Matern Child Health J (2016) 20:808–818
DOI 10.1007/s10995-015-1911-y

ORIGINAL PAPER

Hospital Utilization and Costs Among Preterm Infants by Payer: Nationwide Inpatient Sample, 2009

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Published online: 6 January 2016
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Abstract *Objectives* To describe hospital utilization and costs associated with preterm or low birth weight births (preterm/LBW) by payer prior to implementation of the Affordable Care Act and to identify areas for improvement in the quality of care received among preterm/LBW infants. *Methods* Hospital utilization—defined as mean length of stay (LOS, days), secondary diagnoses for birth hospitalizations, primary diagnoses for rehospitalizations, and transfer status—and costs were described among preterm/LBW infants using the 2009 Nationwide Inpatient Sample. *Results* Approximately 9.1 % of included hospitalizations (n = 4,167,900) were births among preterm/LBW infants; however, these birth hospitalizations accounted for 43.4 % of total costs. Rehospitalizations of all infants occurred at a rate of 5.9 % overall, but accounted for 22.6 % of total costs. This pattern was observed across all payer types. The prevalence of rehospitalizations was nearly twice as high among preterm/LBW infants covered by Medicaid (7.6 %) compared to commercially-insured infants (4.3 %). Neonatal transfers were more common among preterm/LBW infants whose deliveries and hospitalizations were covered by Medicaid (7.3 %) versus commercial insurance (6.5 %). Uninsured/self-pay preterm and LBW infants died in-hospital during the first year of life at a rate of 91 per 1000 discharges—nearly three times higher than preterm and LBW infants covered by either Medicaid (37 per 1000) or commercial insurance (32 per 1000). *Conclusions* When comparing preterm/LBW infants whose births were covered by Medicaid and commercial insurance, there were few differences in length of hospital stays and costs. However, opportunities for improvement within Medicaid and CHIP exist with regard to reducing rehospitalizations and neonatal transfers.

Keywords Preterm birth · Low birth weight · Insurance

Significance

Medicaid finances nearly half of all births and will likely cover an even larger proportion of births in the future as a result of the Affordable Care Act. We examined potential areas for improvement in neonatal outcomes among preterm or low birth weight (LBW) infants whose births were covered by Medicaid. While hospital costs and lengths of stay were similar among preterm/LBW infants whose births were covered by Medicaid and commercial insurance, rehospitalizations and neonatal transfers occurred more frequently among preterm/LBW infants covered by Medicaid. This suggests that Medicaid is uniquely positioned to impact neonatal morbidity and mortality through improvements in the delivery of risk-appropriate perinatal care.

Electronic supplementary material The online version of this article (doi:10.1007/s10995-015-1911-y) contains supplementary material, which is available to authorized users.

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Introduction

Preterm birth (<37 weeks gestation) and low birth weight (<2500 g) are associated with increased neonatal morbidity and mortality as well as pediatric disorders and lifelong chronic conditions [1]. These adverse birth outcomes often require longer hospital stays than term and normal birth weight infants, resulting in higher hospitalization and treatment costs [2, 4]. Despite the decline in preterm birth and low birth weight rates in the US since 2006 [3], findings from an analysis of population-based data indicated that the cost of care for preterm or low birth weight infants accounted for 47 % of the total cost of all births while only representing 8 % of all of the births [5].

The relationship between preterm birth and low birth weight and their associated costs also remains a major concern for health officials and policymakers. In the U.S., public insurance, primarily Medicaid, has borne a larger share of the costs associated with all births during the past decade. In 2011 it was estimated that Medicaid financed nearly half of all births [6]. Medicaid is likely to cover an even larger proportion of births in the near future because it is estimated that the Affordable Care Act will add 21.3 million beneficiaries to the Medicaid program by 2022 [7].

Improving neonatal outcomes, such as reducing the numbers of preterm births and low birth weight infants, has the potential to relieve some of the financial pressures associated with the expansion of Medicaid. The most recent multi-state evaluation of hospital utilization among preterm infants which also takes into account payer type is over 10 years old [5]. A clear understanding of current birth outcomes is critical in order to inform recommended approaches to assuring better outcomes in the future. Given this major policy shift and the changing national trends in preterm/LBW infants, a robust evaluation of recent data is warranted. The purpose of this analysis is threefold: (1) describe hospital utilization and costs associated with preterm birth and low birth weight prior to the implementation of the Affordable Care Act in 2014; (2) assess differences in hospital utilization and costs among preterm infants by insurer; (3) identify areas for improvement in the quality of care received among preterm/LBW infants who are Medicaid recipients.

