Polybius was right. The world must be seen as an organic whole where everything affects everything else. That being the case, we are faced with such complexity that attempts to understand the full ramifications of any given event or person’s life are fraught with peril, including the attempt to understand Alexander D. Langmuir’s impact on public health. Some people are indeed “larger than life” and have a broader impact than others. When that happens, it is often because such people have an important message, possess the ability to be effective messengers, and are in the right place for that message to have an impact. In the absence of all three ingredients, the impact may be muted.

For example, the Marshall Plan is seen as a key ingredient in the rebuilding of Europe at the end of the Second World War. We link that plan with General George Marshall and his 1947 Harvard University commencement address. In fact, the plan was written on an airplane by Undersecretary of State Will Clayton as he returned from Europe. Would it have had the same impact if called the Clayton Plan? It is doubtful. Clayton took the plan to Dean Acheson, who took it to President Truman. Truman approved it. The plan was presented in a commencement address given by Dean Acheson on May 8, 1947, at the Delta State Teacher’s College in Cleveland, Mississippi. The New York Times reported on the address and James Reston even did an analysis, but the wire services did not pick up the story. The message was right, but evidently it was sent in the wrong place or by the wrong person. Less than a month later, on June 5, General Marshall presented the same idea at the Harvard commencement, and his talk was sent around the world. Message, messenger, and location all came together (1).

Alexander Langmuir was the right messenger, with an important public health message, and while the Centers for Disease Control was the right place for that message, he helped make the Centers for Disease Control the optimal place for it. What was the message? That epidemiology is the basic science of all public health and that there are scientific rules for the optimal application of epidemiologic methods.

“Stripped to its basics,” Langmuir used to say, “epidemiology is simply a process of obtaining the appropriate numerator and denominator, determining a rate, and interpreting that rate.” If it is that simple, what is the essence of Langmuir’s contribution? This writer will use two approaches to attempt an answer. The first will be to examine in more detail the message, messenger, and place of message, and the second will be to note the greatest contributions Langmuir made to public health, in this author’s opinion.

MESSAGE, MESSENGER, AND PLACE OF MESSAGE

The message

Epidemiology has been used since the beginning of human history. Surely early hunters determined the risks of stalking certain animals, used methods with the highest likelihood of success, concentrated their activities in the geographic areas of highest productivity, and added to their base of knowledge with each encounter. This was a process of making an estimate of rates and interpreting them.

In public health, we are reminded of people who used such approaches in a systematic manner before a body of knowledge based on experience had been assembled. Edward Jenner observed smallpox rates to be lower among milkmaids who had been exposed to cowpox than among people without such exposure. Only after years of careful observation did he, on May 14, 1796, try the first vaccine on James Phipps (2). Oliver Wendell Holmes, using epidemiologic reasoning, concluded in 1843 that unclean attending physicians were spreading infection to women giving birth (3). The paper by Holmes was largely ignored until Ignaz Semmelweis gathered numerators and denominators on deaths occurring among women giving birth on two different wards in Vienna. He calculated an-
nual mortality rates as being over 10 percent on a ward where physicians and medical students treated patients, and compared this with a ward run by midwives, where the rate was below 3 percent. He concluded that infections were being spread to the women by physicians and medical students, who at that time did not wash their hands, even after doing autopsies (4, 5). Snow used differential cholera rates between the customers of two different water companies to conclude that the disease was being spread through contaminated water (5, 6). Each of these examples provided valuable lessons in public health methodology, but they continued to be individual lessons without the assemblage of a body of scientific knowledge to be shared with all public health practitioners.

The move toward the creation of a body of skills and knowledge available to all public health workers began 76 years ago, when Wade Hampton Frost, on loan from the US Public Health Service, started the first Department of Epidemiology at The Johns Hopkins University’s new School of Hygiene and Public Health (7). Alex Langmuir was in the second grade. Today, it would be impossible to contemplate a public health curriculum without epidemiology, which makes it difficult to remember that epidemiology as an academic discipline is less than a century old. Langmuir went to Johns Hopkins the year after Frost’s death, but he inhaled the heady atmosphere Frost had created in that institution and began to refine the discipline in practical and applicable ways.

