led to ergonomics (citation)

William Farr (1807-1883)

- First "Compiler of Abstracts at the General Register Office in England" since 1839, worked for 40 years.
- Founder of surveillance (cf. <https://doi.org/10.1093/ije/5.1.13>)
- Followed the way of Graunt
- Tested the theory proposed by Malthus on population growth (exponential growth) using compiled data
- Constructed actuarial tables
- Analyses of cholera epidemics in mid-19C London
 - Farr first believed miasma theory (foul air = bad atmosphere causes disease), but changed his mind to believe germ theory later (cf. <http://dx.doi.org/10.1136/fn.87.1.F67>)
 - Under cholera epidemic, Farr included the altitude of the cholera victims in the registry to prove miasma theory, and criticized Snow's causation of drinking water by the equal possibility of miasma. But Snow conducted "natural experiment", to deny miasma theory.

John Snow (1813-1858)

- The father of epidemiology and anesthesiology (used chloroform as anesthetic gases to Queen Victoria's delivery using inhaler to control the flow of the gases)
- cf. <https://doi.org/10.1097/01.ede.0000135915.94799.00>
- cf. [https://doi.org/10.1016/S0140-6736\(08\)60978-2](https://doi.org/10.1016/S0140-6736(08)60978-2)
- As epidemiologist, his excellent works on London cholera epidemic are best known (Details are given in Chapter 4 and 5).
 - From the episode of physician who had close contact with 2 cholera victims who shared the same hotel room but didn't get cholera, he refused direct transmission theory and miasma theory, and assumed the cause of cholera to be contaminated drinking water.
 - Making an epidemic curve and a map of the 1854 cholera outbreak in London. Used stacks of bars to represent the number of fatalities at a given address. Then he found the aggregation of victims around Broad Street Pump. He persuaded to remove the handle, which prevented second outbreak.
 - Compared the mortality risk between 2 water company consumers, then proved that the higher mortality was linked with the water from lower stream of Thames river: "Natural experiment"

Ignasz Semmelweis (1818-1865)

- One of the pioneering epidemiologist born in Hungary, studied medicine and practiced obstetrics in Vienna. Founder of sterilization (cf. <http://dx.doi.org/10.1136/qshc.2004.010918>)
- In his time, puerperal fever was prevalent.
- There were 2 obstetric clinics. Mothers were admitted on alternate days to each of those. Medical students were taught in the first, midwives in the second clinic. The risk of maternal death during delivery was about 10% for women admitted to the first clinic, 4% to the second clinic.
- He investigated a theory that doctors themselves were the source of disease. Medical doctors and students conducted autopsy when patients died and returned to the clinic to examine other patients.
 - Observation: (1) Mortality declined during the absence of autopsy, (2) Doctor nicked himself with a scalpel during an autopsy died of a disease like puerperal fever.
 - Hypothesis: Doctor and students spread the disease from cadavers to patients
 - Intervention: Washing hands in a chlorinated lime disinfectant before returning to the ward
 - Result: The risk of puerperal fever in the first clinic was reduced to the same level as the second clinic
- Germ theory has not been accepted yet and the personality of Semmelweis was bad to persuade others. The wide introduction of antiseptic technique to surgery practice was not done until English surgeon Joseph Lister, influenced by Pasteur.

Florence Nightingale (1820-1910)

- Best known by the great contribution to nursing, but also epidemiologist and statistician, contributed to public health
- cf. <https://www.jstor.org/stable/24969329>
- cf. <https://doi.org/10.1080/15225445.1916.10503703>
- Early professional efforts were paid to care for people in poverty, worked to reform the Poor Law of the UK
- In 1854, she went to the front of the Crimean war with trained nurses, then found that poor nutrition and hygiene, lack of medicines, and indifference were responsible for more deaths among soldiers than injuries. She instigated improvements such as better sewage and ventilation → Death rate dropped soon.
- Wrote a treatise on health conditions in the Crimea, for which she invented "polar-area diagram" or "coxcomb" (Fig 2-1). Monthly deaths attributable to preventable and unpreventable causes were plotted to proportionate to its area → Most deaths were preventable
- Later, she paid attention to improve sanitation in India.

Janet Lane-Claypon (1877-1967)

- The inventor of the modern case-control study.
- cf. <https://doi.org/10.1007/s000380200003>
- cf. <https://doi.org/10.1093/aje/kwh185>
- In 1912, published the results of a study examined weight gain during infancy between
 - Breast feeding vs bottle feeding
 - Boiled vs raw cow's milk among bottle-fed
- It has been described as the first retrospective cohort study, but the earlier studies of Snow on cholera or Semmelweis on puerperal fever may be also referred as retrospective cohort studies
- But her study on infants' weight gain was excellent in basic design and avoidance of systematic and random errors
 - Excluded sick infants to prevent confounding
 - Wrote about possible confounding by social class
- In 1926, she published the results of the first modern case-control study about the risk factors of breast cancer. Selected 500 cases and 500 controls from hospitals, exposure information was obtained by the questionnaire designed for the study
 - She wrote the possibility of recall bias
 - The study became the groundwork of breast cancer epidemiology.

Wade Hampton Frost (1880-1938)

- First professor of epidemiology at Johns Hopkins School of Hygiene and Public Health
- cf. <https://doi.org/10.1093/aje/kwn268>
- cf. <https://doi.org/10.1007/s10654-006-0022-x>
- Graduated from the medical school of the University of Virginia, but chose a career in public health. Germ theory was still new.
- He investigated the yellow fever at New Orleans, just after the establishment of transmission route by vector mosquito *Aedes aegypti*. Then he eliminated the breeding spots for the mosquito and eventually stopped the outbreak after 459 people died.
- He studied infectious diseases, influenced by William Budd study on typhoid fever (<https://dx.doi.org/10.2105%2Fajph.8.8.610>) and Snow on cholera.
 - His study on polio led to understanding that paralytic cases constitutes only a small proportion of those infected.
 - His study on Spanish flu showed that the effects of influenza epidemics could be tracked using death rates for pneumonia, then revealed the case-fatality rate (now called as case-fatality ratio or risk) during pandemic showing bimodal age distribution
 - His study on tuberculosis showed the power of analysis of mortality rates by birth cohort.
 - He also developed mathematical model with Lowell Reed (details will be given in Chapter 6).

ALSO NOTEWORTHY

- Many others could be mentioned
 - William Budd
 - Edward Goldberger
 - Major Greenwood
 - Edward Jenner
 - James Lind
 - Pierre Louis
 - Peter Panum
 - Geoffrey Rose
 - Edgar Sydenstricker
 - Austin Bradford-Hill
 - Richard Doll
 - Brian MacMahon
 - Abraham Lilienfeld
 - John Cassel
 - ...