2. An evolving historical perspective[*]

The evolution of epidemiology into a science of the distribution of disease in populations and evaluation of interventions for disease prevention and therapy.

Why study history [and herstory]?

To understand a condition or event, we need to understand where it came from.

To learn the lessons of the past

To broaden our awareness from contemporary views by gaining perspective

What is history?

History, according to Edward Hallett Carr, is a "continuous process of interaction between the historian and his facts, an unending dialogue between the present and the past"[*]

Propositions from studying history of epidemiology

1. Life has not always been the way it is in the developed countries today.
2. Scientific understanding of disease and the factors that affect it is largely a product of the last 150 years, with very rapid advances in the last half-century..
3. Epidemiologic studies have not always been like ______ (insert the name of your favorite epidemiologic study).
4. There are many histories of epidemiology
   - History of health and disease
   - History of ideas and concepts
   - History of methods
   - History of knowledge gained through these concepts and methods
   - History of teachers and students
   - History of organizations and actions

A brief history of public health

Community attempts to prevent and limit the spread of disease go back to antiquity. For example, religious traditions against eating pork and shellfish reflect the special hazards of eating those foods

[*] The following material draws heavily on lectures at the UNC Department of Epidemiology by Drs. Abraham Lilienfeld (1984) and Joellen Schildkraut (1989, 1990, 1991).
[*] Carr, Edward Hallett. *What is history.* NY, Knopf, 1963, taken from the George Macaulay Trevelyan Lectures in the University of Cambridge in 1961, p.35.

when inadequately preserved or prepared. As often happens in public health, even without an understanding of the underlying etiology, effective preventive measures can be taken.

Successes in prevention reinforce the concept that disease can be prevented through human action other than prayers and sacrifices to the gods, which in turn encourages additional attempts at prevention. By the 1600's, the practices of isolation and quarantine had begun to be employed to prevent the spread of certain diseases; by the 1800's these practices had become common in the American colonies. Methods of smallpox inoculation also began to be used and apparently mitigated some epidemics, even before Edward Jenner's introduction of a safe vaccine based on cowpox virus.

With the 19th century came two dramatic advances in the effectiveness of public health – "the great sanitary awakening" (Winslow, quoted in *The Future of Public Health* [FPH]: 58) and the advent of bacteriology and the germ theory. Those of us who see all progress in the field of health in terms of laboratory discoveries and medicines have not had the experience of living in a 19th century city. In New York City, piles of garbage two-three feet high were accompanied by epidemic smallpox and typhus. The crowding, poverty, filth, and lack of basic sanitation in the working class districts of the growing cities provided efficient breeding grounds for communicable diseases. Diseases that formerly arrived from outside to cause epidemics in basically healthy populations now became permanent residents. Quarantine and isolation, which were somewhat effective against individual cases and illness brought by travelers, were inadequate against mass endemic disease.

Moreover, industrialization and urbanization brought people of different classes geographically closer. No longer able to escape to their country estates, well-to-do families also fell prey to the highly contagious diseases that incubated among the working class. The shared vulnerability and the succession of reports of conditions in the working class supported the view that while poverty might still reflect individual weakness and moral defects, society nevertheless had to take actions to improve conditions.

In England, the Poor Law Commission led by Edwin Chadwick studied the English health of the working class. Their famous – and controversial – *General Report on the Sanitary Conditions of the Labouring Population of Great Britain* presented a "damning and fully documented indictment of the appalling conditions" (Chave, in FPH: 59-60). The studies revealed that the *average age at death* for laborers was 16 years. For tradesmen it was 22 years; for the gentry, 36 years. In London more than half of the working class died before their fifth birthday (Winslow, in FPH).

A comparable document in the United States was Lemuel Shattuck's 1850 *Report of the Massachusetts Sanitary Commission*. Unlike Chadwick's report, however, Shattuck's report went largely ignored due to the political turmoil in the United States. After the Civil War, though, many of its recommendations were adopted, and it is now regarded as one of the most influential American public health documents (FPH: 61).

Though controversial in many ways, sanitary reforms fit reasonably well with the moral views of the time. Much of the scientific rationale for the reforms – the relatively nonspecific model by which filth and putrid matter gave off emanations (miasma) that gave rise to disease – has only modest correspondence to modern biological understanding. Nevertheless, many of the reforms did reduce the transmission of disease and were therefore effective.

