References

1. Foege, W. H.: Centers for Disease Control. J Public Health Policy 2: 8–18 (1981).
2. Langmuir, A. D.: The Epidemic Intelligence Service of the Centers for Disease Control. Public Health Rep 95: 470–477, September-October 1980.
3. Dean, A. D., Dean, J. A., Burton, A. H., and Dicker, R. C.: EPI INFO, Version 5: a word processing database, and statistics program for epidemiology on microcomputers. Centers for Disease Control, Atlanta, GA, 1990.
4. Goodman, R. A., et al.: Epidemiologic field investigations by the Centers for Disease Control and Epidemic Intelligence Service, 1946–87. Public Health Rep 105: 604–610, November-December 1990.
5. Shands, K. N., et al.: Toxic shock syndrome in menstruating women. N Engl J Med 303: 1436-1442, Dec. 18, 1980.
6. Pneumocystis pneumonia—Los Angeles, MMWR 30: 250–252, June 5, 1981.
7. Williams, S. J., et al.: Epidemiologists in the United States: an assessment of the current supply and the anticipated need. Am J Prev Med 4: 231–238 (1988).
8. Gunn, R. A. et al.: State epidemiology programs and State epidemiologists: results of a national survey. Public Health Rep 104: 170–177, March-April 1989.
9. Music, S. I., and Schultz, M. G.: Field epidemiology training programs: new international health resources. JAMA 263: 3309–3311, June 27, 1990.

Epidemiologic Field Investigations by the Centers for Disease Control and Epidemic Intelligence Service, 1946–87

RICHARD A. GOODMAN, MD, MPH
CINDY F. BAUMAN, MPH
MICHAEL B. GREGG, MD
JANIS F. VIDETTO
DONNA F. STROUP, PhD
NANCY P. CHALMERS

The authors are or were with the Epidemiology Program Office (EPO) of the Centers for Disease Control (CDC), Public Health Service, when the study was conducted. Dr. Goodman is the Office's Assistant Director, Ms. Bauman was assigned to EPO as an intern through the Association of Schools of Public Health–CDC Internship Program, Dr. Gregg was Acting Director, Ms. Videtto was a Program Analyst, Dr. Stroup was Chief, Statistical Services Branch, and Ms. Chalmers was a Statistical Assistant.

The paper was presented in part at the International Scientific Conference on Epidemiology, in Beijing, China, on April 27, 1989.

The authors are indebted to the State Epidemiologists who have served the people of their States and Territories and to more than 1,700 EIS Officers who have participated in epidemiologic field investigations.

Tearsheet requests to Richard A. Goodman, MD, Epidemiology Program Office, Mail Stop C08, Centers for Disease Control, 1600 Clifton Road, Atlanta, GA 30333.

Synopsis

The epidemiologic field investigation is an important tool used by the Centers for Disease Control (CDC) to provide assistance to State, local, and international public health agencies. The Epidemic Intelligence Service (EIS) of the CDC is an ongoing program that gives physicians and other health professionals opportunities to learn and practice epidemiology.

In the period 1946–87, EIS Officers and other professional staff based at CDC headquarters participated in 2,900 epidemiologic field investigations requested by State, local, and international public health agencies. Nearly two-thirds of the investigations involved infectious disease problems, while 13 percent involved noninfectious conditions; for 21.1 percent, the etiology of the problem was unknown when the investigation was initiated. Among the specific subcategories, bacterial causes were the most common, accounting for 864 (29.8 percent) of all investigations. During this 41-year period, an increasing proportion of the field epidemiologic investigations involved public health problems of noninfectious etiology. Trends in the types of investigations done probably represent the influence of such factors as CDC's priorities, organizational structure, and budget; the size of the EIS Program; national health initiatives; and the States' needs and programs.

