

NEONATAL DEATHS IN THE ASIR REGION OF SAUDI ARABIA: EXPERIENCE IN A REFERRAL NEONATAL INTENSIVE CARE UNIT

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We reviewed a total of 169 deaths among 969 infants referred from various health institutions in the Asir Region to the neonatal intensive care unit of Asir Central Hospital, Abha, Saudi Arabia, during a four-year period (January 1992 to December 1995). The results showed that the major causes of neonatal mortality in the region were low birth weight (LBW) (45%), congenital malformations (CM) (30.8%), infection (13.6%), and birth asphyxia (7.7%). The majority of the LBW infants died from respiratory insufficiency, sepsis, and necrotizing enterocolitis. The alimentary, central nervous and cardiovascular systems were the parts most commonly involved in CM, with cardiac defect accounting for the highest fatality rate due to lack of facilities for cardiac surgery in the region, and delay in effecting a transfer. *Klebsiella*, *Serratia* and *E. coli* are the predominant organisms causing neonatal sepsis, in contrast with the group B *streptococcus* dominating in America and the United Kingdom. Generally, factors causing neonatal deaths in the Asir region are similar to those reported in other tertiary hospitals in Saudi Arabia, and tally closely with observations in America and Europe, where the standard of health care is excellent. Nevertheless, the study indicates the need for upgrading of facilities, as well as for more trained personnel for obstetric and neonatal care in Asir region. It may be necessary to consider the need for the establishment of a regional cardiac surgery center in the region. *Ann Saudi Med* 1997;17(5):522-526.

Neonatal mortality rate is a reliable yardstick for evaluating the overall progress of perinatal care in a community. Knowledge of local or regional health problems is a prerequisite for establishing an effective health care delivery system. In the developed countries of Europe and North America, major causes of neonatal mortality are lethal congenital malformations and extreme prematurity of 24 weeks or less, which are currently considered to be beyond the scope of modern intervention. In contrast, underdeveloped countries continue to lose infants as a result of infection, malnutrition and birth asphyxia, which are potentially preventable.¹

Saudi Arabia is a rich and fast-developing nation with free medical services, medical evacuation facilities and a large number of well-equipped tertiary health institutions with highly specialized manpower. In Asir region alone (population: 2 million; 8,000 m² land area), there are 19 hospitals and 238 primary health care centers (PHCC). Using the American standard, the Asir Central Hospital is the only facility which can provide Level-3 neonatal

service. There is another facility that operates at Level-2, with the rest operating at Level-1. The etiological pattern of neonatal deaths in Jeddah,² Riyadh,^{3,4} and Tabuk,⁵ which are large cities in Saudi Arabia, has been established. In each of these areas, prematurity, congenital malformation and birth asphyxia have been found to be the leading causative factors. To our knowledge, the pattern of neonatal mortality in Asir region, lying in southwest Saudi Arabia, has not yet been documented. There may be a regional variation in the pattern of neonatal mortality. The aim of this study, therefore, is to define the relative importance of the various causes of death among neonates who were admitted in the intensive care unit of ACH. The data could be used to plan the future direction of perinatal and neonatal care appropriate to need.

Materials and Methods

All neonates who died in AHC during a four-year period (January 1992-December 1995) constitute the subject of this study. The newborn service in ACH operates as a purely referral neonatal intensive care unit (NICU). The hospital has no obstetric unit, but admits sick infants from the other secondary and primary health institutions in the region. It is government policy that any patient in the Asir catchment area requiring transfer for the purpose of specialized investigations and treatment must first be

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TABLE 1. *Yearly neonatal admissions and mortality rate in ACH.*

Year	No. of admissions	No. of deaths (%)
1992	226	43 (19)
1993	251	42 (16.7)
1994	245	41 (16.7)
1995	247	43 (17.4)
Total	969	169 (17.4)

referred to ACH. The NICU has a bed capacity of twenty, and admits an average of 250 infants per year. Being the only tertiary referral unit in the region, the service has four attending neonatologists, and a number of residents, all of whom are in the Arab Board postgraduate training program. There are nurses specialized in the care of the newborn, but the nurse/patient ratio at 1:3 is inadequate. Facilities are available for basic care, such as mechanical ventilation, intravenous alimentation, portable plain radiography, echocardiography and modern neuro-imaging techniques (ultrasonography, CT scan and MRI). Other laboratory capabilities include metabolic screening, tissue histology, electron microscopy, chromosomal analysis and infection screening for bacteria, viruses and fungi. As a routine, sepsis work-up (blood and urine cultures, complete blood count) is conducted on every infant upon admission. Spinal tap is performed on the infants only if they demonstrate clinical signs of sepsis.

