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## Centers for Disease Control

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### Early History of the Centers for Disease Control and Prevention

The history of the Centers for Disease Control and Prevention (CDC) began in 1942 with the establishment of the Malaria Control in War Areas (MCWA), under the U.S. Public Health Service (PHS). The U.S. military had suffered severely from malaria during World War I, and although the reported incidence had dropped during the 1930s, a cyclical 5- to 7-year pattern of disease raised concern. Because the disease had been endemic in the southern United States, concern was heightened because 600 military bases and more than 1000 essential war establishment facilities were located there. MCWA was the actualization of the vision of Joseph W. Mountin, MD (1891–1952), an assistant surgeon general in the PHS and director of the Bureau of State Services, who reported to the surgeon general of the PHS. The headquarters was located in Atlanta, Georgia, with close associations with 15 state health departments, Puerto Rico, and the Virgin Islands, as well as laboratory facilities and field stations in multiple states that worked with all the affected states and territories.

Although the PHS provided leadership for the new program, much of the expertise in malaria had been recruited by the military; therefore, substantial training became an essential component of the multifaceted approach taken by MCWA. Physicians assessed clinical malaria and parasitologists managed the laboratories; however, mosquito control was the emphasis, and engineers and entomologists dominated MCWA. Field staff from the recently terminated Works Progress Administration were recruited to continue their work of draining malaria breeding grounds and larviciding with diesel oil and insecticides (beginning with Paris Green but adding DDT in 1943, which substantially changed the approach to malaria control). State laboratory staff were trained to diagnose malaria by using the most effective techniques. The program's scope expanded to the civilian population and to other vector-borne diseases such as dengue and typhus. MCWA laboratory workers also responded to requests from states for assistance in epidemic investigations, a role previously left to the National Institute for Health (NIH) (now the National Institutes of Health). The MCWA program was regarded as highly successful, and even before the end of the war, Mountin and his staff were considering the future. With the support of Surgeon General Thomas Parran, Jr (Surgeon General, 1936–48), the Communicable Disease Center was established on 1 July 1946. At the time, CDC had 400 employees and a budget of \$1.2 million (Table 1).

The legislation that created the CDC explicitly charged the new agency with responsibility for dealing directly with state health departments in the control of communicable diseases. This role was solidified in 1950 when the Association of State

Health Officials and the American Public Health Association agreed that CDC take the lead in defining what diseases were of highest priority and should be reportable. The key figure in this expansion of the CDC role was Alexander D. Langmuir, MD (1910–93), who was brought to the CDC in 1949 as Chief of the Epidemiology Division. Langmuir brought experience as a member of the Armed Forces Epidemiology Board, as a practicing epidemiologist at both the local and state health departments in New York, and as a professor teaching at the Johns Hopkins School of Hygiene and Public Health. He also brought vision and a strong personality that helped bring the role of the epidemiologist to prominence at the CDC and in public health practice throughout the country.

The CDC expanded during those first years to include field stations in Missouri, Colorado, and Texas, and to conduct special studies in other states. Influential events and decisions in the 1950s, however, truly established the CDC as an agency with national recognition, and Mountin and Langmuir were forces behind the majority of these changes. In 1950, the Cold War set the tone in international affairs, and the Korean Conflict fueled a concern about the pointed use of biologic weapons there and in the United States. Langmuir successfully championed the concept of the Epidemic Intelligence Service (EIS), which would respond to disease outbreaks as part of a program of biologic warfare defense. The EIS program was established in 1951 with the recruitment of 23 men, including 22 physicians and a sanitary engineer. This first class became the disease detectives, the symbol of applied epidemiology practiced at the CDC and the core of epidemiologists who would come to lead the agency in future years. By 2006, more than 2700 men and women had graduated from the program, all with different backgrounds and experiences. Together they have conducted more than 10 000 investigations, not only in infectious disease but also in chronic diseases, injury, and the many other health areas that the CDC has engaged in during subsequent years (Table 2). EIS alumni have become public health leaders at the CDC, throughout the United States, and around the world.

