that can result in abortions, miscarriages, and stillbirths. The risk of CRS is greatest in the first trimester of pregnancy, with defects rarely resulting from infection after the 20th week. Fetal infection without clinical stigmata of CRS can occur at any stage of pregnancy. The main goal of rubella immunization programs is to prevent fetal infection and CRS (7).

The threat of CRS remains greatest among religious groups like the Amish. Increased surveillance for adverse birth outcomes consistent with CRS is a challenge, because many births to Amish women occur at home and are not observed and reported. Cord-blood samples for rubella titers would provide additional epidemiologic information and again are not likely to be available from this population. Health care providers who are trusted by this community are encouraged to improve levels of rubella vaccine coverage among children and adults, particularly women of childbearing age, perhaps by identifying missed or underused opportunities for vaccination.

References

1. Levinson, P. M., et al.: Behavioral risk factors in an Amish community. Am J Prev Med 5: 150–156 (1989).
2. Adams, C. E.: and Leaverland, M. B.: The effects of religious beliefs on the health care practices of the Amish. Nurse Pract 11: 58–60 (1986).
3. Hostetler, J. A.: Amish society. Ed 2. Johns Hopkins University Press, Baltimore, 1980.
4. Sutter, R. W., et al.: Measles among the Amish: comparative study of measles severity in primary and secondary cases in households. J Infect Dis 163: 12–16 (1991).
5. Rubella and congenital rubella surveillance, 1983. MWWR Morb Mortal Wkly Rep 33: 237–242, 247, May 11, 1984.
6. Increase in rubella and congenital rubella syndrome—United States, 1988–1990. MWWR Morb Mortal Wkly Rep 40: 93–99, Feb. 15, 1991.
7. Rubella and congenital rubella syndrome—United States, 1985–1988. MMWR Morb Mortal Wkly Rep 38: 173–178, Mar. 24, 1989.

Pneumococcal Vaccination in a Remote Population of High-Risk Alaska Natives

MICHAEL DAVIDSON, MD, MPH
CAROL CHAMBLEE, RN, MPH
HENRY G. CAMPBELL, RN, MPH,
LISA R. BULKOW, MS
GRADY E. TAYLOR
ANNE P. LANIER, MD, MPH
JAMES BERNER, MD
JOHN S. SPIKA, MD
WALTER W. WILLIAMS, MD, MPH
JOHN P. MIDDAUGH, MD

Five authors are with the Public Health Service's Centers for Disease Control and Prevention (CDC). Dr. Davidson, Ms. Bulkow, and Mr. Taylor are with the National Center for Infectious Diseases, Arctic Investigations Program. Dr. Spika is with the National Center for Infectious Diseases, Division of Bacterial Diseases. Dr. Williams is with the National Center for Prevention Services, Division of Immunization. Miss Chamblee, Mr. Campbell, Dr. Lanier, and Dr. Berner are with the Public Health Service's Indian Health Service, Alaska Area Native Health Service. Dr. Middaugh is with the State of Alaska, Department of Health and Social Services, Division of Public Health, Section of Epidemiology.

Tearsheet requests to Michael Davidson, MD; Alaska Native Medical Center, Department of Medicine, 255 Gamble St., Anchorage, AL 99501; tel.: (907) 279-6661; fax.: (907) 257-1115.

Synopsis

In response to an increasing prevalence of serious pneumococcal disease among adult Alaska Natives of northwest Alaska, a 3-year program was begun in 1987 to identify residents of that remote region who were at high risk for developing invasive pneumococcal disease, to determine their pneumococcal vaccination status, and to deliver vaccine to at least 80 percent of those at risk.

After reviewing public health nursing and Indian Health Service data bases, the authors identified 1,337 persons, 20 percent of the 6,692 residents of the region, at high risk for invasive pneumococcal infection, defined either by having a specific chronic disease or by age criteria. Cardiovascular disease and alcoholism were the two most common chronic diseases. Only 30 percent of those determined to be at high risk had received one or more doses of pneumococcal vaccine previously. Half of those persons had received their most recent vaccination 6 or more years earlier.

