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Special Feature

Perinatal Care in Arizona 1950–2002: A Study of the Positive Impact of Technology, Regionalization and the Arizona Perinatal Trust

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INTRODUCTION

Arizona is a large state that has undergone profound population changes since the end of World War II. It has two major population centers (Phoenix and Tucson) that together account for approximately 75% of the state's population. Much of the remaining population is found in small communities scattered throughout the state. There is a high Native American population, largely rural but with some metropolitan dwellers. There is also a high number of Hispanics, which is increasing rapidly through immigration.

The development of neonatal intensive care centers, neonatal transport, maternal tertiary care centers and maternal transport have had a profound impact on perinatal health in Arizona. The development of a perinatal regional system and the maintenance of that system through the partnership of the Arizona Department of Health Services and the Arizona Perinatal Trust (APT) has been vital to the improvement of perinatal health in Arizona.

METHODS

Birth and death certificates were analyzed from Arizona Department of Health Services (ADHS) vital records. Data were collected by the APT for maternal and neonatal transports and analyzed by the author utilizing standard statistical methods. Race/ethnicity are the mother's from the birth certificate. Analyses and graphs are the author's.

RESULTS

Factors with a Major Impact on Infant Mortality

Figure 1 shows the changes in infant and neonatal mortality rates that have occurred in Arizona from 1950 to 2002. The infant mortality rate in 1950 was 53/1000 live births and 6.3/1000 in 2002; the neonatal mortality rate fell from 25.7/1000 in 1950 to 4.1/1000 in 2002. Changes in rates can be correlated with major changes in perinatal care. The overall rates for the United States were infant mortality 29.2/1000 in1950 and 6.9/1000 in 2002; US neonatal mortality in 1950 was 20.5/1000 and in 2001 was 4.6/1000. In 1960, Arizona neonatal and infant mortality rates were in the worst quartile in the nation; by the late 1970s these rates were in the best quartile. Since then Arizona has been consistently better than national averages, and in 2002, is 26th among states and territories in infant mortality rate.

1. *Antibiotics* — The drop in infant and neonatal mortality rates from 1950 to 1956 coincides with the introduction and widespread use of antibiotics.
2. *Perinatal health project* — In approximately 1960, a program to reduce perinatal mortality on the Navajo reservation was introduced by Cornell University and the Federal government, headquartered at Many Farms. This was the first perinatal health project in Arizona.
3. *Neonatal intensive care* — In 1964, a Premature Advisory Committee was established by the ADHS and the first neonatal intensive care center (NICU) was established in Phoenix.
4. *Perinatal transport* — In 1965, the Arizona Perinatal Study was completed by ADHS and the Arizona Medical Association (ArMA) (Arizona Department of Health Service, Arizona Medical Association. Arizona Perinatal Mortality, unpublished 1965). A major outcome of that study was the realization that there was a major discrepancy in mortality between neonates, particularly prematures, born in rural Arizona and those born in metropolitan areas. By 1968, a newborn transport demonstration project was undertaken, with analysis of results performed by the Arizona State University College of Engineering in conjunction with the Premature Advisory Committee, ArMA and ADHS (Wagner BL, Turk GW, Dorson WJ, Meyer BP. Evaluation study of Arizona premature transport and newborn intensive care systems. Unpublished 1970; Arizona State University College of Engineering.). The marked improvement in neonatal and infant mortality in this demonstration project convinced the Arizona State Legislature to fund a newborn transport and intensive care program. Under this program, three additional neonatal intensive care centers were established, making a total of four, two in Phoenix and two in Tucson. Transport of premature or ill newborns and services at the NICU were