### The CDC Attracts National Attention in the 1950s

The event that first brought national attention to the CDC came with poliomyelitis, the crippling childhood disease. In 1952, more than 50 000 cases were reported in the United States, and polio was the leading infectious cause of childhood death in the country. In 1954, the University of Michigan conducted a national randomized trial of the killed virus vaccine developed by Jonas Salk on more than 200 000 U.S. school children during a year when more than 38 000 cases had been reported. The positive results were announced on 12 April 1955, the tenth anniversary of the death of Franklin Delano Roosevelt,

<sup>†</sup>Deceased.

**Table 1** Centers for Disease Control and Prevention (CDC) timeline

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1946 – Communicable Disease Center formed on July 1
1947 – Public Health Service (PHS) Plague Laboratory transferred to CDC, including epidemiology division
1950 – CDC conducts first investigation of a poliomyelitis epidemic (Ohio) and provides epidemiologic assistance to Canada during the Winnipeg flood
1951 – Epidemic Intelligence Service (EIS) established
1953 – CDC reports first case of bat rabies in the United States
1955 – CDC establishes Polio Surveillance Unit during national investigation of contaminated vaccine
1957 – Asian influenza pandemic; Venereal Disease Division (VDD) transferred to CDC
1958 – First assistance to southeast Asia in response to cholera and smallpox epidemics
1960 – Permanent facilities open on property adjacent to Emory University campus; tuberculosis program transferred to CDC
1961 – <i>Morbidity and Mortality Weekly Report (MMWR)</i> moves to CDC; Cooperative Cholesterol Standardization Program established
1967 – Foreign Quarantine Service joins CDC; hemorrhagic fever investigation (Marburg, Germany)
1968 – Hong Kong influenza pandemic
1969 – Biocontainment laboratory completed; Lassa fever investigation (Nigeria); Nutrition Program moved to CDC
1970 – CDC renamed the Center for Disease Control; smallpox eradicated in West Africa
1972 – National Institute for Occupational Safety and Health moves to CDC
1973 – <i>MMWR</i> reports that lead emissions in residential area are a public health threat
1975 – First Field Epidemiology Training Program established in Canada
1977 – Global smallpox eradication achieved (eradication certified by the World Health Organization in 1980)
1978 – First outbreak of multidrug-resistant tuberculosis (Mississippi) reported
1979 – Publication of <i>Healthy People</i> established measurable public health goals for the United States for 1990
1980 – Agency for Toxic Substances and Disease Registry established; <i>MMWR</i> publishes first report of toxic shock syndrome associated with tampon use
1981 – <i>MMWR</i> publishes first report of fatal disease eventually called acquired immunodeficiency syndrome (AIDS)
1982 – CDC reorganized with new centers for infectious diseases, environmental health, prevention services, and health promotion; CDC advisory published in <i>MMWR</i> regarding risk for Reye's syndrome associated with using aspirin among children with chickenpox and influenza
1983 – CDC established Violence Epidemiology Branch
1986 – Office on Smoking and Health moves to CDC
1987 – National Center for Health Statistics moves to CDC
1988 – National Center for Chronic Disease Prevention and Health Promotion established
1991 – PHS recommends that all women of childbearing age consume 400 mg of folic acid daily to reduce risk for spina bifida and anencephaly
1992 – National Center for Injury Prevention and Control established
1993 – CDC's prevention mission is recognized, and it becomes the Centers for Disease Control and Prevention
1994 – Polio elimination certified in the Americas
1996 – CDC reports measurable levels of serum cotinine in blood of 88% of nonsmokers in the United States
1997 – CDC participates in presidential apology for the Tuskegee study of syphilis treatment among black men
1999 – CDC's Laboratory Response Network established
2000 – CDC's Public Health Law Program established
2001 – National Center for Birth Defects and Developmental Disabilities established
2002 – Director's Emergency Operations Center opened
2003 – CDC provides global assistance for surveillance and clinical and laboratory evaluation regarding severe acute respiratory syndrome (SARS); CDC reorganized around coordinating centers and offices to address cross-cutting goals in life stages, preparedness, places, and global health
2005 – CDC responds to hurricanes Katrina and Rita
2007 – Recommendation for use of human papilloma vaccine to prevent cervical cancer
2009 – CDC responds to H1N1 influenza pandemic
2011 – Million Hearts initiative to prevent 1 million heart attacks and strokes by 2017
2012 – Recommendation to screen all 'baby boomers' for hepatitis C infection
2014 – Advanced Molecular Detection initiative to enhance CDC's microbiology and bioinformatics capabilities
2014 – Publication of guidelines for the use of pre-exposure prophylaxis to prevent HIV transmission

