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The Consortium on Safe Labor

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Context Late preterm births (34⁰⁄₇-36⁶⁄₇ weeks) account for an increasing proportion of prematurity-associated short-term morbidities, particularly respiratory, that require specialized care and prolonged neonatal hospital stays.

Objective To assess short-term respiratory morbidity in late preterm births compared with term births in a contemporary cohort of deliveries in the United States.

Design, Setting, and Participants Retrospective collection of electronic data from 12 institutions (19 hospitals) across the United States on 233 844 deliveries between 2002 and 2008. Charts were abstracted for all neonates with respiratory compromise admitted to a neonatal intensive care unit (NICU), and late preterm births were compared with term births in regard to resuscitation, respiratory support, and respiratory diagnoses. A multivariate logistic regression analysis compared infants at each gestational week, controlling for factors that influence respiratory outcomes.

Main Outcome Measures Respiratory distress syndrome, transient tachypnea of the newborn, pneumonia, respiratory failure, and standard and oscillatory ventilator support.

Results Of 19 334 late preterm births, 7055 (36.5%) were admitted to a NICU and 2032 had respiratory compromise. Of 165 993 term infants, 11 980 (7.2%) were admitted to a NICU, 1874 with respiratory morbidity. The incidence of respiratory distress syndrome was 10.5% (390/3700) for infants born at 34 weeks' gestation vs 0.3% (140/41 764) at 38 weeks. Similarly, incidence of transient tachypnea of the newborn was 6.4% (n=236) for those born at 34 weeks vs 0.4% (n=155) at 38 weeks, pneumonia was 1.5% (n=55) vs 0.1% (n=62), and respiratory failure was 1.6% (n=61) vs 0.2% (n=63). Standard and oscillatory ventilator support had similar patterns. Odds of respiratory distress syndrome decreased with each advancing week of gestation until 38 weeks compared with 39 to 40 weeks (adjusted odds ratio [OR] at 34 weeks, 40.1; 95% confidence interval [CI], 32.0-50.3 and at 38 weeks, 1.1; 95% CI, 0.9-1.4). At 37 weeks, odds of respiratory distress syndrome were greater than at 39 to 40 weeks (adjusted OR, 3.1; 95% CI, 2.5-3.7), but the odds at 38 weeks did not differ from 39 to 40 weeks. Similar patterns were noted for transient tachypnea of the newborn (adjusted OR at 34 weeks, 14.7; 95% CI, 11.7-18.4 and at 38 weeks, 1.0; 95% CI, 0.8-1.2), pneumonia (adjusted OR at 34 weeks, 7.6; 95% CI, 5.2-11.2 and at 38 weeks, 0.9; 95% CI, 0.6-1.2), and respiratory failure (adjusted OR at 34 weeks, 10.5; 95% CI, 6.9-16.1 and at 38 weeks, 1.4; 95% CI, 1.0-1.9).

Conclusion In a contemporary cohort, late preterm birth, compared with term delivery, was associated with increased risk of respiratory distress syndrome and other respiratory morbidity.

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Late preterm birth (34⁰⁄₇ to 36⁶⁄₇ weeks' gestation) accounts for 9.1% of all deliveries and three-quarters of all preterm births[1] in the United States and has been the focus of multiple investigations as well as a workshop in 2005.[2] Considerable evidence and expert opinion suggest that short-term morbidities are prevalent[2-5] and that the neonatal mortality rate is higher compared with those born at term.[6]

However, much of the supporting data for these conclusions are derived from studies that are more than a decade old, are from outside the United States, or used administrative data such as birth certificate or *International Classification of Diseases, Ninth Revision* code data, and many were drawn from small populations. For example, Wang et al[3] studied neonates born at 35 to 36⁶⁄₇ weeks and found that a statistically higher proportion had respiratory distress syndrome (RDS) and clinical problems compared with term neonates. However, this case-control study included only 120 late preterm birth neonates. Rubaltelli et al[4] documented a 30.8% incidence of respiratory problems in neonates born at 34 to 36 weeks compared with less than 1% at term but also noted in another survey an incidence of respiratory problems of only 3% in late preterm birth.[5] Both surveys were performed 14 to 15 years ago in Italy.

Given advances in obstetric and neonatal care over the last 20 years, we hypothesized that many published rates of morbidity may overestimate the clinical burden attributable to late preterm birth. We were interested in whether high rates of respiratory morbidity would be verified after careful chart review, controlling for possible confounding factors in a large cohort of late preterm infants. Thus, the purpose of this

Consortium on Safe Labor members and their author affiliations are listed at the end of this article.

