# Factors Affecting Maternal Mortality and Morbidity Among American Indians

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SINCE THE FIRST ROUTINE recording of maternal mortality in the United States in 1915, a steady decline in the rates has been reported. The decline was minimal between 1915 and 1930, but from 1930 to 1950 it dropped precipitously—almost 90 percent. Most of these years preceded the antibiotic era, and the reduction in deaths presumably was related to improved maternal care; increasing use of hospitals for deliveries; increasing safety of hospital deliveries as antisepsis and safer delivery room techniques became widespread; improvements in fluid therapy and blood banking; and development of maternal mortality committees (*1–3*).

Toward the end of this period, about 1945, the sex ratio (number of males per 100 females), which had been declining gradually since the beginning of the century, finally reversed—females began to outnumber males in the general population for the first time in U.S. history. Although many factors may have influenced this shift, a shift that is commonly observed as populations undergo "modernization" or industrialization, an important contributing factor was the decline in maternal mortality (*4*). The same shift in sex ratio occurred among American Indians 10 to 15 years later (*4*).

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Despite the many improvements made in health care for American Indians, accessibility continues to be a problem for many tribes, including the Navajos. However, maternal mortality and the male to female ratio have declined, lagging perhaps 8 to 10 years behind the rates for the general population. The following comparison of U.S. and American Indian maternal mortality rates per 100,000 live births shows a 1.4 to 2.7 higher rate among Indians.

| Year | Number of Indian deaths | Rate | | Relative risk |
|---|---|---|---|---|
| | | Indians | Non-Indians | |
| 1935 | 77 | 922 | 582 | 1.6 |
| 1940 | 69 | 723 | 376 | 1.9 |
| 1945 | 57 | 566 | 207 | 2.7 |
| 1950 | 35 | 262 | 83 | 2.1 |
| 1958 | 16 | 83 | 37 | 2.2 |
| 1963 | 24 | 84 | 36 | 2.3 |
| 1966 | 16 | 55 | 29 | 1.9 |
| 1969–71 | 22 | 34.5 | 24.2 | 1.4 |

SOURCE: references 13 and 14.

Reports of studies of maternal mortality among American Indians have been published since the 1930s. Sterling (*5*) reviewed 1,815 hospital deliveries among Chippewas, Sioux, and Navajos in 1930 and 1931; 10 maternal deaths were reported—612 per 100,000 live births—a rate comparable to that of 695 for the general U.S. population in 1929. But if home deliveries had been included, the rate would likely have been a great deal higher.

Aberle (*6*), for instance, in a review of maternal deaths among the Pueblos in New Mexico from 1927 through 1932, noted a death rate due to "the puerperal state" of 292.7 per 100,000 females 10 to 55 years old compared to 38.4 for the same age group in the U.S. population in the census registration area. Aberle remarked that "Hrdlicka in 1908 pointed out the excess of males among the relatively peaceful Rio Grande Pueblos. In a community hav-

ing a high maternal mortality and no concomitant male mortality, a shift in the sex ratio would be inevitable." On the other hand, White (*7*) was not convinced that high maternal mortality accounted for the high male to female ratio at Zia Pueblo in the 1930s, although he did observe a decline in the sex ratio between the 1800s and the 1950s.

It does seem, however, that the death rates of Navajo males and females changed differentially, and presumably this has had some impact on the present population structure (*4*). Johnston (*8*) observed that "It can be concluded that Navajo mortality . . . has declined in the period from 1945 to 1955. This decline is especially noteworthy since 1950, and is stronger in the female segment of the population than the male."

McCammon (*9*) described 475 deliveries between 1948 and 1950 at the Indian Health Service (IHS) hospital on the Navajo Reservation at Fort Defiance, Ariz. Two maternal deaths occurred during that period, one from heart disease and the other from tuberculosis—a rate of 421 deaths per 100,000 live births. Vaughn (*10*) reported the following rates for maternal deaths in New Mexico between 1956 and 1966: for Apaches, Navajos, and Pueblos combined, 119 per 100,000 live births; for Spanish-Americans, 69.8; and for Anglo-Americans, 23.9.

In British Columbia, 145 maternal deaths occurred between 1955 and 1965 (*11, 12*). Although Indians comprised only 2.4 percent of the population, they accounted for 16.1 percent of the maternal deaths and 5.7 percent of the live births. Their maternal mortality rate was 109 per 100,000 live births compared to 34.6 for non-Indians, a relative risk of 3.15.

