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Delivery Indications at Late-Preterm Gestations and Infant Mortality Rates in the United States

Uma M. Reddy, MD, MPH, **Chia-Wen Ko, PhD**, **Tonse N.K. Raju, MD**, and **Marian Willinger, PhD**
Pregnancy and Perinatology Branch, Eunice Kennedy Shriver, National Institute of Child Health and Human Development, National Institutes of Health, Department of Health and Human Services, Bethesda, Maryland

Abstract

OBJECTIVE—The rate of preterm births has been increasing in the United States, especially for births 34 to 36 weeks of gestation (late preterm), which now constitute 71% of all preterm births. The causes for these trends remain unclear. We characterized the delivery indications for late preterm births and their potential impact on neonatal and infant mortality rates.

PATIENTS AND METHODS—Using the 2001 US Birth Cohort Linked birth/death files of 3 483 496 singleton births, we categorized delivery indications as follows: (1) maternal medical conditions; (2) obstetric complications; (3) major congenital anomalies; (4) isolated spontaneous labor: vaginal delivery without induction and without associated medical/obstetric factors; and (5) no recorded indication.

RESULTS—Of the 292 627 late-preterm births, the first 4 categories (those with indications and isolated spontaneous labor) accounted for 76.8%. The remaining 23.2% (67 909) were classified as deliveries with no recorded indication. Factors significantly increasing the chance of no recorded indication were older maternal age; non-Hispanic, white mother; ≥13 years of education; Southern, Midwestern, and Western region; multiparity; or previous infant with a ≥4000-g birth weight. The neonatal and infant mortality rates were significantly higher among deliveries with no recorded indication compared with deliveries secondary to isolated spontaneous labor but lower compared with deliveries with an obstetric indication or congenital anomaly.

CONCLUSIONS—A total of 23% of late preterm births had no recorded indication for delivery noted on birth certificates. Patient factors may be playing a role in these deliveries. It is concerning that these infants had higher mortality rates compared with those born after spontaneous labor at similar gestational ages. Given the excess risk of mortality, patients and providers need to discuss the risks of delivering a pre-term infant in the absence of medical indications at 34 to 36 weeks.

Keywords

infant mortality; preterm; preterm infants

The preterm birth rate has increased in the United States by 20% in 15 years, from 10.6% in 1990 to 12.7% in 2005. Infants born at 34 to 36 weeks (239–259 days) of gestation now account for 71% of all preterm births. This group, referred to as “late preterm” is increasing at a greater

Address correspondence to Uma M. Reddy, MD, MPH, Pregnancy and Perinatology Branch, Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health, Department of Health and Human Services, 6100 Executive Blvd, Room 4B03F, Bethesda, MD 20892-7510. reddyu@mail.nih.gov.

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rate than all other preterm birth subgroups. The late-preterm birth rate was 7.3% in 1990 compared with 9.1% in 2005, a 25% increase.[1]

Compared with term infants, late-preterm infants manifest higher frequencies of neonatal and postneonatal morbidities, such as respiratory distress, temperature instability, hypoglycemia, kernicterus, apnea, and feeding problems.[2] Their rehospitalization rates after neonatal discharge are also higher,[2] as are their rates for neonatal and postneonatal mortality.[3] Furthermore, a recent population-based study of all of the preterm infants followed for ≥20 years of age reported significantly increased rates of cerebral palsy, mental retardation, and other major disabilities in the late-preterm infant subset compared with term infants.[4] Thus, the increasing late-preterm birth rate should be of great concern, because the societal burden is profound. However, comprehensive studies that address the reasons for the increasing rate of late-preterm births, which may potentially lead to reduction strategies, are lacking. The aim of this study was, therefore, to determine why singleton late-preterm births are taking place and to compare the delivery indications with neonatal and infant mortality rates.