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and the response was dramatic. Within hours, Surgeon General Leonard A. Scheele (Surgeon General, 1948–56) announced a national vaccination program.

Unfortunately, however, on April 25 of that year, a baby was reported to have contracted polio 9 days after vaccination; this proved to be the index case of an epidemic of vaccine-associated polio that led to a decision to shut down the program. Four days later, Langmuir was directed to establish the national polio surveillance unit he had been advocating, and he immediately directed the EIS officers to focus their efforts on this national emergency. Within less than a week, daily reports were produced by the epidemiologists

in the unit. Rapid investigation in the field and in the laboratory clearly implicated one of the five vaccine manufacturers as the source of the epidemic (although a second manufacturer might have had problems as well). Weeks later Surgeon General Scheele was able to announce that the problem had been identified, safety standards had been instituted, and the vaccine was now safe to distribute. The CDC's role had been critical, and the importance of public health surveillance and of the EIS was recognized. National surveillance for Asian influenza in 1957–58, together with the work of CDC epidemiologists and laboratory staff, cemented the national role of the agency in disease control.

**Table 2** Select investigations in which EIS officers have participated, 1951–2014

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<p><b>1951–60</b></p> <ul style="list-style-type: none"> <li>● Contamination of killed poliovirus vaccine with live virus</li> <li>● Asian influenza epidemics</li> <li>● Nosocomial staphylococcal epidemics</li> <li>● Childhood lead poisoning from peeling paint</li> </ul> <p><b>1961–70</b></p> <ul style="list-style-type: none"> <li>● Cases of poliomyelitis associated with oral vaccine</li> <li>● Smallpox epidemics through 1977</li> <li>● Hong Kong influenza epidemics</li> <li>● Hurricane Camille after-effects</li> <li>● Salmonellosis in commercially produced chicken</li> </ul> <p><b>1971–80</b></p> <ul style="list-style-type: none"> <li>● <i>Salmonella</i> associated with pet turtles</li> <li>● Oyster-associated hepatitis</li> <li>● Bacteremia from contaminated intravenous fluids</li> <li>● Childhood lead poisoning from environmental exposure</li> <li>● Norwalk virus epidemic</li> <li>● Vinyl chloride-associated liver cancer</li> <li>● Legionnaires' disease</li> <li>● Ebola virus in Zaire and Sudan</li> <li>● Guillain-Barré syndrome associated with swine influenza vaccine</li> <li>● Toxic shock syndrome associated with tampon use</li> <li>● Heat wave-associated morbidity and mortality in Missouri</li> <li>● Aspirin-associated Reye's syndrome</li> <li>● National Study of the Efficacy of Nosocomial Infection Control (SENIC)</li> <li>● National cancer and steroid hormone study</li> <li>● Investigation of the health effects of the Three Mile Island nuclear incident (Pennsylvania)</li> <li>● Health effects of the Mount Saint Helens volcano eruption (Washington state)</li> <li>● Health effects of exposure to chemicals from an abandoned toxic waste site at Love Canal (New York)</li> </ul> <p><b>1981–90</b></p> <ul