But the advance in understanding of infectious disease that constituted the arrival of the bacteriologic era at the end of the century dramatically increased the effectiveness of public health action. In one dramatic example, mosquito control brought the number of yellow fever deaths in Havana from 305 to 6 in a single year (Winslow, in FPH: 65). Cholera, typhoid fever, and tuberculosis, the great scourges of humanity, rapidly came under control in the industrialized countries.

	Time line for the history of public health and epidemiology.
Antiquity	Concepts of health closely tied to religion (e.g., Old Testament)
	Greek writers draw links to environmental factors (e.g., Hippocrates)
	Romans associate plumbism with wine from lead-glazed pottery
1334	Petrarch introduces the concept of comparison and indeed of a clinical trial
1603	John Graunt – Bills of Mortality and the "law of mortality". The first life table, giving the probability of dying at each age.
1700	Bernadino Ramazzini – "father of occupational epidemiology"; also breast cancer in nuns
1706-1777	Francois Bossier de Lacroix (known as Sauvages) – systematic classification of diseases (*Nosologia Methodica*)
1747	James Lind – scurvy experiment
1775	Percival Pott – scrotum cancer findings
1798	Edward Jenner – cowpox vaccination against smallpox
1787-1872	Pierre Charles Alexandre Louis (1787-1872) – the "Father of Epidemiology", *La methode numerique*
	LaPlace, Poisson – the birth of statistics
1834	William Farr, William Guy, William Budd (all students of Louis) – founded the Statistical Society of London
1847	Ignaz Semmelweiss (Vienna) – discovers transmission and prevention of puerperal fever
1849	John Snow – waterborne transmission of cholera
1850	Epidemiological Society of London established
1851	John Grove – *On the nature of epidemics* (presented the germ theory)
	Oliver Wendell Holmes and George Shattuck, Jr. (and Shattuck's student, Edward Jarvis) – founded the American Statistical Society
1870	Beginning of the era of bacteriology
1887	The Hygienic Laboratory, forerunner of the U.S. National Institutes of Health, is created within the Marine Hospital Service in Staten Island, NY
1900	Yule – notion of spurious (i.e., nonsubstantive) correlations, "Simpson's paradox"
1914-1918	Joseph Goldberger studies pellagra
1920	Split between U.S. organized medicine and physicians interested in public health (the latter were interested in national health insurance; public health concern vs. individual concern)
1937	Austin Bradford Hill, *Principles of Medical Statistics*
1942	Office of Malaria Control in War Areas (in US; became Communicable Disease Center (CDC) in 1946, Center for Disease Control in 1970, Centers for Disease Control in 1980,

	and Centers for Disease Control and Prevention in 1992)
1948	World Health Organization (WHO)
1948	John Ryle becomes first chairman of social medicine at Oxford. Observed that physicians have curiously little concern with prevention.
1950's-1970's	Epidemiology successes – fluoride, tobacco, blood pressure and stroke, CHD risk factors, toxic shock syndrome, Legionnaire's disease, Reye's syndrome, endometrial cancer and exogenous estrogens
1975	Lalonde Report (Canada)
1979	*Healthy People U.S.* and *Health Objectives for the Nation*
1988	U.S. Institute of Medicine *Report of the Committee for the Study of the Future of Public Health* – Public health system is in "disarray" – AIDS, injuries, teen pregnancies, Alzheimer's disease

Rise of epidemiology

Epidemiology was at the core of many of the studies that led to the above advances and to subsequent ones. But until well into the 20th century, epidemiology was not a distinct profession and/or practice, so it is not meaningful to say when its contributions began. The studies that led to the Chadwick and Shattuck reports drew on concepts that had arisen during earlier centuries, including the use of quantitative reasoning, the idea of comparing groups or populations, the collection of vital statistics, and methods of analysis (e.g., the life table).

The birth of modern epidemiology occurred during the 19th century. According to David Morens (*Epidemiology Monitor*, February 1999: 4), epidemic investigations prior to the middle of that century were mostly descriptive, rather than etiologic in orientation. Peter Panum, however, investigated the 1846 measles outbreak on the Faroe Islands "much the way an Epidemic Intelligence Service Officer at CDC would today". The classic investigations on the transmission of cholera (John Snow), typhoid fever (William Budd), and puerperal fever (Ignaz Semmelweis) led to understanding and the ability to reduce the spread of major infections. John Grove presented the germ theory in his 1851 treatise *On the nature of epidemics*.