In 1949, Langmuir accepted a position at the Communicable Disease Center (8), now called the Centers for Disease Control and Prevention (CDC), and until 1970 he revolutionized the way epidemiology was used in public health practice, first in the United States and then throughout the world.

The messenger

The messenger grew and developed at the same time that epidemiology was evolving as an academic discipline. Langmuir’s first paper was published in the *New England Journal of Medicine* while he was still in medical school (9). The paper discussed mortality risk factors for pulmonary tuberculosis, a harbinger of his later focus on respiratory infectious diseases. He was trained as a clinician first, but then undertook a variety of public health responsibilities that provided abundant problems and an opportunity to apply epidemiology to their solutions. He worked in the New York State Health Department, in a county health department (Westchester County, New York) with military problems during the Second World War, and finally as an academic at Johns Hopkins. He was well prepared and well experienced for national responsibilities when he arrived at the CDC, but more than that, he had a vision of how epidemiology could be used in the practice of public health.

The place of the message

The Communicable Disease Center had only been in operation for 3 years at the time Langmuir arrived. It had evolved from the wartime malaria program, had a good reputation, and was free of the many limitations imposed by tradition. The CDC was seemingly ready-made for the delivery of Langmuir’s epidemiologic message, but in turn he helped to provide a credibility that made the institution stronger and worthy of that message. He helped make the CDC a world-class institution through the development of the Epidemic Intelligence Service, the willingness to respond to every request for assistance made by state health departments, and the institution of training programs oriented toward public health applications rather than academic degrees—training programs that combined the challenge of delivering a service with the use of basic epidemiology to produce quality science. He also strengthened the CDC by upgrading a communications system that provided public health information and interpretation on a weekly basis through the *Morbidity and Mortality Weekly Report*.

LANGMUIR’S GREATEST CONTRIBUTIONS TO PUBLIC HEALTH

The solving of specific public health problems

During Langmuir’s tenure, it became expected and almost unnoticed that public health problems large and small were being solved. The institution of a malaria surveillance system in the early 1950s revealed that malaria had quietly disappeared from the United States. Influenza surveillance tracked the spread of the influenza virus around the country, but it also led to global surveillance and an attempt to develop tailor-made vaccines based on viruses recovered in the Southern Hemisphere during the US summer. Langmuir’s continuing fascination with influenza preceded his work at the CDC. He wrote extensively on the subject as part of his work with the military during World War II. He continued to publish papers on influenza while at the CDC and supervised much of the work being done in that field, but in addition, he was still publishing articles on influenza long after leaving the CDC (10). He was involved in demonstrating that hepatitis could be spread through raw seafood, which changed our eating practices; and his officers conducted investigations of salmonellosis, which helped identify risk factors that could be modified.

*Am J Epidemiol* Vol. 144, No. 8 (Suppl), 1996
Perhaps the most important of his early investigations took place in April 1955 with what became known as the Cutter poliomyelitis incident. Administration of polio vaccine was causing cases of polio, and Langmuir was asked, by Surgeon General Leonard Scheele, to develop a surveillance system, literally overnight, to determine the extent of the problem and to decide whether polio vaccine should be withdrawn from the market. Using the new system of Epidemic Intelligence Service (EIS) officers, it was possible for Langmuir to undertake an unprecedented investigation. Within days, detailed information had been obtained from dozens of persons with polio with which to examine dates of onset, prior polio vaccination, type of vaccine, etc., and it was determined that the vaccine problem was limited to a single manufacturer. Langmuir was able to predict with great accuracy the expected size of the epidemic and the number of secondary cases that would occur. The defective vaccine was withdrawn, but the polio vaccination program itself continued. This and other examples of an immediate response to public health problems and crises set a pattern that continues today. The EIS is now a national public health resource that is being copied by other countries and supported by the CDC through the Field Epidemiology Training Program.

The routine use of epidemiology in public health practice

Responding to the states’ requests for assistance provided a workshop for refining the tools of surveillance, epidemiologic investigation, and response. The lessons learned from these field investigations provided a body of experience and knowledge for the CDC, for the states involved in each outbreak, and, through CDC publications, for all of the states. Public health norms changed so that there was an expected protocol for investigating problems. Even when the CDC was not asked to provide personnel, they became a resource available by telephone for local investigations. This revolution in the use of epidemiology in daily public health work may turn out to be Langmuir’s most lasting legacy.