SINCE ITS INCEPTION, the mission of the Centers for Disease Control (CDC) has required the agency to combine the science of epidemiology with the approaches of other public health disciplines in providing assistance to State, local, and international health agencies. Because CDC represents a service-oriented resource for public health constituencies, the programs and methods that it uses emphasize the provision of services in the "field" setting—that is, at the site of the problem or need. The epidemiologic field investigation (*1*) is one of the most important tools used by CDC to assist constituents.

In July 1946, the Communicable Disease Center was

created from the Office of Malaria Control in War Areas and assigned responsibility to assist States with the control of a broader range of communicable diseases (*2*). This role for the new agency included technical assistance and training to address problems that exceeded the States' resources or were interstate or national in nature. In October 1947, CDC was made responsible for helping States to conduct epidemiologic investigations of communicable disease outbreaks. To meet this need, and to increase the number of field-trained epidemiologists in the United States, the Epidemic Intelligence Service (EIS) Program was created at CDC in 1951 (*3*).

Operating continuously since 1951, the EIS enrolls approximately 60 new officers each year and assigns them primarily to organizational units within CDC or to State public health agencies. The EIS Program is a unique opportunity for health professionals not only to learn practical epidemiology but also to provide essential services to CDC's public health constituents. As an integral part of CDC's professional staff, EIS Officers have played a key role in helping CDC respond to requests from State, local, and international public health agencies that need epidemiologic assistance. The first EIS Officers investigated primarily outbreaks of acute communicable diseases. Since the late 1960s, however, the spectrum of problems addressed by EIS Officers and other CDC professional staff has broadened considerably to include chronic diseases, occupational health, injuries, environmental health, and others.

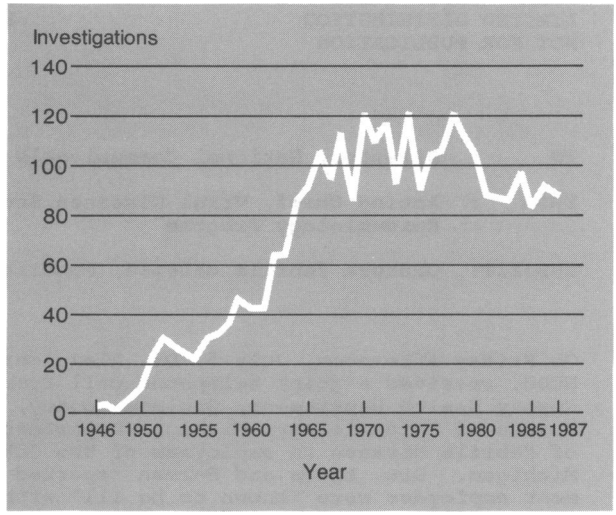
The experiences of EIS Officers and other CDC staff in providing epidemiologic field assistance reflect a combination of CDC's own evolution as well as the changing needs of its constituents. Because these experiences give some indication of the distribution of important public health problems, the information which characterizes these experiences in field work may be of use in planning, staffing, and allocating resources for epidemiologic field investigations. In addition, the information should be of archival value to State health departments and other agencies that CDC has assisted.

In this article, we describe the process by which CDC provides field epidemiologic assistance and use CDC and EIS records to summarize this experience for the 41-year period, 1946–87. The analysis in this report illustrates the types of public health problems that come to the attention of CDC and the opportunities that these problems provide for EIS Officers to learn practical epidemiology in the field.

The Epidemiologic Field Investigation

Within the Public Health Service, CDC is the lead agency for control and prevention of disease through its relationship with State health departments. Because CDC serves a variety of constituents, several strategies are used to meet this responsibility. The direct dispatch of CDC staff to States to participate in epidemiologic field investigations is a major form of assistance. Other modalities of assistance with problems in field settings include telephone consultations, on-site technical consultations or hazard evaluations, the analysis of data sent to CDC from State health agencies, and the assignment of CDC staff to State, local, or international health agencies.

Figure 1. Epidemiologic field investigations by the Epidemic Intelligence Service, by year, 1946-87



NOTE: These investigations used the "Epi-Aid" field response administrative mechanism described in "The Epidemiologic Field Investigation." Some investigations involved other CDC professional staff.