The program used both customary and innovative methods to deliver 23-valent polysaccharide

vaccine to 1,046 of those at high risk (78 percent), including 388 persons who were revaccinated. At the completion of the project, 1,123 persons, 84 percent of those at high risk, had received at least 1 dose. They included 1,088 persons, 81 percent of those at high risk, with vaccination within the previous 5 years as a result of the project, compared with a 15-percent rate prior to the vaccination phase of the project. The program demonstrated that high levels of vaccination against pneumococcal disease, exceeding Year 2000 objectives of 60 percent, are attainable in a remote rural Alaskan population.

AMONG THE 10 MOST COMMON CAUSES of hospitalization and death, pneumonia and influenza are the only disorders for which efficacious vaccines are available. Besides causing both lobar and bronchopneumonia, *Streptococcus pneumoniae* is a major cause of bacterial meningitis, otitis media, and sepsis among Native Americans of all ages.

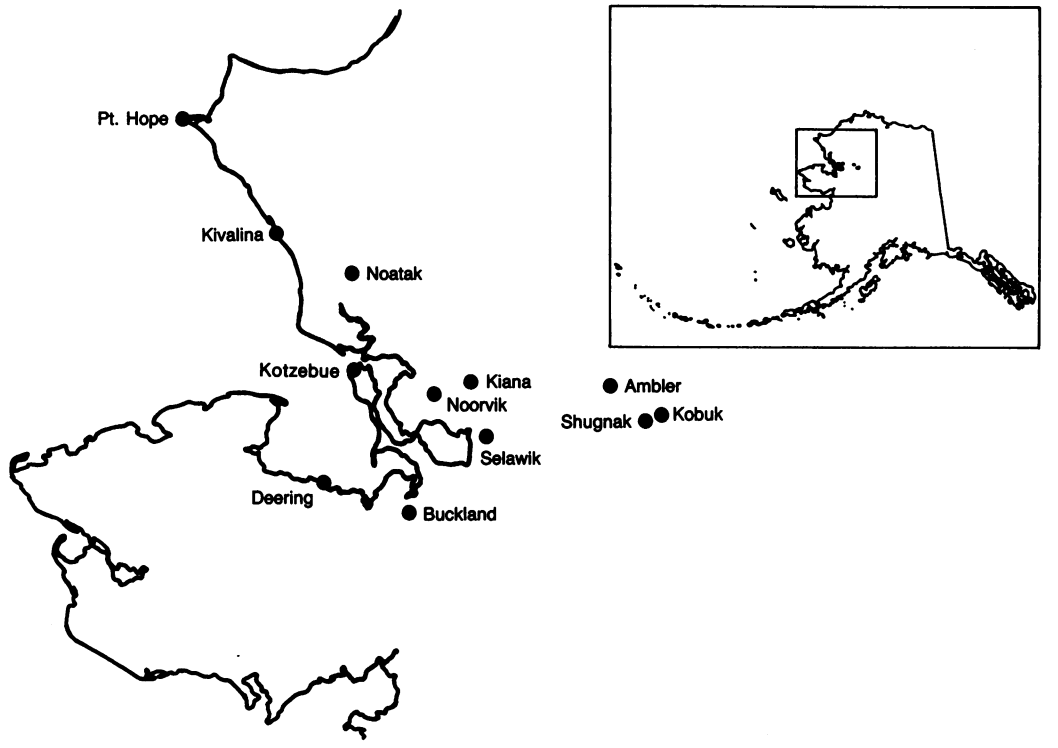
Rates of confirmed pneumococcal bacteremia have been documented to be 34 times higher among Alaska Native children younger than 2 years and 6 times higher among Alaska Native adults living in the Yukon-Kuskokwim Delta than are found in typical U.S. populations (*1*). More than 96 percent of those infections were caused by pneumococcal types that are represented in the 23-valent pneumococcal polysaccharide vaccine currently available. The incidence of invasive pneumococcal disease (a positive culture from a normally sterile body site) is more than four times higher among Alaska Natives ages 55–64 years than among non-Native Alaskan residents of the same age and more than twice the rate for persons 65 years and older of all races combined and living in Charleston County, SC (*2*), for example. The rate of invasive pneumococcal disease among Alaska Natives ages 55–64 years with no underlying conditions is equal to that of all adults 65 years and older residing elsewhere in the United States (unpublished data, Centers for Disease Control and Prevention, National Center for Infectious Diseases, Arctic Investigations Program, 1986–90).

