
Mortality Pattern of Isolated Indians in Northwestern Ontario: A 10-Year Review

T. KUE YOUNG, MD, MSc

Tearsheet requests to T. Kue Young, MD, Department of Social and Preventive Medicine, University of Manitoba Faculty of Medicine, 750 Bannatyne Ave., Winnipeg, Manitoba, Canada R3E 0W3.

SYNOPSIS

The mortality experience of an isolated Indian population in the Sioux Lookout Zone of northwestern Ontario from 1972 through 1981 is reviewed and compared with that of the Canadian population. Standardized mortality ratios for major categories of causes computed showed excessive risks in most conditions. Notable exceptions included circulatory diseases and neoplasms.

Injuries and poisonings accounted for more than one-third of deaths. The proportionate mortality and

age-specific mortality rates were considerably higher in all age groups in the Sioux Lookout Zone than in the whole of Canada. Excessive risks were found in almost all categories of accidental and violent deaths except motor vehicle accidents and accidental falls. Local conditions that contributed to the pattern observed are discussed. More than 90 percent of deaths from accidents and violence occurred before the medical care system was involved, highlighting the need for primary preventive strategies in reducing mortality due to these causes.

While the infant mortality rate declined, pneumonia, gastroenteritis, and meningitis still accounted for 28 percent of infant deaths in the decade. Even with sudden infant death syndrome excluded, about 25 percent of infant deaths still occurred at home.

Some features of the pattern of mortality reported here are also observed in other North American Indian groups undergoing the stresses of social change.

THE HEALTH CARE DELIVERY SYSTEM in an isolated region of scattered, small Cree-Ojibwa communities in the Sioux Lookout Zone (SLZ) of northwestern Ontario (see fig. 1) has been described in a previous paper in this journal (1) and elsewhere (2). In this paper I review the mortality experience of this population from 1972 through 1981. Preliminary data on crude mortality rates and causes of deaths up to 1976 have been reported in a longer paper on historical epidemiologic trends (3). This paper reports on the continuing surveillance of mortality rates and causes of death in the SLZ up to the end of 1981, utilizing age-standardized comparisons with the Canadian national population, and provides a more detailed analysis of accidental deaths and infant deaths.

Methods

All deaths among Indians resident in the communities of the SLZ were recorded and coded according to ICD-9 (International Classification of Diseases, Ninth Revision) rules (4). Medical services staff for the zone discussed the past history and circumstances surrounding the deaths and established the

causes. Deaths that occurred in institutions or locations outside the zone were "charged back" to the zone. Regional newspapers were also regularly perused to ensure inclusion of all accidental deaths. The isolation of the communities, the relative lack of mobility of the population, and the fact that health care was the responsibility of a single agency with a comprehensive medical records system ensured that few deaths escaped registration. Considerably more detail on each death was thus available than would ordinarily be provided by the death certificate alone.

For cultural and logistical reasons, a very low proportion of deaths (9.4 percent) were followed by autopsies; the few that were performed were mainly required for medicolegal purposes under a coroner's orders.

In the 10-year period, about 9 percent of causes of death were "ill defined" or "unknown." Hospital deaths constituted less than one-third of all deaths, and the causes of nonaccidental deaths outside a hospital were established with much less certainty. Sudden deaths at home were frequently attributed to cardiac causes, but pathological confirmation was seldom available. Nosological "impurity" is a well-

Figure 1. The Sioux Lookout Zone. Here some 8,000 Indians live in 25 remote communities; 2,000 more in settlements on the railway and highway and in small mining or logging towns