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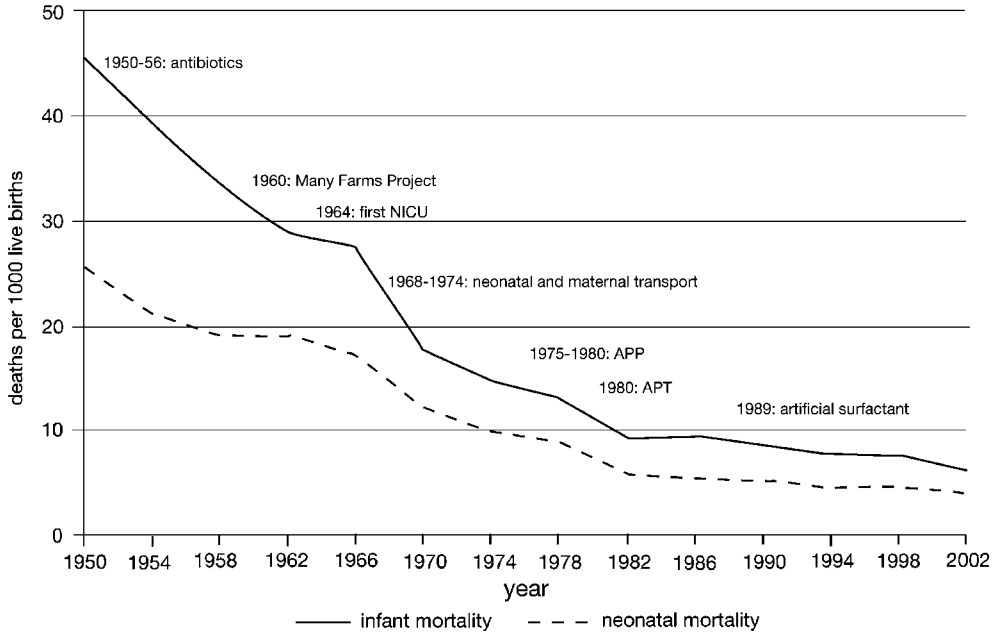

Figure 1. Infant mortality rate, deaths occurring in the first year of life per 1000 live births and neonatal mortality, deaths occurring <28 days of life per 1000 live births correlated with major changes in perinatal care, Arizona, 1950–2002.

provided, with the State acting as the payor of last resort and as coordinator of services. Maternal transport was added to the program in 1974, although maternal services at the receiving facility were not paid for by the State.

5. *Robert Woods Johnson Grant–Arizona Perinatal Program* — In 1975, the ArMA Maternal and Child Health Committee, the University of Arizona College of Medicine and ADHS jointly applied for and received a grant from the Robert Woods Johnson Foundation (RWJ). The purpose of this grant was to establish a perinatal regional system throughout Arizona. Between 1975 and 1980, intermediate perinatal care centers (Level II) were established, to fit with the NICU (Level III) centers and provide better care to moderately ill newborns who needed more than basic care but not all the tertiary services provided by a Level III center. Back transport of infants who no longer needed high-level services but were not ready to go home was also instituted. A statewide perinatal record/data system was envisioned, but never completed. An advisory council and maternal high-risk identification and transport were an integral part of this program. ADHS had the role of coordination and established a statewide hotline with neonatal and maternal consultation and transport available 24 hours/day from all areas of the state. Identification of high-risk mothers and maternal transport/consultation became a priority. This program was known as the Arizona Perinatal Program (APP). A major part of this program was statewide perinatal education for providers and the establishment of recommendations and guidelines for perinatal care centers. By 1980, the neonatal mortality rate had fallen to 8.3/1000 and the infant mortality rate to 12.4/1000.

6. *Perinatal regionalization and the APT* — As the RWJ grant was ending in 1980, permission was obtained from RWJ to put the remaining money in trust to be used for perinatal health in Arizona. As a result, the APT was formed. APT assumed many of the responsibilities of the APP and added to them. The Trust, through a daughter corporation, the Arizona Perinatal Regional System, Inc. (APRS), establishes and promulgates recommendations and guidelines for all levels of perinatal care in Arizona, including Levels I, II, IIEQ, III and free standing Birthing Centers.[1] APT also certifies hospitals and birthing centers at their appropriate level. In 2002, 93% of all Arizona births occurred in APT certified centers. Certification is a voluntary process. Except for Level I centers the State pays a higher rate for Arizona Health Care Cost Containment System (AHCCCS) patients in APT certified centers than it does for AHCCCS patients in noncertified centers. AHCCCS is Arizona's version of Medicaid. The only hospitals not certified are a few rural facilities, Level I equivalents. It is important to note that all the members of the Trust board and the APRS board are unpaid volunteers; these volunteers make the recommendations and guidelines and conduct all the site visits for certification. APT also provides education to perinatal health care professionals, also done through the efforts of volunteers. APT has a very small paid staff consisting of one full time executive director and several part time employees. There is a great deal of cooperation and collaboration among the APT, ArMA, ADHS, AHCCCS, the University of Arizona College of Medicine, Arizona State University College of Nursing, hospitals, the March of Dimes, medical transport companies and many individuals. As