Every patient who dies in the hospital is thoroughly discussed at the levels of unit, department and hospital mortality committee meetings, with the aim of determining the details of the primary and associated causes of death and possible preventive steps to take in future. Each case is summarized by the consultant in charge of the patient before the chart is filed.

A list of all neonatal deaths occurring during the review period was obtained from the ward registers, and the charts were pulled out for detailed study. Data abstracted from the records included date of admission, sex, age at admission and at death, admission and final diagnosis, mode of delivery, gestational age and birth weight. The clinical features, laboratory reports, and other relevant data, including management measures and operative findings, if any, were obtained. No autopsy was performed on any of the deceased infants. All the data were entered into a specially designed form, and subjected to analysis using the software package SPSS for Windows, Version 6.1. The causes of death were classified according to Wigglesworth's Classification.⁶

For the purpose of this study we applied the following definitions. A major or lethal congenital malformation was defined as any condition of prenatal origin which is potentially life-threatening or, if not corrected, would seriously impair development or well being. The low birth

weight (LBW) infant was one whose body weight was 2.5 kg or less at birth. Neonatal infection or sepsis applied to an infant who was clinically unwell, and demonstrated micro-organisms in the blood, urine or cerebrospinal fluid. Birth asphyxia was defined as failure to initiate or sustain respiration at birth, thereby requiring vigorous resuscitation and resulting in multiple organ failure. Respiratory distress syndrome or hyaline membrane disease was diagnosed when a newborn infant presented with expiratory grunting, chest retraction, cyanosis in room air, coupled with a chest radiograph showing a fine diffuse reticulogranular pattern. Pulmonary hemorrhage involved a bleed into the lung tissue and alveolar with the blood exuding profusely through the endotracheal tube. Intraventricular hemorrhage involved a bleed into the lateral ventricles which could extend into the surrounding brain parenchyma if advanced. Persistent pulmonary hypertension of the newborn occurred when fetal cardiopulmonary circulation was sustained after birth due to pulmonary vasoconstriction. The definition or diagnosis of necrotizing enterocolitis (NEC) was based on the modified Bell's criteria.⁷ We found that the gestational ages either by date or physical/neurological characteristics of these referred and ill newborns were not always reliable, and therefore, preferred to categorize them purely by birth weight.

Results

During the four-year review period, a total of 969 infants were admitted to the NICU of Asir Central Hospital. These were made up of 851 Saudis (87.8%) and 118 non-Saudis (12.2%). Of these 969 newborns, 169 died (17.4%). Of the 169 deaths, 92 weighed over 2.5 kg while 77 were of LBW. Fifty-six percent of these infants were admitted in the first or second week of birth, and only 8% were admitted in their third or fourth week of life. The number of admissions and the corresponding deaths for each consecutive year were about the same throughout the period.

The principal causes of death among the infants included low birth weight (LBW), lethal congenital malformation (CM), sepsis, and birth asphyxia, in descending order of frequency (Table 2). The birth weights of the 77 LBW infants ranged from 600 g to 2.5 kg. The LBW babies died of a multiplicity of factors, including respiratory insufficiency due to hyaline membrane disease, sepsis, and NEC. (Table 3). All the NEC cases were admitted in a moribund state and had gut perforation.

Of the 52 deaths associated with CM, 29 involved the gastrointestinal tract (GIT) (55.7%), 17 involved the cardiac (32.7%), four the nervous (7.7%), and two the respiratory systems (3.8%). Further analysis of the data revealed that the fatality rate was highest among the

TABLE 2. Causes of neonatal deaths in ACH according to Wigglesworth's classification.