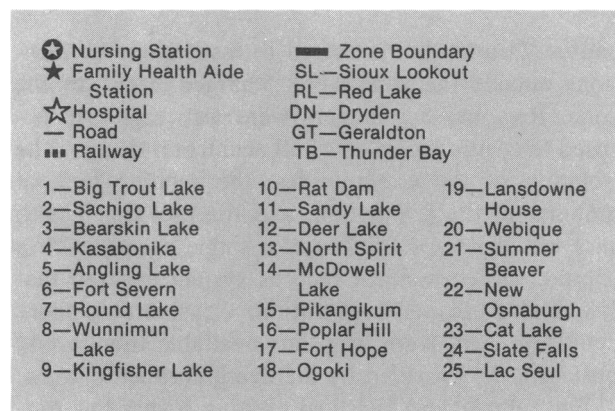
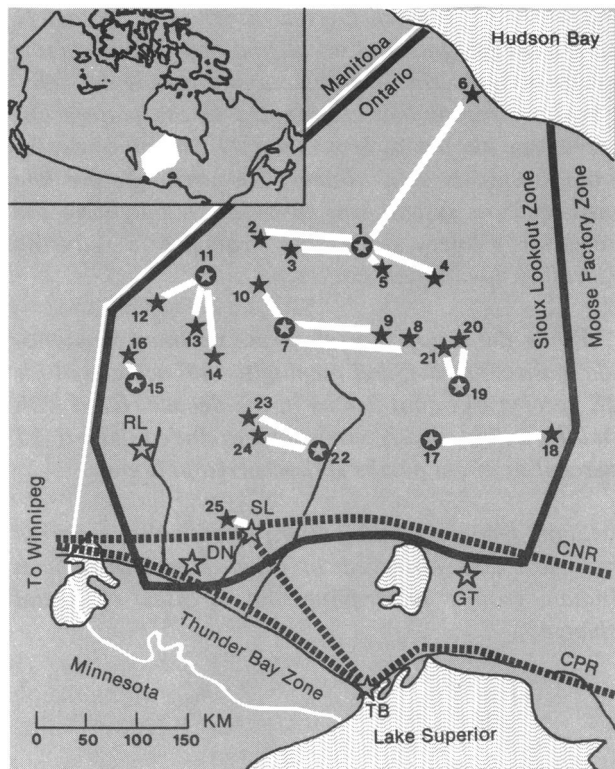


Table 1. Indian population and crude mortality rates, Sioux Lookout Zone, 1972–81

Year	Population	Number of deaths	Crude mortality rate ¹
1972	9,381	66	7.0
1973	9,865	72	7.3
1974	9,802	84	8.6
1975	9,938	65	6.5
1976	10,328	83	8.0
1977	10,531	50	4.8
1978	10,611	62	5.8
1979	11,446	66	5.8
1980	11,304	61	5.4
1981	12,219	59	4.8
1972–81		668	6.4

¹ Per 1,000 population.

of Indian and Northern Affairs' "band lists." The age-sex distribution of the 1977 (midperiod) population was used in calculating age-specific and age-standardized mortality rates in this study.

Table 1 lists the annual midyear population, the number of deaths, and crude mortality rates for the SLZ. From 1972 through 1981, 668 deaths were registered and available for analysis. The 10-year mean crude mortality rate was 6.4, compared with a rate of 7.2 for all of Canada. However, the Indian population is predominantly young; about 50 percent of Indians resident in the SLZ are under 15 years of age. Age standardization by the indirect method would have increased the crude mortality rate in the zone by about 80 percent, giving an age-standardized mortality rate of about 11.5.

A declining trend in the infant mortality rate in the SLZ was evident, even allowing for year-to-year fluctuation due to the relatively small number of live births (between 300 and 400) and infant deaths (fig. 2). However, the infant mortality rate was still two to three times that for Canada as a whole. For all of Canada, the postneonatal mortality rate was half the neonatal mortality rate; in the SLZ, on the other hand, the postneonatal rate usually exceeded the neonatal rate. In fact, in the SLZ the neonatal mortality rate almost approached that of Canada as a whole, while the postneonatal mortality rate was four to five times higher (table 2).

Causes of mortality. The major causes of death in the SLZ during the period 1972–81, classified according to ICD-9, are listed in table 3. The proportionate mortality rates and standardized mortality ratios (SMRs) for specific groups of causes are also presented to allow for comparison with Canadian

known problem in mortality analysis; nevertheless, it is still possible to infer broad trends and draw valid conclusions on health status and the quality of medical care.

