Neonatal Care and the Neonatal Intensive Care Unit: Challenges & Opportunities

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by Sabitha Rajan, MD, MSc, Associate Managing Editor

Although infant mortality rates (death within the first year of life) have been dropping, the United States still has a relatively high rate – approximately 70% higher – in relation to comparable developed countries in the Organization for Economic Co-operation and Development (OECD).\(^1,2\) From 2000 to 2014, the infant mortality rate in the United States improved by about 16%, while the comparable country average improved by 32%.\(^1\) Differential reporting techniques may explain a third of that difference.\(^2\)

Infant mortality is higher in the U.S. than in comparable countries

The Centers for Disease Control and Prevention (CDC) reports that there were over 3.9 million live births in the United States in 2016 with 587 deaths per 100,000 births.\(^3\) Leading causes of infant mortality include congenital malformations, chromosomal abnormalities, low birth weight, short gestation lengths, and sudden infant death syndrome.\(^3\)

In 2014, 69% of all infant deaths in the United States were attributed to the top 10 diagnoses. The top 2 causes, congenital malformations and low birth weight or preterm births, accounted for approximately 38%.\(^1,3\)
Neonatal mortality, as opposed to infant mortality, is death within the first 28 days of birth and, once again, rates in the United States are higher than comparable OECD countries. Preterm birth is the leading cause of death in the first month of life. Risk factors for having a preterm birth include lack of prenatal care, smoking, substance abuse, and lower socio-economic status.

Newborns do not escape changing demographics; increasing rates of maternal obesity, advanced maternal ages, diabetes, multiple births (twins and higher), assisted reproductive techniques, and opiate addiction have impacted their early lives. The effects of Zika viral infections have yet to be completely elucidated. Although differential reporting accounts for a portion of the difference between the United States and comparable OECD countries, higher preterm birth rates along with regional variation, ethnic differences, poverty, and a weaker social safety net have all been thought to account for the main variance.
Efforts to combat neonatal mortality is a relatively new endeavor. In 1930, the American Academy of Pediatrics (AAP) was officially incorporated. Passage of the Social Security Act in 1935 included Title V, the Maternal and Child Health Services Block Grant, which continues to be a federal and state partner in funding programs for maternal and child health. In 1948, the Committee on Fetus and Newborn of the AAP published the first edition of a booklet titled “Standards and Recommendations for Hospital Care of Newborn Infants.” Previously, care of the newborn was often delegated to obstetricians. In 1952, Virginia Apgar presented her seminal work in developing the Apgar score and neonatal assessment in the delivery room. The term “neonatology” was coined in 1960 and is attributed to Alexander Schaffer, who used the term in the introduction of the first edition of his book *Diseases of the Newborn*.

Also in 1960, the first newborn center was opened at Grace New Haven Hospital. Soon after, the concept of regionalization was introduced. The genesis of regionalization began in 1965 with the creation of the Regional Medical Programs initiative, which was sponsored by President Lyndon B. Johnson as an effort to “conquer heart disease, cancer, and stroke.” The goal was to concentrate resources, increase efficiency of care, and make the latest advances in biomedical research available to benefit the general population. Fifty-six regions were created, mostly centered near university medical schools. The Regional Medical Programs initiative was subsequently folded in to the Health Services and Mental Health Administration and eventually phased out. However, the impact of those efforts continues and the success of these programs resulted in broadening the concept of regionalization to encompass neonatal care. A policy statement on regionalization and centralization of perinatal care was endorsed by the American Medical Association House of Delegates in August 1971.
During this time an important distinction was beginning to be made between small infants who were born preterm and term infants who were small because of intrauterine growth restriction. Previously, any infant whose birth weight was 2500 grams or less was considered premature. By 1974, the AAP established a perinatal section and in 1975, the first board certification in neonatal-perinatal medicine was offered.\textsuperscript{7}

Technology and medical advances surged ahead as well. In the 1950s, one of the first randomized controlled trials in neonatology found incubators that were 4 degrees warmer than the usual temperature improved survival in preterm infants.\textsuperscript{7,12} In addition to temperature maintenance, implementing miniaturization of required blood samples and providing intravenous nutrition, assisted ventilation, antenatal corticosteroid administration, and exogenous surfactant were crucial steps forward. Pharmacologic manipulation of the ductus arteriosus and advanced imaging has also contributed to increased survival.\textsuperscript{7,13}