Increased rates of invasive pneumococcal disease in the Northwest Arctic Native Borough Association (NANA) region of northwest Alaska (figure 1) became evident to local health care providers during the period June 1986 through April 1987, when 12 Alaska Native adults, 1 non-Native Alaskan adult, and 1 Alaska Native infant were diagnosed (figure 2). Four of the 12 Alaska Native adults died, 3 within 24 hours of admission to the hospital. The annual incidence rate for invasive pneumococcal disease during that period for Alaska Natives 60 years and older was almost 60 times higher than rates available for other U.S. population groups and 23 times higher than for residents of all ages (*3, 4*). Of the pneumococcal serotypes isolated from nine patients, eight were vaccine types. Those high disease rates were documented by sterile site isolates, despite the use of the empiric antibiotic therapy that is frequently necessary in rural Alaska. During the previous 30 months, only two invasive pneumococcal infections were noted.

The increase in morbidity and mortality from pneumococcal disease in northwest Alaska was the incentive for a 3-year program from October 1987 through September 1990 to assess pneumococcal vaccination levels as well as to vaccinate at least 80 percent of those at high risk for developing serious disease. That objective was higher than the goal of 60 percent established for the Year 2000 objectives (*5*). Beginning in 1976, vaccine supplied by the State of Alaska was limited to outpatient distribution by public health nurses and community health aides. However, because the regional provider of primary care and public health services, the Maniilaq Corporation, is operated by Alaska Natives, we sought support outside the Indian Health Service (IHS). Among the agencies that planned the collaborative project were the State of Alaska's Department of Health and Social Services, the Alaska Area Native Health Service, the Maniilaq Corporation, and the Centers for Disease Control and Prevention (CDC).

In Alaska, from 1975 to 1987, the indications for vaccination with pneumococcal polysaccharide were those recommended by CDC's Immunization Practices Advisory Committee. The indications for vaccination included persons 2 years and older who had conditions predisposing to serious infection, such as chronic cardiovascular, metabolic, pulmonary, and renal diseases; alcoholism; cancer; diabetes; immunosuppression; auto-immune disorders; and dysfunction of the spleen. In addition to the age criterion of 65 years and older, expanded indications for the vaccination of Alaska Natives now include all healthy persons 55 years and older, anyone 2 years and older with previously docu-

Figure 1. Location of region and communities in northwest Alaska in 3-year program to vaccinate Alaska Natives at high risk for pneumoccal disease, 1987–90



mented invasive pneumococcal disease, and revaccination of high-risk or elderly persons whose last vaccination was 6 or more years earlier. The expanded indications, developed by the Alaska Area Native Health Service and CDC in 1987, were specifically approved by the Immunization Practices Advisory Committee.

We considered the entire population in the NANA region, 6,692 persons, to be at potentially high risk for invasive pneumococcal infection. The program was directed to all eligible persons living in the area: Alaska Natives and Eskimos (85.9 percent of the population); Indians (1.6 percent); Aleuts (0.2 percent); non-Native Alaskans, including whites (9.6 percent); and persons of unknown ethnicity (2.8 percent). The population is surprisingly mobile and lives in 10 small communities, plus the town of Kotzebue, which has 3,000 residents and a regional medical center. One village, Point Hope, adjacent to the NANA region and included in the project, uses the medical center (figure 1). Except in Kotzebue, many adults in the region maintain a subsistence lifestyle. Health care in smaller communities usually is provided by a trained community health aide or a visiting public health nurse, or both, some of whom are residents.