Corresponding Author: Judith U. Hibbard, MD, Department of Obstetrics and Gynecology, University of Illinois at Chicago, 820 S Wood St, M/C 808, Chicago, IL 60612 (jhibbar@uic.edu).

investigation was to evaluate short-term neonatal respiratory morbidity in late preterm compared with term neonates in a recent large, nationwide cohort of deliveries in the United States using data collected from electronic medical records.

METHODS

The Consortium on Safe Labor was composed of 12 clinical centers (19 hospitals) representing 9 (of 10) American Congress of Obstetricians and Gynecologists districts, designed to reflect all geographic areas of the country. All authors contributed data from electronic medical records to a validated comprehensive database. More detailed information regarding the Consortium on Safe Labor has been published.[7] Centers were urban and included university, tertiary, and community hospitals.

Extensive information from deliveries between 2002 and 2008 was included; however, 87% of the births occurred between 2005 and 2007, reflecting when individual institutions initiated their electronic medical record systems. Data from earlier years were as complete and accurate as data from later years. Data collected included demographics, prenatal complications, labor and delivery information, maternal obstetric and neonatal outcomes, and data from neonatal intensive care units (NICUs) until discharge of the infant or death. In this study, a NICU was defined to include level 2 (intermediate or step-down) nurseries. Thus, any infant requiring more than a regular nursery was included, ensuring capture of all infants with respiratory compromise in our cohort. All participating centers had approval for the study and waiver of informed consent by study participants from their individual institutional review boards.

Late preterm birth was defined as delivery between 34$^{0}/_{7}$ and 36$^{6}/_{7}$ weeks' gestational age, while term birth was defined as 37$^{0}/_{7}$ to 40$^{6}/_{7}$ weeks' gestational age. Gestational age was determined by best obstetric estimate, in most cases by last menstrual period with confirmatory sonogram. In cases for which last menstrual period was unknown, dating was assigned by earliest sonogram. Maternal data of interest included demographics, order of pregnancy, substance abuse, maternal medical and obstetrical complications, and labor and delivery details. Pertinent neonatal data included birth weight, sex, Apgar score, admission to NICU, length of NICU stay, and neonatal mortality. The race/ethnicity of individuals at each institution was determined by report of the mother on initiation of care. Small for gestational age was defined as birth weight less than the 10th percentile.[8] Anomalies were categorically coded if present but not further defined.

Live-born neonates at 34$^{0}/_{7}$ to 40$^{6}/_{7}$ weeks' gestational age who required delivery room intervention with either oxygen or ventilation and admission to a NICU for further respiratory support were identified for inclusion in the study. A detailed chart review was performed, including data extraction on paper forms for information not available in the overall database, and data were entered into electronic format via desktop computer. For quality assurance, the overall electronic database was compared with chart review data for 3 variables; information was highly consistent (97.3%-99.7%). Charts of infants admitted for reasons other than respiratory compromise were not reviewed.

Delivery room variables collected included administration of oxygen, bag and mask oxygenation, intubation, presence of meconium, and need for chest compressions. Respiratory support in the NICU included oxygen delivery by enhanced ambient oxygen (eg, "blow by") or by nasal cannulae; use of continuous positive airway pressure, biphasic positive airway pressure, or noninvasive positive pressure; surfactant administration; and endotracheal ventilation. For the latter, the type and duration of ventilation were obtained.

Clinical definitions for respiratory disorders were determined as documented in the medical record by NICU clinicians. Respiratory distress syndrome/hyaline membrane disease was typically defined as respiratory symptoms (eg, grunting, flaring, tachypnea, retractions), supplemental oxygen requirement, and NICU admission for further respiratory support, with the diagnosis verified by chest radiograph findings of reticulogranular patterns and air bronchograms. Mild, moderate, or severe RDS/hyaline membrane disease was determined by chest radiograph impression and clinical diagnosis assigned by the NICU clinician. Other outcomes included transient tachypnea of the newborn, pneumonia with chest radiograph verification, persistent apnea and bradycardia, pulmonary hypertension, pneumothorax, meconium aspiration, pulmonary hypoplasia, and respiratory failure.

