Cost-Benefit of a Streptococcal Surveillance Program Among Navajo Indians

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THE FREQUENCY, DEMOGRAPHY, AND CLINICAL characteristics of acute rheumatic fever (ARF) and rheumatic heart disease (RHD) among the Navajo Indians over a 16-year period were reported recently (*1*). A school-based rheumatic fever prevention program had been instituted in many parts of the Navajo Reservation during the last 2 years (1975–77) of that period. This program, based on experience with streptococcal disease control in Wyoming and Colorado, involved periodic culturing of throat specimens from both symptomatic and asymptomatic school children and the treatment of those whose cultures were positive for group A beta-hemolytic streptococci (*2,3*). There was some indication that ARF occurred less frequently among children in geographic units covered by the program than in uncovered areas, but the number of reported cases was small in the 2-year period, and the variation may have been caused by chance alone.

During the subsequent 2 years, the rheumatic fever control program continued to reach a large number of Navajo elementary school children, but because of personnel and transportation restraints, it did not reach all schools. Consequently, it was possible to review all cases of ARF diagnosed in school children for a period of more than 4 years and to ascertain whether each affected child attended a school that was active in the program or for whom a throat culture was performed immediately before the development of ARF. Two hypotheses were tested. First, the risk of ARF in children ages 5 to 16 was higher among those who did not attend schools active in the program or for whom a throat culture was not done during the 2 months before their ARF was diagnosed. Second, the benefits of the program, expressed in monetary terms, outweighed its costs.

Methods

As described in the previous report (*1*), we reviewed records of all Navajo patients hospitalized for ARF (ICD-8, 390–391) or chorea (392) from all 8 Indian Health Service or private hospitals serving the Navajo community. This new review included the period from July 1, 1977 through September 30, 1979 (27 months), in addition to the last 2 years of the earlier study (July 1, 1975 through June 30, 1977), during which the streptococcal control program was in operation. Thus, a total of 51 months was considered. For inclusion in the study, the patient had to be identified as Navajo on the hospital chart, and the diagnosis of ARF had to meet the revised Jones criteria of the American Heart Association (*4*). For all patients ages 5 through 16, the school attended was recorded, in addition to age, sex, and clinical characteristics of the illness. If the school was not identified on the chart, it was determined by the following

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methods, used sequentially: (*a*) consulting the public health nurse in the patient's geographic area, (*b*) consulting school nurses in that area, and (*c*) reviewing enrollment rosters of all schools in that area for the period in question.

School coverage by the streptococcal control program was ascertained through records in the program's office; the records included numbers of cultures performed and numbers positive for group A beta-hemolytic streptococci, by month, since the program's inception in 1975. Throat culturing for symptomatic children was done in all active schools, and in most schools all children were screened periodically by means of throat cultures. The program goal was to screen in every school monthly, but participating schools were most often screened four or five times during an academic year, although surveillance ranged from one through nine times. The records were organized by school and, if routine cultures were performed during at least 4 months of a given year, a school was considered "covered." The records also included lists of individual children for whom throat cultures were done, by months and by school, with the results of the throat culture (positive or negative) indicated. Therefore, it was possible to ascertain for each child who developed ARF whether he or she attended a school considered covered during that time and, if the school was covered, whether the child had a throat culture during the 2 months before the diagnosis of ARF.

Enrollment, by year, for public school systems located on the Navajo Reservation, for private schools, and for Bureau of Indian Affairs schools on or near the reservation was available from the respective districts, schools, or agencies. It was assumed that the total enrollment was Navajo in these schools. Off-reservation public school districts in New Mexico and Arizona which serve some Indian children were eligible for extra governmental support through the Johnson O'Malley Program, which is funded by the Office of Education. The number of Indians enrolled in these school districts was tabulated, but tribal affiliation was not necessarily specified. The Indian enrollment of elementary schools in counties adjacent to the reservation was ascertained. Two ways of calculating the percentage of schools covered by the streptococcal control program were employed: (*a*) assuming that 100 percent of Indian students were Navajo and (*b*) assuming that 50 percent of Indian students were Navajo. The Navajo are populous, particularly in northwestern New Mexico, and it is reasonable to assume that they constitute at least 50 percent of the Indians in all adjacent areas. Most of these school systems did not participate in routine throat culturing, but children still were admitted to hospitals linked with the Indian Health Service data system.