Regionalization was given much of the credit. The Robert Wood Johnson Foundation funded a national demonstration project in 1975 of perinatal regionalization and compared 8 regions with funding to 8 regions without funding. However, transfer for management of high-risk pregnancies to tertiary centers had become so much more common that at the time of study completion, the study was not able to find significant differences between funded and unfunded regions. Since neonatal mortality rates had decreased sharply along with the increased rates of transfer to higher levels of care, it was accepted that transfer was one reason for improved outcomes.\textsuperscript{14}

In 1976, the March of Dimes published a report titled \textit{Toward Improving the Outcome of Pregnancy}.\textsuperscript{15} It recommended referral of high-risk patients to centers with both personnel and experience in complex care and divided levels into 3 tiers of care, from I to III.\textsuperscript{15,16}

Table 1 below illustrates the decrease in infant mortality during these years\textsuperscript{17}; rates are listed as per 1000 births. The percentages at the bottom for low birth weight and very low birth weight infants reveal increasing numbers of low birth weight babies even as overall infant mortality decreased.\textsuperscript{17}
In 1993, *Toward Improving the Outcome of Pregnancy: The 90s and Beyond* (TIOPII) reiterated the importance of designated care and added descriptive titles: basic, specialty, and subspecialty.\(^{16,18}\)

However, there was wide variation in how these recommendations were implemented. In 2002, only 32 states had published definitions of levels of care and the details, both in nomenclature and in the actual services associated with each level, varied not only by each state but also within states depending on regional networks and available resources.\(^{16,18}\) In 2004, the American Academy of Pediatrics attempted to provide more detailed standardization and organized regionalization of NICU care into 3 levels and sub-levels.\(^{18}\)

Efforts toward regionalization are supported by most research.\(^{17,19,20}\) Although confounders exist, a meta-analysis of “adequate and high quality” publications in 2010 supported the concept of a Level III nursery for high-risk neonates; very low birth weight or very preterm infants had higher rates of mortality if born outside a Level III NICU.\(^{21}\) Most studies have also reinforced the effects of patient volume; neonates fare better in a high volume NICU.\(^{17,19,20}\)

### Table 1

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<tr>
<td>All birth weights</td>
<td>26.0</td>
<td>12.6</td>
<td>9.2</td>
<td>7.60</td>
<td>6.90</td>
<td>6.90</td>
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<td>Less than 2500 g</td>
<td>190.3</td>
<td>—</td>
<td>78.1</td>
<td>65.3</td>
<td>60.2</td>
<td>57.6</td>
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<tr>
<td>Less than 1500 g</td>
<td>—</td>
<td>—</td>
<td>317.6</td>
<td>270.7</td>
<td>246.9</td>
<td>245.7</td>
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<tr>
<td>Less than 500 g</td>
<td>1000.0</td>
<td>1000.0</td>
<td>898.2</td>
<td>904.9</td>
<td>847.9</td>
<td>857.2</td>
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<td>695.2</td>
<td>440.1</td>
<td>351.0</td>
<td>313.8</td>
<td>305.1</td>
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<td>223.7</td>
<td>97.9</td>
<td>69.6</td>
<td>60.9</td>
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<tr>
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<td>43.8</td>
<td>33.5</td>
<td>28.7</td>
<td>27.0</td>
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<td>26.0</td>
<td>17.8</td>
<td>13.7</td>
<td>11.9</td>
<td>10.9</td>
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<td>—</td>
<td>3.7</td>
<td>3.0</td>
<td>2.5</td>
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<td>19.0</td>
<td>8.9</td>
<td>6.7</td>
<td>5.5</td>
<td>4.6</td>
<td>4.2</td>
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<td>10.1</td>
<td>4.8</td>
<td>3.7</td>
<td>2.9</td>
<td>2.4</td>
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<td>3.5</td>
<td>2.6</td>
<td>2.0</td>
<td>1.7</td>
<td>1.5</td>
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<td>4000 g or more</td>
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<td>—</td>
<td>2.4</td>
<td>2.0</td>
<td>1.6</td>
<td>1.6</td>
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<td>3.4</td>
<td>2.2</td>
<td>1.8</td>
<td>1.5</td>
<td>1.5</td>
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<td>—</td>
<td>—</td>
<td>2.5</td>
<td>2.2</td>
<td>2.1</td>
<td>2.2</td>
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<tr>
<td>5000 g or more</td>
<td>—</td>
<td>—</td>
<td>9.8</td>
<td>8.5</td>
<td>6.1(^{a})</td>
<td>4.6(^{a})</td>
</tr>
<tr>
<td>%VLBW (&lt; 1500 g)</td>
<td>1.03</td>
<td>1.15</td>
<td>1.27</td>
<td>—</td>
<td>1.43</td>
<td>1.49</td>
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<tr>
<td>%LBW (2500 g)</td>
<td>6.82</td>
<td>6.84</td>
<td>6.97</td>
<td>—</td>
<td>7.57</td>
<td>8.19</td>
</tr>
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</table>

\(^{a}\) Considered unreliable because of small sample size.

for high-risk deliveries is also associated with improved outcomes.\textsuperscript{17} Specialized neonatal transfer teams have reduced the risk of transferring neonates between facilities.