PATIENTS AND METHODS

We analyzed data from the National Center for Health Statistics (NCHS) 2001 birth cohort linked birth/death files of 3 483 496 live singleton births at 34 to 41 weeks of gestation. The 2001 birth cohort numerator file consisted of deaths of infants who were born in 2001, and the denominator file consisted of all of the 2001 live births. Neonatal and infant mortality rates were calculated by week of gestation at birth and the indication for delivery. Week 39 (39 0/7 to 39 6/7 weeks) had the lowest neonatal mortality rate and was, therefore, used as the reference week when comparing mortality by week of delivery.

Late-preterm births (those occurring between 34 0/7 through 36 6/7 weeks of gestation) were classified by delivery indications into the following 5 categories: (1) maternal medical conditions; (2) obstetric complications; (3) major congenital anomalies; (4) isolated spontaneous labor: vaginal delivery without induction and without associated medical/obstetric factors; and (5) no recorded indication: no documented indications. The complete list of conditions composing categories 1 to 3 is contained in Table 1. The maternal medical conditions, obstetric complications, and major congenital anomaly categories were not mutually exclusive; therefore, a late-preterm birth could be represented in > 1 of these categories.

Because birth certificates do not specifically collect information for the spontaneous onset of labor, this category was imputed by including all of the vaginal deliveries that were not accompanied by an induction. Pregnancies in which there was spontaneous onset of labor but there was an obstetric complication leading to a cesarean delivery were captured in the obstetric indications category. Thus, the isolated spontaneous labor category was a subset of all of the vaginal deliveries in which there was no induction of labor and no coexisting reported indications for delivery, including those with missing values for maternal medical conditions, obstetric complications, or major congenital anomalies. Route of delivery was classified either as vaginal delivery (vaginal deliveries and vaginal births after previous cesarean delivery combined) or cesarean delivery (primary and repeat cesarean deliveries combined).

Deliveries with no recorded indication were computed by excluding deliveries with maternal medical conditions, obstetric complications, major congenital anomalies, or isolated spontaneous labor from all of the deliveries. A total of 97.3% of cases with no recorded indication had “none” checked for all of the data fields pertaining to the first 3 categories of conditions noted in Table 1; only in 2.7% of these deliveries was “none” not checked for a category, thus suggesting potentially missing data values. When comparing the mortality rate

by indication for delivery, we used the deliveries with no recorded indication as the reference group.

Odds ratios and 95% confidence intervals were calculated to assess the association between selected maternal demographic and medical risk factors to late-preterm deliveries. Those factors included maternal age, maternal race/ethnicity, maternal education, region of maternal residence, parity, previous infant with a birth weight ≥4000 g, and previous preterm or small-for-gestational-age infant. Multivariate logistic regression was used to assess the contribution of the above factors to deliveries with no recorded indication versus indicated deliveries (deliveries with clinical indications).

The primary determinant of gestation in the NCHS data files is the interval between the first day of the last menstrual period (LMP) and date of delivery. NCHS edits the data for LMP-based gestational ages that are not consistent with birth weight and plurality. Clinical estimate was used when there was no LMP or there was a gross discrepancy based on weight. All of the data analyses were performed using the statistical software SAS 9.0 (SAS Institute, Cary, NC).

RESULTS

There were 292 627 singleton deliveries at 34 to 36 weeks of gestation, representing 8.4% of singleton births from 34 to 41 weeks of gestation. The neonatal and infant mortality rates were inversely related to gestational age in weeks ≤39 weeks of gestation. At 34 weeks of gestation, the neonatal mortality rate peaked to ~10-fold higher than that of 39 weeks of gestation. The lowest neonatal mortality rate was seen for singleton births at 39 weeks of gestation (Table 2).

Between 34 and 36 weeks, the percentages of deliveries associated with medical conditions, obstetric complications, and congenital anomalies were highest at 34 weeks, and these progressively decreased with advancing gestational age (Table 3). Of all of the late-preterm deliveries, 49% were associated with isolated spontaneous labor. In addition, 16% were reported to have obstetric complications, 14% had medical conditions, and 1% had major congenital anomalies.