Results

Mortality rates. The total Indian population in the SLZ in the mid-1970s was about 10,000. Accurate annual census and age-sex composition of the population are available from the Canadian Department

Table 2. Comparison of infant, neonatal, and postneonatal mortality rates, Sioux Lookout Zone and Canada as a whole

Time of death	Mortality rates (per 1,000 live births)			
	Sioux Lookout Zone		Canada	
	1972-76	1977-81	1972-75	1976-79
Infancy (less than 1 year old)	45.6	27.8	15.5	12.2
Neonatal period (less than 28 days old)	18.2	11.9	10.6	8.2
Postneonatal period (28 days to 1 year old)	27.4	15.9	4.9	4.0

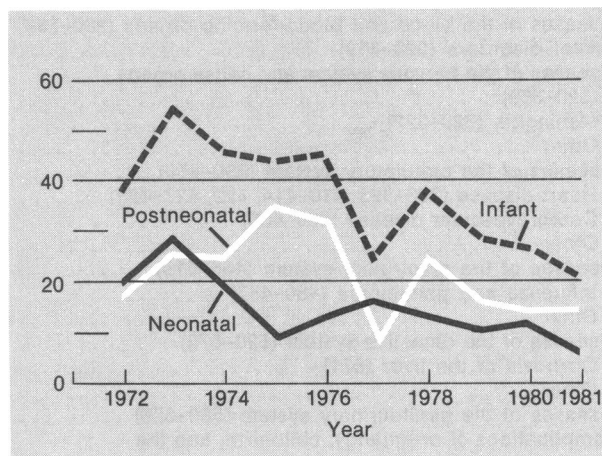
national data as reported by Statistics Canada (5,6). Because of the small number of deaths in some age classes for certain causes, even in the national population, the mean age-specific rates for 2 years (1975 and 1978) in the Canadian population were used in the computation to reduce the variance in the "expected" number of deaths. The use of the mean of 2 separate years also provides a more representative picture of Canadian mortality, which during the decade showed a decline in mortality rates for many conditions. Significance levels for SMRs, distributed as Poisson variables, were obtained from the table published by Bailar and Ederer (7). The limitations and strengths of SMRs in small populations have been discussed by Kleinman (8).

Injuries and poisonings, circulatory diseases, respiratory diseases, and neoplasms constituted the four highest ranking groups of causes in both populations, though not necessarily in the same rank order. In the SLZ, injuries and poisonings accounted for more than one-third of all deaths, compared with less than one-tenth of all deaths in Canada as a whole. On the other hand, circulatory diseases—the highest ranking group of causes in the Canadian national population, producing just under half of all deaths—were responsible for only 14 percent of the deaths in the SLZ.

From the computed SMRs, it is evident that the SLZ Indian was at equal or greater risk of death in almost all categories of causes with the exception of circulatory diseases (SMR 0.6, $P < 0.01$), as a whole, and heart diseases specifically (SMR 0.7, $P < 0.01$), where the risks were lower. There were excessive risks of death from injuries and poisonings (SMR 4.5, $P < 0.01$), respiratory diseases (SMR 4.0, $P < 0.01$), and infectious and parasitic diseases (SMR 4.5, $P < 0.01$). The risks were not significantly different for neoplasms (SMR 0.9) and stroke (SMR 0.8).

Infectious diseases (4a), which contributed to only a small proportion of deaths (2.4 percent), were the eighth-ranking cause of deaths in the SLZ.

Figure 2. Indian infant, neonatal, and postneonatal mortality rates, Sioux Lookout Zone, 1972-81



NOTE: Infant death = death at less than 1 year of age; neonatal death = death at less than 28 days of age; postneonatal death = death at 28 days to 1 year of age.

Diarrheal diseases, tuberculosis, whooping cough, and septicemia were the only diseases in this group that caused deaths. Still, a resident of the SLZ was almost five times as likely to die from this group of conditions as a resident of Canada considered as a whole. In addition, meningitis (SMR 12.1, $P < 0.01$), classified under diseases of the nervous system (4b), and pneumonia and influenza (SMR 6.5, $P < 0.01$), classified under respiratory diseases (4c), were also conditions with an infectious etiology and were thus potentially preventable and treatable.

Age distribution. Children and young adults contributed most heavily to overall mortality in the SLZ. Almost a quarter of deaths occurred among those under 5 years of age, as opposed to only 3 percent of deaths in the population of Canada as a whole (table 4). Even when age-specific death rates were compared, the SLZ rate was almost four times higher among children under 5 years, two times higher among the 5-14 year group, and four times higher among the 25-44 year group, than the rates for the

Table 3. Causes of death, Sioux Lookout Zone, 1972–81, compared with those for Canada as a whole, 1975 and 1978