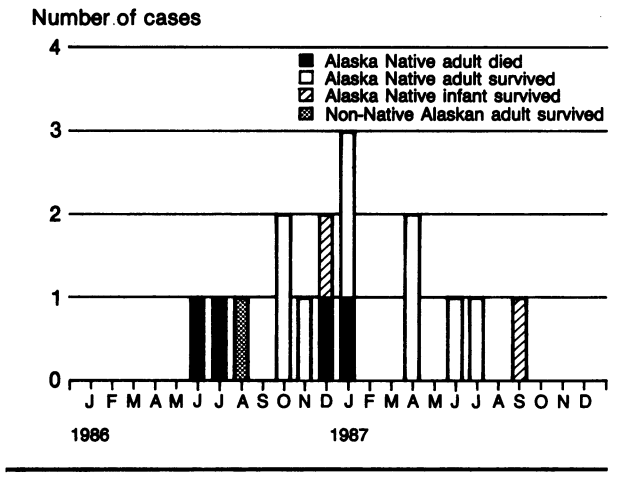
'The annual incidence rate for invasive pneumococcal disease during that period for Alaska Natives 60 years and older was almost 60 times higher than rates available for other U.S. population groups and 23 times higher than for residents of all ages.'

Methods

Patient selection. We identified persons residing in the region who had previously diagnosed high-risk conditions and persons 55 years and older. We determined their vaccination status by matching information from four data bases:

1. A computerized list of residents that originally had been compiled for a regional hepatitis B vaccination program,
2. Recent and archival computer files from the IHS Patient Care Information System (PCIS) that contained information on diagnoses and vaccina-

Figure 2. Monthly incidence and outcome of invasive pneumococcal infections, all ages, northwest Alaska, 1986-87, before 3-year vaccination program of high-risk population



tions of about 12,000 patients seeking care within the region during the past 10 years.

PCIS is a large-scale automated medical record system that compiles the ambulatory, inpatient, and public health experience of Alaska Natives and the State's rural health care delivery system and involves many facilities and agencies (*6*). When the project was carried out, PCIS included data on more than 476,000 patients and contained 3 times as many health records. The system since has been replaced by an interactive computerized data base, the Patient Care Component (PCC) of the Resource Patient Management System (RPMS).

3. A public health nurse card file of recorded vaccine administration, and

4. A computerized CDC demographic data base of information on Alaska Natives, which we used to identify deaths and resolve duplicate entries in the other data bases that may have resulted from name changes or inconsistencies.

Community health aides in each village confirmed the census lists periodically throughout the 3-year period. We removed from the working files the names of persons known to have died or moved away.

Assessment of vaccination status. Considerable consolidation of vaccination information was necessary. Vaccinations administered within 30 days at one location were considered identical and counted as a single event. Multiple vaccinations administered at different times or different places, more than 30 days apart or located in different communities, were independently recorded. A review of medical records from clinics staffed by community health aides in four NANA region villages revealed few vaccinations not otherwise recorded, and this source of information was not pursued.

Evaluation of high-risk conditions. The following specific high-risk conditions were considered to predispose a person to severe pneumococcal infections: chronic cardiovascular disease, chronic pulmonary disease, alcoholism, diabetes mellitus, chronic renal failure, nephrotic syndrome, lymphoma, invasive cancer, multiple myeloma, severe connective tissue disease, metabolic disorders, immune dysfunction, disorders of the spleen, and HIV infection.

To validate the computer-listed diagnoses, we reviewed hospital and clinic records from 250 randomly selected persons with representative diagnoses. Records were searched for preestablished clinical criteria based on hospitalization discharge diagnoses, clinic visits, laboratory data, and medications prescribed. The total positive predictive value of these computer-listed diagnoses was only 46 percent, because many represented inactive conditions, like benign cardiac murmurs, positive tuberculin skin tests, obesity, and transient disorders, such as electrolyte abnormalities and anemia. We eliminated these and other diagnoses, and achieved a refined definition of high-risk status, with an estimated overall positive predictive value of 90 percent. High-risk status was assigned for the following conditions and ICD-9 (*7*) codes.