Only the first delivery from each participant that was reported in the electronic database was included to avoid intraperson correlation. Continuous variables were compared using the *t* test. Univariate comparisons for categorical variables were performed using χ^2 or 2-sided Cochran-Armitage trend tests where appropriate. A multivariate logistic regression model was developed to examine infant respiratory morbidities across gestational ages controlling for hospital, onset of labor, mode of delivery, number of fetuses, race, maternal body mass index at delivery, infant birth weight and sex, presence of anomalies, and maternal medical disorders including chronic hypertension, pregnancy-related hypertension (defined as preeclampsia, eclampsia, gestational hypertension, or chronic hypertension with superimposed preeclampsia), preexisting diabetes, gestational diabetes, heart, renal, or gastrointestinal diseases, seizure disorder, asthma, and substance abuse.[9-11] Body mass index was included in the model because of the increased risk among women with higher body mass index to have medical conditions or undergo cesarean delivery, which may affect the respiratory outcome of the neonate.[12] Maternal medical conditions were included in the model because they have been demonstrated to contribute to morbidity in late preterm birth as well as need for early delivery.[13]

Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) comparing respiratory outcomes for infants at each gestational week less than 39 weeks with those born at 39⁰⁄₇ to 40⁶⁄₇ weeks were estimated from the logistic models. Infants born at 39 to 40 weeks' gestational age were used as the reference population because they had the lowest rates of morbidity and mortality on univariate analysis. To exclude bias, multivariate logistic regression analyses were repeated for deliveries between 2005 and 2007. The incidences of most outcomes were less than 10%; thus, the OR can approximate the risk ratio or relative risk in the current study.[14] The study has 92.6% power to detect a difference in rates of RDS in infants delivered between 35 to 36 weeks and 39 to 40 weeks if the rate in the 35- to 36-week group exceeds that in the 39- to 40-week group by 50% (morbidities with a higher rate in term infants have even higher power). Two-sided significance was set at $P<.05$, and SAS version 9.1 (SAS Institute Inc, Cary, North Carolina) was used for all analyses.

RESULTS

From 2002 through 2008, a total of 228 668 women delivered 233 844 infants at the 12 centers, of which 21 367 were late preterm births (9.1%) and 183 790 were term infants (78.6%). After selecting the first delivery from each mother, 19 334 late preterm and 165 993 term neonates were included in the analysis. TABLE 1 illustrates maternal demographic data for late preterm compared with term deliveries. Women delivering late preterm had significantly more medical complications in all categories, including chronic hypertension (late preterm, 7.2% [n=1255/17 474] vs term, 2.3% [n=3803/164 589]), pregnancy-related hypertension (15.8% [n=2767] vs 5.2% [n=8542]), preexisting diabetes (5.0% [n=852] vs 1.8% [n=2921]), and renal disease (1.2% [n=211] vs 0.6% [n=1022]).

TABLE 2 shows neonatal demographics for late preterm vs term deliveries. Overall, late preterm neonates were more frequently small for gestational age (late preterm, 20.2% [n=3910] vs term, 10.9% [n=18 155]), male (52.4% [n=10 081] vs 50.9% [n=84 327]), and had an anomaly (10.0% [n=1933] vs 5.9% [n=9866]).

Among late preterm infants, 36.5% (n=7055/19 334) were admitted to the NICU compared with 7.2% (n=11 980/165 993) of term infants (TABLE 3). Overall, 4701 infants were admitted to the NICU with respiratory compro-

Table 1. Maternal Characteristics[a]

Characteristics	Late Preterm Births (34-36 wk) (n=17 474)	Term Births (37-40 wk) (n=164 589)
Age, y[b]		
Mean (SD)	27.8 (6.5)	27.7 (6.2)
Median (IQR)	27 (23-33)	27 (23-32)
Gravidity[c]		
Mean (SD)	2.8 (2.0)	2.6 (1.8)
Median (IQR)	2 (1-4)	2 (1-3)
Parity[c]		
Mean (SD)	1.1 (1.4)	1.1 (1.3)
Median (IQR)	1 (0-2)	1 (0-2)
Race/ethnicity[c]		
White	8032 (46.0)	83 779 (50.9)
African American	4878 (27.9)	34 469 (20.9)
Hispanic	2949 (16.9)	28 117 (17.1)
Asian	570 (3.3)	7228 (4.4)
Other	1045 (6.0)	10 996 (6.7)
BMI ≥30[c,d]	6835 (39.1)	61 987 (37.7)
Smoker[c]	1590 (9.1)	10 246 (6.2)
Alcohol use[c]	374 (2.1)	2930 (1.8)
Illicit drug use[c]	576 (3.6)	2545 (1.7)
Order of pregnancy[c]		
Singleton	15 661 (89.6)	163 144 (99.1)
Twins	1751 (10.0)	1431 (0.9)
Triplets	62 (0.4)	14 (0.0)
Onset of labor[c]		
Spontaneous	12 364 (70.8)	107 524 (65.3)
Induced	5110 (29.2)	57 065 (34.7)
Mode of delivery[c]		
Vaginal, spontaneous	10 143 (58.0)	111 190 (67.6)
Vaginal, operative	632 (3.6)	8649 (5.3)
Intrapartum cesarean	2619 (15.0)	20 608 (12.5)
Prelabor cesarean	4080 (23.3)	24 142 (14.7)
Medical disorders		
Chronic hypertension[c]	1255 (7.2)	3803 (2.3)
Pregnancy-related hypertension[c]	2767 (15.8)	8542 (5.2)
Preexisting diabetes[c]	852 (5.0)	2921 (1.8)
Gestational diabetes[c]	863 (5.5)	5750 (4.0)
Heart disease[c]	181 (1.1)	1123 (0.7)
Renal disease[c]	211 (1.2)	1022 (0.6)
Gastrointestinal[c]	243 (1.5)	1521 (1.0)
Seizure disorder[c]	172 (1.1)	1020 (0.7)
Asthma[c]	1430 (8.5)	10 573 (6.7)