There were 67 909 late preterm deliveries (23.2%) classified as having no recorded indication. Multivariate analyses revealed that deliveries with no recorded indication were associated increasingly with higher maternal age; non-Hispanic white ethnicity; maternal educational level ≥13 years; deliveries occurring in the Midwest, South, and West regions of the United States; multiparity; and a history of previous infant with a birth weight ≥4000 g. Maternal age <35 years and history of previous preterm or small-for-gestational-age infant were significantly less associated with deliveries with no recorded indication (Table 4).

Major congenital anomalies were associated with the highest neonatal and infant mortality rates followed by obstetric complications (Table 5). Deliveries with no recorded indication had significantly higher neonatal and infant mortality rates compared with deliveries attributed to isolated spontaneous labor ($P < .001$) but lower neonatal and infant mortality rates compared with those deliveries associated with an obstetric indication ($P< .001$) or congenital anomaly ($P < .001$).

DISCUSSION

We found that 23% of late preterm deliveries had no recorded indication for delivery (maternal disease, obstetric complication, congenital anomaly, and spontaneous labor) on the birth certificate. The American College of Obstetricians and Gynecologists guidelines state that delivery before 39 weeks of gestation should only be undertaken when there is an accepted

medical or obstetric complication or if fetal lung maturity has been documented.[5] In deciding the timing of delivery for women at high risk for adverse pregnancy outcomes before term, the anticipated risk of continuing pregnancy and stillbirth should outweigh the attendant neonatal morbidity and mortality with preterm delivery.

These principles apply for late-preterm gestations with known or newly diagnosed medical, obstetric, or fetal conditions and complications. Because we found that 1 in 5 late-preterm deliveries occurred with no recorded medical or obstetric indication, we speculate that other factors may have influenced the patient and health care provider's decision regarding the timing of delivery, namely, the perception that infants born in the late preterm period are at no greater risk for mortality and morbidity than term infants. However, confirming several recent reports,[3,6–8] our data show that infants born at late-preterm gestations have significantly higher rates of mortality compared with term infants.

Whether increased rates of deliveries with no indication are the source of increasing rates of preterm births (including late-preterm births) in the United States remains unclear. To our knowledge, this is the first study to examine not only the delivery indications for late preterm births but their relationship with neonatal and infant mortality rates using recent US vital statistics data.

A novel finding in our study was that infants born at late preterm delivered without an indication had higher neonatal and infant mortality rates compared with those born after isolated spontaneous labor. It has been hypothesized that, in preterm births, labor may be "triggered" so that the fetus can exit a potentially "hostile" in-utero environment. Thus, spontaneous onset of preterm labor may be a consequence of an earlier idiopathic activation of the normal labor process or the result of a pathologic insult in an attempt to protect the fetus.[9] Furthermore, the process of labor itself facilitates fetal lung maturation and improves clearance of pulmonary fluid, reducing the risk of neonatal respiratory distress.[10,11] These factors may explain why the neonatal and infant mortality rates for infants born at late preterm after spontaneous labor may be lower than those for infants born at late preterm with no documented indication.

Late-preterm deliveries with an obstetric complication or major congenital anomaly had significantly higher neonatal and infant mortality rates compared with all of the other categories, including deliveries with no recorded indication, suggesting that the underlying condition that prompted the delivery was associated with poorer outcomes. Thus, it seems that survival rates for infants born at late preterm may be affected by the indication for delivery and that, within gestational age strata, all late-preterm infants are not alike with respect to their risk of death. Therefore, the decision to deliver or not during late-preterm gestations should be based on the underlying medical or obstetric factor(s) and a careful assessment of the risks of preterm delivery versus the potential benefits of expectant management.

