Status of Infant and Perinatal Morbidity and Mortality

A Review of the Literature

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To REDUCE INFANT AND PERINATAL MORTALITY in the United States, two major national programs have been established, the Maternity and Infant Care (MIC) Projects and regional perinatal care programs. The known results of these programs are summarized here.

As part of the national effort in the field of mental retardation, the Maternity and Infant Care Projects evolved as a result of the 1963 Amendments to Title V of the Social Security Act. The MIC Program is intended to demonstrate a variety of approaches toward prevention of mental retardation and reduction of infant mortality. MIC Projects were established in 56 sites—in 34 States, the District of Columbia, and Puerto Rico—selected because they had the highest maternal and infant mortality rates. The projects provide interdisciplinary team care to women during pregnancy, labor, delivery, the postpartum period (including family planning), and care of their infants during the first year of life. Services include medical and dental care, social and nutrition services, patient education, family planning, nursing services, transportation, and child care.

In fiscal year 1973, the Federal appropriation for the MIC Projects was $42.94 million; the Federal Government paid 75 percent of the costs of the projects. On July 1, 1974, responsibility for the administration of the projects was turned over to the States. Each State is required to have a MIC Project.

In fiscal year 1974, the MIC Projects provided care for 117,314 maternity patients, family planning for 101,990 women, and care for 44,196 infants (*1*). It is evident that the MIC Projects are reaching only a small percentage of high-risk maternity patients—the 117,314 patients who received care represent only about 15 percent of an estimated 750,000 high-risk patients delivered each year.

Results of MIC Projects

When the project was started in Denver, Colo., in 1965, 18.9 percent of the babies delivered there weighed between 500 and 2,500 grams. In 1972, 17.8 percent of the infants were of low birth weight (*1*). The infant mortality rate in Denver decreased from 28.1 in 1965 to 17.3 per 1,000 live births in 1971.

In Augusta, Ga., the project registered a decrease of 41.2 percent in the infant mortality rate—from 38.8 in 1964 to 22.8 per 1,000 live births in 1970 (*1*). In Atlanta, Ga., the project recorded a 28.4 percent improvement in perinatal mortality from 1964 to 1973—from 46.4 per 1,000 live births to 33.2 (*1*). In Dade County, Fla., the project registered a decrease in the infant mortality rate from 20.7 per 1,000 live births in 1968 to 10.9 in 1972; during the same time, the county's infant mortality rate decreased from 21.5 to 15.9 (*1*). In Mobile, Ala., the

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MIC Project began in late 1966; from 1960 to 1971, the infant mortality rate decreased from 32.0 to 17.9 per 1,000 live births (*2*).

Region IV (the Atlanta region) had 15 MIC Projects in 1973, and all reported decreases in infant and maternal mortality, in incidence of low birth weight, and in the number of patients not receiving prenatal care. They also reported increases in the rate of returns for postpartum care, in the number of patients accepting family planning services, and in the number of patients seeking care during the first and second trimesters of pregnancy.

The Birmingham, Ala., project reported a reduction in the fetal death rate from 21.7 in 1965–66 to 12.9 in 1970–71, in the neonatal death rate from 25.4 to 18.1, and in the perinatal mortality rate from 46.5 to 30.8 (*2*). The Baltimore project reported a decrease in the infant mortality rate from 30.0 per 1,000 live births in 1964 to 20.4 in 1972 (*3*). In Broward County, Fla., infant mortality data for 1967 through 1972 showed that patients who received care under the MIC Project had a 70 percent lower average infant mortality rate than the county's indigent nonproject patients (*2*).

In the Tri-County MIC Project in Colorado, the 2 counties that were the principal targets for the project showed declines in the infant mortality rates from 1968 to 1972—Adams County from 21.5 to 16 and Arapahoe County from 24 to 14 per 1,000 live births (*2*).

Zackler and associates (*3*) reported the outcome of pregnancy in adolescents, age 15 and under, in Chicago and compared those under the care of the MIC Project with nonproject adolescents. The hebdomadal mortality rate was 15.6 and the neonatality mortality rate was 19.0 for the project adolescents in contrast to 30.0 and 36.8 per 1,000 live births for the nonproject adolescents. The hebdomadal mortality rate was 125 percent higher and the neonatal mortality rate was 136 percent higher for the nonproject adolescents. The incidence of low birth weight infants for project patients was 13.7 percent compared with 16.6 percent for the nonproject patients. Mortality due to birth injury and asphyxia, infections of the newborn, and "other disease peculiar to the newborn" was lower in project than in nonproject patients.