Methods

Data Source and Sample

The 2009 Nationwide Inpatient Sample (NIS) includes data from 1000 hospitals, representing between 5 and 8 million hospital stays in any given year. It is the largest all-payer inpatient care database in the US. The 2009 NIS data were drawn from a stratified random sample of community hospitals from 44 state organizations participating in the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality [8]. Approximately 20 % of hospitals were sampled on the basis of five strata (geographic region, ownership type, location, teaching status, and bed size); all discharges from the selected hospitals were included in the sample. Community hospitals were defined as "all nonfederal, short-term, general and other specialty hospitals, excluding hospital units of institutions" by the American Hospital Association (AHA) [9].

Study Variables

Birth hospitalizations were identified as hospital discharges with a birth-related ICD-9-CM diagnosis code (see Appendix in electronic supplementary material) among infants 0–1 days old at the time of admission. NIS data do not allow for the analysis of preterm and low birth weight as distinct outcomes; therefore, birth hospitalizations among preterm or low birth weight infants (preterm/LBW) were classified using the following ICD-9-CM diagnosis codes: 764, 765, and V21.3. All other infant discharges with a birth-related ICD-9-CM code were classified as term and normal birth weight (NBW). Preterm/LBW infants were further categorized by birth weight based on ICD-9-CM codes: missing birth weight, <1500, 1500–2499, and ≥2500 g. Infant rehospitalizations were defined as discharges among infants between 2 and 28 days old at the time of admission without an associated birth-related diagnosis code.

Hospital utilization, defined as mean lengths of stay (LOS, in days), secondary diagnoses for birth hospitalizations, primary diagnoses for rehospitalizations, and transfer status (no transfer, transferred out, transferred in), was described among preterm/LBW infants. Secondary diagnoses of respiratory distress syndrome (RDS: ICD-9-CM code 769.0), bronchopulmonary dysplasia (BPD: ICD-9 code 770.7), intraventricular hemorrhage (IVH: ICD-9-CM codes 772.10–772.14), and necrotizing enterocolitis (NEC: ICD-9-CM codes 777.50–777.53) during the birth hospitalization were described among preterm and LBW infants due to their severity, high cost to treat, and frequent occurrence among preterm and LBW infants. Neonatal deaths were categorized as early (<7 days), late (7–28 days), or post-neonatal (≥28 days) based upon the American Academy of Pediatrics' definitions [9].

Costs associated with birth-related hospitalizations among preterm/LBW and NBW infants were estimated by multiplying charges by HCUP-provided, hospital-specific cost-to-charge ratios. Costs for rehospitalizations among preterm/LBW infants were estimated in a parallel manner.

Payment source, derived from the discharge files, was based upon the expected payer and was classified as Medicaid, commercial, or uninsured/self-pay.

Statistical Analysis

The number of discharges, mean LOS, and mean costs were reported along with 95 % confidence intervals (CI) for NBW and preterm/LBW birth hospitalizations and all infant rehospitalizations. The number of discharges per 1000 admissions, mean LOS, mean costs, and 95 % CIs were also reported for preterm/LBW birth hospitalizations by diagnoses of death, RDS, BPD, IVH, and NEC. Mean LOS, costs, and 95 % CIs associated with the most common primary diagnoses for rehospitalizations were also reported. Finally, the proportion of discharges, mean LOS, mean costs, and 95 % CIs were reported by transfer status.

All analyses were stratified by payer to allow for comparisons among Medicaid, commercial, and uninsured/self-pay. ANOVA, *t* test, and Chi-squared analyses were used to assess differences in reported indicators across payer categories. Findings from overall or global tests of significance (*p* values) are reported; *p* values of $p < 0.05$ indicated significant differences. When a significant difference was detected in the global test, pairwise comparisons (i.e., Medicaid vs. commercial, medicaid vs. uninsured/self-pay, commercial vs. uninsured/self-pay) were also tested for significance. All analyses were conducted using SAS Survey Procedures (Research Triangle Institute, Research Triangle Park, NC) to account for the complex survey sampling design. The Centers for Disease Control and Prevention (CDC) classified the project as research not involving human subjects because the administrative dataset does not include any personal identifying information.

Results

In 2009, there were just over 4 million births and rehospitalizations in this sample of US hospitals. About 48 % of these hospitalizations were covered by Medicaid, 47 % by commercial payers, and 5 % were uninsured or self-pay (Fig. 1). Preterm/LBW births were similarly distributed across payer type, where 51 % were covered by Medicaid, 45 % by commercial, and 4 % by self-pay. Total costs associated with infant birth hospitalizations and rehospitalizations were over $13 billion. Although 9.1 % of included hospitalizations were preterm/LBW births, these birth hospitalizations accounted for 43.4 % of total costs (Fig. 1). Similarly, although rehospitalizations only occurred at a rate of 5.9 % overall, they accounted for 22.6 % of total costs. This pattern was observed across all payer types.

