Effect of Improved Sanitary Facilities on Infant Diarrhea in a Hopi Village

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DIARRHEA is a major health problem among southwestern Indian infants (*1*, *2*). Many environmental factors have been implicated in the high prevalence of diarrheal disease on Indian reservations and at all socioeconomic levels where living conditions are poor. Among these factors, the availability of water for personal hygiene is of prime importance in the control of diarrheal disease (*3–5*). Adequate sewage disposal systems including indoor flush toilets are also important in diarrheal disease control (*6*).

Although the infant in his first year of life neither uses a toilet nor washes himself, the sanitary problems of his mother are reflected in the infant's health status. Because children in the first 12 months of life are extremely susceptible to infectious diarrhea and therefore to the results of poor sanitation, the number of infants who become ill with diarrhea provides a subtle indication of the effectiveness of sanitary control measures. We investigated the influence of indoor water and toilets on the prevalence of infant diarrhea in the first year of life, as reflected in hospital use of infants living in a Hopi pueblo in northern Arizona.

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Subjects and Methods

Moenkopi, a Hopi Indian village of approximately 700 people, is 2 miles from the Public Health Service Indian Hospital in adjacent Tuba City, Ariz. Moenkopi is divided both politically and geographically into traditional (lower Moenkopi) and progressive factions (upper Moenkopi).

Nagata gives a detailed ethnographic study of this village (*7*). In this paper we can only indicate the ways that the two segments of the village differ.

The upper village elects representatives to the tribal council and at least superficially appears to be more cooperative with government representatives. Its traditional ceremonial cycle and clan system are not intact.

The lower village does not participate in tribal council affairs and still attempts to rely on the traditional theocratic forms of social control. It, too, has a ceremonial cycle and clan system that is no longer intact and self-con-

tained. Many of its members, however, are related to families in Oraibi, a traditional village 50 miles to the east, and many of them participate in ceremonials held there.

The two segments of Moenkopi are similar in that in both there is a heavy reliance on work for wages. They are roughly equal in numbers. In addition to differing political and cultural attitudes the two divisions of Moenkopi differ in their plumbing facilities. Indoor plumbing is limited almost exclusively to the progressive upper village.

In the spring of 1964, indoor plumbing lines were constructed by the Public Health Service with the cooperation of the upper villagers under Public Law 86–121, the Indian Sanitation Facilities Act. The lower villagers refused to cooperate in this project and continued to use the outdoor water taps and outdoor privies. The lower village, however, benefited indirectly from this project because the common spring which provides water for both the indoor upper Moenkopi system and the outdoor lower Moenkopi system was protected from contamination at this time (personal communication of November 1, 1967, from J. A. Confrancesco, sanitary engineer, office of environmental health, Indian Health Service).

In this study children from Moenkopi were classified according to residence in the upper or lower village to compare their rates of hospital use for diarrheal complaints. Because we lacked useful official census data, information on the total population of Moenkopi children was gathered from the following sources: the patient and field health records of the Public Health Service's Tuba City Indian Hospital, a sanitation survey of Moenkopi by the Service's Keams Canyon Indian Hospital, and the testimony of several village residents. Comparison of our list of children with the unofficial census information provided in a recent study of Moenkopi (*7*) suggested that our census was complete.

The Tuba City and Keams Canyon Hospital records were examined to identify all children born on or after January 1, 1961, who had completed at least 1 year of life as of July 1, 1967, and whose parents resided in Moenkopi at that time. There were 124 children who fulfilled these requirements; 20 boys and 20 girls from upper Moenkopi and 42 boys and 42 girls from lower Moenkopi. One boy and two girls from lower Moenkopi had died and were omitted from the study.

The following information was abstracted from the hospital records for each infant's first year of life: (*a*) outpatient department visits for all causes and for diarrhea, by month of visit, and (*b*) admissions, by month of admission, and diagnosis on discharge. Well-baby visits were not counted as outpatient visits. To compare the effect of the indoor plumbing installed in 1964, Moenkopi infants from both upper and lower villages were classified according to whether they had spent their first summer, the peak diarrheal season, before or after the water lines were built.