Pierre Charles Alexandre Louis (1787-1872), sometimes called the "Father of Epidemiology", systematized the application of numerical thinking ("*la methode numerique*") and championed its cause. Using quantitative reasoning, he demonstrated that bloodletting was not efficacious therapy, and wrote books on tuberculosis and typhoid. Louis' influence was widespread, primarily through his students. (An interesting historical observation is that Louis was of lower class background; absent the French Revolution, he would probably not have had the opportunity to contribute to science and medicine.)

Many of Louis' students became leading exponents of and contributors to epidemiology. William Farr pioneered the use of statistics in epidemiology and introduced the concepts of the death rate, dose-response, herd immunity, and cohort effect. He also showed that prevalence is a function of incidence and duration and the need for large numbers to demonstrate associations. He and two other students of Louis (William Guy and William Budd) founded the Statistical Society of London. William Guy studied tuberculosis in relation to occupation and, I believe, conceptualized the odds ratio – the method for estimating relative risk from case-control data. Two other of Louis' students, Oliver Wendell Holmes and George Shattuck, Jr. (and Shattuck's student, Edward Jarvis) founded the American Statistical Society (see genealogy table in Lilienfeld and Lilienfeld, 2nd ed., Fig. 2-1).

Epidemiology continued to grow and develop, particularly in Britain and America. In addition to the continuing challenges from urban crowding and large-scale immigration, the revolution in bacteriology had great applicability for military forces, for which infection and disease were major threats to effectiveness. Thus, 20th century combat brought epidemiologists into the war effort. The Hygienic Laboratory (the forerunner of the U.S. National Institutes of Health, originally established as a one-room bacteriology laboratory in an attic of the Marine Hospital Service in Staten Island, NY) provided laboratory support for the U.S. military during the Spanish-American War (Winkelstein, 2000). The U.S. Army Medical Corps and its British counterpart played major roles in preserving the health of the troops in several wars.

The relationship of epidemiology to war has been a reciprocal one. The U.S. Centers for Disease Control and Prevention (CDC) was born as the World War II Office of Malaria Control in War Areas, becoming the Communicable Disease Center in 1946, the Center for Disease Control in 1970, the Centers for Disease Control in 1980, and receiving its present name in 1992. The CDC's Epidemic Intelligence Service was established in response to concern about importation of exotic diseases from Asia, a concern arising during the Korean War. In the second half of the 20th century, epidemiology flourished, with the creation of departments of epidemiology in many universities and corporations, dramatic expansion of research (and funding for biomedical research in general), broadening of methodological and technological capabilities, growth of professional societies and journals, and coverage of epidemiology in the mass media. Growing fears of bioterrorism during the latter half of the 20th century blossomed with the mailing of anthrax spores to two U.S. senators and two news organizations and prompted a major infusion of resources into public health.

Threads in the fabric of the development of epidemiology

Quantitative reasoning
Comparative studies – comparison of groups or populations
Vital statistics system
Hygienic and public health movement
Improvements in diagnosis and classification
Statistics
Computers
Personal computers
User-friendly statistical software
Biotechnology revolution
Genomics

The importance of context

Public health advocates often accuse medicine of being reactive, since physicians treat disease after it occurs whereas public health professionals work to prevent disease. Interestingly, though, advances in public health knowledge and practice occur typically as reactions to public health problems. A century and a half ago, for example, cholera epidemics in London stimulated the public health movement and the development of the London Epidemiological Society. During the past two decades, the emergence and re-emergence of major infectious pathogens (HIV, TB) have stimulated the resurgence of infectious disease epidemiology, which as recently as the 1970's seemed to be on the road to extinction, as well as to an enormous expansion in other types of research directed at infectious disease.

Wars are also a very important factor in public health, devastating to public health and public health programs in populations that suffer attack and engines of advances in public health knowledge in countries whose homeland remains undamaged. Improved treatment of wounds (Britain) and the purification, testing, and manufacture of penicillin (Britain and the U.S.) are only two of the many advances stimulated by military exigencies. Apart from military motives, the growth of government is responsible for public health advances for other reasons when there are supportive attitudes about what government should do. For example, the French Revolution and the growth of populist thinking in Europe were strong stimuli to interest in public health.