Overall, mean LOS did not differ significantly by payer for term birth hospitalizations and rehospitalizations (Table 1). However, mean LOS was significantly shorter for preterm/LBW birth hospitalizations among the uninsured/self-pay (7.2, 95 % CI 6.3–8.1) compared to those paid by Medicaid (12.8, 95 % CI 12.1–13.5, $p < 0.0001$)

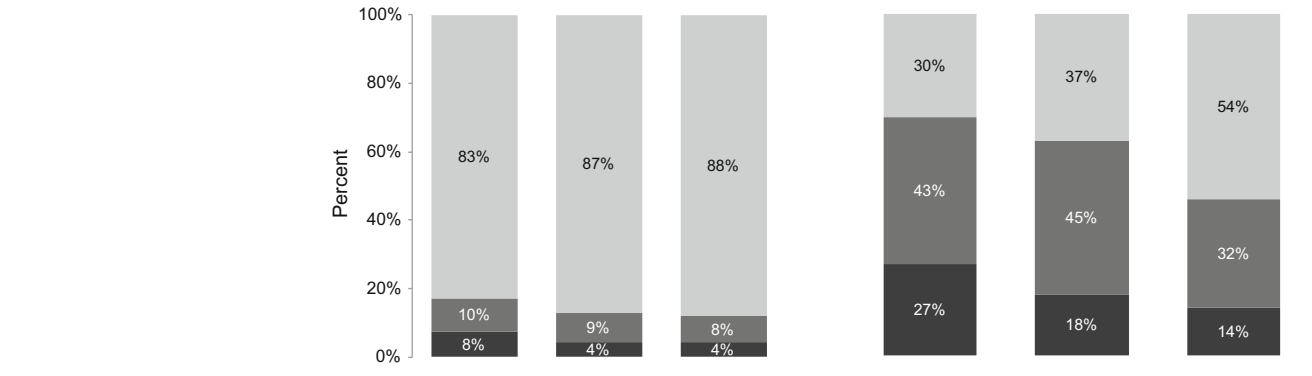

Fig. 1 Percentage of hospital discharges and total costs of hospital stays are presented by payer type (Medicaid, commercial, or uninsured/self-pay). Admission type is also presented within each payer group, where infant admission classification is either term and normal weight at birth, preterm/low weight at birth, or readmitted within the first 28 days of life. These hospitalizations were identified as hospital discharges with a birth-related ICD-9-CM diagnosis code among infants 0–1 days old at the time of admission (preterm/low weight classified based on codes 764, 765, and V21.3.; term/normal weight classified based on all other infant discharges with a birth-related ICD-9-CM code) or in the case of readmissions, discharges among infants between 2 and 28 days old at the time of admission without an associated birth-related diagnosis code

Table 1 Discharges, length of stay, costs for hospitalizations by payer type: Nationwide Inpatient Sample, 2009