Such investigations often solve a local problem by suggesting a logical intervention, but frequently an investigation provides information that leads to changes in national or international public health policy. Two dozen deaths following the use of liquid protein diets in the 1970s led to an understanding of the cardiac risks of such severe nutritional restrictions and to the development of guidelines on prudent diet regimens (11). Cases of toxic shock among women, found to be associated with certain kinds of tampons, led to the voluntary withdrawal of one product from the market and to policy guidelines that have reduced the risk of toxic shock syndrome (12). The use of aspirin during illness due to influenza or chickenpox was found to increase children’s risk of Reye’s syndrome, a severe and often fatal condition. Subsequent policy decisions by the Public Health Service led to warnings to parents and the labeling of children’s aspirin. A marked decrease in Reye’s syndrome has resulted (13).

An attempt to interrupt measles transmission in the United States has involved the intense use of surveillance and epidemiologic analysis. This has led to continuing changes in policy as more information becomes available. Consideration of age at measles immunization, the failure of vaccine to induce secure protection due to the continuing circulation of maternal antibodies during the first year of life, and similar factors has resulted in continuing scrutiny of strategies and evolving policies (14). The military began immunizing all new recruits when they were found to constitute a reservoir of susceptibles who could then transmit the virus to other recruits or to civilians during leaves (15). College entry immunizations were instituted on the basis of epidemiologic findings. A booster dose of measles vaccine was added to the national guidelines when it was found that failure rates threatened the target of interruption (16). These measures illustrate that public health policy is absolutely dependent on the best epidemiology possible.

The development of national surveillance systems

The United States had no national surveillance system for any disease prior to the middle of the 20th century. In the 1990s, this is hard to comprehend. The malaria surveillance system was the first to be instituted; then came surveillance for polio in 1955, influenza in 1957, and finally dozens of other diseases. These systems work not because the CDC develops them but because the federal-state-local coalition, so frequently criticized in other fields, actually works in public health. The states decide which conditions will be reported on a national basis; for conditions that are not reported nationally, individual states can decide to take part in ad hoc surveillance systems in collaboration with the CDC. The net effect has been an information system that is far better today than ever before. It has provided a valuable model for global programs, and it has now expanded to include information from occupational and environmental sources, police departments, coroners’ offices, hospitals, and emergency rooms, as well as ongoing random-sample surveys that include risk factors extending far beyond morbidity and mortality.
The system is now being expanded in some pilot states to intensify the level of surveillance, because of concern that emerging infections are not being recognized early enough. If this attempt to learn more about new infections—and their risk factors, etiology, and connection to antibiotics—proves useful, the system will be expanded to the entire United States and beyond. These systems build upon the pioneering work of Alex Langmuir.

The development of the Epidemic Intelligence Service

Out of the fear of biologic warfare during the Korean War, officials concluded that it was necessary to develop defensive strategies to rapidly characterize disease outbreaks, provide for diagnosis, and develop control procedures. Langmuir saw the opportunity to meet this requirement and at the same time provide epidemiologic assistance to the states by supplying preceptorial training to public health officers assigned in the field, with full support and mentoring available from the CDC. Officers were given a few weeks of basic training at CDC headquarters in Atlanta and then assigned to CDC programs, to state, county, or municipal governments, or to universities. The plan was to help these persons develop expertise on the job by investigating the many disease problems that occur daily, such as foodborne outbreaks, hepatitis, streptococcus, hospital infections, etc. Not only would this improve their capacity to recognize unusual outbreaks of disease but the training obtained in recognizing and controlling endemic and epidemic problems would be directly transferable in the event of intentional biologic conflict. Beyond expectations, and quite aside from biologic warfare, this capacity turned out to be of great domestic assistance. Problems were solved, the public health infrastructure was strengthened, and nationwide surveillance was established.

It has often been noted that the presence of EIS officers in the states made for stronger state public health programs. Not often noted is the impact of the EIS on the growth of CDC headquarters. Laboratory and epidemiologic capability was needed to support the field staff, and as the capacity of CDC headquarters increased, the CDC became increasingly credible. Within two decades, the training of epidemiologists at the CDC became a standard for other countries and for the World Health Organization.