style="list-style-type: none"> <li>● Human immunodeficiency virus and acquired immunodeficiency syndrome</li> <li>● Acne medication Isotretinoin is associated with birth defects</li> <li>● <i>Escherichia coli</i> O157:H7 associated with hemorrhagic diarrhea and hemolytic uremic syndrome</li> <li>● Role of parvovirus in erythema infectiosum (Fifth disease)</li> <li>● Toxic oil syndrome in Spain</li> <li>● Eosinophilia-myalgia syndrome</li> <li>● Clusters of suicides by teenagers</li> <li>● Vietnam War veterans health studies</li> <li>● Mercury poisoning from commercial paint</li> </ul> <p><b>1991–2000</b></p> <ul style="list-style-type: none"> <li>● Multistate outbreak of <i>E. coli</i> O157:H7-associated diarrhea and hemolytic uremic syndrome from hamburgers</li> <li>● <i>Hantavirus</i> pulmonary syndrome</li> <li>● Health after-effects of Hurricane Andrew</li> <li>● Cryptosporidiosis from contaminated public drinking water in Milwaukee (Wisconsin)</li> <li>● Acute renal failure in Haiti from acetaminophen contaminated with diethylene glycol</li> <li>● Impact of physician-assisted suicide in Oregon</li> <li>● Multistate outbreak of salmonellosis associated with commercial ice cream</li> <li>● Suicide after natural disasters</li> <li>● Rotavirus vaccine recall</li> <li>● West Nile virus epidemic</li> <li>● Cardiac valvulopathy associated with fenfluramine and phentermine (fen-phen)</li> <li>● Violence against mothers of newborns from unintended pregnancies</li> <li>● Definition of excessive weight gain in pregnancy</li> </ul>	<p><b>Table 2</b> Select investigations in which EIS officers have participated, 1951–2014—cont'd</p> <hr/> <p><b>2001–10</b></p> <ul style="list-style-type: none"> <li>● Aftermath of World Trade Center and Pentagon terrorist attacks and anthrax mailings</li> <li>● Monkeypox</li> <li>● Severe acute respiratory syndrome (SARS)</li> <li>● Health effects of hurricanes Katrina and Rita</li> <li>● Multistate outbreaks of <i>E. coli</i> and <i>Salmonella</i> associated with eating raw vegetables</li> <li>● Multiple investigations of the obesity epidemic</li> <li>● Dengue hemorrhagic fever in Puerto Rico and Texas</li> <li>● Ebola hemorrhagic fever in Democratic Republic of Congo and Uganda</li> <li>● Hepatitis C infection associated with colonoscopy</li> <li>● H1N1 influenza</li> <li>● Formaldehyde levels in trailers used for temporary housing following hurricanes</li> <li>● Antimicrobial-resistant <i>Enterobacteriaceae</i></li> <li>● Childhood lead poisoning in Nigeria</li> </ul> <p><b>2011–14</b></p> <ul style="list-style-type: none"> <li>● Cholera in Haiti</li> <li>● Fungal soft tissue infections following a tornado</li> <li>● Listeriosis associated with cantaloupe consumption</li> <li>● Tuberculosis in the homeless</li> <li>● Multistate outbreak of fungal meningitis associated with medication from a compounding pharmacy</li> <li>● Overdoses of prescription opioid analgesics</li> <li>● Middle Eastern Respiratory Syndrome Coronavirus (MERS-CoV)</li> </ul>
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Adapted from Thacker, S.B., Dannenberg, A.L., Hamilton, D.H., 2001. Epidemic Intelligence Service of the Centers for Disease Control and Prevention: 50 years of training and service in applied epidemiology. *Am. J. Epidemiol.* 154, 987 and updated.