Bronstein (*4*), in a detailed report on the MIC Project in Augusta, Ga., compared 1964 and 1970 data for 3 groups: (*a*) 10 rural counties under the project, (*b*) 1 urban county under the project, and (*c*) the remainder of Georgia, except the 5 counties of Atlanta (the site of the other MIC Project). In the 10 rural and 1 urban counties, the infant mortality rate decreased from 38.8 to 22.8 (41.2 percent) compared with a decrease from 29.9 to 23.9 (20 percent) in the rest of the State, except Atlanta. The Augusta MIC Project reported a 13.8 percent reduction in low birth weight infants compared with an increase of 3.9 percent in the remainder of the State, minus Atlanta. The perinatal mortality rate decreased by 28.1 in the 11-county project area from 1964 to 1970

compared with 17.3 in the rest of the State, minus Atlanta.

Gold (*5*) reported a significant decrease in the perinatal mortality rate for women cared for at the MIC Project at Metropolitan Hospital in New York City. In 1966 the perinatal mortality rate was 80.3 per 1,000 live births; in 1967 it had decreased to 49.7. The hebdomadal mortality rate was 54.1 in 1966 and 29.5 in 1967. The fetal death rate was 28.5 in 1966 and 21.3 in 1967.

Power and associates (*6*) reported a greater improvement in adequacy of prenatal care in MIC Project census tracts in Boston than in non-MIC Project census tracts. The percentages of patients with adequate prenatal care in the MIC Project census tracts rose from 42.3 percent in 1971 to 63.5 percent in 1974, and in the non-MIC Project census tracts they were 61.0 percent and 70.1 percent, respectively.

Kessner and associates (*7*) summarized data on MIC Projects in New York City, Providence, Chicago, Albuquerque, and Los Angeles. These data showed declining neonatal, infant, and perinatal mortality rates among the project populations. They concluded:

> In most instances, however, data for comparison or control groups are inadequate, absent, or tenuous; lack of such control data coupled with the small size of some of the MIC populations make it hazardous to reach definitive conclusions about the impact of the projects on infant death.

Henderson (*8*) reported a decrease in the neonatal mortality rate from 21.4 in 1969 to 17.2 in 1971 and an increase in the fetal death rate from 7.1 to 11.4 in the Albuquerque MIC Project.

Pearse (*9*) reported a decrease in the perinatal mortality rates in MIC Project patients in Omaha, from 26 in 1964 to 15.2 in 1968 in "Perinatal Group I" and from 42 to 25.3 in "Perinatal Group II."

Morehead and associates (*10*) studied the quality of obstetric care in neighborhood health centers, hospital outpatient departments affiliated with medical schools, group practices, and MIC projects. The MIC Projects received a significantly higher rating.

In summary, it is evident that data from individual MIC Projects show a decline in neonatal, infant, and postneonatal mortality and in the incidence of low birth weight infants among various project populations. However, no nationwide study has been made of the outcomes of projects in which project patients are compared with control groups.

Special Care Facilities for the Newborn

Special efforts to reduce infant and perinatal mortality associated with pregnancy and its outcome originated in Chicago in the early 1930s, under the leadership of Dr. Julius Hess and Dr. Herman Bundesen. Special centers for the care of premature infants were developed, a special transport service was in operation, and individual infant deaths were studied. A decade later, Dr. Ethel Dunham of the U.S. Children's Bureau was a national leader in this field.

In the 1940s, New York City had a number of premature infant care centers and a special transport service. Also, infant deaths were being studied, a special training program for pediatricians and nurses was held at Cornell University, and efforts were aimed at improving overall hospital prenatal, intrapartum, postpartum, and newborn care through a hospital consultation program. Special services and programs were provided in Maryland, including Baltimore; Illinois; Louisiana, including New Orleans; North Carolina; West Virginia; Denver; and other States. These efforts resulted in some reduction of infant mortality in the 1940s and early 1950s. From 1955 to 1968, however, the infant mortality rate decreased very little.