To gain an idea of how socioeconomic factors such as mother's education may influence the effects of the presence or absence of indoor plumbing on infant health, the mothers of 58 lower Moenkopi children were interviewed. These were the mothers of all lower Moenkopi children born in 1961 and 1962 plus their siblings born in the 6½-year sample period.

Findings and Discussion

Table 1 summarizes hospital use by Moenkopi infants in the first year of life from January 1, 1961 to July 1, 1967. Upper Moenkopi infants had fewer outpatient visits and admissions, both for all causes and for diarrhea, than did lower

Table 1. Average hospital outpatient visits and admissions per year in the first year of life of 121 infants, January 1, 1961 to July 1, 1967

Type of hospital contact	Upper Moenkopi	Lower Moenkopi	[1] *t*-value
Outpatient visits, all causes	7.75	8.90	1.12
Outpatient visits, diarrhea	1.40	3.00	[2] 3.34
Admissions, all causes	.32	.81	[2] 2.50
Admissions, diarrhea	.12	.25	[2] 1.84

[1] *t*-test for comparing means of two independent samples.
[2] $P<0.05$, df=119.

NOTE: Ratio of admissions per year (all causes) to outpatient visits per year (all causes) was 1:23 for upper Moenkopi and 1:10 for lower Moenkopi.

Table 2. Average outpatient visits per year of infants in first year of life before and after indoor waterlines were installed

Areas and reason for visit	Before water		After water		df	*t*-value
	Number infants	Average visits	Number infants	Average visits		
Upper Moenkopi:						
All causes	20	9.5	20	6.0	38	[1] 2.32
Diarrhea	20	2.0	20	.85	38	[1] 2.02
Lower Moenkopi:						
All causes	41	8.6	40	9.5	79	.72
Diarrhea	41	3.1	40	2.6	79	.78

[1] $P<0.05$.

Moenkopi infants. The ratio of admissions to outpatient visits is much higher for the lower village infants. That is, a lower village infant is more than twice as likely to be admitted to the hospital for inpatient care when he is brought to the outpatient department as an upper village infant.

This higher admission rate suggests that lower village children are more seriously ill when they are brought to the clinic, and it may also suggest that their parents are more reluctant to bring them until they are seriously ill compared with upper village families who are less reluctant to bring in children earlier and before hospitalization is necessary. Another indication of this possible reluctance is that 25 percent of upper Moenkopi children required hospitalization in the first year of life for all causes compared with 45.7 percent of lower village children. The number of infants hospitalized for diarrheal disease alone was 12.5 percent in the upper village and 21.0 percent in the lower village.

As mentioned previously, indoor plumbing was installed in the upper village in the spring of 1964. This installation seems to have made a difference in admissions and clinic use in the upper village. Before plumbing was installed, children from the upper village averaged two clinic visits a year for diarrhea in their first year and after plumbing was installed, 0.85 visits. For the same period, the average visits of lower village children was 3.1 compared with 2.6. What this indicated is that upper Moenkopi infants had significantly fewer clinic visits after water was available indoors than before (P less than 0.05, df=38), whereas there was no significant change for lower village infants (P more than 0.05). Table 2 gives the detailed figures.

Although it is obvious that this does not prove causation and may indicate nothing more than that the changes in both plumbing and hospital use were caused by some third factor, we are unable to determine what that factor might be if it indeed exists. We are unable to find, for instance, any changed attitudes towards the Public Health Service that would account for the observed changes in hospital use.

Average number of outpatient visits per child for diarrhea by month of year during the 6½-year period is shown in the following table.

Month	*Lower Moenkopi*	*Upper Moenkopi*
January	0.02	0.01
February	.02	.01
March	.07	.02
April	.12	.03
May	.11	.02
June	.13	.05
July	.20	.11
August	.16	.11
September	.13	.13
October	.14	.13
November	.08	.08
December	.07	.08

The peak of incidence of diarrhea in the lower village occurred in July, but the peak incidence in the upper village occurred in September and October. Possibly infectious diarrhea reached its peak in the lower village in July and then gradually spread to upper village infants by interpersonal contact of older siblings and relatives.