Cause (ICD-9 code in parentheses)	Sioux Lookout Zone				Canada	
	Number	Percent	Rank	Standardized mortality ratio	Percent	Rank
Infectious and parasitic diseases (001–139)	16	2.4	8th	14.5	0.6	13th
Intestinal diseases (001–009)	9			19.5		
Tuberculosis (010–018)	4			17.7		
Other	3			....	
Neoplasms ² (140–239)	62	9.3	4th	0.9	21.4	2nd
Malignant neoplasms (140–208)	62			0.9		
Endocrine, nutritional, and metabolic diseases and immunity disorders (240–279)	5	0.8	12th	0.6	2.3	6th
Diabetes mellitus (250)	1			0.2		
Other	4			....	
Diseases of the blood and blood-forming organs (280–289)	1	0.1	13th	0.9	0.3	15th
Mental disorders (290–319)	0	0.0	17th	....	0.7	12th
Diseases of the nervous system and sense organs (320–389)	15	2.2	9th	12.7	1.1	10th
Meningitis (320–322)	8			12.1		
Other	7			....	
Diseases of the circulatory system (390–459)	92	13.8	2nd	10.6	48.1	1st
Heart disease (393–398, 410–414, 422, 427–428)	67			10.7		
Cerebrovascular disease (430–438)	23			0.8		
Other	2			....	
Diseases of the respiratory system (460–519)	92	13.8	2nd	14.0	6.7	4th
Influenza and pneumonia (480–487)	76			16.5		
Other	16			....	
Diseases of the digestive system (520–579)	7	1.0	11th	0.5	3.8	5th
Cirrhosis of the liver (571)	2			0.3		
Other	5			....	
Diseases of the genitourinary system (580–629)	14	2.1	10th	13.7	1.2	9th
Complications of pregnancy, childbirth, and the puerperium (630–676)	1					
Diseases of the skin and subcutaneous tissue (680–709)	1					
Diseases of the musculoskeletal system and connective tissue (710–739)	1					
Congenital anomalies (740–759)	19	2.8	7th	1.6	1.0	11th
Conditions originating in the perinatal period (760–779)	28	4.2	6th	1.6	1.2	8th
Ill-defined or unknown (780–799)	61	9.1	5th	16.8	1.5	7th
Injuries and poisonings (E800–E991)	253	37.9	1st	14.5	9.7	3rd
All causes	668	100.0	....	11.8	100.0	....

¹ P < 0.01.

² All deaths in the SLZ were from malignant neoplasms, while in

Canada benign neoplasms were also included.

³ P < 0.05.

Table 4. Number, percentage distribution, and age-group-specific rates for all deaths, Sioux Lookout Zone, 1972–81, and Canada as a whole, 1975 and 1978

Age group	Sioux Lookout Zone			Canada	
	Number	Percent	Age-group-specific mortality rate ¹	Percent	Age-group-specific mortality rate ¹
0–4	163	24.4	1,066	3.1	296
5–14	19	2.8	63	0.9	37
15–24	79	11.8	399	2.9	106
25–44	121	18.1	548	5.6	144
45–64	101	15.1	1,098	22.9	856
Over 65	185	27.7	5,110	64.6	5,091
All ages	668	100.0	640	100.0	716

¹ Per 100,000 population.

Table 5. Age distribution of deaths from injuries and poisonings, Sioux Lookout Zone, 1972-81, and Canada as a whole, 1975 and 1978

Age group	Sioux Lookout Zone			Canada	
	Number	Proportionate mortality rate ¹	Age-group-specific mortality rate ²	Proportionate mortality rate ¹	Age-group-specific mortality rate ²
0-4	32	19.6	209	10.7	31.7
5-14	14	73.7	47	60.2	22.0
15-24	70	88.6	353	79.7	84.3
25-44	93	76.9	421	46.3	66.5
45-64	31	30.7	337	8.8	104.8
Over 65	13	7.1	359	2.8	140.8
All ages	253	37.9	244	9.6	68.5

¹ Percentage of total deaths in age group due to injuries and poisoning.

² Per 100,000 population.