Abbreviation: IQR, interquartile range.
[a] Data are expressed as No. (%) of mothers unless otherwise specified.
[b] $P=.002$ using χ^2 or t test as appropriate.
[c] $P<.001$ using χ^2 or t test as appropriate.
[d] Body mass index (BMI) is calculated as weight in kilograms divided by height in meters squared.

Table 2. Neonatal Characteristics[a]

Characteristics[b]	Late Preterm Births (34-36 wk) (n = 19 334)	Term Births (37-40 wk) (n = 165 993)
Gestational age, mean (SD), wk	35.6 (0.8)	39.0 (1.0)
Birth weight, mean (SD), g	2612.9 (483.7)	3334.4 (452.4)
Small for gestational age (<10th percentile)	3910 (20.2)	18 155 (10.9)
Apgar score <7 at 5 min	541 (2.8)	1318 (0.8)
Resuscitation in delivery room	5412 (28.0)	36 478 (22.0)
Sex		
Female	9165 (47.6)	81 416 (49.1)
Male	10 081 (52.4)	84 327 (50.9)
Had an anomaly	1933 (10.0)	9866 (5.9)

[a]Data are expressed as No. (%) of neonates unless otherwise specified.
[b]For all characteristics, $P<.001$ using χ^2 or t test as appropriate.

mise. Sixty charts randomly distributed among centers were not available for review. A total of 4641 charts were reviewed and extracted in detail; 3906 infants (20.5% of all NICU admissions) met criteria and were included in the analysis.

Infants delivered at 34 weeks required more oxygen supplementation (8.3% [n=307/3700]), delivery of oxygen by bag and mask (4.0% [n=148]), intubation (2.9% [n=107]), and chest compressions (0.2% [n=9]) in the delivery room than infants born at each successive week of gestational age until 39 weeks (oxygen supplementation, 0.30% [n=184/62 295]; bag and mask, 0.12% [n=77]; intubation, 0.10% [n=60]; and chest compressions, 0.03% [n=20]) (Table 3). With the exception of intubation for meconium, level of resuscitation required in the delivery room and NICU respiratory support decreased significantly with each advancing gestational week until 39 weeks ($P<.001$ for all).

Respiratory distress syndrome/hyaline membrane disease was the most common respiratory morbidity, occurring in 10.5% (n=390) of 34-week deliveries, decreasing with gestational age to 0.3% (n=118/41 465) at 40 weeks (Table 3). Transient tachypnea of the newborn was the second most common morbidity at 6.4% (n=236) at 34 weeks, reaching a low of 0.3% (n=207/62 295) at 39 weeks. Also decreasing from 34 weeks were pneumonia, from 1.5% (n=55) to 0.1% (n=86) at 39 weeks; persistent apnea and bradycardia, from 1.6% (n=58) to 0.02% (n=8) at 40 weeks; pulmonary hypertension, from 0.5% (n=19) to 0.06% (n=35) at 39 weeks; pneumothorax, from 0.8% (n=29) to 0.07% (n=44) at 39 weeks; and overall respiratory failure, from 1.6% (n=61) to 0.09% (n=38) at 40 weeks. Although these diagnoses were not mutually exclusive, the percentage of infants with each diagnosis decreased significantly as gestational age increased until 39 weeks ($P<.001$ for all), with the exception of meconium aspiration, which increased (0 at 34 weeks to 0.2% [n=79] at 40 weeks).