One study that evaluated the etiology for late-preterm deliveries in a large academic center found that ~80% were attributed to idiopathic preterm labor or ruptured membranes and 20% to obstetric complications.7 Another study examined the temporal trends in preterm birth subtypes and perinatal mortality in the United States for 1989–1991 and 1995–2000.[12] The authors defined medically indicated preterm births as those that followed iatrogenic intervention (labor induction or a primary or repeat cesarean delivery) and spontaneous preterm births as those that were neither associated with ruptured membranes nor were medically indicated. However, we believe that equating "primary cesarean," "repeat cesarean," or "labor induction" from the birth certificate files with "medically indicated deliveries" may be inaccurate. One cannot assume that a clear medical, fetal, or obstetric indication existed for preterm delivery based only on the fact that a delivery was a planned cesarean delivery or labor induction.

Some of the factors reported as contributing to the increase in late-preterm births include increasing rates of elective cesarean delivery and induction[13] and increasing rates of multiple gestations.1 A recent study documented that physician practices may have changed over time. Over a 9-year period in an academic institution that had significantly lower baseline cesarean delivery rates compared with the US rates, there was a gradual increase in cesarean delivery rates paralleling their increase in late-preterm birth rates.[14] These findings have significant implications as the cesarean delivery rate (24.4 in 2001 and 29.1 in 2004) and pre-term birth rate (11.9 in 2001 and 12.5 in 2004) continue to rise, indicating that the magnitude of the late-preterm birth problem will likely increase.

These factors, however, do not fully explain the dramatic increase in the rate of late-preterm births, especially for singleton gestations. Whether the increasing frequency of early cesarean deliveries is because of improved and earlier recognition of medical/obstetric indications or a greater willingness to perform a cesarean delivery for the same or even lesser indications has not been established. In fact, Declercq et al[15] found no association between changes in the maternal risk profile and shifts in the primary cesarean delivery rates between 1991 and 2002, suggesting that factors other than medical or obstetric conditions may be related to increasing rates of preterm cesarean deliveries and, indirectly, late preterm births.

Our finding of an association between late-preterm deliveries with no recorded indication and social and geographic factors suggests that patient-driven factors are playing a role in this category of late-preterm births. We found that women with no recorded indication for delivery were more likely to be older, white, have higher levels of education, and live outside the Northeast. If such deliveries are occurring, it can have a major impact on the overall preterm birth rate, because non-Hispanic white women form the majority of US women of reproductive age. There are no studies assessing patient factors related to late-preterm delivery with no recorded indication, but it may be that this group of women is more likely to request that their obstetric provider deliver them before term.[16,17] Consequently, patient and provider convenience factors may be contributing to the increasing rate of late-preterm delivery.

The analysis of vital statistics is of value because of the large cohort size representing the United States, comprehensiveness of births and deaths (>99%), reduced selection bias, and the ability to examine sub-populations.[18] In our study, the use of linked birth-infant death files allowed us to examine the associations between maternal characteristics and subsequent infant mortality. Studies comparing birth certificate data with hospital records suggest that demographic characteristics and some medical variables, such as method of delivery, are accurately reported on the certificates, lending validity to stratification by those factors.[18–23]

There are limitations to using vital statistics. The inaccuracies of gestational age estimates in birth certificates are known; however, they are less frequent for late-preterm and term births.[24]

Underreporting for medical diagnoses, obstetric complications, and congenital anomalies is known to occur and will lead to an overestimate of the number of deliveries with no recorded indication.[18–23,25–26] Although we cannot determine the magnitude of underreporting of conditions in our data set, our analyses showed that the contribution of missing data to our findings was minimal.

CONCLUSIONS

There is an urgent need to understand the reasons for the increasing rate of late-preterm births and their sequelae. The Institute of Medicine[27] and the Surgeon General[28] have called for research to understand all facets of this significant public health problem. Our findings that a significant proportion of late-preterm deliveries occur without a recorded medical indication

and that these deliveries are associated with an increased mortality rate underscore the need for increased dialogue between providers and patients about the potential negative consequences of late-preterm delivery. Although such assessments may be difficult in certain cases, obstetricians and pediatricians must consult and discuss with the mother and the family the benefits and risks of late-preterm delivery versus continued monitoring. The higher morbidity and mortality for late-preterm infants throughout the first year of age, and possibly beyond, should be included in patient counseling.