School enrollment and streptococcal control program participation of Navajo children, pre-school through eighth grade, 1976 through 1979

Year	Navajo enrollment		Number in participating schools [2]	Percent participation	
	Maximum [1]	Minimum		Maximum	Minimum
1976	32,400	27,834	15,360	47.4	55.2
1977	34,431	29,643	16,042	46.6	54.1
1978	36,257	31,215	14,783	40.8	47.4
1979	38,571	33,217	21,608	56.0	65.0
Average	35,415	30,478	16,948	47.8	55.6

[1] Includes "Indian" enrollment of public school districts in adjacent counties: 1,727 persons (1979). Maximum enrollment was based on the assumption that 100 percent were Navajo, and minimum was based on the assumption that 50 percent were Navajo.

[2] Schools in which throat cultures were performed four or more times in a given academic year.

Results

ARF cases among school children. During the 51-month period, 30 cases of ARF were confirmed in Navajo children ages 5 through 16. These included 25 children with initial episodes and 5 with recurrences, all of whom had their first episode of ARF before this study period. We were able to determine the schools attended by 29 of the 30 children. Only 7 (24 percent) attended schools that were covered during the year when they developed ARF. An additional 33 cases were confirmed in persons who were over age 16. Throat cultures were not done for 6 of the 7 children attending covered schools during the 2 months before their ARF was diagnosed. These omissions were either due to absenteeism on the days when cultures were performed or because routine cultures were not done during that period. A culture for 1 child 3 weeks before the diagnosis of ARF was reported to be negative for group A beta-hemolytic streptococci. Of the children with recurrent ARF, 2 attended covered schools but cultures had not been done for them in the preceding 2 months, and 3 attended nonparticipating schools. There was chart evidence of routine prophylaxis (LA bicillin about 1 month before the ARF episode) for only 1 of these 5 children.

The table demonstrates the number of Navajo children enrolled in school through eighth grade for 4 academic years, assuming first that all off-reservation Indian students were Navajo (maximum) and

then that 50 percent were Navajo (minimum); it also shows the number and respective percentages attending schools in which throat cultures were taken during 4 or more months in a year. Depending on the estimated denominator, 48 to 56 percent of the children attended schools active in the streptococcal program. The other 44 to 52 percent had 76 percent (22 of 29) of the ARF occurrences. Within this range of denominators, children attending covered schools were less likely to develop ARF than those attending uncovered schools ($\chi^2 = 4.72$, continuity corrected, $P<0.05$, using the minimum estimate; $\chi^2 = 2.79$, continuity corrected, $P<0.10$, using the maximum estimate). If only initial cases of ARF are considered, 19 of 24 (79 percent) attended uncovered schools ($\chi^2 = 4.71$ according to the minimum estimate and $\chi^2 = 2.79$ according to the maximum estimate).

Since the initial criterion for uncovered schools included any with three or fewer surveys in a given year, we ascertained the exact number of surveys performed in schools of children who developed ARF. Of the 22 uncovered cases, only 2 were in schools with any culturing performed during that academic year. Most cases occurred during the years before participation of the school in the control program or among those that had never participated, often in off-reservation public schools of border towns. However, five new ARF cases occurred in children attending previously covered schools, during years in which participation lapsed. In one school, a child developed ARF during the only year in which no culturing was done, after 3 previous years of participation; the following year this school reactivated the program.

While there were at least 52 pre-school and Head Start units in the Navajo area, no cases occurred in these during the 4 years, whether or not they participated. At the other end of our age spectrum, only three cases occurred in junior high school children, two of whom were in uncovered schools. An attempt was made to ascertain if ARF cases were more likely to occur in certain types of schools (that is, public versus Bureau of Indian Affairs) or in certain geographic areas, irrespective of control program participation. It is possible that the covered schools were in more developed areas and had a more acculturated student population than the uncovered schools. However, by 1979, schools participating in the program were distributed fairly evenly throughout the reservation and in adjacent areas. Participation was associated with major administrative decisions (for example, the Shiprock Service Unit entered the program later than the Fort Defiance Service Unit) rather than with the type of school involved.