The second major event of the decade was less obvious to the public – the transfer of the PHS Venereal Disease Division (VDD) to the CDC in 1957. At the time the VDD had a larger budget than the CDC and certainly a longer history. However, the effect was more important than the budget. The VDD brought with it a grant program that distributed money to states and a program management function – the public health advisor. The grant program enhanced the agency's connection and collaboration with state health departments, and the public health advisor became the primary nonscientific manager of CDC programs and of the agency itself. Another program that came to the CDC with the VDD – unfortunately one that was highly negative – was the Tuskegee study of the complications of syphilis, which had begun in 1932 among black men in rural Alabama. Although the gravity of this study was little recognized in 1957, the matter became public in 1972 and led to a formal apology by President William J. Clinton in 1997.

### The 1960s: The CDC Plays a Global Role in Disease Control

The CDC moved into new facilities adjacent to the Emory University campus in 1960. At the time, the CDC had more than 1000 employees and a budget of \$20 million. The expansion of the agency mission was equally substantial. By the end

(Continued)

of the decade, the budget had reached \$45 million, and the CDC encompassed programs in immunization, hospital infection control, tuberculosis, and environmental health. The journal *Morbidity and Mortality Weekly Report (MMWR)* was brought from the National Office of Vital Statistics to the CDC by Langmuir in 1961. The publication rapidly became the agency's premier publication and the avenue for publishing concise, science-based articles of current events of public health interest such as epidemics, as well as current data regarding disease occurrence and death. The CDC increasingly was recognized for its responsiveness to epidemics of infectious diseases, including drug resistance among hospitalized patients, *Salmonella* in commercially produced chicken, polio associated with oral vaccine, and for its international work in smallpox eradication and disaster assistance. The CDC also maintained its lead federal role in disaster assistance, and staff studied the immediate and long-term health effects of such disasters as Hurricane Camille in 1969.

Possibly, the most important event for the CDC during that decade, however, occurred in Geneva at the World Health Assembly in 1966 when the World Health Organization (WHO), under the joint leadership of the United States and the United Soviet Socialist Republic, endorsed the plan to eradicate smallpox. This political will, together with improved technology (e.g., the jet injector gun to deliver vaccine), was the impetus for an extraordinary global program. Donald A. Henderson, MD (EIS 1955), was transferred to WHO to help lead the international effort. A global mass-vaccination strategy was undertaken, and active surveillance documented rapid decreases in illness and death. However, the program began to founder and eradication appeared out of reach. William H. Foege, MD, another EIS alumnus (1962), demonstrated in West Africa that an active surveillance and containment strategy was an effective complement to the mass-vaccination strategy. In 1979, these efforts resulted in the first successful eradication of a human disease in history, 2 years after the last case of wild-strain smallpox in Somalia.

The CDC's global role in disease control was founded on its active role in smallpox eradication. Two future CDC directors, Foege and Jeffrey P. Koplan, MD, who had served as an EIS officer (1972) in the program, and dozens of future public health leaders and hundreds of public health workers domestically and internationally were trained in this effort. The critical role of epidemiology and public health surveillance was now recognized by a much broader audience, and the importance of international, cross-disciplinary, and cross-cultural collaboration was appreciable.

### The CDC's Expansion during the 1970s

The 1970s brought further change to the CDC and initiated its programmatic expansion to broader areas of public health, including environmental health, additional chronic diseases, occupational safety and health, and injury prevention and control. The CDC's expansion in part came from the transfer of programs in these areas, notably the National Institute for Occupational Safety and Health, which was transferred in 1972. Other expansions resulted from calls for assistance from states or other federal agencies. Childhood lead

poisoning was being reported as a result of industrial pollution or from parents bringing lead home on their work clothing. Vinyl chloride-associated liver cancer was demonstrated in population studies. Investigating the short- and long-term effects of exposure to radiation after the incident at the nuclear reactor at Three Mile Island in Pennsylvania was initiated at the end of the decade. A collaborative study with the National Cancer Institute was conducted to investigate the association of cancer with both oral contraception and estrogen therapy. All these changes provided background for major organizational changes that occurred at the end of the decade.