Classification	N discharges (95 % CI)			Mean LOS (95 % CI)			*p*	Mean costs (95 % CI)			*p*
	Medicaid	Commercial	Self-pay	Medicaid	Commercial	Self-pay		Medicaid	Commercial	Self-pay	
Total hospitalizations	1,999,500 (1,842,100–2,156,800)	1,948,100 (1,746,400–2,149,700)	220,300 (168,500–272,000)	3.8 (3.6–3.9)	3.4 (3.2–3.5)	2.8 (2.6–2.9)	0.06	$3600 (3200–4000)	$3000 (2700–3300)	$1900 (1700–2100)	<0.001
Term and NBW births	1,655,100 (1,528,000–1,782,200)	1,693,900 (1,523,400–1,864,300)	193,900 (147,900–240,000)	2.4 (2.3–2.4)	2.4 (2.3–2.4)	2.3 (2.2–2.4)	0.97	$1300 (1200–1400)	$1300 (1200–1300)	$1200 (1100–1300)	0.77
Preterm/LBW births	193,000 (175,900–210,200)	169,600 (148,200–190,900)	17,000 (13,100–20,800)	12.8 (12.1–13.5)*	11.9 (11.0–12.8)	7.2 (6.3–8.1)	<0.001	$16,200 (14,900–17,500)*	$15,300 (13,800–16,900)	$8000 (6200–9800)	<0.001
<1500 g	28,200 (24,700–31,600)	20,600 (17,200–23,900)	1800 (1400–2200)	38.3 (36.0–40.6)*	39.4 (35.3–43.5)	15.9 (9.8–22.1)	<0.001	$57,000 (52,400–61,600)*	$61,100 (54,000–68,200)	$24,000 (11,800–36,100)	<0.001
1500–2499 g	99,300 (90,900–107,600)	81,800 (71,800–91,700)	8700 (6500–10,900)	10.9 (10.4–11.4)*	11.1 (10.5–11.7)	7.9 (7.3–8.5)	0.02	$12,300 (11,200–13,300)*	$12,600 (11,600–13,600)	$8200 (7200–9300)	0.01
>2500 g	64,800 (59,000–70,600)	66,800 (58,100–75,500)	6400 (5100–7700)	4.6 (4.4–4.8)	4.5 (4.3–4.7)	3.9 (3.6–4.2)	0.31	$4600 (4200–5100)*	$4500 (4100–5000)	$3300 (2800–3900)	0.03
No stated birth weight	780 (59,000–70,600)	460 (310–600)	50 (20–90)	11.0 (6.2–15.7)	10.5 (3.3–17.8)	1.7 (0.5–2.9)	0.06	$11,000 (6700–15,400)	$10,300 (4400–16,200)	$2600 (1000–4700)	0.07
Rehospitalizations	151,400 (116,900–185,900)	84,600 (69,300–100,000)	9400 (6900–11,800)	7.4 (6.3–8.6)	6.8 (5.7–7.8)	4.6 (3.9–5.2)	0.11	$12,800 (9500–16,100)	$12,400 (9500–15,300)	$6400 ($4800–$8000)	0.07

LOS length of stay, *NBW* normal birth weight, *LBW* low birth weight

Pairwise tests completed when global test of significance results in $p < 0.05$. Unless indicated, all pairwise comparisons are significant at $p < 0.001$ level

* $p \geq 0.05$ for Medicaid versus commercial insurance comparison

or commercial payers (11.9, 95 % CI 11.0–12.8, $p < 0.0001$). Differences were greatest among very low birth weight infants and low birth weight infants, regardless of gestational age. Similarly, overall mean costs did not differ by payer for term birth hospitalizations and rehospitalizations (Table 1). However, mean costs were lower among uninsured/self-pay preterm/LBW birth hospitalizations ($8000, 95 % CI 6200–9800) compared to those paid by Medicaid ($16,200, 95 % CI 14,900–17,500, $p < 0.0001$) or commercial payers ($15,300, 95 % CI 13,800–16,900, $p < 0.0001$). For both LOS and total costs, differences between uninsured/self-pay hospitalizations and other payers (Medicaid, commercial) were greatest among very low birth weight infants and low birth weight infants, regardless of gestational age.

Among preterm and LBW infants, the number of in-hospital infant deaths was higher among the uninsured/self-pay population (91 per 1000) compared to those whose hospitalizations were paid for by Medicaid (37 per 1000, $p = 0.0002$) or commercial insurers (32 per 1000, $p = 0.0002$) (Table 2). Among preterm/LBW infants who died, rates of inpatient late neonatal (i.e., 7–28 days) and postneonatal deaths (≥28 days) were highest among those covered by Medicaid compared to commercial insurers ($p = 0.0005$ and 0.0002, respectively) and uninsured/self-pay ($p = 0.0002$ and $p = 0.0002$, respectively). Rates of secondary diagnoses for RDS, BPD, and IVH also differed by payer, such that rates of these diagnoses were lower among the uninsured/self-pay population compared to those covered by Medicaid or commercial insurance. There was no difference in the rates of NEC by payer ($p = 0.18$).

Overall, mean LOS and costs of rehospitalizations among preterm and LBW infants differed by payer. Uninsured/self-pay infants had shorter stays and lower costs compared to infants whose hospitalizations were covered by Medicaid or commercial insurance (Table 2). On average, those uninsured/self-pay infants who died during the first 28 days of life had shorter LOS and costs than those covered by Medicaid ($p < 0.0001$) or commercial insurance ($p = 0.0004$). Similarly, mean LOS and costs were shorter and lower for RDS, IVH, and NEC among the uninsured/self-pay compared to Medicaid and commercial insurance.

Table 3 displays the ten most frequently occurring primary diagnoses for rehospitalizations as well as associated LOS and costs by payer. Jaundice was the most common diagnosis, accounting for 9.6 % of Medicaid discharges, 18.7 % of commercial discharges, and 21.4 % of uninsured/self-pay discharges. The second most frequently occurring diagnosis was acute bronchiolitis due to RSV (Medicaid: 7.0 %; commercial: 5.2 %; uninsured/self-pay: 5.7 %). These conditions were significantly less costly than other diagnoses associated with the respiratory system. For example, RDS occurred in 2.8 % of Medicaid discharges with a mean LOS of 27.0 days (95 % CI 22.0–32.1) and mean cost of $46,200 (95 % CI $$33,100–$59,400).