During the 1960s, new techniques were devised for monitoring maternity patients, screening for high-risk patients, and care of the fetus and the newborn; also, special newborn intensive care units and perinatal centers were established. By 1977 a number of States, including Wisconsin, Illinois, Utah, Colorado, Florida, Alabama, Mississippi, Massachusetts, California, Arizona, New York, Tennessee, and Georgia, had regional perinatal care programs (*11*). The Great Plains Organization for Perinatal Health was organized in 1970—a joint effort of North Dakota, South Dakota, Minnesota, Wisconsin, Iowa, and Nebraska. The Intermountain Regional Newborn Intensive Care Unit in Salt Lake City serves a six-State area—Utah, Idaho, Wyoming, Nevada, Montana, and northern Arizona (*12*). By 1974, the Federal Maternal and Child Health Service was supporting eight newborn intensive care units (*13*). In June 1971, the House of Delegates of the American Medical Association adopted the following statement (*14*), which was subsequently endorsed by the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists.

> Application of recent advances in scientific knowledge and skills in the intensive care management of high-risk pregnant

women and high-risk newborn infants will result in reduction of present maternal and infant mortality. A major contribution to such a program is the development of a centralized community (or regional) hospital-based newborn intensive care unit. Concentration of high-risk infant care programs in hospitals specially staffed and equipped to provide optimal care is a proven life-saving mechanism for infants at risk.

The AMA urges that in every community (or if more appropriate geographic region) attention be directed to the development and operation of such centralized special care facilities. Goals in these programs should include:

1. Programs to identify the high-risk pregnancy in sufficient time to allow for delivery at those hospitals which are staffed, equipped, and organized for optimal perinatal care.

2. Programs for the early recognition of high-risk infants not identified during the prenatal period, which provide for the prompt transfer of a distressed infant to a more appropriately equipped facility when indicated. Arrangements for transport should be an integral part of the planning for community centered programs.

The AMA recognizes that the implementation of centralized community or regionalized perinatal programs is a responsibility of physicians, government, and the public and encourages:

1. Training programs for medical and allied personnel necessary to staff regional facilities

2. Allocation of facilities and equipment within communities and the development of guidelines, consistent with state law, for the operation of regional facilities

3. Continuing research into the etiologic factors responsible for the high-risk infant and improved methods of medical management

4. Continuing evaluation of the results of the regionalized programs.

More recently, the Committee on Perinatal Health, composed of participants from the American Academy of Family Physicians, American Academy of Pediatrics, American College of Obstetricians and Gynecologists, and American Medical Association, assisted by the National Foundation, formulated recommendations for the regional development of maternal and perinatal health services (*15*). It recommends concentration of the care of perinatal patients at extremely high risk in one center located in a region where 8,000 to 12,000 live births occur annually. It recommends a systematized, cohesive regional network having a coordinated cooperative system, in which all physicians and hospitals are linked by communications in order to provide (*a*) expert telephonic and ambulatory consultations (*b*) basic and continuing education for physicians, nurses, and other allied health personnel in perinatal health care, (*c*) under certain circumstances, efficient and safe transfer of selected maternity patients with complications and selected sick newborns to another hospital possessing more comprehensive specialized maternal and perinatal services. Three levels of care are described in the committee's report:

Level I

Hospitals for uncomplicated maternity and newborn patients. These hospitals are expected to be able to detect early high-risk patients and to provide emergency obstetric and newborn care.

Level II

Hospitals with a full range of maternal and neonatal services for uncomplicated patients and for the majority of complicated obstetrical problems and certain neonatal illnesses.

Level III

Hospitals for all serious types of maternal-fetal and neonatal illnesses and abnormalities. The region served by these Centers should have 8-12,000 live births annually. Level III units are expected to provide leadership in education, in new concepts and techniques of maternity and perinatal care, and in clinical and basic research.