In this paper, we report several causes of maternal morbidity and mortality among American Indians generally and Navajos in particular and describe changes in the implementation and use of several preventive maternal health practices among the Navajos.

## Sources of Data

We used three sources for our data: (*a*) computer tapes of all discharges from IHS and contract facilities in the Navajo and Phoenix Area Offices during fiscal years 1972 and 1973 (July 1, 1971–June 30, 1972, and July 1, 1972–June 30, 1973), (*b*) clinical data on all deliveries at the IHS hospital at Fort Defiance between July 1, 1968, and June 30, 1971, and (*c*) material published by the Indian Health Service in 1957 (*13*).

The IHS data for fiscal years 1972 and 1973 represent as nearly complete coverage of any population group as one is likely to find in the United States. Particularly in the Southwest, Indians are likely to be treated either at IHS facilities or at others that provide care under contract with the IHS. However, there are some losses from the system because of (*a*) the use of facilities such as some mission hospitals that do not have contracts with the IHS, (*b*) out-of-pocket or third-party payments for hospitalization, (*c*) failure to seek care, and (*d*) outpatient care for certain conditions. Despite these losses, the vast majority of Navajos use the facilities for which data are available, and the data we discuss are limited to these facilities.

The Fort Defiance hospital serves between 10,000 and 15,000 Indians, living primarily on the southeastern portion of the Navajo Reservation in northeastern Arizona and northwestern New Mexico. During the 3 years from July 1968 to June 1971, Dr. George Walter and one of us (J.C.S.) kept records on all 1,885 deliveries at that hospital. These records included prenatal care, certain demographic variables such as age, race, and tribal affiliation, pregnancy outcome and management, methods of labor and delivery, and maternal and fetal complications.

The data published after responsibility for care passed from the Bureau of Indian Affairs to the Public Health Service were based on information provided by the Bureau of the Census, special surveys by the IHS (*14*), and State health department records. Our material relating to maternal mortality comes primarily from the health department records and is subject to an unknown amount of error as a result of both underreporting of vital events and uncertainties of diagnosis even when events were reported.

## Methods and Findings

**Causes of maternal mortality.** Using the IHS data for 1940–53 (*13*), we divided the period into two intervals, 1940–45 and 1946–53. First, we applied the maternal mortality rates from the general population to the number of births of Indians in each interval to calculate an expected number of maternal deaths, under the assumption that the rates for Indians and non-Indians were similar. The observed number of Indian deaths in 1940–45 was 333 and the expected 163. The comparable figures for 1946–53 were 287 and 101. Thus, the Indian deaths were 2.04 times the expected number in the first period and 2.84 times the expected number in the second, reflecting a more rapid decrease in non-Indian maternal mortality in the immediate post-war years.

We next compared the number of Indian maternal deaths for the most common causes in the two

intervals. The figures shown in the following table indicate that the decline in mortality was attributable primarily to a reduction in deaths from sepsis, reflecting among other things mentioned previously the introduction of antibiotics in the post-war years.

| *Causes of Indian maternal mortality* | *Number of deaths* [1] | |
|---|---|---|
| | *1940–45* | *1946–53* |
| Sepsis | 83 | 38 |
| Toxemia | 85 | 84 |
| Hemorrhage | 60 | 76 |
| All others | 105 | 89 |

[1] $X^2_3 = 16.63$, $P < .001$.

Finally, we applied the proportionate distribution of causes of death in the non-Indian population in each interval to the total number of Indian maternal deaths in the same intervals in order to compare the observed with the expected distribution of causes of death. The expected distributions were based on the proportionate distribution of causes of mortality, averaged for the period, for the general U.S. population. In each interval, we noted a greater than expected number of deaths due to hemorrhage among Indians, as shown in the following table.

| *Causes of Indian maternal mortality* | *Number of deaths* | | | |
|---|---|---|---|---|
| | *1940–45* | | *1946–53* | |
| | *Observed* | *Expected* | *Observed* | *Expected* |
| Sepsis | 83 | 77.9 | 38 | 49.1 |
| Toxemia | 85 | 84.2 | 84 | 82.9 |
| Hemorrhage | 60 | 42.4 | 76 | 45.4 |
| All other | 105 | 128.5 | 89 | 109.6 |
| Total | 333 | 333.0 | 287 | 287.0 |
| | $X^2_3 = 11.92$, $P < .01$ | | $X^2_3 = 27.00$, $P < .001$ | |

Thus, it seems that (*a*) maternal mortality declined more rapidly for non-Indians than for Indians from 1940 to 1953, (*b*) the decline in Indian deaths resulted primarily from a reduction in mortality due to sepsis, and (*c*) deaths due to hemorrhage were more common proportionately to other causes than expected among Indians compared to non-Indians.