Heart disease: 093, 391, 393-398, 401-405, 410-414, 415-417, and 423-429.8, excluding 424.9, 427.0-427.2, 427.6-427.9
Lung disease: 490-496, 500-508, 510-519.7, excluding 491.9
Connective tissue disease: 710, 714, 720-721
Diabetes: 250-250.9
Other metabolic disorders: 240-246.9, 251-277.8, excluding 276
Renal disease: 581-589, 590.0-590.8
Alcoholism: 303, 305.0, 331.7
Cancer: 140-208, 235-239.9.

Additional codes defined other conditions with few or no patients in the PCIS data base:

Acute and chronic liver disease (excluding hepatitis): 570-572.8
HIV infection: 042-044
Immune dysfunction and disorders of the spleen: 289.4-289.59, 865.

During the final 3 months of the project, a manual review of medical records of the remaining subject population eliminated other noncontributory diagnoses.

Vaccine administration. In the project, vaccination was administered largely by the customary providers of this service. They included public health nurses and health aides, as well as clinic and hospital nurses in three settings:

1. An inpatient program, designed to query all physicians regarding the administration of pneumococcal vaccination to their patients prior to discharge;
2. An outpatient facility program that provided simultaneous pneumococcal vaccination to those adults receiving a tetanus and diphtheria toxoid (TD) booster; and
3. The coadministration of pneumococcal and influenza vaccines by community health providers, guided by the project's lists of high-risk persons.

Using a personal computer and the Borland International relational data base Paradox, we generated a master list of all persons 2 years and older who lived in the project area. The list included their risk status and pneumococcal vaccination history. Hospital staff members used the master list in the clinic and inpatient settings to find the vaccination status of outpatients and inpatients with high-risk diagnoses before discharge. Public health and primary care providers in the field used shorter lists of high-risk persons requiring vaccination. During the final 20 months of the project, we updated both the master list and the short lists frequently as people were vaccinated. Both lists identified patients for simultaneous administration of influenza and pneumococcal vaccines in the autumn and simultaneous doses of tetanus-diphtheria (TD) booster and pneumococcal vaccine during outpatient and emergency room encounters.

Specific outreach programs were undertaken for high-risk persons within the town of Kotzebue. After sending letters encouraging appointments for vaccination, a student volunteer found many with direct telephone calls. Public service announcements on a local radio station reached many persons who were without telephone service. Lists of local utility customers helped in locating and reaching people without a telephone or postal service. Pneumococcal vaccination was offered during a local health fair and by the health services of a National Guard summer camp. The project nurse made many visits to a nursing home, a senior citizen center, and a regional jail to provide vaccination.

Table 1. Prevalence of high-risk diagnoses in the general population and the population 20 years and older in northwest Alaska, 1987–90

Diagnosis or category	All patients		Patients 20 years and older	
	Number	Percent	Number	Percent
Chronic cardiovascular...	482	7	452	12
Chronic lung.....	296	4	252	17
Connective tissue	116	2	112	3
Diabetes.....	48	1	47	1
Other metabolic.....	164	3	148	4
Renal	15	<1	14	<1
Cancer.....	80	1	78	2
Alcohol abuse.....	334	5	337	9
55 years and older	256	4	256	7
All high risk patients.....	1,081	16	985	27

NOTE: Patients in multiple diagnostic categories were counted more than once.

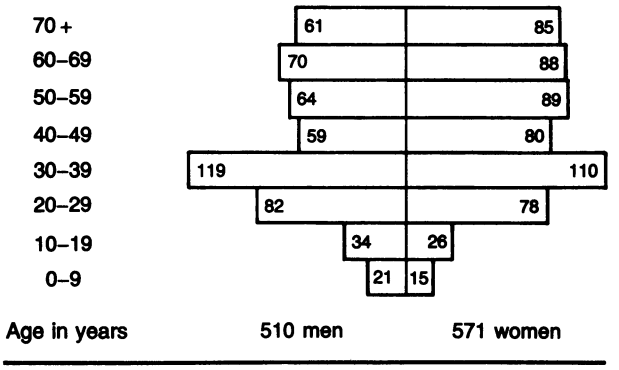
Results

When the project ended, the data base included 6,692 current residents in northwest Alaska. Of them, 1,081 (16 percent) had specific high-risk diagnoses, including 27 percent of all those 20 years and older (table 1). Almost half of the high-risk persons were 20–49 years old, with an equal distribution of men and women (figure 3). The most prevalent high-risk conditions among adults 20 years and older were cardiac disease (12 percent), alcoholism (9 percent), and chronic lung disease (7 percent) (table 1). We identified for vaccination an additional 256 persons, 4 percent of the total population, who were in good health, but 55 years or older (table 1).