WHAT'S KNOWN ON THIS SUBJECT: Compared with term infants, late-preterm infants manifest higher frequencies of neonatal and postneonatal morbidities and mortality.

WHAT THIS STUDY ADDS: Survival rates for infants born at late-preterm gestational ages vary by the indication for delivery. No indication for delivery was recorded on the birth certificate for 1 in 5 late-preterm births.

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ABBREVIATIONS

NCHS	National Center for Health Statistics
LMP	last menstrual period

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TABLE 1

Indication Categories

Category 1: maternal medical conditions
Cardiac disease
Acute or chronic lung disease
Diabetes
Hemoglobinopathy
Chronic hypertension
Pregnancy-associated hypertension
Eclampsia
Seizures during labor
Renal disease
Category 2: obstetric complications
Hydramnios/oligohydramnios
Incompetent cervix
Rh sensitization
Uterine bleeding
Premature rupture of membranes (>12 h)
Abruptio placenta
Placenta previa
Other excessive bleeding
Cord prolapse
Fetal distress
Category 3: major congenital anomalies
Anencephalus
Spina bifida/meningomyelocele
Hydrocephalus
Microcephalus
Other central nervous system anomalies
Heart malformations
Other circulatory/respiratory anomalies
Rectal atresia/stenosis
Tracheo-esophageal fistula/esophageal fistula
Omphalocele/gastroschisis
Other gastrointestinal anomalies
Renal agenesis
Other urogenital anomalies
Diaphragmatic hernia
Other musculoskeletal/integumental anomalies
Down syndrome
Other chromosomal anomalies
Category 4: isolated spontaneous labor: vaginal delivery that was not induced and there were no associated medical or obstetric factors or major congenital anomalies.

Category 5: no recorded indication

Births without any of the indication categories noted above

TABLE 2

Neonatal and Infant Mortality Rates for Singleton Births 34 to 41 Weeks of Gestation

GA, wk	Total	Neonatal Mortality: Neonatal Deaths per 1000 Births			Infant Mortality: Infant Deaths per 1000 Births		
		Count	Rate	RR (95% CI)	Count	Rate	RR (95% CI)
34	50 717	359	7.1	9.5 (8.4–10.8)[a]	599	11.8	5.4 (4.9–5.9)[a]
35	85 218	405	4.8	6.4 (5.6–7.2)[a]	732	8.6	3.9 (3.6–4.3)[a]
36	156 692	437	2.8	3.7 (3.3–4.2)[a]	890	5.7	2.6 (2.4–2.8)[a]
37	320 169	546	1.7	2.3 (2.1–2.6)[a]	1323	4.1	1.9 (1.8–2.0)[a]
38	674 892	700	1.0	1.4 (1.3–1.5)[a]	1842	2.7	1.2 (1.2–1.3)[a]
39	966 281	721	0.8	1.00 (reference)	2118	2.2	1.00 (reference)
40	821 934	625	0.8	1.0 (0.9–1.1)	1704	2.1	0.9 (0.9–1.0)
41	407 593	326	0.8	1.1 (0.9–1.2)	888	2.2	1.1 (1.0–1.1)

GA indicates gestational age; RR, relative risk; CI, confidence interval

[a] $P < .001$ when compared with the reference group of 39-week deliveries.

TABLE 3

Indications for Singleton Late-Preterm Births

Week	Total	Medical Indications[a]		Obstetric Indications[a]		Congenital Anomaly[a]		Isolated Spontaneous labor		Total Indicated		No Recorded Indication	
		N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
34	50 717	7650	15.08	10 443	20.59	790	1.56	23 005	45.36	39 485	77.85	11 232	22.15
35	85 218	12 330	14.47	14 440	16.94	1135	1.33	41 246	48.40	65 945	77.38	19 273	22.62
36	156 692	22 056	14.08	21 566	13.76	1772	1.13	78 836	50.31	119 288	76.13	37 404	23.87
Total	292 627	42 036	14.37	46 449	15.87	3697	1.26	143 087	48.90	224 718	76.79	67 909	23.21

[a]These categories are not mutually exclusive; the same patient may be represented in >1 category.