The regional organization for perinatal care, and the setup and personnel have been described in detail (*16–18*). Briefly, the program includes the development of regional centers for high-risk maternity patients and newborn infants; establishment of liaison between the regional center and referral hospitals; provision for consultation and collaboration with the staff of other hospitals for education, planning, and administrative purposes; transport service; development of a referral plan based on the diagnosis, condition of the infant, and type of care needed; and collection of information regarding medical followup, growth, and development by the regional center.

Schneider (*11a*) reported in 1974 that since the initiation of neonatal intensive care units in Wisconsin in 1969, coupled with a statewide, continuing education program, a progressive decline occurred in the neonatal mortality rate. Perinatal loss in the 14-county region covered by the center in Madison decreased since 1968. Schneider reported that the improvement in neonatality mortality occurred almost entirely in the first 24 hours of life, demonstrating the improved care given to the newborn at the place of birth.

Zachman and Graven also reported results from Wisconsin (*19*). The neonatal mortality rate for Wisconsin's south-central region in 1968 was 15 per 1,000 live births, and in 1972 it had decreased to 9.

Brann (*11b*) reported in 1974 that since the initiation of two programs in Mississippi (the Maternity and Infant Care Project and the Neonatal Intensive Care Project) the neonatal mortality rate decreased from 22.5 per 1,000 live births in 1968 to 12.8 in 1972 in Hinds County. For nonwhites, the neonatal mortality rates were 27.1 in 1968 and 17.9 in 1972,

per 1,000 live births. Holmes County had a similar reduction in the neonatal mortality rate from 31.3 in 1968 to 20.4 in 1972. The University of Mississippi Medical School Newborn Center had a reduction in the neonatal mortality rate from 26.4 in 1968 to 10.1 in 1972.

Levering (*11c*) reported in 1974 that, since the opening of the regional perinatal center at the Long Beach (California) Memorial Hospital, neonatal mortality among infants born at the hospital had been reduced by nearly 50 percent.

Meyer (*11d*) reported some of the effects of the Arizona program on mortality. After 3 years' experience, significant reduction in neonatal mortality occurred. The earliest changes seen were among infants born in transport centers, but significant reductions also occurred among hospitals transporting sick newborns to centers. The most striking change was observed among infants weighing 1,001–2,500 grams who were born in the centers; their mortality rate was reduced by half. The State neonatal mortality rate decreased from 17.3 to 11.5 per 1,000 live births. Arizona improved its State ranking for infant mortality from 45th to 43d from 1959 to 1966 and from 43d to 11th from 1967 to 1972. Neonatal mortality improved from 35th to 3d. The infant mortality rate among American Indians served by the Phoenix area newborn service unit of the U.S. Indian Health Service decreased from 31.9 to 14.4 during the lifespan of the Newborn Transport and Intensive Care Project.

At Temple University, the neonatal intensive care program resulted in a decrease of about one-third in the hospital's infant mortality rate. For 1973, the infant mortality rate at Temple was 21.2 per 1,000 live births (*13*).

At the Robert B. Green Nursery in San Antonio, Tex., the neonatal death rate was 24.5 in 1970, before the special nursery was established. In 1973, the death rate had been reduced to 12.3 (*13*).

At the Los Angeles County/University of Southern California Medical Center, the perinatal mortality rate decreased from 41 per 1,000 live births in 1965–69 to 23 in 1973 (*20*). This decrease began in 1970 when fetal monitoring and the newborn intensive care unit were instituted.

Schlesinger (*21*) in 1973 summarized available data which showed that decreases in the neonatal mortality rate had occurred in individual centers (Johns Hopkins, University College Hospital in London, Vanderbilt University Hospital, Mt. Zion Hospital in San Francisco, and the University of Tennessee Medical Units in Memphis). He also summarized data from regional progams in the Province of Quebec, Wisconsin, and Arizona at that time.

Ellis and associates (*22*) reported on the effects of establishing a regional newborn center on the neonatal mortality of referring hospitals. Seven hospitals in the suburban counties in New Jersey were classified as users or nonusers of the regional newborn center. Three periods were identified: control, 1962–56; study A, 1968; and study B, 1969–71. The data showed a decrease in mortality rate in users from 309 in 1962–67 to 97 in 1969–71; for nonusers, the mortality rates were 240 in 1962–67 and 172 in 1969–71.