Overall, 7.0 % of preterm infants were transferred to a different hospital after birth (Table 4). The prevalence of neonatal transfer differed significantly by payer. Transfers were more prevalent among infants covered by Medicaid (7.3, 95 % CI 7.2–7.5) compared to those who were commercially insured (6.5, 95 % CI 6.4–6.6, $p = 0.0002$). However, mean LOS and costs did not differ between Medicaid and commercial insurance. Overall 3.3 % of preterm/LBW infants were re-hospitalized within 28 days of their birth. The prevalence of rehospitalizations among preterm/LBW infants varied by payer. Preterm/LBW infants covered by Medicaid (3.7, 95 % CI 3.6–3.8) were rehospitalized more often than those covered by commercial insurance (2.8, 95 % CI 2.7–2.9, $p = 0.0002$) or uninsured/self-pay (2.7, 95 % CI 2.5–3.0, $p = 0.0002$). Additionally, mean LOS and costs were significantly higher among those covered by Medicaid compared to commercial insurance ($p = 0.002$ for LOS, $p = 0.02$ for costs).

Multiple births were included in this analysis, comprising 3.2 % of the overall population and accounting for mean hospitalization costs over four times higher than singletons (data not shown). Multiple births occurred more frequently among the commercially insured compared to Medicaid; however, mean LOS and costs did not differ significantly among multiple births covered by Medicaid and commercial insurance.

Discussion

This analysis of HCUP data estimated that Medicaid was the primary payer for 47 % of all births and almost 51 % of preterm/LBW births in 2009. This is higher than the estimate 42 % of preterm/LBW births covered by Medicaid in 2001. With over half of preterm/LBW births now paid by Medicaid, it is essential to identify and address potential areas for improvement in the quality of care delivered in an effort to improve perinatal outcomes and to reduce public costs associated with perinatal care. These findings suggest there were few differences in hospital utilization and costs (i.e., mean LOS, secondary diagnoses for hospitalization, mean costs, total costs) when comparing preterm/LBW infants whose births were covered by Medicaid and commercial insurance. However, opportunities for improvement within Medicaid and CHIP exist in terms of reducing rehospitalizations and neonatal transfers. Opportunities for improvement within Medicaid and Children's Health Insurance Program (CHIP) include reducing rehospitalizations and neonatal transfers. The prevalence of rehospitalization was

Table 2 Discharge rate, length of stay, and costs for preterm and LBW complications by payer type: Nationwide Inpatient Sample, 2009

Complication type	Discharge rate per 1000			*p*	Mean LOS (95 % CI)			*p*	Mean costs (95 % CI)			*p*
	Medicaid	Commercial	Self-pay		Medicaid	Commercial	Self-pay		Medicaid	Commercial	Self-pay	
Preterm and LBW related complications												
Total preterm and LBW admissions					16.9 (16.0–17.8)*	16.8 (15.5–18.1)	9.2 (7.8–10.5)	<0.001	$22,200 ($20,400–24,000)*	$22,400 ($20,100–24,600)	$10,700 ($8000–13,500)	<0.001
Survived to discharge	962*	968	909	<0.001	17.3 (16.4–18.2)*	17.2 (15.8–18.5)	9.9 (8.5–11.3)	<0.001	$22,300 ($20,500–24,100)*	$22,600 ($20,300–24,900)	$11,400 ($8400–14,300)	<0.001
Died during stay	37*	32	91	<0.001	6.4 (5.0–7.8)*	4.9 (3.4–6.4)	1.7 (0.7–2.7)	<0.001	$18,200 ($14,900–21,500)*	$15,400 ($12,000–18,700)	$4500 ($2800–6200)	<0.001
<7 days	30*	27	86	<0.001	0.7 (0.6–0.8)	0.8 (0.7–1.0)	0.5 (0.3–0.7)	0.23	$3900 ($3200–4600)	$4600 ($3800–5400)	$2700 ($1800–3600)	0.13
7–27 days	5	4	3	<0.001	15.3 (14.5–16.2)	15.3 (14.1–16.6)	17.1 (12.4–21.8)	0.98	$48,000 ($42,500–53,500)	$51,600 ($45,100–58,000)	$45,800 ($36,500–55,100)	0.97
≥28 days	2	1†	1	<0.001	58.0 (47.1–68.9)	65.3 (46.7–84.0)	51.0 (46.7–55.3)	0.94	$129,500 ($107,100–152,000)*	$148,100 ($119,000–177,300)	$47,200 ($47,200–47,200)	0.04
Birth complications												
Respiratory distress syndrome present	238*	242	141	<0.001	34.6 (32.9–36.4)*	34.8 (32.3–37.2)	20.6 (16.3–24.9)	<0.001	$50,200 ($46,300–54,200)*	$52,300 ($47,600–57,100)	$29,700 ($20,700–38,700)	<0.001
Bronchopulmonary dysplasia present	27*	27	7	<0.001	79.9 (76.6–83.2)	81.1 (77.1–85.0)	57.9 (37.1–78.7)	0.35	$127,200 ($117,100–137,200)	$139,200 ($128,000–150,400)	$104,500 ($47,900–161,100)	0.70
Intraventricular hemorrhage present	46*	39†	20	0.01	48.2 (45.2–51.3)*	48.8 (45.2–52.3)	26.8 (20.3–33.4)	<0.001	$73,900 ($66,700–81,000)*	$80,700 ($73,000–88,400)	$36,600 ($28,300–44,200)	<0.001
Necrotizing enterocolitis present	18	13	8	0.18	53.1 (48.1–58.0)*	54.4 (49.5–59.3)	29.5 (16.5–42.4)	0.03	$86,700 ($75,800–97,700)	$94,600 ($82,800–106,300)	$44,200 ($22,300–66,200)	0.01

