Differences in Mortality between Late-Preterm and Term Singleton Infants in the United States, 1995–2002

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Objective To assess differences in mortality between late-preterm (34-36 weeks) and term (37-41 weeks) infants.

Study design We used US period-linked birth/infant death files for 1995 to 2002 to compare overall and cause-specific early-neonatal, late-neonatal, postneonatal, and infant mortality rates between singleton late-preterm infants and term infants.

Results Significant declines in mortality rates were observed for late-preterm and term infants at all age-at-death categories, except the late-neonatal period. Despite the decline in rates since 1995, infant mortality rates in 2002 were 3 times higher in late-preterm infants than term infants (7.9 versus 2.4 deaths per 1000 live births); early, late, and postneonatal rates were 6, 3, and 2 times higher, respectively. During infancy, late-preterm infants were approximately 4 times more likely than term infants to die of congenital malformations (leading cause), newborn bacterial sepsis, and complications of placenta, cord, and membranes. Early-neonatal cause-specific mortality rates were most disparate, especially deaths caused by atelectasis, maternal complications of pregnancy, and congenital malformations.

Conclusions Late-preterm infants have higher mortality rates than term infants throughout infancy. Our findings may be used to guide obstetrical and pediatric decision-making. *(J Pediatr 2007;151:450-6)*

The rate of preterm birth (<37 weeks' gestation) has increased >30% in the United States since the early 1980s.[1] More recent increases in preterm birth may be explained in part by an increase in late-preterm births (34-36 completed weeks' gestation).[1,2] From 1990 to 2004, the percentage of all births that were late-preterm increased 22%, from 7.3% to 8.9% (Figure; available at www.jpeds.com).[3] In 2004, late-preterm births accounted for 71% of all preterm births, up from 69% in 1990.[3] Some of the increase in late-preterm births likely is caused by changes in obstetric practice, such as more frequent labor induction and use of cesarean delivery before 37 weeks gestation in women at high risk for adverse pregnancy outcomes.[1,4-6] These practice decisions are made after considering the fetal, maternal, and infant risks associated with preterm delivery. Clinical decisions may be driven, in part, by the perception that late-preterm infants are at no greater risk for morbidity and mortality than are term infants (37-41 weeks' gestation). Although this has not been proven, a detailed assessment of mortality comparing late-preterm infants with term infants could help inform clinical decision-making.

Late-preterm infants experience a higher incidence of respiratory distress syndrome, apnea, transient tachypnea of the newborn, hypoglycemia, hypothermia, hyperbilirubinemia, and feeding difficulties when compared with infants born at term.[7-17] Studies have also found that late-preterm infants have longer hospital stays when admitted to the neonatal intensive care unit and higher hospital costs. Most of these studies were small hospital-based analyses that, because of their limited sample size, were unable to assess severe morbidity resulting in death. One US and 1 Canadian study examined the risk of mortality in late-preterm infants versus term infants using data from before 1995.[18,19] Both studies demonstrated that late-preterm infants are at greater risk of dying before their first birthday than are term infants. Neither study, however, used the system for classifying leading causes of death used by the National Center for Health Statistics

ICD	International Classification of Diseases	NCHS	National Center for Health Statistics
LMP	Last normal menstrual period	SIDS	Sudden Infant Death Syndrome

See editorial, p 445

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(NCHS) to examine differences in the leading causes of mortality by age at time of death and the ranking of these causes.[20] A more recent analysis of all infant deaths from Utah found similar results, but also demonstrated that the risk of infant death decreased significantly from 34 to 36 weeks gestation.[21]

The objective of this study was to compare trends and differences in overall US mortality rates by age at time of death (ie, during infancy and the early-neonatal, late-neonatal, and postneonatal period) between late-preterm and term singleton infants. To gain a better understanding of the underlying causes of death for these 2 groups of infants, we used the National Center for Health Statistics' (NCHS) leading cause of death classification system to examine differences in cause-specific mortality rates by age at death and the ranking of the leading causes of death.[20]