A multivariate logistic regression model was developed to compare morbidities across gestational ages while controlling for potentially confounding factors. The adjusted ORs all decreased from 34 to 38 weeks' gestation for RDS (adjusted OR, 40.1; 95% CI, 32.0-50.3 at 34 weeks to 1.1; 95% CI, 0.9-1.4 at 38 weeks), transient tachypnea of the newborn (adjusted OR, 14.7; 95% CI, 11.7-18.4 to 1.0; 95% CI, 0.8-1.2), pneumonia (adjusted OR, 7.6; 95% CI, 5.2-11.2 to 0.9; 95% CI, 0.6-1.2), and respiratory failure (adjusted OR, 10.5; 95% CI, 6.9-16.1 to 1.4; 95% CI, 1.0-1.9) (TABLE 4). Surfactant administration decreased from 7.4% to 0.2% (adjusted OR, 58.5; 95% CI, 44.1-77.6 to 1.1; 95% CI, 0.8-1.4), standard ventilatory support from 6.6% to 0.5% (adjusted OR, 13.9; 95% CI, 11.0-17.6 to 1.2; 95% CI, 1.0-1.5), and oscillatory ventilator support from 2.8% to 0.1% (adjusted OR, 18.8; 95% CI, 12.6-28.1 to 0.9; 95% CI, 0.6-1.3).

When the analysis was restricted to deliveries in 2005 through 2007, minimal changes were noted, confirming no bias due to year of birth. While all selected morbidities decreased inversely and significantly through gestational week 37 in comparison with weeks 39 and 40, at 38 weeks none of the morbidities were significantly increased compared with neonates born at 39 and 40 gestational weeks.

COMMENT

This large, representative US population of gravid women with data from validated medical records had late preterm birth rates virtually identical to those reported by the Centers for Disease Control and Prevention[1] from administrative data (9.14% and 9.1%, respectively). To our knowledge, this is the largest investigation to date of respiratory morbidity in late preterm birth using recent medical record data and controlling for multiple factors. Our findings reflect current management, including surfactant treatment. While morbidity in the late preterm period is clearly increased compared with at term, the magnitude of problems is less than that documented in a number of previous reports.[3,5] Our descriptive data are unique in providing insight into delivery room resuscitation requirements at each gestational age, as well as details of requisite NICU respiratory support compared with infants at term. Unlike many previous investigations, ours used a multivariate logistic regression model to control for a number of factors that influence neonatal respiratory outcomes, including maternal medical conditions,[13] labor and mode of delivery,[9-11] and birth weight.

We found that for neonates born at 34 weeks, the odds of RDS were increased 40-fold and that risk decreased with each advancing week of gestation until 38 weeks. Even at 37 weeks, the odds of RDS were still 3-fold greater than that of a 39- or 40-week birth. Similar patterns were seen for transient tachypnea of the newborn, pneumonia, standard or high-frequency ventilator requirements, and respiratory failure. In multivariate logistic regression analysis, there was no difference in respiratory morbidity in 38-week vs 39- to 40-week infants.

We did not collect information on reasons for NICU admission other than for respiratory compromise, but it may be that a large percentage of late preterm births were admitted as a precaution for more intense observation and evaluation as recommended by the American Academy of Pediatrics.[15] Also, we did not assess additional morbidity such as sepsis and necrotizing enterocolitis.[9]

It has been suggested that obstetricians, with pressure for early inductions and cesarean deliveries, may too readily deliver late preterm infants, though others have documented that indications for late preterm births are justified.[16,17] A recent study noted that 23% of late preterm births occur with no recorded indication on the birth certificate.[18] Interestingly, women without a recorded indication for their late preterm deliveries were more likely to be older, white, and well educated, suggesting that patient-driven factors may play a role in late preterm birth.[18] Our

Table 3. Neonatal Resuscitation and Respiratory Morbidity[a]