Usher (*23*) reported on perinatal mortality rates in the Province of Quebec in 1967 and 1968. The perinatal mortality rate in hospitals with a neonatal intensive care facility was 14.0; in hospitals using a referral facility, it was 17.2; and in hospitals that lacked an intensive care facility or did not use a referral facility, it was 19.9.

Cassady (*24*) reported a reduction in perinatal mortality, in the county served by the University of Alabama, from 26.0 to 21.6 per 1,000 live births during the 3 years from 1969 to 1971 and an increase from 25 to 51 percent in referrals of babies ultimately dying in the neonatal period. In 1971, the perinatal mortality rate in the seven hospitals that used the intensive care facilities was 20.0 in contrast to 25.5 in four nonuser hospitals.

In summary, there is evidence that the establishment of modern intensive care units for newborn infants has reduced the perinatal and neonatal mortality rates among infants cared for in such units. There is need for a national study of the results of special programs in hospitals as well as in communities.

Before the present era of perinatal care, the incidence of significantly handicapping conditions was high in low birth weight and other high-risk infants. Present evidence suggests that intensive care of the newborn and regionalized care are having a more favorable outcome in regard to long-term morbidity and handicapping conditions.

Schlesinger (*21*) summarized this evidence with data from the University College Hospital in London, the Hospital for Sick Children in Toronto, and

the University of Washington Medical School in Seattle. Rawlings and associates (*25*) at the University College Hospital in London did a followup study of 68 surviving infants, born during 1966 to 1969, who weighed 1,500 grams or less at birth. At the mean age of 2 years and 3 months, 59 (86.7 percent) of the infants appeared to be normal, 5 (7.4 percent) abnormal, and 4 (5.9 percent) doubtful. The authors pointed out that a full assessment could not be made until the children had had 2 or 3 years of schooling.

Stewart (*26*), also at the University College Hospital, reported on 195 infants with birth weights less than 1,501 grams, who were born during 1966 to 1970. Of these infants, 98 survived more than 28 days and 2 had handicapping birth defects.

Alden and associates (*27*) reported a 5-year followup of 161 infants, born during 1965 to 1970, with birth weights less than 1,000 grams. Of 20 survivors, 2 had abnormal developmental quotients and 6 had borderline findings, 4 had retrolental fibroplasia, and 4 had minor neurological abnormalities. All survivors were evaluated at 10 and 15 months and then yearly for a maximum of 6 years.

Dweck and associates (*28*) compared the early outcome of 15 surviving infants with birth weights between 960 and 1,100 grams, born after July 1968, with a control group. The children were examined 11½ to 33½ months after birth. The results of neurological examinations were normal for 11 children. Two of the low birth weight children had neurological deficits, and three mature and one low birth weight children had borderline results. The mean IQ scores for both groups were identical.

Egan and associates (*29*) reported on the outcome of Florida's regional neonatal intensive care program in 1974–75. Of 112 survivors weighing less than 1,500 grams, 95 were evaluated and 93 percent were normal. Of 159 survivors weighing more than 1,500 grams, 135 were evaluated and 91 percent were normal.

Drillien (*30*) reported a followup study in the first year of life of infants with low birth weights, who were born during 1966 to 1971 in Edinburgh, Scotland. Of the 300 infants studied, 71 percent were normal, 17 percent had moderately abnormal neurological signs, 6 percent had severely abnormal neurological signs, and 6 percent had cerebral palsy. Those with lower birth weights had a higher percentage of abnormal neurological signs.

Walters and associates (*31*) reported the followup of infants born in and cared for in an obstetric and neonatal intensive care unit at St. Joseph's Hospital, University of Western Ontario, from 1967 to 1971. The Denver developmental screening test was administered to 300 of the children at 3 years of age, and 291 (97 percent) were normal. The Stanford-Binet test was administered to 155 children, also 3 years old, and 135 (87.1 percent) were normal.

Family Planning, Abortion, and Infant Mortality

It is likely that the recent availability of family planning services and of safe abortion services has helped to reduce infant mortality because these services are provided to high-risk women, some of whom may have otherwise had pregnancies with unfavorable outcomes. Morris and associates (*32*) estimated that 27 percent of the recent decrease in infant mortality has resulted from shifts in age and parity of mothers delivering live babies, due to family planning and abortion services. While most women have shared in the general fertility decline, which began in 1957 and increased after 1965, the decline has been greater among women who are black, older, of high parity, and of low income (*33, 34*). The decline in New York City is thought to be related to family planning and liberalization of the abortion law (*35*), as well as significant advances in medical technology, special care of low birth weight infants, and the MIC Project.