the majority of the RWJ monies have been spent, APT funding comes from a combination of donations, grants, membership and certification fees and contracts, particularly to collect and analyze perinatal data.

APT annually collects data from member hospitals, including information on all maternal and neonatal transports sent and received (including dispositions, diagnoses, length of stay, birthweights and gestational ages), maternal deaths, fetal deaths and neonatal deaths and types of anesthesia used. Birth and death certificate information is analyzed for each hospital including method of delivery, birth weight distribution, race/ethnicity, payor, prenatal care, teen pregnancies, Apgar scores, marital status, singleton or multiple births and compared to all hospitals in the same level of care. Each hospital is given their own data with the comparison to same level hospitals annually. The data are also used by reviewers at site visits. Particular attention is paid to the birth of infants at a center not capable of caring for them, such as a 28-week gestational age infant delivering at a Level I center.

A site visit team consists of an obstetrician or perinatologist, pediatrician or neonatologist, obstetrical nurse, neonatal nurse, anesthesiologist or certified nurse anesthetist, a representative of ADHS who is usually social service oriented and a representative of AHCCCS. This team reviews hospital policies and procedures, staffing, physical layout, quality improvement activities, appropriate medical staff minutes, education activities (professional and community) and data. A site visit may be undertaken for certification purposes or may be a consultation requested by the hospital. The process is meant to be instructive and collaborative, not punitive.

7. *Artificial surfactant* — Artificial surfactant became generally available in 1989. The reduction in infant mortality from 9.7/1000 in 1988 to 7.6/1000 in 1995 coincides with the use of artificial surfactant.

Other Changes in Perinatal Health/Care

1. *Place of birth* — In 1967, only 30% of low birth weight babies (LBW) (<2500 g) were born in a facility appropriate to their gestational age and weight. By 2002, 91% were born in an appropriate center. The number of facilities involved in perinatal care has changed drastically in 1968. A total of 75 hospitals offered obstetric services; in 2002 only 47 provided such care. There are now six Level III centers, 13 Level II centers, four Level IIEQ (enhanced qualifications) and 13 Level I centers certified by APT. The uncertified centers are all Level I equivalent, in rural areas. 93% of all deliveries occur in APT certified facilities (2002), up from 80% in 1989. All Level II, IIEQ and III centers in Arizona are APT certified.
2. *Payor* — The most significant change regarding who pays is the increase in AHCCCS participation. In 1989, 26.5% of all deliveries were paid for by the AHCCCS; eligibility was 100% of Federal poverty level. By 2002, with eligibility at 140% of Federal poverty level, 48.6% were paid for by the AHCCCS.
3. *Transport* — Neonatal transports have fallen from 18/1000 live births in 1975 to 8.9 in 2001. At the same time, maternal transports have risen from a rate of 0/1000 to 11.6/1000 in 2001 (Figure 2). This is partly due to the increased ability of Level II and IIEQ centers to handle ill or premature newborns and more importantly the realization that the mother is a better transport vehicle than the incubator. Thus, more high-risk pregnancies are being recognized before delivery and the undelivered mother transported to a facility that can appropriately care for her and her child if she proceeds to delivery. As noted previously, 91% of LBW infants were born in an appropriate center in 2002.
4. *Demographics* — Arizona recorded 20,510 live births in 1950, 37,591 in 1970, 68,814 in 1990 and 88,400 in 2002. There has also been a major increase in the number and per cent of Hispanic mothers delivering. In 1990, 28.7% of delivering mothers were Hispanic, and 13.2% of all mothers were