**Toxemia.** Toxemia accounts for almost one of three maternal deaths among American Indians. In pregnancy, this disorder is marked by hypertension, proteinuria, and edema. Complications include convulsions (eclampsia), cerebral vascular accidents, liver and kidney failure, consumption coagulopathies (blood clotting), and fetal deaths (*3*). Factors thought to influence the incidence of toxemia include maternal nutrition; potentiating diseases such as diabetes, hypertension, and vascular disease; genetic predisposition; and relative maternal-placental insufficiency (twins, primiparas).

The highest incidence of toxemia in the United States occurs among lower socioeconomic populations; populations with inaccessible or inadequate use of prenatal care facilities; and particularly among blacks, in whom essential hypertension is more commonly observed. In the United States, the incidence of toxemia is estimated to be between 5 to 7 percent of all deliveries and of eclampsia between 0.12 and 0.26 percent of all deliveries (*15*).

Chesley and associates (*16*) reported that among 63,200 deliveries at the Kings County Hospital in New York City between 1958 and 1967, the incidence of toxemia was 5.9 percent and of eclampsia 0.11 percent. Tyler and Saeger (*17*) reported a toxemia rate of 25 percent among 345 Indian patients from a nonreservation area (mostly Cherokee) in eastern Oklahoma in 1965.

The following comparison of toxemia and eclampsia rates observed in several Navajo studies and at the Kings County Hospital shows a far greater incidence among the Navajos:

| *Population and reference No.* | *Number of deliveries* | *Rate per 100 live births* | |
|---|---|---|---|
| | | *Toxemia* | *Eclampsia* |
| Navajo, Fort Defiance, 1948–50 (*9*) | 475 | 13.2 | 0.41 |
| Navajo, Fort Defiance, 1969–71 [1] | 1,882 | 15.2 | 0.32 |
| Navajo area, 1972–73 [1] | 9,256 | 9.9 | .... |
| Kings County Hospital (*16*) | 63,200 | 5.9 | 0.11 |

[1] Authors' data.

When eclampsia occurs, the rate of maternal mortality soars to between 4 and 6 percent (*15, 17, 18*). Toxemia accounted for 19.7 percent of maternal deaths in the United States in 1967 (*3*) and 10.3 percent of maternal deaths in Los Angeles County between 1957 and 1972 (*18*). Vaughn (*10*) reported that among 156 maternal deaths in New Mexico during 1956–66, toxemia was responsible for 30 percent of those among American Indians. The rate was 35.1 per 100,000, 12.1 times that for Anglo-Americans in the same State. Clearly, a rate that is so excessive, compared to others reported for high-risk populations (*16, 19*), reflects either a genetic predisposition of the population or social and health care factors that predispose to a high rate of toxemia and eclampsia.

Chronic hypertension, an important predisposing factor in the etiology of toxemia and eclampsia, is not common among Navajos (personal communication, February 1975, from Dr. D. Hall, senior obstetrician, Indian Health Service, and *20*). On the other hand, it has been suggested by some Navajo Area obstetricians that the diet, high in salt and starches and low in vitamins and proteins, may be

an important factor (*21*). Also significant is the lack of prenatal care, which we discuss later in this paper. Inadequate preventive measures and lack of early detection and treatment may be largely responsible for the higher incidence and mortality rates for this syndrome for Indians compared to non-Indians.

**Sepsis.** Factors predisposing to sepsis in pregnancy include failure to obtain specimens for culture at an early stage, prolonged rupture of membranes, prolonged labor, pelvic trauma, postpartum hemorrhage, anemia and malnutrition, and lack of early detection and treatment of postpartum fever.

Among the Navajos at Fort Defiance in 1968–71, the incidence of postpartum endometritis was 8.8 percent as opposed to 1.4 percent among whites (*3*). McCammon (*9*) reported a rate of 6.9 percent at the Fort Defiance hospital in 1950, and Tyler and Saeger (*17*) reported a rate of 30 percent for intrapartum and postpartum infection among nonreservation Indians in eastern Oklahoma.