Cost benefit. If we assume that the experience of children in all schools would have been similar to that of children in uncovered schools had the program not existed, 44.1 to 49.5 cases would have been expected in the 51 months, rather than the observed 30 cases. In covered schools, 20.1 (47.8 percent) to 27.5 (55.6 percent) would have been expected, depending on the enrollment estimate, while only 7 cases were observed. Thus, the program may have prevented from 3.3 to 4.6 ARF episodes per year.

The overall Navajo ARF attack rate for 14 years before school surveillance began (1962–74) was 12.6 per 100,000 (*1*). In addition to the 30 ARF episodes in school children, 33 other ARF cases were documented during this 51-month period. The attack rate for the current period (1975–79), including all age groups, is 10.0 per 100,000 per year—63 total cases in 4.25 years, given a midpoint (1977–78) population estimate of 146,370—representing a rate reduction of 21 percent. If all prevented cases would have occurred in the 5 through 16 age group, a reduction of about 13.2 cases (63 observed $\times$ 0.21) or 3.1 per year would have been expected. Thus, this analysis from overall rates is consistent with the lower estimate from surveillance program data.

The preceding rates are unstable because of the small number of cases, although no secular trend was observed from 1962 through 1974. The most that can be claimed is that 4.6 episodes prevented per year represents a maximum from program and clinical data for the age group 5-16, and 3.1 per year represents a more conservative estimate based on extrapolation from annual attack rates.

The budget for the streptococcal disease control program in 1979 was $146,284 (*5*). According to directors of the Navajo Area Service Units, a conservative estimate for personnel time in performing about 10,000 cultures per month is about 2.5 full-time school nurse equivalents—or $50,000 a year—supported by the Indian Health Service, in addition to the program budget. Additional personnel costs to public school districts and the Bureau of Indian Affairs are not included because relatively small time commitments per school are involved. Thus, a conservative estimate for program costs is $200,000 per year.

Thompkins and co-workers reported in 1977 a decision analysis of the cost effectiveness of pharyngitis management and ARF prevention (*6*). They estimated the cost of an ARF episode to be $10,560, based on 11 days of hospitalization, 90 days of total disability, cost of penicillin prophylaxis, possible allergic reactions, and likelihood of recurrent ARF and class IV rheumatic heart disease. Since 1977 is

the midpoint of the current series, it is reasonable to adopt this estimate, although medical care costs (for example, hospitalization) are less in the Indian Health Service than for the population at large. If 3.3 ARF cases per year were prevented, the savings would be $34,848. To equal the cost of the preventive program, approximately 19 cases per year would have to be prevented.

Discussion

The Navajo streptococcal control program appears to be associated with less frequent occurrence of ARF in participating schools. Although this association is marginally significant, it is strengthened by two other observations: (*a*) six of seven children in covered schools who developed ARF apparently did not have throat cultures before the attack and (*b*) five episodes of ARF occurred in previously covered schools during years in which participation lapsed, while none occurred in those schools during active years. At most, however, three to five ARF cases were prevented per year. Since school participation was not randomly assigned, participating schools could serve populations at different risk from those of nonparticipating schools. In the earlier survey, we compared rates of ARF occurrence in broad geographic areas (Indian Health Service Units), before and after some of them instituted the streptococcal control program in many of their schools. Before this program was started, 5 "active" Service Units, which included about 55 percent of the population, appeared to have a higher rate of ARF occurrence than the 3 other Service Units—13.5 versus 9.5 per 100,000. After 2 years, however, the situation was reversed—8.2 versus 10.0 per 100,000 (*1*). The two groups of Service Units were not distinguished by average income, family size, or urban-rural distribution. Although these comparisons were based on a small number of cases, they at least suggest that active areas (or schools) are not at less risk than others.