Causes of death	No. of infants	% of total (n=169)
Low birth weight	77	45.5
Congenital malformation	52	30.8
Infection	23	13.6
Birth asphyxia	13	7.7
Meconium aspiration syndrome	2	1.2
Inborn error of metabolism	2	1.2

TABLE 3. Factors contributing to death in 77 LBW infants.

Conditions	No. of cases
Hyaline membrane disease	33
Sepsis	23
Necrotizing enterocolitis	14
Pulmonary hemorrhage	4
Intraventricular hemorrhage	3
Persistent pulmonary hypertension	3
Undetermined	10

cardiac cases. The cardiac deaths included two infants with Edward's syndrome and one with Patau's syndrome, all of whom had cardiac defects and were in intractable cardiac failure. The 29 cases with GIT anomalies died postoperatively, and those with complex cardiac lesions died while waiting to be transferred to the cardiac surgery centers in Riyadh or Jeddah.

The 23 cases with infection consisted of septicemia (13 cases) and urinary tract infection (8 cases). One infant had a combination of septicemia and meningitis, and another grew *Candida albicans* in the blood and urine simultaneously. The major bacterial organisms isolated from these infants included *Klebsiella*, *Serratia*, *E. coli* and *Staphylococcus aureus*, in descending order of frequency. During the period of the study, there were two outbreaks of *Klebsiella pneumoniae* infection in the unit. The Infection Control unit serotyped the organisms and traced the origin of the outbreaks. It was proved that in each of these instances the *Klebsiella* was not of nosocomial origin, but were brought in by the patients, as was indicated by positive blood cultures taken on admission.

Regarding the 13 infants with birth asphyxia, details of pregnancy showed that these were largely unbooked cases. All infants in this group were admitted in an unconscious state and with recurrent seizures, severe respiratory depression and brain edema, as shown by CT scan. The two patients with meconium aspiration syndrome were both postmature.

The two infants with inborn errors of metabolism were proven to be cases of propionicacidemia. They were admitted with intractable seizures, respiratory depression, severe metabolic acidosis and very high ammonia levels. Apparently, there was a delay in recognizing the primary problem in the referring hospital where they were inadvertently treated as cases of sepsis.

Discussion

Comprehensive statistical information regarding neonatal deaths is the basis for developing a sound program for the early detection of symptoms of fetal and neonatal wastage, along with the ability to assess treatment and outcome. Reliable statistics should ideally be based on community surveillance, but so far much of the reliance has been placed entirely on hospital-based statistics, which are bound to be skewed. In spite of these limitations, hospital-based data can still be useful in demonstrating the pattern of neonatal morbidity and mortality in a population. Since our neonatal unit is purely referral, it attracts only the high-risk patients, and so the mortality rate is obviously bound to be high. The authors are therefore not attempting to produce figures on mortality and fatality rates in our patient population, as these may be misleading. We regard this as a preliminary study. The figures are presented as raw data and no comparisons are made, but we offer suggestions on how to reduce some causes of mortality and morbidity. Nevertheless, since the NICU in ACH presumably pulls the potential high-risk neonates from all over the Asir region, and as it serves as a clearinghouse before any further referral, the mortality pattern revealed in this survey is most probably a reflection of what constitutes the underlying causes of death among infants born in the region.

The data emanating from this survey shows that, in descending order of frequency, prematurity, congenital malformations, infections and birth asphyxia are the major and primary causes of neonatal wastage in our region. These causative factors are similar to what is observed in other tertiary hospitals in the Kingdom of Saudi Arabia^{2-5,8} and tally closely with the data in the developed countries of North America⁹ and Europe,¹ where the standard of health care is high.