The higher rate of sepsis (five to six times the rate among whites) undoubtedly accounts for the higher rate (3.2) of maternal mortality from sepsis observed among New Mexico Indians (*10*). A lack of preventive services and lower resistance to the effects of infection as a result of anemia and malnutrition may be of etiological importance. Factors such as the ready availability of antibiotics and greater accessibility of hospital services have evidently led to a disproportionately greater reduction in mortality than in morbidity from sepsis.

**Hemorrhage.** The diagnosis of hemorrhage in pregnancy includes antepartum conditions, such as abruptio placenta and placenta previa, that result in excessive blood loss, as well as delivery complications—ruptured uterus, vaginal and cervical laceration, and postpartum uterine atony— that result in blood loss in excess of 500 cc. Potentiating factors such as anemia, malnutrition, or no prenatal care can result in severe hemorrhage and maternal mortality when the patient is unable to adjust to the amount of blood lost.

Although maternal deaths due to hemorrhage decreased in the U.S. general population by 75 percent from 1940 to 1953, they declined minimally among Indians during that period. Vaughn (*10*) reported that although the Indian maternal death rate due to hemorrhage (35.1 per 100,000) was 5.4 times the rate among whites in New Mexico, the execessive rate was not accounted for by rural place of residence because the rural rate was only twice the urban rate. Carpenter and Bryans (*11*) reported that hemorrhage accounted for 50 percent of 145 maternal deaths in British Columbia, and Thomas (*12*) reported that 23 of 26 deaths of British Columbian Indians were associated with lack of prenatal care and that many deaths that occurred at home were due to hemorrhage. At Fort Defiance, from 1968 to 1971, the incidence of postpartum hemorrhage among the Navajos was 9.6 percent compared wih 5 to 6 percent in a non-Indian population (*3*). The combined incidence of abruptio placenta and placenta previa was 2.0 as opposed to 1.1 (*22, 23*) in the general U.S. population.

Although the preceding rates are difficult to compare because of variations in diagnostic standards, it is clear that the incidence of hemorrhage is only about two times higher among Indians. This finding suggests that the high rate of maternal mortality due to hemorrhage among Indians is related more to the severity of hemorrhage and inadequacy of treatment than to the more frequent occurrence of the complication.

Finally, Prosnitz and Wallach have presented some anecdotal evidence that Indians may experience more panhypopituitarism (Sheehan's syndrome) than non-Indians as a result of postpartum hemorrhage (*24*).

**Other complications of pregnancy.** The prevalence of syphilis as reflected by positive blood tests among American Indians has decreased during the past 50 years; however, it is still considerably higher than among non-Indians. Positive tests were reported for 31 percent of the Pueblos in 1923, for 9.6 percent of the Apaches in 1946, and for 5 percent of the Navajos in 1951 (*25*). Among pregnant Navajos at Fort Defiance, in 1969–72, the rate was 4.2 percent compared to 0.1 to 0.5 percent among U.S. whites (*3*).

The prevalence of diabetes varies considerably among Indian tribes—as high as 49 percent among Pimas and as low as 2 percent among Eskimos and Athabaskans. For the Navajos (southern Athabaskans), it was reported to be between 5.8 and 10 percent (*26*). Among the 1,885 pregnant Navajos at Fort Defiance from 1968 to 1971, the diabetes rate was 1.8 in contrast to 6.2 percent for pregnant non-Indians (*27*).

**Health care utilization.** A gross measure of the utilization of health care is the proportion of infants born in hospitals. The proportion has increased dramatically for American Indians—from 88.2 percent in 1955 to 98.0 percent in 1968 compared to 94.4 and 98.5 respectively for the general U.S. population (*28*).

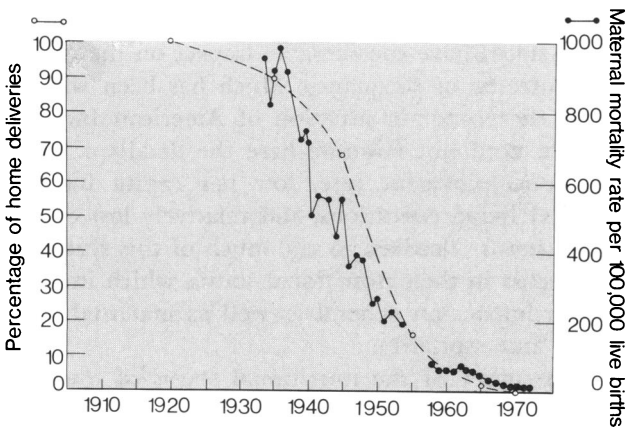
Utilization is influenced by many factors, of course, including accessibility and acceptability of facilities. In a study of two communities on the Navajo Reservation in 1953, Aberle (*29*) found that 75 percent of the mothers in Aneth, the more isolated of the two communities, had never delivered in a hospital, whereas this was true for only 34 percent of the women in Mexican Springs. Aberle concluded that accessibility of services considerably influences the proportion of women who use the hospital for delivery.