Hospital use for 58 lower Moenkopi infants by mother's educational level is listed in table 3.

Table 3. Hospital use for 58 lower Moenkopi infants by mother's educational level

Education of mother	Average number per year		
	Outpatient visits, all causes	Outpatient visits, diarrhea	Admissions, all causes
34 infants whose mothers attended high school	9. 80	2. 90	0. 51
24 infants whose mothers did not attend high school	7. 90	3. 40	. 72

The 7.80 average outpatient visits for all causes for lower Moenkopi infants whose mothers attended high school approached the 7.75 of upper Moenkopi infants (table 1). Although the 2.90 average outpatient visits for diarrhea of lower Moenkopi infants whose mothers attended high school were lower than the 3.40 for children of nonhigh-school-educated lower Moenkopi mothers, they were still twice the average outpatient diarrhea visit rate of 1.40 for upper Moenkopi infants (table 1). Too few upper Moenkopi mothers were available for interviewing to determine the effects of education on their children's hospital use.

In lower Moenkopi, the mother's education apparently does influence overall hospital use of infants, but the lack of indoor plumbing is the limiting factor in determining the rate of hospital use for infant diarrhea.

Conclusion

Many other socioeconomic conditions and values may contribute to the differences in hospital use observed between upper and lower Moenkopi infants in the first year of life. An important uninvestigated variable may be differences between mothers who breast feed their babies and those who do not. Other differences in diet between the two segments were assumed to be minimal, because the villagers buy most of their food from the same stores. In addition, practically all households in both segments of the village have refrigerators of their own or the use of one.

Still another variable that has not been measured is willingness to use the hospital and other modern facilities. The refusal of the villagers of lower Moenkopi to install water indoors was in large part a political decision and not necessarily hostility to good health practices. Indeed, the villagers of lower Moenkopi had installed their own outdoor water taps without government help long before the residents of the progressive upper village got their facilities by cooperating with the government. Rather than rejecting sanitary facilities as such, the traditional element of the village seems unwilling to become embroiled in the political machinations of the progressive villagers and the Public Health Service.

Although this is not the place to describe the intricacies of Hopi politics, it can be stated briefly that the major cleavage in the tribe is between the procouncil and anticouncil factions (*8*). Under the Wheeler-Howard Act, Indian tribes were authorized to vote for or against a constitutional form of government and democratically elected councils that would be empowered to deal with the Federal Government. Many traditional Hopis refused to vote at all as voting would have implied de facto recognition of the Federal Government's right to make laws pertaining to their own social organization. Those who did vote therefore voted for the new form of government, and in areas where they held the majority, effectively destroyed the old theocracy. The feeling between the two groups at present is so intense that it is virtually impossible for them to cooperate on any project, including the installation of water and sewerlines.

The lower villagers are not opposed to modern conveniences per se and many homes have gas refrigerators. The lower villagers also installed waterlines years before the upper villagers, and many lower villagers work for wages and have automobiles. The two segments differ on how the village is to be governed and how the dominant society is to be dealt with.

The lower villagers do use the hospital. Another important and uninvestigated variable, however, is whether they seek help as early as

the upper villagers. Coming to the hospital and waiting in the clinic to be seen by a physician is time consuming. Upper village people tend to have more contacts in the hospital and are better able to manipulate the system to get themselves seen earlier with less waiting. This ability to deal with the hospital does not seem to be as characteristic of lower villagers.

Nevertheless, the data indicate that constructing indoor plumbing lines in itself does make a measurable difference in the health of children, especially in the first year of life, even considering some of the aforementioned variables.