The costs of this program are far in excess of benefits, assuming Thompkins' estimate of costs for an ARF episode. Even if actual illness costs exceeded this estimate by fivefold, program costs would still outweigh benefits. In addition, the risks of treating thousands of asymptomatic children with penicillin must be considered. In 1979, for example, 9,198 children had positive throat cultures, and they presumably were treated with oral or intramuscular penicillin. Although no data on allergic reactions in the Navajo are available, it is clear that some reactions in asymptomatic persons must occur, given this number of treatments (*7,8*).

School-based streptococcal surveillance programs generally have included throat cultures for children with symptoms of pharyngitis (*2,3*), while others have included a method of reducing the "carriage rate" by surveillance of asymptomatic children (*3,9*). In 1976, only 5 of 25 State control programs recommended treatment for asymptomatic carriers of group A beta-hemolytic streptococci (*9*). To our knowledge, only in the Navajo area was routine surveillance of all school children recommended, with the exception of a similar program on the Papago Indian Reservation (personal communication, B. Phibbs, MD, clinical professor of medicine, University of Arizona Medical School, Tucson). This goal was at least partly related to the perception that Navajo children had a very high risk of ARF due to frequent streptococcal infections. However, we found that attack rates for ARF among the Navajo were modest and comparable with other U.S. populations (*1*). Nevertheless, a small but real decrease observed in recent years does seem to be associated with implementation of the Navajo program.

Kaplan recently reviewed the literature on the respiratory carrier state for group A streptococci (*10*). He drew a distinction between infection and carrier state. While it is possible to be infected and without symptoms (as in the convalescent period), the large majority of asymptomatic persons with a positive throat culture are "carriers," meaning that no serologic evidence of streptococcal infection is present or will develop (*10*). Almost all patients with ARF demonstrate antibody rises consistent with recent streptococcal infection (*11*). Thus, most asymptomatic children with positive throat cultures are unlikely to be at risk for ARF. Routine surveillance could theoretically reduce the overall carriage rate and thus prevent epidemics in school populations, but it has not yielded an overall decrease in the percentage of positive cultures among Navajo children. Although there were seasonal and local variations, the positivity rate was 6.9 percent for 1975–77, 10 percent for 1978, and 9.1 percent for 1979.

We recommend that in the future the program's efforts be targeted primarily on children symptomatic with pharyngitis. Surveillance of asymptomatic children should be performed (*a*) only intermittently to monitor carriage rates (for which a systematic sample of children, rather than entire schools, would be required) and (*b*) perhaps in certain schools during streptococcal pharyngitis epidemics. Additionally, the program could undertake a system of monitoring penicillin prophylaxis among RHD patients and children who have had ARF in the past.

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SYNOPSIS

COULEHAN, JOHN L. (University of Pittsburgh School of Medicine), BAACKE, GEORGE, WELTY, THOMAS K., and GOLDTOOTH, NORMA L.: *Cost-benefit of a streptococcal surveillance program among Navajo Indians. Public Health Reports, Vol. 97, January–February 1982, pp. 73–77.*

A school-based streptococcal surveillance program has been in effect among Navajo Indians for more than 4 years. Throat cultures of symptomatic children are obtained when indicated, and routine throat cultures are performed monthly. Children whose cultures are positive for group A beta-hemolytic streptococci are treated. During 4 academic years, between 48 percent and 56 percent of elementary school children attended the schools that had 4 or more monthly surveys in each year, but only 24 percent (7 of 29) of the acute rheumatic fever (ARF) cases occurred in children at those schools. Six of seven children attending covered schools were not cultured before their ARF episodes. Five cases occurred in children attending previously covered schools, during years in which participation lapsed. Three or four ARF cases per year appeared to have been prevented, but the program's costs were five times the estimated costs of the prevented cases, even excluding risks of allergic reactions to penicillin. There is little evidence that most asymptomatic carriers are at risk to develop ARF. The authors recommend that streptococcal surveillance efforts be confined largely to culturing throat swabs of children with pharyngitis.