However, several forces have led to deregionalization.\textsuperscript{17} Expanding numbers of physicians, nurses, and respiratory therapists have allowed non-academic and non-tertiary hospitals to successfully staff a Level III NICU.\textsuperscript{18} In 2008, there were more than 850 neonatal ICUs and 4300 neonatologists in the United States, which represents extraordinary growth.\textsuperscript{17} Families also generally prefer to be closer to home. Community hospitals have multiple incentives to install new NICUs and to upgrade existing facilities, including the desire to provide better care for the infants who are born in their hospitals. To avoid potential litigation issues, obstetric physicians desire that the hospitals where they practice have a NICU.\textsuperscript{17} One delivery provides 2 hospitalizations (or more for twins or higher order multiples) for each hospital and allows them to meet targets for Medicaid disproportionate share programs for participating hospitals.\textsuperscript{17} Up to 35% of newborns are cared for in an academically affiliated NICU and the remainder are cared for at private or community NICUs.\textsuperscript{22}

Intensive care for neonates, wherever the facility is located, is expensive.\textsuperscript{23} The March of Dimes estimated a $45 billion cost in 2001 for preterm and low birth weight infants.\textsuperscript{17} Forty-five percent of NICU graduates (from both private and academic clinics) have public aid as their primary insurance coverage. In 2017, 43.0% of all births had Medicaid as the source of payment for the delivery, up from 42.6% in 2016.\textsuperscript{24}

Although neonatal care is expensive, it has been shown to be effective.\textsuperscript{17,19} In 1960, a 1-kilogram infant had a mortality risk of 95%. By 2000, it had a 95% chance of survival. The mortality rate dropped from 2.6% in 1960 to 0.69% in 2007 and 0.59% in 2016. These rates are decreasing despite an increase in the number of preterm deliveries, which in 2006 accounted for 12.8% of all births.

However, recent findings have raised concerns about variance in the appropriate utilization of neonatal intensive care units. One study examined data collected over 2 years covering 486,741 infants hospitalized at 381 NICUs encompassing over 9 million days. Seventy-four percent of these infants were 34 weeks or higher gestational age and 15% of these were high acuity babies. High acuity was pre-defined by a list of criteria, such as requiring assisted ventilation for at least 4 hours or suspected perinatal asphyxia. However, the remaining infants were not high acuity and 10% were discharged in 3 days or less, leading to the inference that they likely did not require a NICU for care. The authors point out that NICU care is not benign – it carries infection risks, increases acute stress for families, and may interfere with breastfeeding.\textsuperscript{25} Another study examining over 3 million newborns found a NICU admission rate of 7.2 per 100 births but persistent underuse of NICU care for very low birth weight infants along with possible overuse for newborns weighing 2500 grams or more if they were born in an area with higher NICU bed supply.\textsuperscript{26} Use of guidelines or quality improvement pathways may help reduce NICU utilization variance and prevent potentially unnecessary NICU admissions.\textsuperscript{25}

Neonatal levels of care describe the type of unit and medical care available in the nursery or NICU; billing codes, however, are independent of the location of care. Each billing code corresponds to the intensity of medical care and services the newborn required.\textsuperscript{19} The Uniform Billing Data Specifications Manual is published by the American Hospital Association. The 2016 National Uniform Billing Committee Level Definitions reference the second edition of the AAP
and American College of Obstetrician and Gynecologists Guidelines for Perinatal Care, which was published in 1988.\textsuperscript{19}

The billing level of care should be evaluated on a daily basis and consider the resources needed to provide care to the infant. The assigned code should correspond to the intensity and level of care provided. The level of care and resulting revenue code will likely fluctuate daily during an infant’s stay in a facility.\textsuperscript{19}

While the billing designations usually correspond to a nursery level, the level of care may vary from day to day even in the same nursery, so a billing/revenue code is not necessarily a one-to-one correlation to a nursery level. The 8th edition of the Guidelines for Perinatal Care, referencing the 2012 American Academy of Pediatric guidance, lists the latest nursery level definitions\textsuperscript{27,28}:

- **Level I** nurseries have personnel and equipment to perform resuscitation at every delivery and provide routine care for healthy neonates born after at least 37 weeks of gestation. In addition, Level I nurseries can care for physiologically stable infants born after at least 35 weeks of gestation. They may also stabilize a newborn infant who is ill and/or born at less than 35 weeks gestation until they are transferred to a higher level of care.