Because of the primary legal responsibility each State has to protect the health of its residents, States have maintained the prerogative of investigating outbreaks and other disease problems. Accordingly, CDC has always abided by these defined lines of responsibility and authority and, by convention, requests for epidemiologic field assistance are made by the State Epidemiologists on behalf of the State public health agency (*4*). However, the requests may have been originated by a local public health agency, hospital, private-sector health-care provider, private citizen, or other Federal agency (for example, the Indian Health Service). Under special circumstances, such as interstate or multistate outbreaks, CDC may take the lead in initiating investigations. CDC also provides assistance to international health organizations or ministries of health in other countries.

CDC headquarters-based EIS Officers are usually assigned to help a public health agency that needs field assistance, although other CDC professional staff may be involved in a support role, in the actual field response, or both. In most field investigations, EIS

FOR ADMINISTRATIVE USE
LIMITED DISTRIBUTION
NOT FOR PUBLICATION

PUBLIC HEALTH SERVICE-HSMHA-NCDC-Atlanta
EPI-69-3-1

July 9, 1968

TO : Director, National Communicable Disease Center

FROM : Acting Chief, Viral Diseases Section
Epidemiology Program

SUBJECT: Obscure febrile disease, Pontiac, Michigan

On Friday afternoon, July 5, Dr. Alexander D. Langmuir, Chief, Epidemiology Program, NCDC, received a joint telephone call from Dr. Bernard Berman, Director of Oakland County Health Department, Oakland County, Michigan, and Dr. George Agate, Chief, Bureau of Epidemiology, Michigan Department of Public Health, concerning an outbreak of febrile disease in employees of the Oakland County Health Department in Pontiac, Michigan. Drs. Agate and Berman reported that approximately 60 of 100 health department employees were "known to be ill" with a syndrome consisting of chills, fever up to 102-103°F., headache, generalized aches, and chest pain. There was no nausea or vomiting and few symptoms referable to the respiratory tract. At the present time there are persons who are still ill with this clinical syndrome.

Drs. Berman and Agate requested that NCDC send a team to assist in the epidemiologic investigation. Consequently, Dr. Thomas Glick, EIS Officer, Neurotropic Viral Diseases Unit, Viral Diseases Section, Epidemiology Program, Dr. Ira Kassanoff, EIS Officer, State Services Section, Epidemiology Program, and Dr. James Nuckolls, Virology Section, Laboratory Program, left Atlanta Friday night, July 5, 1968, to confer with Dr. Agate and Dr. Berman Saturday morning, July 6, regarding the investigation of the epidemic.

Michael B. Gregg, M.D.

DISTRIBUTION
SG
OIH: Dir., Assoc. Dir. (Bi-Lateral Affairs).
PPE: Dir., Assoc, Dir. (Plan. & Anal.).
NIH, NIAID: Dir., Ch. Lab. Clin. Inv.
HSMHA: Adm., Dep. Adm., Assoc. Adm., Info. Off.
Regional Health Directors
Chiefs, NCDC Serv.
Assoc. Dir., NCDC Wash. Off. (2 copies)
NCUIH: Dir., Ch. Env. Sanitation Prog.
NCDC: Dir, Dep. Dir., Asst. Dir., Exec. Off., Info. Off., Ch. Off. Plan. & Anal., Program Chiefs, Field Sta. Chiefs, PPEP.
Dr. Bernard Berman, Director of Oakland County Health Department, Pontiac, Michigan 48053.
Dr. George Agate, Chief, Bureau of Epidemiology, Michigan Department of Public Health, 3500 N. Logan Street, Lansing, Michigan 48914.

Officers work under the direction of State and local public health officials who have requested assistance and who bear ultimate responsibility for the problem and its solution.

Every effort is made to respond to requests for epidemiologic field assistance. When a State or international health agency formally asks for assistance, the response to this request is referred to as an "Epi-Aid" within CDC. This term denotes that a specific administrative mechanism has been invoked to support the field response and that prescribed guidelines will be used by the EIS Officers and other professional staff who are involved. In addition, this category of investigation usually involves EIS Officers who are based at CDC headquarters, rather than those who are assigned to State health departments.