Previous pneumococcal vaccination was documented for 9.5 percent of the population, including 30 percent of all those 2 years and older with high-risk diagnoses, 68 percent of those 55–64 years old, 86 percent of those 65 years and older, and 64 percent of those 55 years and older without another indication for vaccination (table 2).

The information was collected largely from computerized vaccination records. A review of public health nursing files identified an additional 10 percent of vaccinations not recorded elsewhere. Categories of patients diagnosed with high-risk conditions, previously vaccinated one or more times, ranged from 15 percent of those with alcoholism to more than 68 percent of those with diabetes (table 2). The most recent vaccination for

Figure 3. Age distribution of residents of northwest Alaska pneumococcal disease vaccination project region with chronic disease diagnoses, as of August 30, 1990



NOTE: Patients with multiple diagnoses were counted once.

50 percent of those high-risk persons previously vaccinated had been administered 6 or more years earlier.

The high-risk unvaccinated persons identified included those from all diagnostic categories, mainly younger than 55 years, who lived in the 12 communities. However, the community with the highest proportion (83 percent) of high-risk persons requiring vaccination or revaccination was the regional population center of Kotzebue.

At the completion of the project, 1,123 persons, 84 percent of those at high risk, had received at least 1 dose of the 23-valent polysaccharide pneumococcal vaccine (PNEU-IMMUNE (R)), and 81 percent of the high-risk population had current vaccinations, that is, within the previous 6 years, compared with only 15 percent at the beginning of the project's vaccination phase. Ten of the 12 communities achieved a vaccination rate of more than 90 percent, including 2 that achieved 100 percent. During the project, 658 persons received their first pneumococcal vaccination and 388 were revaccinated.

Discussion

The project demonstrated that a high level of vaccination against pneumococcal disease, well above the Year 2000 objectives for the general population, can be achieved in a remote high-risk Alaska Native population. Estimates of existing vaccine coverage of high-risk candidates nationwide have been cited as less than 10 percent (*5, 8*).

We used a computerized health information system (PCIS) that is no longer in use. Additional data bases, not generally available outside Alaska, permitted a population-based, rather than clinic- or hospital-based, approach to identify those needing vaccination. That permitted precise calculation of the total number of high-risk persons and their vaccination rates before and after the program. The total number of residents in the area calculated by this project in 1990 was within 1 percent of the 1990 census estimates, indicating the high degree of accuracy of the population-based methods.

To validate the computerized source of diagnostic and vaccination data (PCIS), we searched other sources of vaccination and clinical information. By limiting diagnoses to specific ICD-9 codes, high-risk diagnostic status was captured reliably from computerized IHS data. Computerized vaccination records appeared 90 percent complete, and we usually confirmed the date of vaccination by alternate sources. The expanded guidelines for pneumococcal revaccination of Alaska Natives required a correct assessment of previous vaccination dates, and computerized IHS data appeared adequate for this purpose.

The current Immunization Practices Advisory Committee recommendations for pneumococcal vaccination include the vaccination of "certain Native American populations with an identified increased risk of disease" (*9*). Any extension of the guidelines should be based on high incidence rates of disease determined by surveillance programs. Similarly, Immunization Practices Advisory Committee guidelines currently restrict revaccination to those at highest risk for fatal pneumococcal infections or conditions such as renal disease with rapidly declining antibody levels. A forthcoming report on the antibody levels achieved by participants in our project will help in formulating future recommendations.