- **Level II** nurseries care for sick but not critically ill infants who do not require prolonged mechanical ventilation or continuous positive pressure airway pressure (ie, less than 24 hours). Level II nurseries are appropriate for infants born after at least 32 weeks of gestation and weighing 1500 grams or more, who have physiologic immaturity or who are moderately ill with problems that are expected to resolve rapidly and are not anticipated to need subspecialty services on an urgent basis. They may also care for infants convalescing after intensive care or stabilize infants born before 32 weeks gestation and weighing less than 1500 grams until transfer to a neonatal intensive care facility.

- **Level III** nurseries are appropriate for neonates born after less than 32 weeks of gestation, or who weigh less than 1500 grams, or who are critically ill (eg, require respiratory support for more than 24 hours, need urgent subspecialty care). Level III nurseries have the personnel (e.g., neonatologists, respiratory therapists) and equipment continuously available to provide life support for as long as needed and have a broad range of pediatric medical subspecialists and pediatric surgical specialists readily accessible on site or by prearranged consultative agreements. In addition, Level III nurseries have the capability to care for infants who have undergone major surgery onsite or at a closely related institution.

- **Level IV** nurseries are usually regional referral centers and have the ability to provide care for neonates who have undergone surgical repair of complex conditions, such as congenital cardiac malformations that require cardiopulmonary bypass or extracorporeal membrane oxygenation. They have the added capability to care for the most complex and critically ill newborn infants and have pediatric medical and pediatric surgical specialty consultants continuously available 24 hours a day.
National Uniform Billing Committee Level Definitions are provided in the Uniform Billing Data Specifications Manual:

- **NUBC Level 1 (code 0171)** – Routine care: For apparently normal full-term or pre-term neonate.

- **NUBC Level 2 (code 0172)** – Continuing care: For low birth-weight neonates who are not sick but require frequent feeding and neonates who require more hours of nursing than do normal neonates.

- **NUBC Level 3 (code 0173)** – Intermediate care: For sick neonates who do not require intensive care but require 6 hours to 12 hours of nursing each day.

- **NUBC Level 4 (code 0174)** – Intensive care: For severely ill infants who require constant nursing and continuous cardiopulmonary and other support.

Note that nursery facility levels are labeled with Roman numerals while billing codes carry Arabic numerals. Generally, care in Level I nursery corresponds to a National Uniform Billing Committee (NUBC) Level 1 or Level 2 code (0171 or 0172). Care in a Level II nursery usually corresponds to a National Uniform Billing Committee (NUBC) Level 2 or 3 code (0172 or 0173). Care in a Level III or Level IV nursery usually corresponds to a National Uniform Billing Committee (NUBC) Level 3 or 4 code (0173 or 0174). However, the billing code is determined independently from the facility level and may vary day by day even within the same facility.

MCG guidelines can offer multiple tools to navigate this intricate landscape of care for the newborn, whether they are premature, very premature, term and doing well, or term and ill. Comparison charts for each level supports determination of both facility level and NUBC level for each patient day. The most common diagnoses, such as apnea, neonatal jaundice, mild neonatal ischemic encephalopathy, and others, have additional condition-specific guidelines that incorporate the latest available evidence.

Although NICU length of stay varies widely, MCG offers data for the most common ICD-10 diagnoses in term deliveries for benchmarking. Discharge criteria can allow for documentation of concrete milestones and safe discharge. The three physiologic milestones that are essential before discharge include stable feeding sufficient to sustain appropriate growth, the ability to maintain acceptable body temperature in a home-like environment, and adequately mature respiratory function. In most instances, these competencies are met by 36 weeks to 37 weeks of postmenstrual age, with the understanding that some infants (e.g., those who are extremely premature, or those with complicated medical or surgical conditions) may require more time to attain these milestones.

In addition to inpatient care, MCG guidelines offer guidance for home services, durable equipment requirements, and other post-acute care needs. Evidence supporting these complex decisions are updated annually in the rapidly changing field.
References