	Gestational Age, wk						
	34 (n = 3700)	35 (n = 5477)	36 (n = 10 157)	37 (n = 20 469)	38 (n = 41 764)	39 (n = 62 295)	40 (n = 41 465)
Data based on NICU admission							
NICU admission	2492 (67.4)	2321 (42.4)	2242 (22.1)	2411 (11.8)	3002 (7.2)	3825 (6.1)	2742 (6.6)
Total reviewed	757 (20.5)	649 (11.9)	626 (6.2)	511 (2.5)	442 (1.1)	525 (0.8)	396 (1.0)
Mortality	29 (0.8)	21 (0.4)	29 (0.3)	36 (0.2)	35 (0.1)	21 (0.1)	17 (0.1)
Days in NICU, median (10th-90th percentile)	12.0 (3-24)	8.0 (2-19.1)	6.0 (2-17)	4.6 (1-16)	3.7 (1-12)	3.0 (1-10)	3.0 (1-9)
Data based on detailed NICU chart reviews							
Delivery room resuscitation							
Oxygen	307 (8.3)	266 (4.9)	252 (2.5)	176 (0.8)	135 (0.3)	184 (0.3)	136 (0.3)
Bag and mask oxygen	148 (4.0)	139 (2.5)	104 (1.0)	89 (0.4)	76 (0.2)	77 (0.1)	59 (0.1)
Intubation	107 (2.9)	84 (1.5)	83 (0.8)	67 (0.3)	62 (0.1)	60 (0.1)	45 (0.1)
Intubation for meconium	3 (0.1)	4 (0.1)	6 (0.1)	4 (0)	9 (0)	22 (0)	34 (0.1)
Chest compressions	9 (0.2)	7 (0.1)	10 (0.1)	12 (0.1)	14 (0)	20 (0)	18 (0)
NICU respiratory support							
Oxygen by nasal cannulae	357 (9.6)	354 (6.5)	340 (3.3)	238 (1.2)	190 (0.5)	235 (0.4)	169 (0.4)
Oxygen by isolette/blow-by	164 (4.4)	143 (2.6)	155 (1.5)	129 (0.6)	91 (0.2)	123 (0.2)	91 (0.2)
CPAP/BiPAP/noninvasive positive pressure	315 (8.5)	274 (5)	228 (2.2)	144 (0.7)	102 (0.2)	116 (0.2)	63 (0.2)
Ventilator	245 (6.6)	247 (4.5)	305 (3)	232 (1.1)	189 (0.5)	188 (0.3)	138 (0.3)
<24 h	111 (3)	118 (2.2)	124 (1.2)	73 (0.4)	72 (0.2)	72 (0.1)	60 (0.1)
24-48 h	46 (1.2)	62 (1.1)	72 (0.7)	58 (0.3)	44 (0.1)	27 (0)	17 (0)
>48 h	79 (2.1)	56 (1.0)	95 (0.9)	84 (0.4)	57 (0.1)	74 (0.1)	49 (0.1)
Oscillator	104 (2.8)	84 (1.5)	84 (0.8)	66 (0.3)	43 (0.1)	66 (0.1)	48 (0.1)
Surfactant administration	273 (7.4)	237 (4.3)	222 (2.2)	149 (0.7)	68 (0.2)	101 (0.2)	60 (0.1)
Respiratory morbidity							
RDS/HMD							
Total	390 (10.5)	329 (6.0)	283 (2.8)	204 (1.0)	140 (0.3)	185 (0.3)	118 (0.3)
Mild	317 (8.6)	285 (5.2)	242 (2.4)	178 (0.9)	125 (0.3)	168 (0.3)	103 (0.2)
Moderate	56 (1.5)	38 (0.7)	36 (0.4)	23 (0.1)	11 (0)	13 (0)	10 (0)
Severe	17 (0.5)	6 (0.1)	5 (0)	3 (0)	4 (0)	4 (0)	5 (0)
Radiography-verified cases	325 (83.3)	292 (88.6)	249 (88.0)	178 (87.3)	84 (60.0)	127 (68.6)	66 (55.9)
Transient tachypnea	236 (6.4)	252 (4.6)	251 (2.5)	206 (1)	155 (0.4)	207 (0.3)	159 (0.4)
Pneumonia							
Radiography-verified cases	55 (1.5)	65 (1.2)	65 (0.6)	59 (0.3)	62 (0.1)	86 (0.1)	83 (0.2)
Apnea and bradycardia	58 (1.6)	24 (0.4)	21 (0.2)	16 (0.1)	14 (0)	14 (0)	8 (0)
Pulmonary hypertension	19 (0.5)	16 (0.3)	46 (0.5)	32 (0.2)	35 (0.1)	35 (0.1)	45 (0.1)
Pneumothorax	29 (0.8)	37 (0.7)	64 (0.6)	51 (0.2)	34 (0.1)	44 (0.1)	30 (0.1)
Meconium aspiration	0	4 (0.1)	9 (0.1)	11 (0.1)	31 (0.1)	54 (0.1)	79 (0.2)
Pulmonary hypoplasia	6 (0.2)	2 (0)	3 (0)	4 (0)	5 (0)	0	3 (0)
Respiratory failure	61 (1.6)	41 (0.7)	81 (0.8)	65 (0.3)	63 (0.2)	62 (0.1)	38 (0.1)

Abbreviations: BiPAP, biphasic positive airway pressure; CPAP, continuous positive airway pressure; NICU, neonatal intensive care unit; RDS/HMD, respiratory distress syndrome/hyaline membrane disease.