The successful delivery of vaccinations in this program depended largely upon three components: pneumococcal vaccination of patients before their discharge from the hospital, simultaneous pneumococcal vaccination of those adults receiving a TD booster, and coadministration of pneumococcal and influenza vaccines. Because of a chronic shortage of outpatient clinic staff, we were unsuccessful in identifying persons 2 years and older in this setting who required vaccination. However, even without the systematic outpatient screening and outreach activities of the project, we believe that the Year 2000 health objective for pneumococcal disease prevention is attainable. A vaccination level of 60 percent of high-risk adults would have been achieved easily using only the three project components described.

Table 2. Vaccination status of population at high risk for pneumococcal disease before and after vaccination program, northwest Alaska, 1987–90

Risk category	Percent ever vaccinated		Percent revaccinated by end of program
	Before program	By end of program	
Chronic cardiovascular disease	49	93	38
Chronic lung disease	41	89	30
Connective tissue	55	91	41
Diabetes	68	100	56
Other metabolic disease	37	92	26
Renal disease	57	87	27
Cancer	47	93	38
Alcohol abuse	15	64	6
Older than 54 years	64	84	27
All high risk patients	30	84	25

NOTE: Patients in multiple diagnostic categories were counted more than once.

A pneumococcal vaccination level of 71 percent was estimated for high-risk patients served by the Portland Area Indian Health Service in 1990, before computerized lists of high-risk persons were distributed (*10*). However, the assessment included only clinic users more likely to have valid high-risk conditions and to comply with health providers offering vaccination. Elsewhere, estimates of pneumococcal vaccination for older Navajo adults recently treated ranged from 36 percent to 63 percent (*11*). The 20 percent vaccination level estimated in high-risk users of urban Indian health clinics in 1989 also exceeded current estimates of high-risk persons (*12*). These methods for estimating vaccine coverage appear useful and may be enhanced with the refined ICD-9 codes used in the project.

The current computerized data system, the Patient Care Component of the Resource and Patient Management System, now operating at more than half of the IHS and tribal health facilities, and its query system, Q-Man, could provide the basis for facility- or community-based programs elsewhere. The multifacility integration of data (MFI) available in the Tucson Area (*13*) could be used to collect the entire immunization history of persons seeking care at several facilities. Such record linking could identify high-risk diagnoses not available in any one medical record. The success of any health maintenance reminder depends on the validity of its information, whether automatically produced by PCC for every patient encounter, or provided on a list for community health workers. Health care providers quickly categorize all such efforts as futile if they perceive outdated or inaccurate data. Before relying on this computer-based strategy to guide vaccination efforts, an assessment must be made of the computer system and data base for local delays in the entry of recent vaccinations and diagnoses, as well as the incomplete retrieval of information regarding those persons requiring vaccination.

Institutional-based immunization programs elsewhere have directed reminders for pneumococcal vaccination successfully to physicians. The reminders are inserted in the medical records of adult patients (*14, 15*). Both outpatient chart reminders and computerized hospital discharge summaries have improved vaccination rates of high-risk patients, including alcoholics. More labor-intensive programs have used infection control nurses effectively in vaccinating inpatients (*16*).

Although the project accessed a unique computerized data base, its success is relevant to other remote populations. Within IHS, PCC can be used. Since successful programs elsewhere (*13–15*) have administered pneumococcal polysaccharide vaccine to high-risk persons, even if prior vaccination status was unknown and revaccination was not generally recommended, the effort expended by the project to confirm prior vaccination status was unnecessary. Current estimates of the cost of delivery of the vaccine by public health providers in rural Alaska is almost $50 per dose. While the cost per dose in this project was threefold higher, data base development was responsible for at least half the increase.

The design of the inpatient component of the project reflected the observation of others, that most unvaccinated adults with serious or fatal pneumococcal infections have been hospitalized within the previous 5 years (*17*). The program seized some frequently missed opportunities for pneumococcal vaccination, including the simultaneous vaccination of appropriate persons who re-

quired TD vaccine booster doses or influenza vaccine.