Gendell and Hellegers (*36*), in an analysis of data from Baltimore, reported that almost 25 percent of the 9.3 percent decline in the perinatal mortality

rate for all live births between 1961 and 1966 was due to the change in maternal age and birth-order distribution of all births.

The Morris and Gendell (*32, 36*) findings agree with those of Wright (*37*), who showed, using 1960 data, that if the family planning services and patterns of birth order were that first children were born only to married women aged 20–29 and second and third children to those aged 25–34, and there were no higher birth orders, the U.S. infant mortality rate might have been 29 percent lower.

Improved Pregnancy Outcome Program

In fiscal year 1976–77, Federal funds were authorized, under Title V of the Social Security Act, to improve maternal care and pregnancy outcome in 13 high-priority States that contribute excessively to the infant mortality rate. With the exception of South Dakota, Illinois, West Virginia, and the District of Columbia, all of these States are southern or border on southern States. Among the details of the program is the requirement that the regionalized concept of perinatal care be included. In addition, funds may be used to provide secondary and tertiary care referral systems, outreach systems, transportation, provision of basic maternity care, identification of high-risk pregnancies and high-risk infants, and an outreach program for pregnant teenagers. The program is now being expanded to 23 States with the highest infant mortality rates.

Suggestions for Next Steps to be Taken

Extensive efforts are needed to promote further reduction of infant and perinatal mortality and morbidity in the United States. Evidence exists that we have a significant excess of infant deaths (*38*). Furthermore, while we have resumed progress since 1965, we have been able to keep up only with the progress made in some other countries, and we have not been able to improve our international ranking in infant mortality. Some suggestions for the next steps to be taken follow.

A major step that requires planning and action is the provision of basic and safe primary maternity care for all pregnant women. This step includes preconceptional, prenatal, intrapartum, postpartum, and interconceptional care and family planning. An important aspect is the establishment of uniform criteria to identify high-risk maternity patients and the screening of all maternity patients for high risk. Once identified, high-risk maternity patients should be referred for care to the best specialized services available. Thus, the concept of Maternity and Infant Care Projects and Improved Pregnancy Outcome Programs needs to be extended to all high-risk pregnant women and their infants. Regional perinatal services, including both the maternity and the perinatal aspects, also need to be extended. It would be well if MIC Projects, Improved Pregnancy Outcome Programs, and regional perinatal services were combined. With the decrease in the birth rate in the United States, it should be possible to provide basic primary maternity care to all pregnant women, to screen them for high risk, and to establish specialized services for those of high risk on a regional basis. Furthermore, it should be possible to consolidate smaller maternity services in hospitals.

Followup programs and services should be provided for high-risk maternity patients and high-risk infants. Followup services for high-risk maternity patients would include preconceptional care to help them reach optimal health before their next pregnancy. Followup services for high-risk infants would insure assessment of their growth and development and stimulate early casefinding of handicapping conditions.

Services for teenagers need strengthening and expansion. High schools, colleges, hospitals, and health departments could offer health services for adolescents. Programs in family life education, including sex education, are in need of expansion and improvement. Teenagers need more premarital and marital counseling, as well as family planning and abortion services. School services for pregnant teenagers also need strengthening and expansion.

Underlying all these steps is a need for increased emphasis on the nutritional status of girls and women of pre-childbearing and childbearing ages. Nutrition is one basic tool we now have to attempt to reduce the incidence of low birth weight and thereby to reduce perinatal mortality and morbidity.

Also needed is a series of well-designed studies to evaluate the effects of such programs as the Maternity and Infant Care Projects, regional perinatal centers, neonatal intensive care units, and improved pregnancy outcome projects. Although there is evidence of the favorable effects of most of these programs, national studies that include control groups are required in order to evaluate their effects fully. These studies could be designed with the assistance of clinical, administrative, and research experts and then conducted on a collaborative basis.

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