[a] Data are expressed as No. (%) of births unless otherwise specified. *P* value for trend 2-sided Cochran-Armitage trend test, $P<.001$ across all weeks until 39 weeks except $P=.17$ for intubation for meconium.

Table 4. Multivariate Logistic Regression Comparing Morbidities Across Gestational Ages

	Adjusted Odds Ratio (95% Confidence Interval)[a]						
Gestational Age, wk	RDS/HMD	Transient Tachypnea of the Newborn	Pneumonia	Respiratory Failure	Surfactant	Ventilator	Oscillator
39-40	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
38	1.1 (0.9-1.4)	1.0 (0.8-1.2)	0.9 (0.6-1.2)	1.4 (1.0-1.9)	1.1 (0.8-1.4)	1.2 (1.0-1.5)	0.9 (0.6-1.3)
37	3.1 (2.5-3.7)	2.5 (2.1-3.0)	1.7 (1.3-2.4)	2.8 (2.0-3.9)	4.8 (3.8-6.1)	2.8 (2.3-3.4)	2.8 (2.0-3.9)
36	9.1 (7.5-11.1)	6.1 (5.1-7.4)	3.6 (2.6-4.9)	6.2 (4.4-8.6)	16.1 (12.7-20.4)	7.3 (6.0-8.8)	7.1 (5.1-9.9)
35	21.9 (17.8-26.9)	11.1 (9.1-13.6)	6.6 (4.7-9.3)	4.9 (3.2-7.6)	35.2 (27.1-45.6)	9.8 (7.9-12.1)	12.3 (8.5-17.7)
34	40.1 (32.0-50.3)	14.7 (11.7-18.4)	7.6 (5.2-11.2)	10.5 (6.9-16.1)	58.5 (44.1-77.6)	13.9 (11.0-17.6)	18.8 (12.6-28.1)

Abbreviation: RDS/HMD, respiratory distress syndrome/hyaline membrane disease.
[a] Adjusted for onset of labor, mode of delivery, number of fetuses, medical disorders, substance abuse, race, body mass index at delivery, birth weight, sex, anomalous infants, and hospital.

data from a large, well-documented cohort may be beneficial to obstetricians in counseling women who have a need for early delivery, as well as in discouraging those without indications from requesting early inductions or planned cesarean deliveries. These results may further assist obstetricians in ensuring that the proper level of neonatal support is available in the delivery room and nursery. The results of our study support the recommendation that every effort should be made to delay delivery of infants until at least 38 weeks' gestational age to decrease respiratory morbidity.

Using well-collected data on neonatal morbidity through electronic medical records and chart review, we noted that respiratory distress was present in 5.2% of neonates delivered at 34 to 36 weeks. This rate differs from that of other studies in which the rates of respiratory distress were as high as 28.9%. Our findings are more in line with those of Melamed et al,[19] who recently described a 4.2% rate of RDS in an Israeli case-control study of late preterm births. Overall, respiratory morbidities occurred in 9% of our late preterm birth cohort, far less than the 30.8% noted by Rubaltelli et al[5] but quite similar to a second report by the same investigator,[4] as well as that noted in a low-risk military population.[20] At 37 weeks' gestation, our rate of RDS was still 1.0%, twice as high as that reported by Cheng et al,[21] and need for ventilator assistance was similarly high in our cohort. However, these rates represent a 3-fold increase in the odds of RDS and ventilator use for infants born at 37 weeks' gestational age compared with those born at 39 to 40 weeks, consistent with adjusted odds reported by Cheng et al.[21]

The strengths of the current report include that data are from 2002 through 2008, with the majority of deliveries from 2005 through 2007, and are derived from 19 academic and community hospitals across the United States. Also, our data are comprehensive in that they include all pregnant women, whether at low or high risk. Our database is composed of electronic medical records from multiple centers, allowing for decreased chance of error in extracting general information regarding pregnancies, deliveries, and outcomes. The data regarding neonatal resuscitation and management in the NICU are reliable in that they were obtained from comprehensive chart reviews by trained extractors for every neonate admitted to the NICU with respiratory problems, thus ensuring that respiratory data are nearly complete. Only 1% of charts were unavailable, randomly distributed among the 12 clinical centers, decreasing the chance that data were biased. Finally, it is likely that mothers were receiving more up-to-date obstetric care than in cohorts reported from the 1990s, including group B streptococci screening and prophylaxis, administration of antenatal steroids when indicated, and higher probability of dating by sonography. Detailing the elements of prenatal care was beyond the scope of this investigation, but more modern obstetric care might account for some of the differences in morbidity compared with older reports.