We particularly mention the first year of life because as the children of the village get older, the differences in health tend to equalize so that by the time they reach school age, their health records become indistinguishable. Whether this equalization indicates the direct effect of adequate medical care for both groups or that diseases that afflict the children earlier are not severe enough to measurably retard them is not yet known, although we feel that good health care is the major contributing factor. What we can say is that sanitary facilities do make a measurable difference in hospital use and in the frequency and severity of childhood disease in this group and presumably to others like them.

Summary

The differences in hospital use for infectious diarrhea of two groups of infants living within the same Hopi pueblo were described. One group, the upper villagers, is allied with the procouncil faction within the tribe and elected to cooperate with the Public Health Service in construction of sanitary facilities under the Indian Sanitation Facilities Act, P.L. 86–121. The other group, the lower villagers, did not cooperate in the construction of these facilities.

Before construction, children from the upper and lower village who were less than a year of age had similar patterns of hospital use for infectious diarrhea. After construction, hospital use for infants of the upper village decreased, but use remained essentially unchanged for infants of the lower village. The differences in use between children of the upper and lower villages were only significant for those under 1 year of age. Subsequent age groups tended to have patterns of hospital use that were indistinguishable.

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phs synopses

BISTOWISH, J. M. (Metropolitan Health Department, Nashville, Tenn.), and BARID, STEVEN J.: *Use of the survey technique to achieve a highly immunized preschool population. Public Health Reports, Vol. 84, December 1969, pp. 1032–1036.*

In April 1965, an estimated 44,000 preschool age children lived in Metropolitan Nashville and Davidson County. The parents of 26,824 children were contacted during an immunization program based on the survey technique with intensive followup. Of the approximately 17,000 children not included, some became of school age between April 1, 1965, and the beginning of the followup in February 1966, others lived in 10 upper income census tracts that were not part of the survey, and a number became of school age during the nearly 2 years it took to complete the followup program.

Of the children whose parents were contacted, 1,200, or 4.6 percent, moved; 570, or 2.1 percent, were refused shots; and the parents of 720, or 3 percent, were not contacted again. In 1968, at the completion of the program, 25,538, or 95.2 percent of the children, had had poliomyelitis vaccine; 25,531, or 95.2 percent, had DPT vaccine; 16,012, or 59.7 percent, had smallpox vaccination; and 18,958, or 70.7 percent, had measles vaccine. Followup activity had increased by 3,216, or 12 percent, the number of children immunized against poliomyelitis; by 3,213, or 12 percent, those protected by DPT vaccine; by 908, or 3.4 percent, those vaccinated against smallpox; and by 6,311, or 23.6 percent, those who had received measles vaccine.

At the time of original contact, 3,685, or 13.7 percent, of the children had already had measles, and an additional 2,049, or 7.7 percent, contracted the disease during the followup period, so that of the total 26,824 children contacted, 5,734, or 21.4 percent, had experienced the disease. Therefore, 92.1 percent of all the children had become immune to measles.

Overall, the program achieved high levels of immunity and accomplished the goal of protecting preschool children who were not part of a birth certificate followup program. The coverage provided under the two programs ensures Metropolitan Nashville and Davidson County of a highly immunized population for the present.

WECHSLER, HENRY (The Medical Foundation, Inc., Boston), KASEY, ELIZABETH H., THUM, DENISE, and DEMONE, HAROLD W., Jr.: *Alcohol level and home accidents. A study of emergency service patients. Public Health Reports, Vol. 84, December 1969, pp. 1043–1050.*

To determine the presence or absence of alcohol in persons admitted to the emergency service of the Massachusetts General Hospital in Boston for treatment of home accident injuries, Breathalyzer readings for 5,622 patients were collected. Venous blood analyses or observations on alcoholic breath were obtained for an additional 1,222 patients.

The results of statistical analyses, significant at the 0.05 level or beyond, indicated that the presence of alcohol on admittance was associated with the reason for admission. Among patients with home accident injuries, 22.3 percent had a positive Breathalyzer reading. As shown by Breathalyzer tests, the highest involvement of alcohol, 29.5 percent, was for patients with transportation accident injuries. Less alcohol involvement was indicated for patients with occupation accident injuries, 15.5 percent, and "other" accident injuries, 24.1 percent.