Meanwhile, the CDC continued to have active engagement in infectious diseases. The identification of *Salmonella* among pet turtles altered that industry, as did discovery of the contamination of commercial intravenous preparations with bacteria and the subsequent documentation of a nationwide epidemic leading to a product recall. The Study of the Efficacy of Nosocomial Infection Control (SENIC) confirmed the effectiveness of hospital infection-control practices. Internationally, the CDC was involved in documenting the threat of hemorrhagic fever viruses – first the Marburg virus in Germany, and subsequently the Lassa and Ebola viruses in Sierra Leone, Zaire, and Sudan.

Two events in 1976, the agency's 30th year, however, might have had the most enduring impact. In spring 1976, an outbreak of influenza at a military base in New Jersey was identified as being caused by a new strain of influenza A, a strain that was quite different than the strain (A/Hong Kong/H3N2) circulating since 1968. The new strain (H<sub>sw</sub>N1) had demonstrated pathogenicity among humans and its ability to be transmitted person to person, circumstances that were believed to always lead to pandemics. As important, this strain was believed to be closely related to the influenza virus that had led to a pandemic in 1918–19, which had killed 500 000 U.S. residents and an estimated 25 million persons globally, affecting particularly young adults. With the CDC in the lead, scientific experts were engaged during the following months to study the problem. They ultimately recommended the policy that led to the National Influenza Immunization Program, which targeted the entire U.S. population. Vigorous efforts by the president, Congress, the vaccine manufacturers, and the public health system enabled the program to begin in October 1976. Within weeks, the CDC's national surveillance program, in collaboration with the states, uncovered an increased reporting of Guillain-Barré syndrome among persons who had been vaccinated during the program. Subsequently, the program was suspended and no epidemic occurred. An association was confirmed in a national case-control study conducted by the agency; the agency was criticized harshly, and other vaccination programs were called into question.

In early August 1976, a report from Pennsylvania of possible swine influenza led to an investigation of fatal pneumonias among veterans and their families who had attended a statewide convention of the American Legion in Philadelphia during the third week of July. The Legionnaires' disease epidemic eventually brought 25 EIS officers and many other staff to Pennsylvania and stayed on the front pages for weeks during this bicentennial year. By the end of August, the field team had identified more than 200 cases – laboratory staff had ruled out all known human pathogens – and together they had investigated multiple leads in an effort to determine

a toxin. Terrorism was considered, and external experts were called in. However, the strongest association identified was with the hotel that had housed the conventioners and had hosted major business and social activities. The team returned to Atlanta without a definitive answer, and in the context of the mounting criticism around the swine influenza program, continued its work. Finally, in December, Joseph E. McDade, PhD (1940–), in the CDC's Rickettsial Diseases Laboratory, identified the Gram-negative rod that proved to be the bacterium that caused the epidemic. *Legionella pneumophila* became the first new human bacterial pathogen identified in decades, and McDade and his coworkers linked it to two previously unsolved epidemics in 1965 and 1968.

### The 1980s: The AIDS Crisis

The 1980s was dominated by the epidemic caused by HIV, but the CDC was also to undergo another major organizational change that reflected a new direction for the agency. However, the decade opened with two investigations of a more traditional nature that brought national visibility to the agency and brought lawyers into the public health policy arena in a dramatic fashion. In the summer of 1980, a report from Arizona in the *MMWR* linked Reye's syndrome with using aspirin. That report was followed by similar data from Ohio and Michigan, which led the CDC to conclude that the association might be real. The aspirin industry aggressively attacked, but the CDC held firm and recommended that aspirin be avoided for children with chickenpox and during influenza epidemics. Surgeon General Julius B. Richmond (1977–81) soon followed with a similar recommendation. The struggle with industry did not stop, but national data demonstrated a noticeable decrease in Reye's syndrome during the next few years. Meanwhile, the CDC was responding rapidly to the national epidemic of toxic shock syndrome among women. Within 6 months, the disease was linked to use of tampons and by the end of 1980, specifically to the use of the Rely tampon, made by Proctor and Gamble. After the manufacturer voluntarily withdrew the product, the epidemic abated dramatically.