As soon as the decision is made to provide field assistance, a memorandum, known as the Epi-1, is prepared by the supervisor of the assigned EIS Officer(s) to notify the CDC Director and others (for example, all

State Epidemiologists) about the problem, the request, and the planned investigation (see box on page 606). The final report required for each investigation is also prepared as a memorandum. This report, known as the Epi-2, documents in full detail the background to the problem, the methods used in the investigation, epidemiologic analyses and findings, a discussion, and recommendations for the control or prevention, or both, of the problem. These memoranda inform key CDC and State authorities about field investigations and also serve training and archival functions. In addition, by requiring EIS Officers to describe thoroughly their reasoning, actions, and recommendations, the final report represents a critical part of the learning process for the officers.

Methods

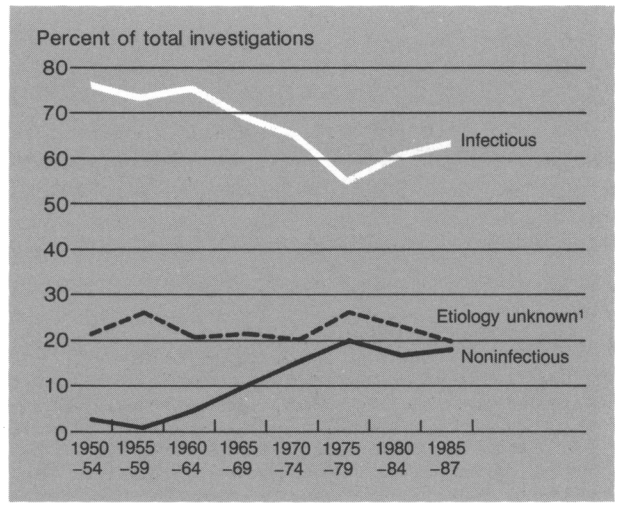
To characterize the experiences of CDC and the EIS in providing epidemiologic services, we examined each of the 2,900 Epi-1 memorandums associated with epidemiologic field investigations in the period 1946-87. For each investigation, we abstracted the following information: the date the investigation was initiated; the disease or problem primary category (that is, infectious, noninfectious, occupational-environmental, etiology unknown) and subcategory (for example, infectious: viral, noninfectious; diabetes) that prompted the investigation; the organ system involved; the source of the request (that is, domestic or foreign); and the type of investigation anticipated.

We also examined a systematic sample (every sixth Epi-2 memorandum) for the period 1946–80 to abstract the following additional information on each investigation: the problem setting (for example, school, residence, restaurant); predominant age group(s) affected; epidemiologic study design; and categories of statistics used. Because during the period 1980–87 changes in reporting practices and policy resulted in a substantial reduction in the completion rate for Epi-2s, we chose not to sample them for this period. Epi-2 or equivalent final reports were available for 1,887 (82.9 percent) of the 2,276 investigations completed through 1980. Epi-2s were not completed for a variety of reasons: for example, EIS Officers may have separated from CDC and the Public Health Service, investigations may not have reached final conclusions, or for administrative reasons.

Results

Temporal trends. Of the 2,900 Epi-Aid field investigations initiated in the 41-year period, only 26 were conducted before 1951, the year that the EIS was formed. Following 1951, the annual number increased substantially; in 1974, 122 investigations were initiated (fig. 1).

Figure 2. Epidemiologic field investigations by the Epidemic Intelligence Service, by problem category and by 5–year intervals, 1950–87



¹Includes 31 problems requiring a different classification (other) when the investigation started.