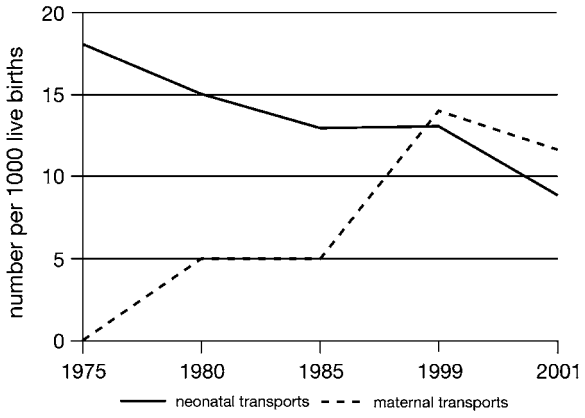

Figure 2. Neonatal and maternal transports, rate per 1000 live births, Arizona, 1975–2001.

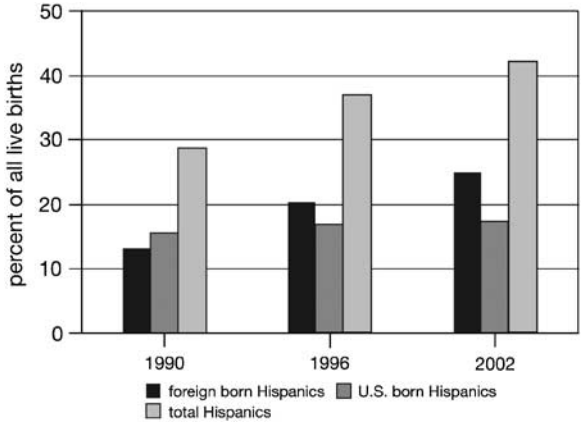

Figure 3. Hispanics as percent of live births, Arizona, 1990–2002.

foreign-born Hispanic. By 2002, 25% of all births were to foreign-born Hispanics and 42.2% to Hispanics (Figure 3).

5. *Low birth weight* — The LBW rate for all Arizona rose steadily from 60/1000 live births in 1981 to 72/1000 in 2000 (Figure 4). The rate fell to 70/1000 in 2001 and 68/1000 in 2002. The rate is not uniform across racial/ethnic groups, however. In 2002, black people had an LBW rate of 114.8/1000, native Americans 62/1000, Caucasian non-Hispanic 64.5/1000, US-born Hispanics 74.5/1000, foreign-born Hispanics 55/1000 and Asians 81.4/1000 (Figure 5). While both of these figures show all births, including multiples, the relationships remain the same when only single births are used.

Figure 6 shows changes in LBW rate by racial/ethnic groups from 1980 to 2002. During this time, the rate for the Black community has gone from 116/1000 in 1980 to 115/1000 in 2002 with considerable variation in the intervening years, the high being 139/1000 in 1988 and the low 115 in 1990 and 2002. US-born Hispanics have risen from 66/1000 in 1990 to 74/1000 in 2002.

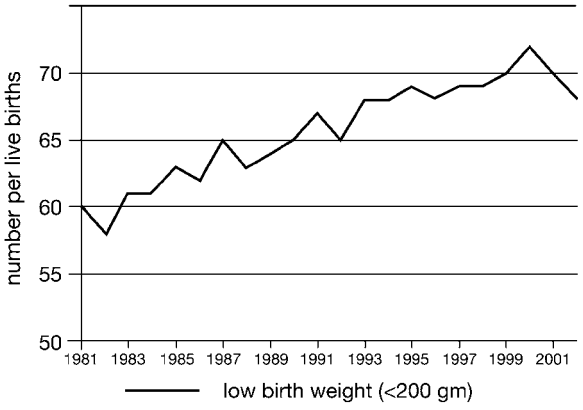

Figure 4. Low birth weight (<2500 g), rate per 1000 live births, Arizona, 1981–2002.