Table 6. Causes of accidental and violent deaths, Sioux Lookout Zone, 1972-81

Cause (ICD-9 code in parentheses)	Number	Percent	Standardized mortality ratio	Probability
Railway accidents ¹ (E800-E807)	16	6.3	57.0	< 0.01
Motor vehicle accidents (E810-E825)	21	8.3	0.97	
Water transport accidents ² (E830-E838)	51	20.2	54.7	< 0.01
Air transport accidents ³ (E840-E845)	12	4.7	20.0	< 0.01
Accidental falls (E880-E888)	4	1.6	1.0	
Accidents due to fires ⁴ (E890-E899)	31	12.3	10.8	< 0.01
Excessive cold, exposure (E901, E904)	32	12.6	82.0	< 0.01
Accidental drowning (E910)	23	9.1	6.5	< 0.01
Firearms accidents (E922)	10	4.0	21.9	< 0.01
Other accidents ⁵	13	5.1	.....
Suicides (E950-E959)	17	6.7	1.8	< 0.05
Homicides (E960-E969)	21	8.3	9.4	< 0.01
Firearms injuries, undetermined whether accidentally or purposely inflicted (E985)	1	0.4	.....
Adverse effects of drug therapy (E930-E949)	1	0.4	.....
Total	253	100.0	4.6	< 0.01

¹ All deaths in this category were the result of being hit by rolling stock.

² 50 of 51 deaths resulted from drowning after a boat overturned or after falling off a boat; 1 resulted from being struck by a boat.

³ 11 died from airplane crashes, 1 from propeller injuries.

⁴ All deaths were from conflagration of private dwellings.

⁵ 7 died from aspiration of vomitus (E911-E912), 2 were struck by lightning (E907), 2 died from accidental mechanical suffocation (E913), 1 was struck by a falling tree (E916), and 1 died as a result of a machinery accident (E919).

corresponding subgroups in the Canadian population. Above age 45, the age-specific death rates were similar in the two populations.

Injuries and poisonings. In every year from 1972 through 1981, injuries and poisonings topped the list of causes of death in the SLZ, accounting for between 30 and 45 percent of all deaths. Deaths of men from this cause outnumbered deaths of women by two to one. Although young people were more likely to be victims of accidents and violence in both the SLZ and Canada as a whole, 46 percent of all deaths in the SLZ from injuries and poisonings occurred in persons under 25 years of age, compared

with 33 percent of deaths from the same causes in all Canada. When each age group was considered individually, both the proportionate mortality and the age-specific mortality rates were considerably higher in the SLZ (table 5).

The etiology of accidental and violent deaths in the SLZ is enumerated in table 6. Exceedingly large SMRs were found in almost all categories except motor vehicle accidents, accidental falls, and suicides.

While it was difficult to ascertain if alcohol was involved, many of the deaths in the drowning, exposure, transport accident, and homicide categories may have occurred as a result of alcohol intoxica-

'In every year from 1972 through 1981, injuries and poisonings topped the list of causes of death in the Sioux Lookout Zone, accounting for between 30 and 45 percent of all deaths.'

tion. Corroborating evidence, such as postmortem blood alcohol levels, was seldom obtained. Twenty-five percent of deaths from injuries and poisonings, conservatively estimated, were considered to be alcohol related.

Local conditions, such as easy access to water and the severe winter climate, contributed to the SLZ's higher incidence of deaths in water and deaths from exposure and excessive cold. In the SLZ, all the Indian communities are situated on the shores of lakes and rivers. The people are constantly dependent on small boats in their daily living, at least during the 7 or 8 months the water remains open.

Drownings were classified under various categories in ICD-9. Fifty drownings following boating accidents were classified under codes E830, "Accident to watercraft causing submersion," and E832, "Other accidental submersion or drowning in water transport accident." Of deaths classified under code E910, "Accidental drowning," 15 resulted from falling off a dock or falling from the shore, and 8 involved people who fell through thin ice while walking, snowmobiling, or skating. One death—classified under code E919, "Accidents caused by machinery"—occurred when an earth-moving machine fell through the ice. In all, there were 74 deaths from drowning, almost 30 percent of all accidental and violent deaths.

Motor vehicle accidents were not as important in the SLZ, chiefly because of the absence of private cars and roads in the majority of the isolated northern settlements. Collisions of pedestrians with trains were frequent occurrences among those residents of the more southerly communities situated near the Canadian National Railway track. The poor air safety record of the region, which depends on small "bush" planes for movement of people and freight, was reflected in the 12 deaths from air transport accidents. Reckless driving of snowmobiles in the winter was responsible for 6 deaths—4 from faulty judgment about the thickness of ice and 2 from collision with other motor vehicles.