TABLE 4

Factors Associated With Singleton Late-Preterm Deliveries With No Recorded Indication

Variable	Frequency, %		Univariate Odds Ratio (95% CI)[a]	Adjusted Odds Ratio (95% CI) [b]
	Indicated	No Recorded Indication		
Maternal age, y				
<20	14.60	10.73	0.56 (0.53–0.59)	0.65 (0.61–0.69)
20–24	27.00	24.30	0.69 (0.65–0.72)	0.71 (0.67–0.74)
25–29	24.31	25.10	0.79 (0.75–0.83)	0.78 (0.74–0.82)
30–34	20.66	22.99	0.85 (0.81–0.89)	0.84 (0.80–0.88)
35–39	10.71	13.30	0.95 (0.90–1.00)	0.93 (0.88–1.0)
≥40	2.73	3.57	1.00	—
Maternal race/ethnicity				
Non-Hispanic white	51.40	54.42	1.00	—
Non-Hispanic black	20.53	18.88	0.87 (0.85–0.89)	0.91 (0.88–0.93)
Hispanic	21.66	21.41	0.93 (0.91–0.95)	1.01 (0.99–1.04)
Other	5.86	4.83	0.78 (0.75–0.81)	0.81 (0.77–0.84)
Maternal education, y				
<12	26.10	22.83	0.81 (0.79–0.83)	0.94 (0.92–0.97)
12	32.85	33.24	0.94 (0.92–0.96)	1.01 (0.99–1.03)
≥13	39.54	42.70	1.00	—
Region of occurrence				
Northeast	15.97	13.05	1.00	—
Midwest	21.70	20.98	1.18 (1.15–1.22)	1.20 (1.16–1.23)
South	40.20	44.74	1.36 (1.33–1.40)	1.40 (1.36–1.44)
West	22.13	21.23	1.17 (1.14–1.21)	1.18 (1.14–1.22)
Parity				
Primipara	41.06	35.10	0.78 (0.76–0.79)	0.80 (0.78–0.82)
Multipara	58.61	64.52	1.00	—
Previous ≥4000-g infant				
Reported	0.61	0.80	1.33 (1.20–1.47)	1.18 (1.06–1.31)
Not reported	98.63	97.72	1.00	—
Previous preterm or SGA infant				
Reported	3.28	2.39	0.73 (0.69–0.77)	0.66 (0.63–0.70)
Not reported	95.96	96.14	1.00	—

SGA indicates small for gestational age.

[a] Data show the odds ratio for delivery with no recorded indication (95% confidence interval).

[b] Data show the odds ratio adjusted for all of the variables in the table.

TABLE 5

Neonatal and Infant Mortality Rates According to Indication for Singleton Late-Preterm Births

Variable	Total *N*	Neonatal Mortality (Neonatal Deaths per 1000 Live Births)			Infant Mortality (Infant Deaths per 1000 Live Births)		
		Count	Rate	RR (95% CI)	Count	Rate	RR (95% CI)
No recorded indication	67 909	222	3.3	Reference	459	6.8	Reference
Medical	42 036	159	3.8	1.2 (0.9–1.4)	295	7.0	1.0 (0.9–1.2)
Obstetric	46 449	407	8.8	2.7 (2.3–3.2)[a]	616	13.3	2.0 (1.7–2.2)[a]
Major anomaly	3697	399	107.9	33.0 (28.1–38.8)[a]	520	140.7	20.8 (18.4–23.5)[a]
Isolated spontaneous labor	143 087	268	1.9	0.6 (0.5–0.7)[a]	680	4.8	0.7 (0.6–0.8)[a]

CI indicates confidence interval; RR, relative risk.

[a] $P < 0.001$ when compared with the reference group of deliveries with no recorded indication.