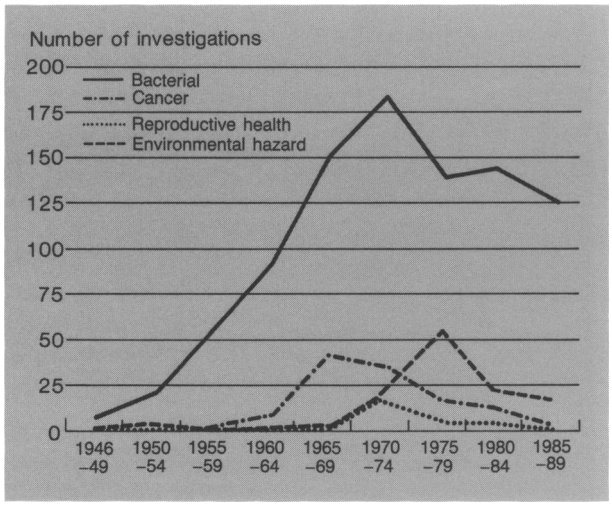
NOTE: These investigations used the "Epi–Aid" field response administrative mechanism described in "The Epidemiologic Field Investigation." Some investigations involved other CDC professional staff.

Problems of infectious etiology accounted for 1,882 (64.9 percent) of the investigations, noninfectious problems for 233 (8.0 percent), and occupational or environmental health threats for 142 (4.9 percent). For 643 (22.2 percent) of the investigations, the problems could not be classified under these categories and were categorized as "unknown" or "other" when investigations were initiated (see table). From 1950 through 1979, an increasing proportion of field epidemiologic investigations involved public health problems of noninfectious etiology (fig. 2). The number of investigations for selected problem categories for various periods are shown in figure 3.

Geographic location. When examined by location, 2,643 (91.1 percent) of all investigations were done in the United States. The most commonly involved States were Georgia, Florida, Texas, California, New York, and Pennsylvania (fig. 4). In 100 instances, the investigation involved more than one State. A total of 257 investigations were done in U.S. possessions or territories or in other countries, including Puerto Rico and the U.S. Virgin Islands (59), other U.S. possessions (20), Central and South America (36), the Caribbean (35), Africa (32), Asia (19), Europe (22), the Pacific (15), and Canada and Mexico (19).

Specific characteristics. The most frequent subcategories of problems involved bacterial causes, which accounted for 864 (29.8 percent) of all investigations,

Figure 3. Epidemiologic field investigations by the Epidemic Intelligence Service, by selected problem categories and period, 1946–89[1]



[1]Numbers for 1988–89 are estimates.

NOTE: These investigations used the "Epi-Aid" field response administrative mechanism described in "The Epidemiologic Field Investigation." Some investigations involved other CDC professional staff.

Classification of problems in epidemiologic field investigations involving the Epidemic Intelligence Service, 1946–87

Problem	*Number*	*Percent*
Infectious	1,882	64.9
Bacterial	864	....
Viral	743	....
Parasitic	170	....
Mycobacterial, rickettsial, and chlamydial	43	....
Fungal	22	....
Other	40	....
Noninfectious	233	8.0
Cancer	113	....
Reproductive health	32	....
Medical therapy, intervention	28	....
Birth defects	25	....
Intentional injury homicide, suicide	11	....
Drug, alcohol abuse	10	....
Nutritional	6	....
Other	8	....
Occupational, environmental	142	4.9
Toxic, chemical exposure	111	....
Natural disaster	22	....
Radiant energy exposure	3	....
Other	6	....
Unknown	612	21.1
Other	31	1.1

viral for 743 (25.6 percent), parasitic for 170 (5.9 percent), and cancer for 113 (3.9 percent) (see table). The gastrointestinal tract was the organ system involved in 555 (19.1 percent) of the investigations, multisystem involvement in 561 (19.3 percent) investigations, the nervous system in 394 (13.6 percent), the liver in 285 (9.8 percent), the respiratory tract in 222 (7.7 percent), and other organ systems in 881 (30.4 percent) of the investigations. Problems primarily of animal populations accounted for 125 (4.3 percent) of all investigations.