Poorly maintained and cleaned stovepipes were probably the main reason for the many deaths in the SLZ from house fires. Parental neglect also led to deaths in house fires of young children left unattended at home.

Because of the tradition of hunting among SLZ residents, firearms were present in most households. Altogether, 22 deaths involved the use and misuse of firearms. Ten of these deaths were accidents; 8 were homicides; 3 were suicides. The nature of 1 death—accidental or intentional—could not be determined.

The number of suicides recorded was in all likelihood an underestimate of the true incidence. Timely, sophisticated medical care probably rendered a few attempts at suicide unsuccessful. Many accidental deaths (from exposure, train accidents, or drowning, for example) could actually have been intentional, but the amount of detail available at the time of death was rarely sufficient for such a determination. Even with under-ascertainment, the risk of suicidal death in the SLZ was still almost twice as high as that in Canada as a whole. Of 17 confirmed suicides during the period studied, 7 were from strangulation, 3 from firearms, and 7 from drug overdoses.

Ninety-two percent of deaths in the SLZ from injuries and poisonings occurred before the medical care system was involved; therefore, better training of personnel in emergency trauma management and a more sophisticated air ambulance system would be unlikely to reduce the mortality rate significantly.

Infant deaths. The causes of infant deaths (deaths of babies under 1 year) in the SLZ are listed in table 7. More than 70 percent of deaths of SLZ infants during the neonatal period (and more than 90 percent of neonatal deaths in Canada as a whole) were the result of congenital anomalies and perinatal conditions. Cardiovascular anomalies accounted for half the deaths in the SLZ from congenital malformations. The most important lethal perinatal condition was prematurity, causing 11 of the 27 deaths in the SLZ in this category.

Other causes of death became more important in the postneonatal period, especially pneumonia, sudden infant death syndrome (SIDS), and gastroenteritis. Three diseases—gastroenteritis, pneumonia, and meningitis—accounted for 28 percent of all infant deaths in the SLZ. These diseases are ones for which effective treatment was known and available. Their predominance indicated deficiencies in the medical care system in early recognition and timely

Table 7. Causes of infant deaths, Sioux Lookout Zone, 1972-81

Cause	Number of deaths		
	Neonatal	Postneonatal	Infant
Infectious or parasitic diseases	2	7	9
Intestinal infections	2	6	8
Whooping cough	0	1	1
Endocrine, nutritional, and metabolic diseases and immunity disorders	0	2	2
Diseases of the nervous system and sense organs	1	4	5
Meningitis	1	2	3
Other	0	2	2
Diseases of the circulatory system	0	1	1
Diseases of the respiratory system	3	29	32
Pneumonia	2	23	25
Other	1	6	7
Diseases of the genitourinary system	0	1	1
Congenital anomalies	10	8	18
Conditions originating in the perinatal period	27	0	27
Symptoms, signs, and ill-defined conditions	6	19	25
Sudden infant death	4	18	22
Unknown	2	1	3
Injuries and poisonings	2	5	7
Total	51	76	127

NOTE: Infant death = death at less than 1 year of age; neonatal death = death at less than 28 days of age; postneonatal death =

death at 28 days to 1 year of age.

intervention. Over time, however, some improvement in mortality due to gastroenteritis was evident. There were no deaths from gastroenteritis among infants in the SLZ in the 4 years from 1978 through 1981, although there had been 8 such deaths in the preceding 6 years.

Location of deaths. Of the 668 deaths in the SLZ from 1972 through 1981, more than two-thirds occurred outside a hospital. Just 5 percent occurred in a nursing station (staffed by outpost nurses) or en route to a hospital, suggesting that air evacuation services appeared to function overall, considering the geographic obstacles involved (table 8).

When violent and accidental deaths were subtracted from the total, about 30 percent of deaths still occurred outside a hospital—these were deaths from illnesses during which the patients preferred to stay at home, sudden nontraumatic deaths, and senility. In the 1970s, the prevailing social norm in the SLZ was still one of taking care of the old and dying at home. With increasing acculturation, this pattern may well change.

Although in the older age groups it may be a desirable feature to die away from a hospital, the number of nonhospital deaths among infants indicated that some medical needs in the communities were not adequately met. Forty-three percent of infant deaths occurred at home, before the health

care system became involved. Even after SIDS deaths were excluded, some 25 percent of infant deaths occurred at home. The 3.2 percent of infant deaths that occurred in nursing stations and the 10.2 percent of such deaths that occurred en route were potentially preventable, had there been early intervention and evacuation.