Deaths among the LBW infants were largely attributed to respiratory insufficiency, necrotizing enterocolitis and infection. We have discovered that only two of the 19 hospitals in the Asir region have occasional supplies of exogenous surfactant, and so hyaline membrane disease, a currently preventable condition, continues to play a fatal role in our preterm population. Lack of adequate respirators, staff and support services in most hospitals in the Asir region, and the very poor nurse/patient ratio in our NICU need to be addressed in order to provide the

optimum care for sick infants in our region. There is an urgent need for a regular supply of surfactant to all the hospitals with obstetric units. Perhaps the early feeding of the preterm babies with full-strength milk formula, which is the practice in all the Level -1 and 2 neonatal services in Asir region, has contributed to the high incidence of NEC, as most of the patients were admitted in the 3B (gut perforated) stage of the disease. This implies a dangerous delay in the recognition of this very lethal condition. This study should therefore draw the attention of pediatricians in the region to this problem of early formula feeding of preterm infants and the recognition of signs of NEC. Hopefully, this will lead to earlier referral. The Baby Friendly Hospital initiative needs to be more intensely promoted in Saudi Arabia, so as to encourage mothers to rely more on breast feeding. Currently, most mothers and health institutions in the Saudi community still profusely rely on breast milk substitutes, a practice which has been identified as a possible etiological factor in NEC.¹⁰

Perhaps the process of transporting infants from the referring hospital, with catheters and endotracheal tubes inserted in these sick infants, has rendered our subjects highly susceptible to infection. This may explain the relative importance of sepsis in our list, compared with the experience in other centers whose patients are taken directly from their annexed delivery units.^{2-5,8} The predominant incriminating organisms causing neonatal sepsis in our region are *Klebsiella*, *Serratia* and *E. coli*, which contrasts with the dominant prevalence of group B *streptococcus* (GBS) in the USA¹¹ and the United Kingdom.^{11,12} There are unpublished reports to show that a common inhabitant of the genitourinary and gastrointestinal tracts of pregnant women in Asir is *Klebsiella pneumoniae*. This contrasts with the experience in the USA¹³ and the UK,¹⁴ where approximately 25%-30% of pregnant women are similarly colonized by GBS. Infants born of women who are heavily colonized are more likely to become colonized or systemically infected. Generally, infection rate may be reduced if more newborn units in the region are upgraded to levels 2 or 3, in order to limit infant transportation, which additionally promotes the contamination of these patients.

A previous study has revealed that in the Asir region the anatomical parts most commonly involved in congenital malformation are the alimentary canal, axis and the cardiovascular system, in descending order of frequency.¹⁵ In the present survey the fatality rate was highest in those infants with cardiac lesions. Lack of a regional cardiac surgery facility in the Asir area, coupled with the delay in getting the infants transferred to the centers where this service can be available, compounded the problems of such patients. Presumably, our cardiac deaths could have been reduced since it is very likely that even those infants who were transferred might have

perished pre- or postoperatively in the cardiac surgery centers. Our experience therefore suggests the need for a regional cardiac surgery center in the Asir area, in order to avoid a delay in instituting appropriate treatment measures on those infants with surgically correctable cardiac defects. Moreover, in-depth analytical research is necessary to determine the possible genetic, sociodemographic and socioenvironmental factors underlying the various types of congenital malformation encountered in the Asir region. A survey in the Al Qassim area of Saudi Arabia has revealed that consanguineous marriage (54%), maternal age above 25 years, and chronic maternal disease such as diabetes were associated with a high incidence of CM.¹⁶ Consanguineous marriage is an important correlate of congenital malformation.¹⁷ We were unable to establish the etiological correlates of our cases of CM due to the limitations of our retrospective study in a purely referral unit. For instance, the referral notes were very sketchy and the parents were rarely able to provide the sociodemographic aspects of the history. Nevertheless, we hope that the present study will provide a database for future surveys on CM and, therefore, a consideration of possible preventive measures. Furthermore, the antenatal recognition of CM is likely to reduce mortality if delivery of those babies can be arranged to be conducted in a center where both medical and surgical facilities required for such infants are available.

The high rate of asphyxia may indicate deficiencies in the antenatal care and intrapartum management, therefore, priority should be given to strengthening the obstetric care in the community. Indeed, it indicates the need to examine the facilities for intrapartum monitoring, the modes of delivery and the availability of trained personnel.

Finally, we recommend that all the hospitals in the region with obstetric units should have their own intensive care unit, so as to improve the outcome of neonates born in the region. Also, Asir Central Hospital should have its own obstetric service so that pregnant women with fetus at risk can be referred for delivery and their infants offered the full benefits of Level-3 facilities.

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