Major change was continuing to happen in public health, and the CDC was involved in measuring the health effects of the radiation release from the nuclear reactor at Three Mile Island in Pennsylvania, the toxic effects of dioxin at Love Canal (New York) and among Vietnam War veterans, and the volcanic eruption at Mount Saint Helens (Washington state). The chemical release in Bhopal, India, and the investigation of toxic oil syndrome in Spain reflected the international recognition of the CDC in environmental health. In 1982, the agency announced a reorganization to reflect these new public health concerns and environmental health, chronic diseases, occupational health, unintentional injuries, violence, and maternal and child health, while maintaining excellence in the prevention of infectious diseases. This reorganization enabled the programmatic growth for the next two decades.

However, a brief report of an unusual pneumonia among five homosexual men in a June 1981 issue of the *MMWR* changed health practice at the CDC and around the world. The pandemic of acquired immunodeficiency syndrome (AIDS) caused by HIV crept slowly into public consciousness,

but by the end of the decade, no health problem in the world generated more interest and controversy. The CDC was at the center of both. During those years, more than a third of the agency's budget was directed toward researching this illness and the virus that causes it. The agency's budget grew to approximately \$1 billion by the end of the decade. Its constituency grew with the budget, and both domestic and global partnerships expanded considerably. At the CDC, behavioral and social scientists rapidly developed an important niche, and the move of the National Center for Health Statistics in 1987 to what was now the Centers for Disease Control brought a wealth of data and enhanced the role of the statistician at the CDC and in public health practice.

### Expansion of the CDC in the 1990s

The last decade of the twentieth century was marked by expansion of programs and budget in the newly defined priority areas at CDC, especially chronic diseases. In 1993, the CDC's name changed to reflect its broadened mission, and it became the Centers for Disease Control and Prevention. By 2000, the CDC budget had exceeded \$3 billion. The chronic disease budget was \$660 million that year and was dedicated primarily to development of programs for preventing breast and cervical cancer. In addition, routine data collection was being established at the state level through the Behavioral Risk Factor Surveillance System, and state-based cancer registries were implemented to provide a data baseline for defining problems and evaluating program effectiveness. Emerging infections (e.g., *Escherichia coli* O157:H7, the hantavirus, and West Nile virus) and reemerging infections (e.g., antibiotic and drug resistance for bacteria, tuberculosis, and malaria), together with an increasing number of effective vaccines, underscored the continuing importance of infectious diseases. By the end of the century, 10 major programs (then termed centers, institute, and offices) were located at the CDC, the last focusing on unintentional injuries and violence. An 11th center was created a year later. Global health programs related to HIV and other worldwide public health concerns continued to grow. By 2000, a global network of more than 30 Field Epidemiology Training Programs modeled on the EIS was established. On any give day, the CDC had more than 200 persons stationed internationally on long-term assignments. Nationally and globally, the science and services of the CDC were in great demand. The *MMWR* was available on the Internet and in 2006 received 1.2 million hits.

### Addressing Threats in the Twenty-First Century

New threats, both man-made and naturally occurring, faced CDC in the early years of the twenty-first century. The first of these threats came in 2001, with the terrorist attacks on the World Trade Center and the Pentagon followed by anthrax attacks. In response to these events, CDC received substantial increases in funding to enhance preparedness and response capabilities within the Agency and at state and local health departments. Both the Strategic National Stockpile (SNS) of vaccines, medications, and medical supplies as well as the

Laboratory Response Network were expanded to improve responses to public health emergencies. This enhanced public health capacity proved critical to national responses to infectious disease outbreaks. In 2003 alone, these included the emergence of a novel coronavirus that sparked the SARS pandemic, the introduction of monkeypox associated with the exotic pet trade, and a resurgence of West Nile virus as it moved westward across the United States. These investments were also important in CDC's responses to environmental disasters including Hurricanes Katrina and Rita in 2005, and the Haitian earthquake and Gulf of Mexico (Deepwater Horizon) oil spill, both in 2010.