LOS length of stay, *NBW* normal birth weight, *LBW* low birth weight

Pairwise tests completed when global test of significance results in $p < 0.05$. Unless indicated, all pairwise comparisons are significant at $p < 0.01$ level

* $p \geq 0.05$ for Medicaid versus commercial insurance comparison

† $p \geq 0.05$ for commercial insurance versus uninsured/self-pay comparison

Table 3 top ten primary diagnoses for rehospitalizations in the first 28 days of life by payer: Nationwide Inpatient Sample, 2009

Diagnosis code	Diagnosis description	Medicaid				Commercial				Uninsured/self-pay			
		Rank	Discharges (rate[a]) (%)	Mean LOS (95 % CI)	Mean costs (95 % CI)	Rank	Discharges (rate[a]) (%)	Mean LOS (95 % CI)	Mean costs (95 % CI)	Rank	Discharges (rate[a]) (%)	Mean LOS (95 % CI)	Mean costs (95 % CI)
774.6	Unspecified fetal and neonatal jaundice	1	9.6	1.8 (1.7–1.9)	$1,600 ($1400–$1800)	1	18.7	1.6 (1.5–1.6)	$1400 ($1300–$1500)	1	21.4	1.5 (1.4–1.6)	$1300 ($1200–$1500)
466.11	Acute bronchiolitis due to respiratory syncytial virus (RSV)	2	7.0	3.5 (3.3–3.8)	$4400 ($3700–$5100)	2	5.2	3.4 (3.2–3.7)	$4500 ($3300–$5600)	2	5.7	3.3 (2.8–3.8)	$3900 ($3000–$4700)
466.19	Acute bronchiolitis due to other infectious organisms	3	4.7	2.8 (2.6–3.0)	$3000 ($2500–$3500)	6	2.5	2.5 (2.3–2.6)	$2700 ($2200–$3200)	5	2.5	2.4 (1.9–2.9)	$2900 ($2000–$3900)
779.89	Other specified conditions originating in the perinatal period	4	4.4	4.6 (3.6–5.5)	$7600 ($4000–$11,100)	3	4.3	4.4 (3.7–5.0)	$7200 ($5100–$9300)	3	5.2	4.0 (1.9–6.1)	$4800 ($2100–$7400)
769	Respiratory distress syndrome	5	2.8	27.0 (22.0–32.1)	$46,200 ($33,100–$59,400)	4	3.3	23.8 (16.4–31.2)	$44,700 ($27,900–$61,500)	8	1.9	17.8 (11.2–24.3)	$26,441 ($11,000–$41,900)
486	Pneumonia, organism unspecified	6	2.8	3.5 (3.1–3.9)	$4100 ($3400–$4700)	10	1.6	3.0 (2.7–3.3)	$3600 ($2900–$4200)	–	–	–	–
778.4	Other disturbances of temperature regulation of newborn	7	2.6	2.6 (2.4–2.7)	$3100 ($2800–$3300)	5	2.6	2.5 (2.3–2.6)	$3300 ($2900–$3600)	4	3.9	2.4 (2.2–2.6)	$2700 ($2400–$3000)
770.89	Other respiratory problems after birth	8	2.4	9.9 (7.2–12.7)	$15,600 ($10,100–$21,100)	7	2.4	11.0 (6.6–15.4)	$18,500 ($10,700–$26,300)	6	2.1	4.6 (3.5–5.7)	$6400 ($4900–$7900)
780.6	Fever, unspecified	9	2.2	2.4 (2.3–2.5)	$2300 ($1900–$2600)	–	–	–	–	7	2.0	2.9 (1.5–4.2)	$4300 ($600–$7900)
750.5	Congenital hypertrophic pyloric stenosis	10	2.0	2.6 (2.4–2.8)	$5000 ($4500–$5400)	–	–	–	–	–	–	–	–
771.81	Septicemia [sepsis] of newborn	–	–	–	–	8	1.9	8.2 (6.4–10.0)	$13,400 ($9200–$17,600)	–	–	–	–
774.2	Neonatal jaundice associated with preterm delivery	–	–	–	–	9	1.7	1.8 (1.6–2.1)	$2000 ($1300–$2700)	9	1.9	1.5 (1.3–1.8)	$1500 ($1100–$1900)