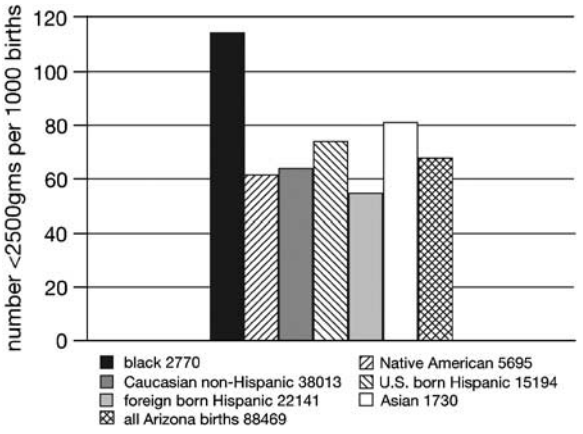

Figure 5. Low birth weight rate by race/ethnicity, Arizona, 2002. Number after racial/ethnic category is number of live births in that category.

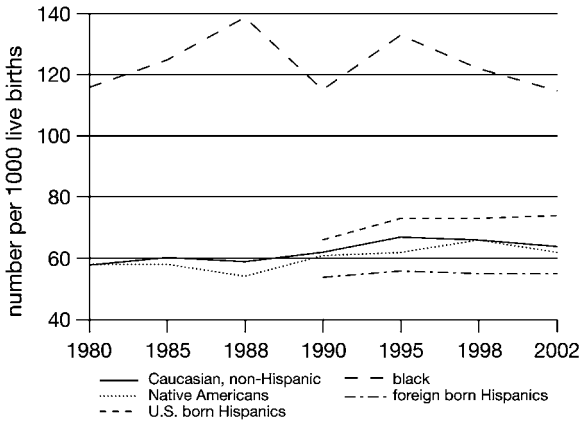

Figure 6. Low birth weight rate by race/ethnicity, Arizona, 1980–2002.

Foreign-born Hispanics have stayed flat, from 54/1000 in 1990 to 55/1000 in 2002. Caucasian non-Hispanics have gone from a rate of 58/1000 in 1980 to a high of 67/1000 in 1995, and 64/1000 in 2002. Native Americans have gone from 58/1000 in 1980 to a high of 66/1000 in 1998 and 62/1000 in 2002. Although there has been some improvement in rate for both Caucasian non-Hispanics and native Americans in the past few years, the biggest effect on the overall state rate is the dramatic increase in the number of live births to the group of women with the lowest rate for LBW, that is foreign-born Hispanics. Without the increased numbers in this group, there would be little or no drop in the overall state LBW rate.

DISCUSSION

The reductions in infant and neonatal mortality over the last half century can be divided causally into technical and nontechnical advances. There is no doubt that the development of neonatology as a specialty has had a profound effect on neonatal and infant health, as did the development and widespread use of antibiotics. The emergence of perinatology, particularly high-risk perinatology, has also had a significant impact. Technological advances within the field that have been of major importance include ultrasound imaging, understanding blood type incompatibilities and prevention, exchange transfusion, the use of mechanical ventilation in neonates and the use of artificial surfactant. Neonatal and infant surgery improvements have also had a positive effect.

Arizona has been a leader in health policy, financing and system development in perinatal care. The Many Farms project on the Navajo reservation attempted to reduce infant mortality by education of the populace and prenatal care. Shortly after the first NICU was established in Phoenix (1964) a study undertaken by ArMA and ADHS showed an appalling difference between infant

mortality rates in rural versus urban areas, particularly for premature or LBW infants (Arizona Department of Health Service, Arizona Medical Association. Arizona Perinatal Mortality, unpublished 1965). By 1968, a newborn transport demonstration project was undertaken whereby premature or ill neonates born in outlying areas were transported to a center with an NICU. A hallmark of this project was widespread cooperation among organizations and individuals, including ArMA, ADHS, Arizona State University, hospitals, nursing, medical transport companies, Indian Health Service and many others, particularly individual physicians and nurses (Wagner BL, Turk GW, Dorson WJ, Meyer BP. Evaluation study of Arizona premature transport and newborn intensive care systems. Unpublished 1970; Arizona State University College of Engineering). Following the positive results, the Arizona Legislature funded a newborn transport and NICU program, to which were added maternal transport in 1974; this program continues to the present.