A quarter of all infant deaths took place in teaching hospitals, while 18 percent occurred in small rural hospitals in northwestern Ontario. The number of infant deaths in general practitioner staffed rural hospitals declined from 19 during the period 1972-76 to 4 during the period 1977-81, a decline from 24 percent to 8 percent of total infant deaths during the two periods. With respect to infant deaths, it would appear that the weak link in the system was between the periphery and the base hospital, and that a variety of factors, such as poor transportation, long distances, unpredictable weather, failure of early diagnosis, and delay in seeking care, prevented critically ill infants from obtaining appropriate care.

Discussion

The mortality pattern of Indians in the SLZ is by no means unique. Other Indian groups in Canada (9,10) and the United States (11,12) have also shown high rates of mortality from accidents

'In the area of infant deaths, the health care system still has a large role to play. Infectious diseases were important killers, and an unacceptably high proportion of infant deaths occurred at home, suggesting serious deficiencies along the pathway to care.'

Table 8. Location of deaths, Sioux Lookout Zone, 1972-81

Location	Total deaths		Infant deaths ¹	
	Number	Percent	Number	Percent
Hospitals	203	30.4	56	44.1
Sioux Lookout Hospital ..	77	11.5	10	7.9
Other hospitals in northwestern Ontario ..	59	8.8	13	10.2
Winnipeg (teaching) hospitals	58	8.7	32	25.2
Other hospitals	9	1.4	1	0.8
Nursing stations	11	1.7	4	3.2
En route	23	3.4	13	10.2
Home or community	431	64.5	54	42.5
Total	668	100.0	127	100.0

¹ Infant deaths = deaths at under 1 year of age.

and violence. Most investigators have attributed the phenomenon to social disintegration resulting from increased contact with the dominant Euro-Canadian society. In northwestern Ontario, the process of social change among the Indians was greatly accelerated after World War II.

Kunitz suggested that, among North American Indian tribes, seminomadic hunters-gatherers were much less well prepared than pastoralists and agriculturalists for life as subordinate members of a colonial society in the postreservation era (13). Originally egalitarian and dependent on dispersion for resolving social stress and conflict—avenues no longer practicable—hunters-gatherers such as the Cree-Ojibwa, in the subarctic boreal forest, suffered high mortality from accidents and violence that were in large part alcohol related.

In addition to its use as an indicator of health and socioeconomic status, mortality analysis is useful in the planning and evaluation of health services. Rutstein and coworkers proposed the monitoring of "sentinel health events," such as untimely death from preventable and treatable conditions, the occurrence of which would indicate faults and weak-

nesses in the system, whether at the individual, the institutional, or the societal level (14).

In the SLZ, as far as accidental and violent deaths are concerned, the present health care system—which utilizes outpost nurses and indigenous aides in the communities, backed by an expensive air evacuation service—appears to have reached its limit of effectiveness. Nine of every 10 deaths from injuries and poisonings during the period of this study occurred before medical intervention was possible. Scrutiny of the causes of these deaths indicates that primary preventive strategies—ranging from safety instruction in the use of boats, snowmobiles, and firearms to improved employment opportunities and other broad social development programs—are needed. There is a role for intensive training of community members in such areas as first aid, cardiopulmonary resuscitation, and management of hypothermia and cold-water near-drowning.

In the area of infant deaths, the health care system still has a large role to play. Infectious diseases were important killers, and an unacceptably high proportion of infant deaths occurred at home, suggesting serious deficiencies along the pathway to care. While deaths from gastroenteritis declined, better teaching of mothers about signs and symptoms of infant diarrhea and distribution of oral rehydration fluids might have prevented some of the earlier deaths.

Because of the small population involved, it would be difficult to postulate any time trend for specific conditions in the 10-year period. Continuing surveillance is necessary to determine if the Indian population is experiencing epidemiologic transition during a period of rapid social change.