Table 3 continued

Diagnosis code	Diagnosis description	Medicaid				Commercial				Uninsured/self-pay			
		Rank	Discharges (rate[a]) (%)	Mean LOS (95 % CI)	Mean costs (95 % CI)	Rank	Discharges (rate[a]) (%)	Mean LOS (95 % CI)	Mean costs (95 % CI)	Rank	Discharges (rate[a]) (%)	Mean LOS (95 % CI)	Mean costs (95 % CI)
770.6	Transitory tachypnea of newborn	–	–	–	–	–	–	–	–	10	1.8	7.0 (4.3–9.6)	$7900 (4700–11,000)

LOS length of stay

[a] Discharge rate = N/sum of all rehospitalizations for the given payer group

– indicates that a diagnosis was not present in the top 10 listing for the given payer type and no data is available for this table

nearly twice as high among preterm/LBW infants covered by Medicaid compared to those whose hospital stays were paid for by commercial insurers. Furthermore, rehospitalizations accounted for 8 % of Medicaid discharges but represented 27 % of costs. There are several plausible explanations for these observations. It is possible that these rehospitalizations are indicative of a system failure to provide high quality comprehensive care to Medicaid beneficiaries. However, it is also plausible that the high cost of care associated with certain common morbidities among preterm/LBW infants, such as bronchopulmonary dysplasia and necrotizing enterocolitis, may predispose them to being covered by Medicaid through income, disability, or institutional levels of care eligibility criteria. Alternatively, a Medicaid-paid rehospitalization may have occurred for an infant whose delivery and/or prenatal care was not initially covered by Medicaid; thus this would not indicate a Medicaid-specific "failure" in the provision of quality care. Since the HCUP NIS does not provide information on ambulatory care and outpatient prescription medications it does not allow for the assessment of pathways to readmission. Future longitudinal research should be attentive to high-cost morbidities common among preterm/LBW infants because understanding the relationship between these morbidities and the timing of Medicaid enrollment (during pregnancy or at birth) could identify important predictors of costly readmissions.

One established effort of the Centers for Medicare and Medicaid Services (CMS) includes the public–private partnership, Partnership for Patients (http://partnershipforpatients.cms.gov/), which is working to improve the quality, safety, and affordability of healthcare for all Americans through the achievement of two goals—making care safer through the reduction of preventable hospital-acquired conditions and improving care transitions. To this end, ten core patient safety areas of focus have been identified by CMS, as the sponsoring agency, and other stakeholders across the healthcare system, including other federal agencies and hospital engagement networks. One of the core patient safety areas is reducing hospital readmissions by 20 % relative to the 2010 rate.

This analysis revealed that neonatal transfers were more common among preterm/LBW infants whose deliveries and hospitalizations were covered by Medicaid versus commercial insurance. Further, preterm/LBW infants who were admitted from another hospital had longer lengths of stay and costs that were nearly three times higher than infants who were not transferred. Unfortunately we were unable to ascertain the reason for transfer with the available data. Nonetheless, these results support the expansion of efforts to ensure that high-risk expectant mothers deliver in comprehensive neonatal facilities [10, 11]. In addition to efforts around perinatal regionalization, the development of guidelines for standardizing regionalized systems is also

Table 4 Discharge rate, length of stay, and costs for transfer status for preterm/LBW hospitalizations by payer type: Nationwide Inpatient Sample, 2009