METHODS

We used the US period-linked birth/infant death data for 1995 to 2002 to compare trends and differences in overall mortality rates by age at time of death between singleton late-preterm infants and term infants born to residents of the 50 states and the District of Columbia. We used aggregated 2000 to 2002 data to compare the differences in cause-specific mortality rates by age at time of death and the ranking of the leading causes of death in these groups. The period-linked data file, compiled by the NCHS, consists of all infants who died in a particular year regardless of whether their birth was in the same year or the preceding year. Infant death certificates are linked to the corresponding birth certificates with a >97% linkage rate during the study period. NCHS applies a weight to the data file to account for deaths that could not be linked.[22]

Late-preterm infants were defined as infants born between 34-0/7 and 36-6/7 weeks gestation, and term infants were defined as infants born between 37-0/7 and 41-6/7 weeks gestation. Gestational age in the period-linked file was reported in completed weeks of gestation and was calculated by NCHS. For most infants, gestational age was calculated by using the interval between the first day of the mother's last normal menstrual period (LMP) and the infant's date of birth, as reported on the birth certificate.[22] If only the month and year of the LMP were available, NCHS imputed gestational age by assigning the weeks of gestation of the previous completed record in the file with a similar race and birth weight. In cases in which the month, year, or entire LMP is missing or is inconsistent with reported birth weight, the clinical estimate of gestation is used. This occurred in approximately 5% of cases. When neither LMP nor the clinical estimate of gestation could be used, the gestational age was reported as missing. During the study years 1995 to 2002, only 3% of singleton infant deaths were missing gestational age data.

To calculate overall mortality rates by age at death, we used data from 1995 to 2002. During this period, there were 30,732,957 singleton live births in the United States; 30,419,290 infants (99.0%) had gestational age data reported. Of these infants, 2,221,545 (7.3%) were born late-preterm and 24,973,117 (82.1%) were born at term. Overall infant mortality rates were calculated by age at time of death and were defined as infant deaths in a given year divided by the live births in that same year, multiplied by 1000. Early-neonatal deaths were between 0 and 6 days of life; late-neonatal deaths were between 7 and 27 days; and postneonatal deaths were between 28 and 364 days. Infant deaths were all those between 0 and 364 days of life.

To calculate more stable estimates of cause-specific mortality rates, we aggregated 3 years of data, choosing 2000 to 2002 for this study. This period corresponded to the year after the change from International Classification of Diseases, Ninth Revision (ICD-9) to ICD-10 took place and 1 year before the introduction of the newly revised US birth certificate. During these years, there were 11,719,205 singleton live births in the United States, and 11,598,521 of these had gestational age data reported. Of the singleton births with reported gestational age, 871,608 (7.5%) were late-preterm and 9,573,950 (82.5%) were term.

Rates for specific causes of death were defined as the number of infant deaths in 2000 to 2002 divided by the number of live births in these years, multiplied by 100,000. Cause-of-death data were derived from the underlying cause-of-death reported by physicians, medical examiners, or coroners on the death certificate and as coded and defined by ICD-10. Final underlying cause-of-death data depends not only on the coding, but also on how conditions are reported by the certifier. Infant deaths were assigned 1 of 71 rankable causes as defined by NCHS.[24] For the 10 leading causes of death in each age-at-death category, the ratio between late-preterm and term mortality rates was calculated.

All data analyses were conducted with SPSS software version 12.0.1 (SPSS, Chicago, IL). Statistical testing of differences in the rates with time was performed by applying the χ^2 test of linear trends in proportions by using StatCalc software from EpiInfo Version 6.[25] Statistical significance was set a priori at a P value $< .01$.

RESULTS

Infant Mortality

Between 1995 and 2002, 187,830 singleton infants died before their first birthday; 18,484 (9.8%) were late-preterm infants, and 67,197 (35.8%) were term infants. Overall infant mortality rates for both late-preterm (by 16.8%, $P < .01$) and term infants (by 20.0%, $P < .01$) declined significantly from 1995 to 2002 (Table I). Throughout the study period, overall infant mortality rates were approximately 3 times higher in late-preterm infants than term infants.

From 2000 to 2002, there were 68,697 singleton infant deaths; 6840 (10%) were late-preterm infants, and 23,956 (34.9%) were term infants. Cause-specific infant mortality rates were 1.8 to 4.5 times higher in late-preterm infants than term infants during the 2000 to 2002 period (Table I). The 5 leading causes of infant mortality for late-preterm and term