Scientific progress is fundamental to public health advances, of course, since regardless of what people think that government *should* do, what it *can* do is constrained by available knowledge and technology. What government can do is also constrained by attitudes and beliefs about what is proper. Former U.S. Surgeon General [C. Everett] Koop has related how, during a 1940's radio program to talk about his studies of childhood cancer, he was told that he could not say the word "cancer" (it was to be referred to as "that dread disease"). Progress in preventing HIV and sexually transmitted diseases has had to contend with legal and extra-legal restrictions on open discussion about sex and particularly about anal sex.

These are only a few of the myriad influences on the evolution of public health and epidemiology. Further examples of these influences, most of which affect each other as well as public health, are:

> *Changing demography, economics, transportation, commerce, technology, organizations, politics, wars –*
> The entire health care delivery system has been transformed through the rise of managed care organizations.
>
> *Changing diseases and afflictions through the centuries –*
> Hunger, infections, malnutrition, reproductive disorders, chronic diseases, environmental and occupational diseases, violence and injury, health care and pharmaceuticals, mental health, aging – different disease patterns dominate at different times, as the conditions of life change
>
> *Developing scientific knowledge and technology changes understanding of disease and approaches to studying it –*
> Introduction of Pap smear in 1940s led to knowledge of natural history of cervical cancer. Development of coronary angiography enabled visualizing of atherosclerosis during life as well

as coronary artery spasm. Consider the impact of the development of microscopy, the stethoscope, electrocardiograms, culture techniques, biochemistry, cytology, computers, angiography, radioimmunoassay, DNA probes, …

Expanding social and political consciousness –
Hygienic movement, Marxism, social democracy, health promotion movement, minority health. Increased demand for (and on) epidemiology and public health (e.g., the Lalonde Report).

Expanding social organization and investment in public health resources increases the opportunities for epidemiologic research and application –
- Hospitals
- Vital statistics systems
- Health surveys
- Research funding
- Disease registries
- Insurance systems
- Record systems, computerized databases

The challenge of hindsight

In order to grasp the significance of the evolution of ideas, we need to put ourselves in the mindset of the time and appreciate the imagination (and deviance) necessary to see things in a new way. Many of the problems faced by past investigators seem so manageable compared to the ones we face today. But how did those problems look without the benefit of the knowledge and concepts that we take for granted.

Induction and latency

Consider the example of the incubation period. In infectious diseases, there is commonly an incubation period, often on the order of 1-14 days. Until this phenomenon became known and accepted, it must have been difficult to make the connection between the onset of an illness and an exposure some two weeks earlier. Panum helped to document this phenomenon, and his studies of measles onset and previous exposure to cases are a classic of careful description and inference. With chronic diseases, the "incubation period" is much longer. Pellagra develops over a period of several months. Atherosclerotic heart disease and cancer can take 5, 10, 20, or even 30 years. Lengthy separation of cause and effect is certainly much more formidable than the 2 weeks involved in measles, but is it more formidable in terms of the level of knowledge then and now?

Rarity of disease

Rarity of a disease is in some respects an advantage for studying it and in some respects an obstacle. Epidemics are easy to study in the sense that each occurrence represents a form of natural experiment. They provide contrasts between the before and the after (e.g., arrival of a ship to the Faroe Islands, arrival of a person with typhoid fever in a previously unaffected village). With an endemic disease, on the other hand, there is no obvious contrast to stimulate perception of new events or new modes of living that could have introduced the disease. On the other hand, very rare diseases are difficult to study because of the difficulty of assembling enough cases.

Thoroughness of methods

Some famous investigators are recognized as such for advances in the methodology of their studies – advances in rigor, exquisite thoroughness, and painstaking attention to detail – before such methods were in common use. We now take it for granted, and grant proposal reviews enforce, that an investigator will conduct a systematic review of existing evidence, make use of vital statistics data, formulate precise definitions of disease and other variables, collect data in an even-handed manner, employ checks of reliability and validity of the data, and analyze the data with due attention to alternative explanations of the findings. But each of these and other desirable methodologic practices had to be introduced at a time when it was not common practice. A common theme in the "classics" is that each investigation involved careful, systematic and detailed observation – "shoe leather" epidemiology. Not all of the practice of epidemiology is as glorious as the celebrated insights.

