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Laboratory Science and Public Health at CDC

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Laboratory technology is as essential to public health practitioners for monitoring threats to public health as it is to clinical practitioners who depend on laboratory technology to diagnose and monitor disease in individuals. Laboratory technology provides essential information for effective public health interventions, whether monitoring emerging infectious diseases, such as avian influenza globally; identifying pathogens, such as *Escherichia coli* in the U.S. food supply and pinpointing its source; screening newborns for devastating disorders, such as phenylketonuria, that can be prevented by early intervention; or developing the capacity to quickly screen for exposure to chemical and biologic agents.

Role of the Laboratory in Infectious Diseases

CDC was founded to address infectious diseases important in the post-World War II era. Today, combating infectious diseases remains a vital part of the CDC mission, including investigating new outbreaks caused by infectious agents and detecting, characterizing, and devising methods for prevention. The laboratory also has been instrumental in identifying newly recognized or reemerging microbes that caused outbreaks, including *Legionella*, hantavirus, West Nile virus, and severe acute respiratory syndrome-associated coronavirus (SARS-CoV). CDC's ability to identify new pathogens has improved over time as laboratory technologies have advanced, as illustrated by *Legionella* in 1977 (*1*) and SARS-CoV in 2003 (*2*). *Legionella*, a bacterium, was discovered after many months of extensive laboratory testing when a scientist inoculated guinea pigs with lung tissue from a patient and caused a febrile illness. Spleen suspensions from the guinea pigs were inoculated into embryonated eggs, and a bacterium grew. Serum from 101 of 111 patients whose illness met the clinical criteria for Legionnaires disease showed diagnostic increases in antibody titers. The laboratory tools used to describe this new bacterium were state-of-the-art in the 1970s, although by today's standards they are rudimentary.

Contrast laboratory techniques used to identify *Legionella* with those used 3 decades later to identify another new organism, the SARS-CoV. The SARS outbreak began in 2003 in China and within weeks affected people in approximately 30 countries. Scientists from about a dozen countries around the world held daily teleconferences to compare findings from specimens they had received. CDC obtained blood from a World Health Organization physician caring for patients whom we now know had SARS; tested it by standard techniques, including tissue culture; and discovered a cytopathogenic effect in one of the tissue culture cell lines. The supernatants from the cells were examined by electron microscopy, and a coronavirus was identified. Patient specimens then were examined for antibody reactions to the isolated virus. Virus-infected cells and cell extracts were used to develop an antibody assay. Then, taking clues from partial RNA sequences of the coronavirus, a molecular assay also was developed, and in record time, CDC had assays to deploy to the state public health laboratories to detect both antibody and antigen. Three weeks after initial identification of SARS-CoV, the complete sequence was determined and compared with other coronaviruses (*3*).

Role of the Laboratory in Chronic Diseases and Environmental Health

CDC's experience in environmental health and chronic disease is more recent than its work in infectious disease. Still, CDC laboratories dedicated to these important public health disciplines provide vital expertise for accomplishing the CDC mission to protect public health.

Smoking and exposure to secondhand smoke (SHS) are responsible for a substantial proportion of death and disease in the United States and worldwide. The Surgeon General's recent report, *The Health Consequences of Involuntary Exposure to Tobacco Smoke*, showed that exposure to SHS increases the risk for developing heart disease by 25%--30% and lung cancer by 20%--30% (*4*). The CDC Environmental Health Laboratory contributed to understanding the risks from SHS. This work included the first national estimate of nonsmokers' exposure to SHS in the U.S. population (*5*) and documentation of a substantial decrease in SHS exposure using cotinine (a marker in the blood for exposure to nicotine) measures from the Third National Health and Nutrition Examination Survey (NHANES III [1998--1991]) (*6*). Earlier studies used less reliable estimates based on self-report or questions related to lifestyle rather than to laboratory measurements of SHS exposure.

The decline in exposure to lead in the United States has been called one of the most important recent accomplishments of public health (*7*). Most of the decline in blood lead levels occurred during the 1970s and 1980s, paralleling removal of lead from gasoline (*8*). Understanding of this relation can be attributed to the accurate and precise blood lead measurements of the CDC Environmental Health Laboratory, which used atomic absorption spectrometric methods to measure lead levels for NHANES III. Analytical results indicated a dramatic decrease in blood lead levels for the population. In addition, the percentage of children with blood lead levels $\geq$10 μg/dL also decreased sharply, from 89% in NHANES II (1976--1980) to 8.9% in NHANES III.

Conclusion

From CDC's beginnings, its expertise in laboratory science has played a vital role in accomplishing its public health mission both domestically and internationally. That role continues to grow as advances in laboratory technology are developed and used in the service of promoting the nation's health and quality of life.

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