A strikingly high involvement of alcohol was found among persons admitted to the emergency service for treatment of injuries from fights or assaults; 56.4 percent had a positive Breathalyzer reading. A uniformly low involvement, 8.9 percent, was found among patients admitted for nonaccident reasons.

These findings were substantiated when other signs of alcohol involvement were used, and were maintained when controls were applied for drinking after the accident or onset of symptoms and for delay between the episode and arrival in the emergency service as well as for sex, age, marital status, and social class.

Among home accident injuries, statistically significant relationships were found between presence of alcohol and external cause and nature of the injury. Positive readings for alcohol were evenly distributed among those injured in falls, collisions, and fires and by cutting or piercing instruments. Patients with head injuries or lacerations more frequently had positive alcohol readings than patients with other types of injuries such as fractures, contusions, sprains, or burns.

The study established that a higher proportion of positive achohol readings occurred among home accident victims and other accident patients than among a comparison group of nonaccident patients admitted to the same hospital emergency service. The findings are consistent and clearcut and implicate alcohol as a factor in home accident injuries as well as in injuries from transportation, occupation (although the findings were less definite here), and other types of accidents and in injuries resulting from fights or assaults.

phr synopses

BRUBAKER, MERLIN L. (Public Health Service), BINFORD, CHAPMAN H., and TRAUTMAN, JOHN R.: *Occurrence of leprosy in U.S. veterans after service in endemic areas abroad. Public Health Reports, Vol. 84, December 1969, pp. 1051–1058.*

Before 1940, 83 cases of leprosy were reported in U.S. veterans. Thirty of these cases were considered to be the result of exposure to the disease outside the continental United States during the Spanish-American War.

From 1940 through 1968, 240 cases of leprosy were reported in U.S. veterans. As indicated in a résumé of their cases, 46 veterans were considered to have service-connected leprosy as a result of their exposure outside the United States.

No study has been reported of contacts of veterans with leprosy. One situation was brought to light, however, in which leprosy was diagnosed in the wife and three children of an infected veteran. The family lived in a nonendemic area in the United States.

Delay in the early diagnosis of leprosy is caused by the failure of both patients and physicians to suspect the disease. Early diagnosis and treatment assure the best possible opportunity for arresting the disease and preventing disability and further spread by reduction of the infectious reservoir.

SCUTCHFIELD, F. DOUGLAS (University of Kentucky School of Medicine), and LONG, W. NEWTON: *Parental medroxyprogesterone as a contraceptive agent. Public Health Reports, Vol. 84, December 1969, pp. 1059–1062.*

Depot-medroxyprogesterone acetate (DMPA) was given intramuscularly in 150 mg. doses every 3 months for contraception to 650 women in a family planning clinic. This treatment represents 5,082 woman-months of experience. To date, there have been no pregnancies.

Calculations based on life tables show that, at the end of 1 year, 56.8 of every 100 women who started using DMPA, continued to use it. Of the 43.2 per 100 who stopped using it, 13.5 did so because of abnormal bleeding, 2.8 because of amenorrhea, 5.5 because of other medical problems, and 14.6 because of nonmedical problems; 6.8 were lost to followup.

Since there have been no pregnancies with this method and the continuance rate is high, we consider DMPA to be an effective and acceptable method of contraception.

BECKER, MARSHALL H. (Johns Hopkins University School of Medicine and School of Hygiene and Public Health, Baltimore, Md.): *Predictors of innovative behavior among local health officers. Public Health Reports. Vol. 84, December 1969, pp. 1063–1068.*

Local health departments have generally failed to undertake new programs advocated by health professionals and national agencies as ways of meeting changing health needs. This study examines the relationships between various attitudes held by the health officer and the time, relative to his peers, at which he adopted two public health innovations.