Outbreak investigations represented the most common approach to problems, accounting for 2,282 (78.7 percent) of the total. They were followed by 335 (11.6 percent) case studies, 95 (3.3 percent) environmental health hazard evaluations, 62 (2.1 percent) program-evaluation investigations, and 125 (4.3 percent) other types of investigations.

Epi-2 subsample. Analysis of the Epi-2 subsample of 370 investigations shows that they involved multiple settings, age groups, and study design methods; therefore, totals exceed 100 percent. Residential or community settings were the primary site in 49.7 percent of the investigations. Hospitals were involved in 14.9 percent of the investigations, schools or universities in 10.8 percent, agricultural or rural locations in 10.3 percent, the workplace in 7.8 percent, military bases in 3.5 percent, recreational settings (such as camps and clubs) in 2.4 percent, and other settings in 31.6 percent.

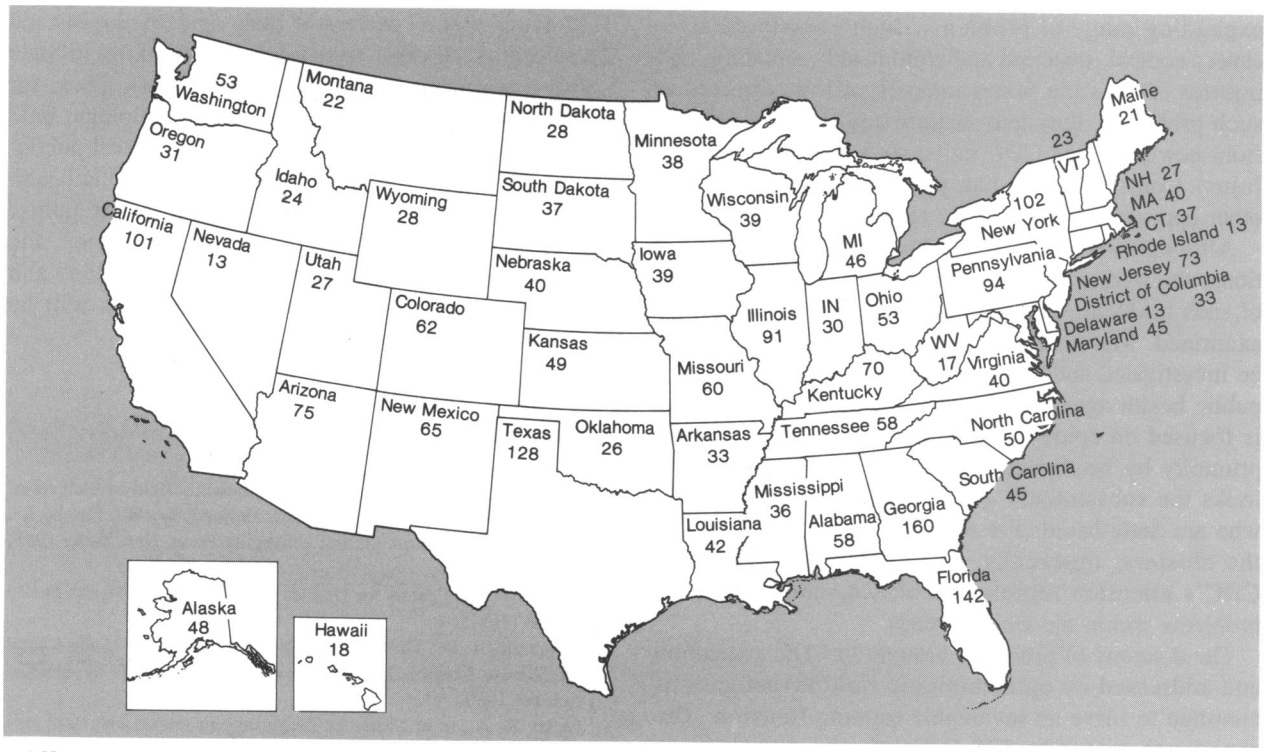
In some investigations, the problem involved multiple age groups. Neonates were the age group primarily affected in 6.8 percent of the investigations; infants, in 9.7 percent; preschoolers, in 16.5 percent; school-age children, in 27.8 percent; adolescents, in 16.8 percent; adults ages 19–44 years, in 29.5 percent; adults ages 45–64 years, in 16.2 percent; and seniors, in 6.2 percent. For 23.2 percent of the investigations, no specific primary age group appeared to be affected.