In an unpublished survey of 137 women at the Tuba City area on the western end of the Navajo Reservation, one of us (S.J.K.) found that none of the children born before 1929 was delivered in a hospital, but 100 percent of the children born after 1969 were so delivered. The greatest change occurred between 1940 and 1949 and 1950 and 1959, as shown in the following unpublished field data collected by S. J. K.:

| | *Place of birth (percent)* | | | |
|---|---|---|---|---|
| *Years* | *Home* | *Hospital* | *Total number* | *Unknown* |
| 1910–29 ..... | 100.0 | 0.0 | 32 | 2 |
| 1930–39 ..... | 91.1 | 8.9 | 45 | 6 |
| 1940–49 ..... | 69.6 | 30.4 | 79 | 13 |
| 1950–59 ..... | 21.8 | 78.2 | 174 | 2 |
| 1960–69 ..... | 2.3 | 97.7 | 259 | 2 |
| 1970–74 ..... | 0.0 | 100.0 | 107 | 0 |

Of note is the similarity in the curves representing declining maternal mortality in the Tuba City area to the decreasing frequency of home deliveries (see chart). Although we cannot infer from this similarity that delivery in the hospital accounted for the mortality decline, a change in health delivery and attitudes—reflected by the use of hospitals and the decline in maternal mortality—is probably associated with this time period. The population surveyed is more isolated and has had less access to health care than most Indians, and it began to use hospitals for delivery 5 to 10 years later than other Indian populations.

Comparison of the percentage of deliveries at home in the Tuba City, Ariz., area with maternal mortality rates for American Indians, 1933–71




**Cesarean section.** Not only has the proportion of hospital deliveries increased, but there is also evidence of improvement in hospital services. Cesarean section—which became increasingly popular as techniques were improved and support services such as anesthesia, blood banking, and antibiotics became available—is a useful indicator. In the late 19th century, maternal mortality from the procedure was so high that it was limited to cases in which the mother's condition was terminal as a result of shock, infection, ruptured uterus, "exhaustion," or "obstruction" (*30,31*). The maternal mortality rate associated with cesarean section was reported to be between 85 and 100 percent in the 1840s (*30*), 54 percent of 1,605 cases in 1867 (*3*), and 10 percent in the 1890s (*30*).

As the survival rates improved, so did the frequency of cesarean section for less serious conditions. Over the past 15 years, much of the increased use of the technique has been associated with improvements in the methods of fetal evaluation. Barclay (*32*) reported a 2.3-fold increase in the cesarean section rate (1.8 to 4.2 percent) between 1938–44 and 1952–59 at Charity Hospital in New Orleans. Johnell (*33*) noted a sixfold increase in Sweden from 1926–30 (0.25 percent) to 1951–60 (1.6 percent). The cesarean section rate was reported to be between 4.2 and 5.7 percent in the United States and 7.7 percent in England from 1950 to 1965 (*34*), and it ranged from 4.7 to 8.3 percent at 8 large eastern referral hospitals between 1957 and 1968 (*3*).

The major factors that affect the rates of cesarean section are availability of support services, referrals from small hospitals, and attitudes toward indications such as vaginal delivery after a previous cesarean section. It is interesting to note that Easterday (*35*) reported almost a twofold higher rate of cesarean section on the private service (8.2 percent) as opposed to the clinic service (4.4 percent) at the Boston Hospital for Women over a 10-year period.