This cooperative statewide approach resulted in the RWJ Foundation grant that led to the APP, the APT and the APRS. Regionalization began in the early 1970s and continues to the present. The Arizona experience in regionalization was relied on heavily in developing the Towards Improving the Outcome of Pregnancy published by the March of Dimes in 1976.[2] Certification of hospitals and birthing centers as Level I (primary), Level II (secondary), Level IIEQ (secondary with enhanced qualifications) or Level III (tertiary) along with guidelines as to which infants are appropriate to be born at each level and a system of neonatal/perinatal consultation and transportation available 24 hours per day seven days per week has contributed greatly to the low rates of infant/neonatal mortality that Arizona enjoys today. It is important to remember that this system is voluntary, and depends on the continued good will and cooperation of many individuals, groups and organizations.

The reduction in the number of hospitals offering obstetric services is probably a good thing in terms of perinatal outcomes. These hospitals were primarily located in rural areas, with a small number of deliveries/year. Their nursing and medical staffs were often lacking in numbers and training, resulting in deliveries under less than optimal circumstances. Even with an initially well-trained staff it is not possible to maintain a good skill level with small numbers of deliveries. Many of the hospitals that offered delivery services in the beginning of the perinatal regionalization effort have closed completely, due to economic constraints. In 2002, 93% of all Arizona deliveries occurred in up-to-date facilities that were certified by APT to have well-trained, adequately practiced staff who were educated regularly, and practiced according to standards and guidelines agreed to by the regional perinatal community, in stark contrast to the situation of the 1950s and 1960s.

Delivering an infant in a facility that has the equipment and skilled staff appropriate for his/her optimal care reduces mortality and morbidity. This has been noted by data from the Canadian Neonatal Network[3] and by the author in Arizona.[4] In Arizona in 1999, the survival rate for infants born in a Level III center at less than 27 weeks gestational age (between 500 and 750 g) was 50%; only one of six survived who was born outside a tertiary center and then transported to a Level III center.[4] In another recent study, the mortality of infants born at an inappropriate level and then transported was not greater than those born in a Level III center, but the transported infants had a much higher incidence of significant morbidity.[5]

Organized maternal transport was added to Arizona perinatal care in 1974. Since then the rate of maternal transport has increased to 11.6/1000 live births in 2001 and now is higher than the rate for neonatal transports, 8.9/1000 live births in 2001 (Figure 2). The effect of maternal transport on neonatal outcomes has been very positive. In Arizona, improved neonatal survival was noted by Harris, et al.,[6] in 1974. Other studies have shown decreased morbidity.[4,5] One of the ways that morbidity is reduced is by stabilizing a mother who is on the verge of delivery and allowing the infant to continue to grow and mature inside the uterus. In the study by Hohoagschwandter, et al.,[5] the average gestational age at the time of maternal transport was 28.5 weeks, and the average gestational age at delivery after maternal transport was 30.6 weeks, a gain in infant maturity of slightly more than 2 weeks. This is very similar to the Arizona[4] experience.

Pregnancy outcomes of immigrant Hispanics are having a positive effect on perinatal statistics in Arizona (Figures 5 and 6). The good outcomes of this group have been shown previously for Arizona and elsewhere.[7,8] These outcomes are not limited to immigrant Hispanics but have been shown to occur in other immigrant ethnic groups when compared to their American born ethnic counterparts.[9] Some of the possible reasons include better nutrition, less drug use, less smoking and less alcohol use, better family support and less stress in the immigrant women.[10,11]

Because they make up such a large proportion (25% in 2002) of births in Arizona, they have a very noticeable effect on LBW rates and infant/neonatal mortality rates.

The poor outcomes of black pregnancies have been the subject of much discussion and research. The cause of this disparity versus other racial/ethnic groups is still largely unknown. When socioeconomic status is controlled, the disparity still exists. Immigrant black women have infants that statistically look more like American-born Caucasians than American-born blacks.[12–15] Much work is needed to resolve this disparity.

APT certification has become the de facto standard of perinatal care in Arizona. The voluntary cooperation of the many participants in the Trust has allowed regionalization to continue and prosper despite competition and the high penetration of managed care in the Arizona marketplace. As long as the APT meets the needs of it's many constituencies, regional perinatal care will continue to be the standard in Arizona.

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