In some investigations, more than one study design was employed. A cross-sectional design was used in 90.3 percent of the investigations; case-control design, in 14.9 percent; and cohort design, in 4.9 percent. Significance tests first appeared in the subsample in 1965, and their use steadily increased throughout the period. Bivariate statistics were introduced in 1965, used again in 1967, but they did not appear regularly until after 1970. Standardization and the use of epidemiologic measures of association appeared in 1973, although measures of association were not used frequently until after 1978. Nonparametric statistical tests and multivariate analyses first appeared in 1975; although multivariate methods were used with increasing frequency, nonparametric methods appeared only sporadically.

Discussion

During the period 1946-70, the number of epidemiologic field investigations involving collaboration between CDC and other public health agencies increased dramatically. At the same time, shifts occurred in both the patterns of the problems investi-

Figure 4. Epidemiologic field investigations by the Epidemic Intelligence Service, by State, 1946–87



NOTE: These investigations used the "Epi-Aid" field response Administrative mechanism described in "The Epidemiologic Field Investigation." Some investigations involved other CDC professional staff.

gated and in the nature of the investigations. The explanations and implications for some of these observations are readily apparent. For example, the large number of investigations done in Georgia probably reflects CDC's presence in that State and the exceptional opportunities to combine service and training. Nonetheless, the data also indicate the substantial distribution of services provided elsewhere in the United States and throughout the world.

A second illustration relates to the settings. Although most investigations involved problems in communities or residential locations, at least one-quarter occurred in institutional settings, such as hospitals and schools. Continuing demographic shifts are likely to require Federal, State, and local public health agency staffs to increase their use of epidemiology in addressing problems in child care centers, nursing homes, and other institutional settings.

Less straightforward is the interpretation of the overall temporal trend in field investigations and the shift in types of problems investigated. These trends probably are influenced by several interrelated factors both internal and external to CDC, including CDC's priorities, organizational structure, and budget; the size of the EIS Program; the States' needs and programs; and national health initiatives, such as the 1990 Objectives for the Nation. For example, until the mid-1960s, CDC involvement with the epidemiology of cancer was limited. In 1965, however, a leukemia unit was created within CDC and supported by the National Cancer Institute; from 1965 to 1969, cancer-related problems were the focus of 40 epidemiologic field investigations (fig. 3).

The States' priorities are critical and may also determine the number and type of requests for epidemiologic assistance. The plateau in the number of investigations done annually, noted initially during the mid-1960s (fig. 1), may have reflected the increasing numbers of EIS Officers assigned to the States, thereby augmenting the States' capacities to conduct their own investigations. During the 1980s, the number of investigations done each year declined relative to numbers in the preceding decade; this trend might reflect the increasing supply of epidemiologists (0.6 epidemiologists per million persons in 1976 compared with 1.1 per million in 1983) and the capacities of the States to carry out investigations independently (*4*).

The programs and needs of States probably also account for the observed trends. By convention, the State Epidemiologists have served as a focal point for communications regarding epidemiologic activities in the States and at CDC. Previously, control of communicable diseases represented the major area of concern to both State Epidemiologists and CDC. More recently,

State Epidemiologists have become responsible for an expanding range of problems, such as birth defects, cancer control, maternal and child health, smoking, and injuries (*4*). As the States intensify efforts directed at such problems, they may require additional assistance from newly formed CDC units, such as the Division of Injury Control, which can provide EIS Officers and other appropriate and specific resources.