References

1. Young, T. K.: Primary health care for isolated Indians in northwestern Ontario. Public Health Rep 96: 391-397, September-October 1981.
2. Bain, H. W., and Goldthorpe, G.: The University of Toronto Sioux Lookout Project—a model of health care delivery. Can Med Assoc J 107: 523-528 (1972).
3. Young, T. K.: Changing pattern of health and sickness among the Cree-Ojibwa of northwestern Ontario. Med Anthropol 3: 191-223 (1979).
4. Manual of the international statistical classification of diseases, injuries, and causes of death, based on the recommendations of the Ninth Revision Conference, 1975, and adopted by the Twenty-Ninth World Health Assembly. Vol. 1. World Health Organization, Geneva, 1977: (a) pp. 49-99; (b) pp. 215-216; (c) pp. 289-291.
5. Statistics Canada: Deaths 1975. Vital statistics, vol. III. Cat. No. 84-206. Ottawa, 1978.

6. Statistics Canada. Mortality, summary list of causes, 1978. Vital statistics, vol. III. Cat. No. 84-206. Ottawa, 1980.
7. Bailar, J. C., and Ederer, F.: Significance factors for the ratio of a Poisson variable to its expectation. *Biometrics* 20: 639-642 (1964).
8. Kleinman, J. C.: Age adjusted mortality indexes for small areas: applications to health planning. *Am J Public Health* 67: 834-840 (1977).
9. Jarvis, G. K., and Boldt, M.: Death styles among Canada's Indians. *Soc Sci Med* 16: 1345-1352 (1982).
10. Schmitt, N., Hole, L. W., and Barclay, W. S.: Accidental deaths among British Columbia Indians. *Can Med Assoc J* 94: 228-234 (1966).
11. Conrad, R. D., and Kahn, M. W.: An epidemiological study of suicides and attempted suicides among the Papago Indians. *Am J Psychiatry* 131: 69-72 (1974).
12. Ogden, M., Spector, M. I., and Hill, C. A.: Suicides and homicides among Indians. *Public Health Rep* 85: 75-80, January 1970.
13. Kunitz, S. J.: Fertility, mortality and social organization. *Hum Biol* 48: 361-377 (1976).
14. Rutstein, D. D., et al.: Measuring the quality of medical care: a clinical method. *N Engl J Med* 294: 582-588 (1976).

Findings from a Major U.S. Survey of Persons Hospitalized with Head Injuries

DALLAS W. ANDERSON, PhD
 J. DOUGLAS MILLER, MD, PhD, FRCS
 WILLIAM D. KALSBECK, PhD

Dr. Anderson is survey statistician and project officer, Office of Biometry and Field Studies, National Institute of Neurological and Communicative Disorders and Stroke, National Institutes of Health. Dr. Miller is professor of surgical neurology, University of Edinburgh, Scotland. Dr. Kalsbeek is assistant professor of biostatistics, University of North Carolina at Chapel Hill.

Tearsheet requests to Dr. Dallas W. Anderson, NIH, NINCDS, Federal Building, Rm 7C-14, Bethesda, Md. 20205.

SYNOPSIS

In 1974, work began on the first national survey of head and spinal cord injuries in the United States. The survey was a project of the National Institute of Neurological and Communicative Disorders and Stroke of the Public Health Service. This article

presents highlights of the survey, particularly the findings about head injuries (that is, brain injuries).

The survey population consisted of people admitted to U.S. hospitals as inpatients between January 1, 1970, and December 31, 1974. To be medically eligible, patients must have experienced physical injury (except birth trauma) caused by an external, mechanical force. Probability sampling was used in a three-stage plan to select appropriate hospital records.

Findings of the head and spinal cord injury survey follow:

- *Of all age groups, 15- to 24-year-olds had the highest rate of head injuries.*
- *Males had a rate of head injuries more than twice that of females.*
- *Head injuries occurred most often on Fridays, Saturdays, and Sundays.*
- *The chief cause of head injuries was motor vehicle accidents.*

A CLEAR NEED FOR STATISTICS on head and spinal cord injuries in the United States prompted the Head and Spinal Cord Injury Survey (HSCI Survey). Among those who needed the statistical information were (a) people concerned with the prevention of head and spinal cord injuries, (b) specialists providing medical or rehabilitative treatment for injury victims, (c) workers engaged in social services for injury victims and their families, and (d) relatives of injury victims.

The first national survey of head and spinal cord

injuries, begun in 1974, was funded by the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) of the Public Health Service. The full report was published in 1980 (1); this article summarizes the survey findings about the head, that is, brain injuries.

Methodology

Survey strategy. Because a complete census of injury victims was not feasible, a sampling technique—