A diagnosis of alcoholism and residence in Kotzebue characterized 41 percent of the remaining 248 residents in the region who required vaccination at the end of the project. Information on the immunogenicity of pneumococcal polysaccharide vaccine obtained during this study suggests that the total antibody response of alcoholics equals or exceeds that of patients with other chronic diseases. Furthermore, the total antibody response of alchoholics to type 12F, the most common serotype responsible for invasive disease in Alaska Native adults, was robust (*18*). The vaccination of high-risk alcoholics should be aggressively pursued in future pneumococcal prevention programs.

At the end of the project, all vaccination data were entered into the local RPMS computer, the master and the short lists were updated and given to primary and public health care providers, and medical records were noted to show those requiring vaccination. Evaluation of those measures to determine their duration and cost effectiveness is necessary.

References

1. Davidson, M., et al.: Invasive pneumococcal disease in an Alaska Native population, 1980 through 1986. JAMA 261: 715-718, Feb. 3, 1989.
2. Breiman, R. F., et al.: Pneumococcal bacteremia in Charleston County, South Carolina. A decade later. Arch Intern Med 150: 1401-1405 (1990).
3. Felice, G. A., Darby, C. P., and Fraser, D. W.: Pneumococcal bacteremia in Charleston County, South Carolina. Am J Epidemiol 112: 828-835 (1980).
4. Mufson, M. A., Oley, G., and Hughey, D.: Pneumococcal disease in a medium-sized community in the United States. JAMA 248: 1486-1489, Sept. 24, 1982.
5. Public Health Service: Healthy people 2000: national health promotion and disease prevention objectives. DHHS Publication No. (PHS) 91-50212. Office of the Assistant Secretary for Health, Office of Disease Prevention and Health Promotion. U.S. Government Printing Office, Washington, DC, 1990.
6. Brown, G. A.: Patient Care Information System. A description of its utilization in Alaska. Proceedings of IV Annual Symposium on Computer Applications in Medical Care, Vol. 2, Nov. 2-5, 1980, Washington, DC, pp. 873-881.
7. International classification of diseases: manual of the international statistical classification of diseases, injuries, and causes of death. 9th revision. Clinical modification. DHHS Publication No. (PHS) 91-1260. Centers for Disease Control, National Center for Health Statistics, and Health Care Financing Administration, Hyattsville, MD, 1992.
8. Williams, W. W., et al.: Immunization policies and vaccine coverage among adults. The risk for missed opportunities. Ann Intern Med 108: 616-625 (1988).
9. Immunization Practices Advisory Committee: Recommendations for pneumococcal polysaccharide vaccine. MMWR Morb Mortal Wkly Rep 38: 64-76, Feb. 10, 1989.
10. Portland area documents achievement of 1990 objective for the nation for adult immunization. IHS Primary Care Provider 16: 165-167 (1991).
11. Houck, P.: Vaccination status of Navajos over age 65. Encouraging results and missed opportunities during annual influenza vaccination. IHS Primary Care Provider 14: 127-130 (1989).
12. Ruid, R. M.: Adult immunizations. Vaccine coverage against tetanus, diphtheria, pneumococcal disease, and influenza at American Indian Health Care Association urban clinics. IHS Primary Care Provider 15: 104-109 (1990).
13. Mason, W. B.: PCC update, 1992. IHS Primary Care Provider 17: 45-48 (1992).
14. Cheney, C., and Ramsdell, J. W.: Effect of medical records' checklists on implementation of periodic health measures. Am J Med 83: 129-136 (1987).
15. Clancy, C. M., Gelfman, D., and Poses, R. M.: A strategy to improve the utilization of pneumococcal vaccine. J Gen Int Med 7: 14-18 (1992).
16. Klein, R. S., and Adachi, N.: An effective hospital-based pneumococcal immunization program. Arch Intern Med 146: 327-329 (1986).
17. Fedson, D. S.: Influenza and pneumococcal immunization strategies for physicians. Chest 91: 436-443 (1987).
18. McMahon, B., et al.: Immunogenicity of the 23 valent pneumococcal polysaccharide vaccine in the Alaska Native chronic alcoholics compared with non-alcoholic Native and non-Native controls. Am J Med. In press.