Our retrospective design precludes collection of information not supplied in the electronic medical record or the NICU chart. For example, we would have liked to include information on the effect of administration of steroids for fetal lung maturity on neonates, but these data were not a discrete field collected in delivery medical records in a significant segment of our population. Overall, 38.0% of late preterm births and 34.6% of term births did not have information on whether mothers had received steroids previously at 24 to 34 weeks to improve fetal lung maturity. Finally, we were not able to corroborate gestational age determination for neonates included in this study; we depended on the clinicians' best estimates.

We suggest that future studies should focus on indications for late preterm birth. Only by more completely understanding reasons for rising rates of late preterm birth might clinicians be able to initiate salutary interventions to decrease neonatal respiratory morbidity. Improved pregnancy dating through early ultrasound confirmation of estimated due date may help prevent neonatal morbidity associated with erroneous delivery of a neonate that is actually at an earlier gestational age. Finally, a better understanding of the effect of mode of delivery on neonates may help with future interventions to decrease morbidity.

Author Contributions: Dr Zhang had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Hibbard, Wilkins, Gregory, Haberman, Hoffman, Kominiarek, Reddy, Bailit, Burkman, Ramirez, VanVeldhuisen, Zhang.

Acquisition of data: Hibbard, Wilkins, Gregory, Haberman, Hoffman, Kominiarek, Bailit, Branch, Burkman, Gonzalez-Quintero, Landy, VanVeldhuisen, Zhang.

Analysis and interpretation of data: Hibbard, Wilkins, Sun, Kominiarek, Reddy, Branch, Gonzalez-Quintero, Hatjis, Ramirez, Troendle, Zhang.

Drafting of the manuscript: Hibbard, Hoffman, Kominiarek, Reddy, Bailit, Gonzalez-Quintero.

Critical revision of the manuscript for important intellectual content: Hibbard, Wilkins, Sun, Gregory, Haberman, Kominiarek, Reddy, Bailit, Branch, Burkman, Gonzalez-Quintero, Hatjis, Landy, Ramirez, VanVeldhuisen, Troendle, Zhang.

Statistical analysis: Sun, Ramirez, Troendle, Zhang.

Obtained funding: Hibbard, Wilkins, Kominiarek, Gonzalez-Quintero, VanVeldhuisen, Zhang.

Administrative, technical, or material support: Hibbard, Wilkins, Haberman, Hoffman, Kominiarek, Reddy, Branch, VanVeldhuisen.

Study supervision: Zhang.

Consortium on Safe Labor Authors: Judith U. Hibbard, MD, Isabelle Wilkins, MD, University of Illinois at Chicago, Chicago; Liping Sun, MD, MS, Division of Epidemiology, Statistics and Prevention Research, National Institute of Child Health and Human Development, Bethesda, Maryland; Kimberly Gregory, MD, Cedars-Sinai Medical Center, Los Angeles, California; Shoshana Haberman, MD, Maimonides Medical Center, Brooklyn, New York; Matthew Hoffman, MD, Christiana Care Health System, Newark, Delaware; Michelle A. Kominiarek, MD, Indiana University Clarian Health, Indianapolis; Uma Reddy, MD, Division of Epidemiology, Statistics and Prevention Research and Pregnancy and Perinatology Branch, National Institute of Child Health and Human Development; Jennifer Bailit, MD, MetroHealth, Case Western Reserve University, Cleveland, Ohio; D. Ware Branch, MD, Intermountain Healthcare and University of Utah, Salt Lake City; Ronald Burkman, MD, Tufts University, Springfield, Massachusetts; Victor Hugo Gonzalez Quintero, MD, University of Miami, Miami, Florida; Christos G. Hatjis, MD, Summa Health System, Akron City Hospital, Akron, Ohio; Helain Landy, MD, Georgetown University Hospital, MedStar Health, Washington, DC; Mildred Ramirez, MD, University of Texas Health Science Center at Houston, Houston; Paul VanVeldhuisen, PhD, EMMES Corp, Rockville, Maryland; James Troendle, PhD, Jun Zhang, PhD, MD, Division of Epidemiology, Statistics and Prevention Research, National Institute of Child Health and Human Development.

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