Although we report on a large number of investigations, the findings do not reflect the overall occurrence of such problems in the United States during the period examined. Many, if not most, of these problems may be investigated and managed entirely by State and local public health agencies. In addition, because this article is focused on epidemiologic field investigations done primarily by headquarters-based EIS Officers, it overlooks the substantially greater number done by those who are State-based. For these reasons, it is likely that the clusters, outbreaks, and epidemics brought to CDC's attention represent a biased sample of these problems within the United States.

The diversity of problems brought to CDC's attention and addressed by epidemiologic field investigations continue to serve an invaluable training function. The experience gained by EIS Officers who participate in these investigations has important implications for public health practice in the United States. A survey in 1983 found that 39 percent of State epidemiologists and 24 percent of all other epidemiologists working in State health departments were EIS alumni(ae) (*4*). Thus, for many EIS Officers, participation in epidemiologic field investigations helps to prepare them for eventual public-service careers as epidemiologists in State public health agencies. As new and increasingly complex public health problems challenge CDC and the States, the impetus to use epidemiologic field investigations and training experiences to solve these problems will be even greater.

References

1. Gregg, M. B.: The principles of an epidemic field investigation. *In* Oxford textbook of public health, Holland, W. W., Detels, R., and Knox, G., editors. Oxford University Press, New York, 1985, 3:284–99.
2. Foege, W. H.: Centers for Disease Control. J Public Health Policy 2:8–18 (1981).
3. Langmuir, A. D.: The Epidemic Intelligence Service of the Center for Disease Control. Public Health Rep 95:470–477, September-October 1980.
4. Gunn, R. A., et al.: State epidemiology programs and state epidemiologists: results of a national survey. Public Health Rep 104:170–177, March-April 1989.

Hepatitis B Vaccination Programs for Health Care Personnel in U.S. Hospitals

PAUL G. ALEXANDER, MPH
REBBECA JOHNSON
WALTER W. WILLIAMS, MD, MPH
STEPHEN C. HADLER, MD
JOHN W. WHITE, PhD
PATRICK J. COLEMAN, PhD

Mr. Alexander is a fourth year medical student at Case Western Reserve School of Medicine, Cleveland, OH. At the time of this study, Ms. Johnson was completing a masters degree in public health at the University of Michigan School of Public Health and working as a summer fellow with the Hepatitis Branch, Division of Viral and Rickettsial Diseases (DVRD), Center for Infectious Diseases (CID), Centers for Disease Control (CDC), Atlanta, GA. Dr. Williams is Chief, Child and Adult Immunization Section, Surveillance, Investigations and Research (SIR) Branch, and Dr. Hadler is Chief, SIR Branch, Division of Immunization, Center for Prevention Services, CDC. Dr. White is a Senior Math Statistician, Epidemiology and Surveillance Branch, Division of Health Studies, Agency for Toxic Substances and Disease Registry, CDC. Dr. Coleman is a Senior Statistician, Hepatitis Branch, DVRD, CID, CDC.

Tearsheet requests to Technical Information Services, CPS, CDC, Mail Stop E07, Atlanta, GA 30333.

Synopsis

A random sample of 232 U.S. hospitals was surveyed. Of those hospitals, 75 percent had hepatitis B vaccination programs. The presence of a program was associated with hospital size (60 percent of those with 100 beds, 75 percent with 100–499 beds, 90 percent with 500 or more beds; P=0.0013) and hospital location (urban 86 percent; rural 57 percent; P<0.001). The frequency of needlestick exposures per month among hospital personnel and hospital location were directly related to and best predicted the existence of hepatitis B vaccination programs.

All hospitals with programs offered vaccine to high-risk personnel (as defined by the hospital). Seventy-seven percent of hospitals paid all costs for vaccinating high-risk personnel; 19 percent paid for any employee to be vaccinated regardless of risk status. Forty-six percent of hospitals with programs were estimated to have vaccinated more than 10 percent of all eligible personnel, and 13 percent to have vaccinated more than 25 percent of eligible personnel.

The highest compliance rates were associated with hospitals paying for the vaccine and requiring vaccina-