Ninety-five local health officers from three States participated in the study, conducted in early 1967 by mail questionnaires and followup telephone interviews. Expert judges rated "measles immunizations" as a program representative of those with high potential for acceptance by health departments, and "screening for diabetes" as having low potential for acceptance.

Health officers who undertook these programs earlier than their colleagues were more oriented toward their profession (cosmopolitanism), considered a larger number of activities as within the legitimate scope of public health (ideology), and expressed greater willingness to fight for support for new programs (activism); they perceived their communities as being more progressive and ready to innovate in both health and other civic matters; and they held a more liberal outlook (political orientation) than the later adopters.

Best predictors of high (innovative) scores on the attitude measures were high rank in his medical school graduating class, number of degrees held beyond the baccalaureate, and recent graduation from medical school.

phs synopses

MARTIN, RUSSELL J. (Illinois Department of Public Health), SCHNURRENBERGER, PAUL R., and ROSE, NORMAN J.: *Epidemiology of rabies vaccinations of persons in Illinois, 1967–68. Public Health Reports. Vol. 84, December 1969, pp. 1069–1077.*

Illinois physicians receiving State-manufactured rabies vaccine in 1967–68 were requested to supply information delineating the circumstances which led to the administration of vaccine. Vaccine was dispensed on 1,063 occasions; information was returned in 937 instances involving 1,011 patients. Males comprised 64 percent of the vaccinees. Thirty-eight percent of the vaccinees were less than 10 years of age. Twenty-five percent of the vaccinees received two or more bites, 62 percent received a single bite, and non-bite exposures were recorded for 9 percent. Sixty-seven percent of the persons reported exposures on the extremities, 22 percent, exposures on the head or neck.

Dogs exposed 55 percent of the persons vaccinated, skunks exposed 3 percent, and 19 percent of the vaccinees reported exposure to a species not usually infected with rabies. Fifty-eight percent of the vaccinees were exposed to animals that were not located, while 21 percent were exposed to animals that later were under the observation of a veterinarian. Only 46 percent of the vaccine series were initiated within 3 days after exposure; 20 percent had a delay of 8 days or more.

SCHNURRENBERGER, PAUL R. (Illinois Department of Public Health), MARTIN, RUSSELL J., MEERDINK, GAVIN L., and ROSE, NORMAN J.: *Epidemiology of human exposure to rabid animals in Illinois. Public Health Reports, Vol. 84, December 1969, pp. 1078–1084.*

All cases of animal rabies occurring in Illinois from 1963 through 1968 were investigated to determine the number of persons receiving rabies vaccine. There were 856 persons vaccinated because of exposure to 332 of the 1,272 reported rabid animals.

Dogs and cats posed the greatest hazard, with 240 persons vaccinated per 100 animal cases in contrast to 13 per 100 rabid skunks. When wild animals were kept as pets, the vaccination rate was similar to the rate following cases associated with dogs and cats. Exposure to rabid farm animals appeared to be occupational.

One-third of the vaccine series were administered in instances where a true exposure was unlikely. Public education should be intensified in an effort to reduce the number of persons exposed.

RUBENSTEIN, A. (Tufts University School of Medicine), BOYLE, J., ODOROFF, C. L., and KUNITZ, S. J.: *Effect of improved sanitary facilities on infant diarrhea in a Hopi village. Public Health Reports, Vol. 84, December 1969, pp. 1093–1097.*

The differences in hospital use for infectious diarrhea of two groups of infants living within the same Hopi pueblo were described. One group, the upper villagers, is allied with the procouncil faction within the tribe and elected to cooperate with the Public Health Service in construction of sanitary facilities under the Indian Sanitation Facilities Act, P.L. 86–121. The other group, the lower villagers, did not cooperate in the construction of these facilities.

Before construction, children from the upper and lower village who were less than a year of age had similar patterns of hospital use for infectious diarrhea. After construction, hospital use for infants of the upper village decreased but use remained essentially unchanged for infants of the lower village. The differences in use between children of the upper and lower villages were only significant for those under 1 year of age. Subsequent age groups tended to have patterns of hospital use that were indistinguishable.