While EIS officers serve for only 2 years, a large number of them remain at the CDC; many serve in health departments in US states, counties, or cities or in other countries; and a network of former EIS officers exists around the world. Continuing connections between these graduates are encouraged by an annual directory which provides information on places where the 2,000 current and former officers live and work. This directory makes it possible to identify former EIS officers for assistance with special disease problems developing anywhere in the world. The citation for the Doctor of Humane Letters degree conferred on Alex Langmuir by The Johns Hopkins University reads, in part, “Through the Epidemic Intelligence Service, you bequeathed to the future a generation of leaders bearing the indelible Langmuirian stamp of excellence and integrity, always seasoned by an appreciation of the adventure implicit in the practice of public health and epidemiology.”

The expansion of public health boundaries

While infectious diseases formed the basis of CDC operations for many years, Langmuir was anxious to broaden the application of epidemiology to the problems of population growth, drug use, chronic diseases, occupational and environmental health, and toxic hazards, as well as to famines and disasters. Just as he recognized the global value of smallpox expertise and started a smallpox program at the CDC during a time when the US population was not at high risk for the disease, so also did he recognize, early on, the impact of the population explosion on future conditions and make a specific effort to train epidemiologists skilled in the area of family planning and population dynamics. That interest can be seen today in programs operating at the CDC and around the world. As the 20th century closes, epidemiology plays a part in such a broad spectrum of health and social problems that it takes effort to realize that “public health” and “infectious disease control” were almost interchangeable ideas in 1950.

An international perspective

Langmuir encouraged a global perspective. For example, despite the low risk of smallpox to US citizens, he promoted the development of expertise and finally the involvement of CDC staff in global smallpox eradication. He was interested in malaria and accepted invitations for CDC staff members, including himself, to participate in malaria prevention activities. He was a member of the World Health Organization’s Expert Advisory Panel on Malaria from 1967 to 1972. His interest in cholera, again a disease of low risk for Americans, led to an interest among EIS officers and their involvement in anticholera efforts in Thailand, Bangladesh, and other countries. EIS officers made contributions to the development of oral rehydration therapy, which now prevents over one million deaths from diarrheal disease per year. There was no disease
anywhere in the world that was beyond his interest, which in turn stimulated a large number of EIS officers to become professionally involved in specific disease problems and international health in general. This influence is still evident today, a quarter of a century after Langmuir left the CDC, in the international work being done there, including the Field Epidemiology Training Program and the Control of Childhood Communicable Diseases program, as well as in the staffs of global organizations, nongovernmental organizations, and schools of public health.

Public health mentoring

An impressive number of public health workers consider Langmuir to have been their mentor. He was always ready to provide suggestions, enjoyed reviewing papers or proposals, and had numerous ideas on how to improve a document. He would not allow his name to be added to a paper unless he had actually been involved in the investigation and preparation of the manuscript, yet his ideas were incorporated into hundreds of papers that do not bear his name. He attended the lectures staff members would give for new EIS officers and was never hesitant to offer his thoughts on how to rectify shortcomings. At the annual EIS conference held each April, current and former EIS officers would compete to get their papers accepted in the program. The 10-minute presentations were followed by 10 minutes of discussion, and many speakers worried about seeing Langmuir approach the microphone, often to point out something they had not thought of. This concern usually turned to gratitude for the interest he showed in both the professional and personal lives of officers. Langmuir was not there to disparage others; he genuinely wanted to be helpful.

Public health cohesion and pride

At a time when public health was not the most prestigious of health specialties and financial compensation did not approach what could be expected in clinical practice, Langmuir provided a sense of pride in public health delivery, promoted a respect for careful science in the service of aggregate health, and fostered cohesion among public health practitioners. His work and example made the CDC a place of credibility where success raised the expectations of those who worked there and those who sought consultation. It is not possible to envision what the Epidemic Intelligence Service will evolve into, but there is absolute clarity when we acknowledge that its foundation was solidly built upon Langmuir's demanding requirements.

We do indeed stand on the shoulders of those who preceded us; and in public health, we are grateful for the shoulders of Alex Langmuir.

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