When maternal or fetal complications, or both, are noted at the smaller hospitals on the Navajo Reservation, patients are referred to the larger facilities such as the Fort Defiance hospital (125 beds). As shown in the following table, the cesarean section rate at this hospital was 1.7 percent during 1948–50 (*9*); at the same time, an equal number of women with internal versions (babies were turned by internal manipulations) were not delivered by

cesarean section. Contrary to expectation, in the reservationwide survey the lowest rate of cesarean section was observed for women under age 20. (In most populations, the cesarean section rate is higher for young women because of untested pelvis resulting in cephalo-pelvic disproportion and higher complication rates such as those for toxemia.)

| *Populations and age groups* | *Number of deliveries* | *Number of cesarean sections* | *Rate of cesarean sections per 100 deliveries* |
|---|---|---|---|
| *Population* | | | |
| Fort Defiance hospital, 1948–50 | 475 | 8 | 1.7 |
| Fort Defiance hospital, 1968–71 | 1,885 | 98 | 7.8 |
| Navajo Reservation, 1972–73 | 7,213 | 373 | 5.2 |
| *Age group* | | | |
| 0–19 years | 1,088 | 34 | 3.1 |
| 20–24 years | 5,229 | 291 | 5.6 |
| 35 and over | 896 | 48 | 5.4 |

We might also add that the increased use of cesarean section among the Navajos is consistent with increased use elsewhere. Currently, cesarean section is performed among the Navajos as frequently as it is at referral hospitals in the United States.

**Prenatal care.** With hospital deliveries becoming almost universal among American Indians, attention turns to the availability and use of preventive services. Prenatal care is the most easily measured and an important preventive service; however, it continues to be unavailable or inadequate for a number of U.S. population groups (*2*).

Early and improved prenatal care has long been associated with lower mortality and morbidity rates. But many communities are unable to provide such care without support from Federal programs, such as the Maternity and Infant Care Projects of the Department of Health, Education, and Welfare. For example, at the Bernalillo County Hospital, Albuquerque, N. Mex., 37 percent of the patients delivered in 1964 had not received prenatal care, and only 1.8 percent of the patients were seen in the first trimester. In 1970, 2 years after the institution of a Maternity and Infant Care Project, 10 percent of the patients delivered at that hospital had not received prenatal care, and 27 percent had been seen in the first trimester (*36*).

Among the Navajos, educational programs and field health contacts are used to encourage women to obtain prenatal care. Because of transportation difficulties, weather, and social factors, however, many patients do not seek care until late in the course of pregnancy or until labor begins. Patients who miss appointments are rarely contacted, and patients who have several children and who feel that their pregnancies are going well often do not seek "well visit" care because of the cost of transportation and baby sitters.

The following table compares prenatal care data, in percentages, reported by Kessner for New York City (*37*), by Loughlin for a rural Navajo community (*38*), and that obtained by us for the Fort Defiance hospital.

| *Parity, age, and trimester seen* | *Navajo community, 1955–60* | *Fort Defiance hospital 1968–71* | *New York City, 1968* |
|---|---|---|---|
| Primipara | 8.3 | 26.4 | 36.5 |
| Age 35 or over | .... | 11.5 | 8.4 |
| Parity of 5 or more | 38.5 | 26.4 | 12.5 |
| Trimester first seen: | | | |
| First | 13.0 | 22.2 | 41.8 |
| Second | 17.0 | 27.9 | 36.2 |
| Third | 23.0 | 31.6 | 13.0 |
| None | 47.0 | 18.3 | 3.3 |

The high frequency of older patients and parity of five or more among the Navajos is apparent from the table. However, compared with the New York City data for a mixed white and nonwhite population, the difference in parity is far more marked than the age 35 difference. The rural Navajo community data show the parity difference most clearly. The percentages for the Navajos seen in the third trimester or not at all are much higher than those for New York City.

The lack of prenatal care is evidenced by greater complications from toxemia; early preventive measures and early diagnosis can modify the severity of the disease. The severity of hemorrhage also can be modified (less so than the incidence) by early detection of the nutritional and iron deficiency that leads to anemia. Anemia does not affect the incidence of hemorrhage as much as it does the severity by weakening hemostatic defenses and reserves.

Even with the increased availability of preventive services, it is clear that other factors such as housing conditions, general economic well-being, and nutritional status have considerable impact on the course and outcome of pregnancy. Much has been written about the economic situation of American Indians, and we need not reiterate here the details of their high unemployment rate, low per capita income, crowded living conditions, and relatively low educational status. Needless to say, much of this situation is reflected in their nutritional status, which in itself has an impact on general as well as maternal morbidity and mortality.