One of the greatest infectious disease challenges of the early twenty-first century was the H1N1 influenza pandemic of 2009. The novel virus causing this pandemic, apparently of swine origin, first appeared in humans in Mexico and quickly spread to the United States and around the globe. CDC's response included developing new diagnostic assays and providing diagnostic test kits to both domestic and international laboratories, increasing influenza surveillance activities, developing candidate viruses for vaccine production, and assisting with vaccine distribution across the U.S. In addition, CDC distributed antiviral drugs and personal protective equipment from the SNS. These efforts resulted in prevention of an estimated 700 000 to 1.5 million cases, 12 000 to 23 000 hospitalizations, and 600 to 1200 deaths in the United States.

Globally, CDC's largest role in the twenty-first century has been as an implementing partner in the U.S. President's Emergency Plan for AIDS Relief (PEPFAR). This plan, announced by President George W. Bush in 2003, supports low- and middle-income countries to provide care and treatment for persons with HIV/AIDS and to prevent HIV transmission. In 2011, President Barack Obama advanced the vision of an AIDS-free generation and set PEPFAR goals to treat 6 million patients and provide treatment to more than 1.5 million pregnant women to prevent mother-to-child HIV transmission by the end of 2013. In support of PEPFAR and to meet other international goals, including polio eradication, CDC had more than 300 internationally deployed staff working in approximately 60 countries in 2014, with over 1300 locally hired employees.

Although public attention often focuses on CDC's infectious diseases and preparedness activities, most Americans will die from chronic diseases, such as heart disease, cancer, chronic lower respiratory diseases, and stroke. Common underlying risk factors for these conditions include tobacco use, uncontrolled hypertension, poor diet, physical inactivity, and high blood cholesterol. Surveillance systems supported by CDC, including the Behavioral Risk Factor Surveillance System, the National Health and Nutrition Examination Survey, and the National Health Interview Survey, measure the prevalence of these conditions and risk factors and track these data over time. The Million Hearts Initiative, led by CDC and including other federal partners, aims to prevent 1 million heart attacks and strokes between 2012 and 2017 through a combination of public health interventions (reduction of smoking and intake of trans fat and sodium) and clinical interventions (improved blood pressure control and hypertension management, increasing aspirin use for high-risk individuals). CDC also leads the National Diabetes Prevention Program,

a public-private partnership to prevent or delay the onset of type 2 diabetes in persons with pre-diabetes.

An increasing priority for CDC in the twenty-first century has been better integration of the public health and medical care systems. To address this priority, CDC has increased its collaborations with the Centers for Medicare & Medicaid Services, the primary source of federal funding for healthcare in the United States. The Affordable Care Act (ACA) also provides opportunities to better integrate prevention with care. For example, the ACA requires that many insurance plans cover a set of evidence-based clinical preventive services without requiring patient co-payment or payment toward a deductible. The ACA is a valuable resource in helping CDC achieve its goals of reducing morbidity and mortality for all Americans.

## Conclusion

Beginning with a regional focus on a single parasite, the CDC has become the premier public health agency in the world, and its expertise has expanded in direct correlation with the expanding view of public health needs. The emerging concerns of the new century – genomics, globalization, the built environment, information technology, global warming, emerging infections, violence, and so on – will require not only the traditional disciplines but also new expertise and new global partners, both public and private. What will remain the same at the CDC is the dedication to its mission in global public health and its adherence to the core values of accountability, integrity, and respect. The new century has already proven challenging and exciting, a situation that CDC anticipates eagerly.

*See also:* International Dietary Guidelines; World Bank; World Health Organization.

## Further Reading

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