Disease prevention

The classic studies also gave rise to health promotion/disease prevention recommendations involving sanitary practices, personal hygiene, and diet – even before the identification of the actual etiologic or preventive agent. But is there a lesson in the observation that the dietary changes recommended by Goldberger for prevention of pellagra – increased intake of meat and dairy products – is in some respects the reverse of current recommendations for the prevention of cancer and CHD? It is also interesting to contrast these diseases and the interventions they recommended with those for contemporary epidemics (CHD, lung cancer, motor vehicle injuries, handgun fatalities). Do you suppose the public reacts differently to being told to eat *less* meat than it did to being told to eat *more* meat?

Insight based on but not constrained by knowledge

Enduring recognition over time comes from distinctive accomplishment, from achievement beyond the expected. One mark of distinction is the attainment of insight that builds on existing knowledge but is not unduly constrained by it. Scientific advances generally build on knowledge that has been successively accumulated by many people over many years. But such knowledge is understood in terms of existing paradigms (see Thomas Kuhn, *The structure of scientific revolutions*). If the existing paradigm or theoretical structure that governs the interpretation of observations is inadequate to the problem at hand, then progress demands a new or modified paradigm.

Almost by definition, a great step forward in thinking occurs in advance of general understanding. Avogadro's theory that the number of molecules in a gas is a function of its volume took 50 years to become accepted. X-rays were originally regarded as an elaborate hoax (Kuhn, 1970). In a number of the epidemiologic classics, the prevailing theories were misleading. A key contribution was the discarding of certain beliefs of the time, and the investigator had to contend with active opposition to his investigations.

According to David Morens (*Epidemiology Monitor*, February 1999: 4), when Panum's 1847 work on measles appeared in French several years later, an unsigned review of his work in the *British and Foreign Medico-Chirurgical Review* observed " 'It is seldom, indeed, that an opportunity like that here described is afforded to a prudent and able man of science, who, like our author, rejecting all previously conceived opinions, diligently investigates the truth for himself.' " Joseph Goldberger, in his studies of pellagra about 65 years later also had to depart from the accepted wisdom of the time. Not long before he began his work, a 1914 commission had concluded that pellagra was an infectious and/or hereditary disease. Goldberger's careful study of all the facts enabled him to deduce that pellagra was not, in fact, a communicable disease. This study took him three months. It then took him several years, including some outlandish (heroic?) experiments in order to convince his scientific peers of the correctness of his deductions. In Goldberger's case, others had known the pertinent facts, but their import had not been grasped.

William Farr fought the idea that cholera was spread by germs because in his data high altitude was associated with cholera, consistent with theories about atmospheric pressure and miasmas. Lind's discoveries were not adopted by the British Navy for a full 40 years, and Percival Pott's discovery about how to prevent scrotal cancer, though quickly adopted in Denmark, was not adopted in England for nearly a century. The classic papers on lung cancer and tobacco smoke, published in the *Journal of the American Medical Association* by Wynder and Graham and Doll and Hill, were almost rejected by the editor because of the lack of existing knowledge supporting the association. Despite numerous studies yielding similar findings, eminent statisticians (R.A. Fisher, Berkson) remained highly skeptical for many years.

> "Truth is the daughter of Time and not of authority." Sir Francis Bacon (1561-1626)
>
> "It is the customary fate of new truths to begin as heresies and to end as superstitions." Thomas Henry Huxley, "The Coming of Age of 'The Origin of Species'" (1880) (http://babbage.clarku.edu/huxley/CE2/CaOS.html)

The study of history broadens our vision and suggests that for us to rise above the common wisdom of our time we may have to accept the discomfort that comes with deviating from the conventional. For example, if an epidemiologist were to suggest that psychiatric disorders are spread by transmission of thoughts, this suggestion would be ridiculed. Was the suggestion that water was a vehicle of transmission of cholera and typhoid similarly regarded in the last century? What about the transmission of measles virus through air? Can we achieve the acuity of hindsight without the wait?

Conceptual and philosophic basis for epidemiologic advances – changing paradigms

Humors in the body
Miasma (17th century)
Contagium vivum
Concept of specificity of disease and causal agent
Multicausality
Molecular and genetic
Biotechnology

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NOTE: www.epidemiolog.net has links to two web sites devoted to the life, times, and studies of John Snow and to sites on the history of medicine at the U.S. National Library of Medicine and the University of Alabama at Birmingham School of Medicine.

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