In a survey of the nutritional status of the residents of a community on the Navajo Reservation,

Reisinger and associates (*39*) observed that 20 percent of the nonpregnant, nonlactating women ages 17 to 44 had lower than acceptable hematocrits, judged by National Nutritional Survey standards (adjusted for altitude), and 29 percent had lower than acceptable serum iron levels. These investigators noted: "The presence of low hemoglobin levels in the menstruating female population and older males, and low serum iron and high TIBC levels, probably indicated low iron intake in these groups."

According to the standards of the National Nutritional Survey, a serum iron of 40 μg per 100 ml or more is acceptable. As just mentioned, 29 percent of the nonpregnant Navajo women had unacceptable levels. McFee (*40*) summarized the results of a World Health Organization survey as follows: in nonpregnant women, serum iron levels lower than 50 μg were found in 15 percent in rural Israel, 9.5 percent in a rural Hindu community, 51 percent in Vellore, India, 22.1 percent in a rural Mexican community, and 14 percent in Caracas, Venezuela. Thus, despite the lower level of serum iron defined as acceptable for the Navajos (40 μg rather than 50 μg), there is evidence that among nonpregnant Navajo women iron deficiency is as prevalent as in some underdeveloped areas of the world.

Similar results were observed when transferrin saturation was measured. Of nonpregnant Navajo women ages 17 to 44, 43 percent had levels below 15 percent saturation, the acceptable standard. The comparable figures from other populations were: Israel, 11.4 percent; a rural Hindu community, 25.8 percent; Vellore, India, 42.5 percent; a rural Mexican community, 28.1 percent; and Caracas, Venezuela, 18.9 percent.

Perhaps the most significant maternal complication of iron deficiency and other anemias is the inability to withstand hemorrhage. We have noted that the effects of hemorrhage among American Indian patients are somewhat more severe than among other populations, and anemia may be a significant predisposing factor. Moreover, anemia is associated with problems for the newborn infant as well as the mother.

In a study of Navajo infant mortality, Brenner and associates (*41*) found that mothers of infants dying in the neonatal period were anemic more often than were the mothers of infants dying in the post-neonatal period or mothers of a control group of surviving infants. Thus, not only is anemia still relatively common, but it also seems to be associated with increased maternal complications and neonatal deaths.

## Conclusions

Several consistent findings appear in our description, in relatively gross terms, of maternal mortality and morbidity among American Indians—despite variations in diagnoses and death reports (*2*). First, there is a high incidence of toxemia and a high case-fatality rate from the disease—not only are pregnant Navajo women predisposed to toxemia, but those who develop it have a greater chance of dying than do non-Indian women with toxemia during pregnancy. The high case-fatality rate could be due as much to the inability of providers of health services to manage the disease as it is to genetic and environmental factors.

Similarly, hemorrhage has a more severe effect on Navajos than on non-Indians, and the incidence among Navajos is decreasing less rapidly. Its severity may stem partly from a greater susceptibility to the effects of hemorrhage, as well as from inadequate services in such areas as intensive care units, monitoring of labor and delivery, and blood banks with enough supplies for a catastrophic event. For instance, of the seven hospitals on the Navajo Reservation that perform deliveries, only one has standard blood banking capabilities, three others rely on prisoners and other donors when more than a few units of blood are needed, and the other hospitals have no such services. Often, blood for catastrophic cases must be flown in from a distance of 400 miles.

Sepsis, on the contrary, although occurring at a higher rate among Navajos compared to non-Indians, was associated with a smaller difference in maternal mortality rates after an infection occurred.

Of the factors relating to the adequacy of hospital care for Indians, only the rates for cesarean section and the low case-fatality rate from sepsis seem to suggest service comparable to that provided for non-Indians. The high case-fatality rate from hemorrhage and the lack of a comparable decline in rates over time suggest an area where hospital services could be improved as well as a need for preventive services.

It seems that the Indian Health Service has been more successful in providing care for acute conditions rather than preventive maternal health care. Therefore, conditions that can be circumvented or alleviated by preventive care are of relatively more significance than they may have been in the past. It may be appropriate, then, for the IHS to consider a more active preventive health care program. Specifically, we recommend the following actions:

- Establish maternal mortality committees to monitor mortality rates and causes and to educate people engaged in maternal health care.

• Evaluate the high frequency of morbidity and mortality due to hemorrhage in terms of hospital resources and skills.
• Evaluate causal factors related to the high incidence and mortality rates resulting from toxemia of pregnancy.
• Encourage, where possible, the development of maternal and child health programs with emphasis on preventive services, health education, and the use of paramedical personnel.

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