Transfer status	Discharges (% of stays)			*p*	Mean LOS (95 % CI)			*p*	Mean costs (95 % CI)			*p*
	Medicaid	Commercial	Self-pay		Medicaid	Commercial	Self-pay		Medicaid	Commercial	Self-pay	
Total Preterm/ LBW hospitalization					13.9 (13.05–14.66)	12.6 (11.63–13.53)	7.6 (6.78–8.44)	<0.001	$18,700 (16,900–20,500)*	$16,900 (15,100–18,600)	$8,700 (7000–10,400)	<0.001
Preterm/LBW delivery no transfer	82.3	85.9	87.0	<0.001	13.2 (12.52–13.88)*	12.3 (11.44–13.17)	7.5 (6.63–8.32)	<0.001	$16,300 (15,000–17,700)†	$15,400 (13,900–17,000)	$8000 (6300–9700)	<0.001
Preterm/LBW delivery transferred out	7.3	6.5	7.1	<0.001	7.8 (6.34–9.33)†	6.9 (4.65–9.25)	4.1 (2.21–6.01)‡	0.02	$14,600 (12,000–17,200)†	$13,800 (9300–18,400)	$7900 (4000–11,900)‡	0.02
Preterm/LBW infant admitted from another hospital	6.7	4.9	3.1	<0.001	26.3 (24.42–28.23)	23.6 (20.47–26.74)	17.2 (14.01–20.35)	0.59	$49,000 (42,000–56,000)	$43,900 (35,600–52,300)	$27,600 (20,500–34,600)	0.45
Preterm/LBW infant rehospitalization	3.7	2.8	2.7	<0.001	17.8 (15.69–19.93)*	15.0 (13.25–16.73)	10.0 (6.97–12.94)	0.03	$24,500 (21,600–27,500)*	$20,900 (17,400–24,500)	$11,700 (8100–15,200)	0.01

Rehospitalizations occurring within 28 days of birth

LOS length of stay

Pairwise tests completed when global test of significance results in $p < 0.05$. Unless indicated, all pairwise comparisons are significant at $p < 0.001$ level

* $0.001 \leq p < 0.05$ for Medicaid versus commercial insurance comparison

† $p \geq 0.05$ for Medicaid versus commercial insurance comparison

‡ $0.001 \leq p < 0.05$ for Medicaid versus uninsured/self-pay comparison

warranted. National indicators to measure risk-appropriate care and systems for the early identification of high-risk pregnancies should be developed.

The findings of this analysis also underscore the importance of health insurance. Uninsured/self-pay preterm and LBW infants died in-hospital during the first year of life nearly three times more often than preterm and LBW infants covered by either Medicaid or commercial insurance. It is plausible that prenatal care initiation may have been delayed or minimal for these infants as expectant mothers who are uninsured at delivery are more likely to have delayed or no prenatal care, compared to mothers whose deliveries are covered by Medicaid or private insurance [12]. Expectant mothers who do not receive prenatal care are nearly three times more likely to have a low birth weight infant compared to mothers who do receive prenatal care; infant's whose mothers do not receive prenatal care are almost five times more likely to die [13]. Prenatal visits provide an opportunity to reduce the infant's risk for morbidity and mortality through maternal counseling and treatment for tobacco and alcohol use, pregnancy-induced hypertension, and diabetes (gestational and chronic) [14–16]. It is also possible that uninsured/self-pay infants received differential care, as our findings indicate shorter birth hospitalization stays among uninsured/self-pay infants compared to insured infants. Expansion of coverage through the Affordable Care Act will increase access to insurance coverage and may improve birth outcomes among currently uninsured populations.

Finally, the conditions that contributed to the highest costs and longest lengths of stay among preterm and LBW infants were respiratory in nature. Examples include respiratory distress syndrome and bronchopulmonary dysplasia. This finding points to a potential area of improvement in the appropriate use of antenatal steroids, which have demonstrated an increase in lung maturity. Their use has been recognized for reducing respiratory distress syndrome and other pulmonary morbidities [17].

The findings of this analysis should be interpreted in light of the following limitations. First, NIS data do not allow for analysis of preterm and low birth weight as distinct outcomes. However, these two conditions often co-occur and have similar sequelae, despite differing etiologies. Also, the nature of administrative data, such as the NIS data, does not allow us to account for differences in hospital-level practices or other community-level characteristics, nor do the NIS data allow for the examination of the adequacy or quality of preconception and/or prenatal care received or pre-existing maternal conditions or comorbidities, which can exacerbate adverse pregnancy outcomes [15, 16], oftentimes resulting in longer lengths of stay and higher costs [5]. As a result of large amounts of missing data, we were also unable to explicitly adjust for sociodemographic characteristics such as race or ethnicity and socioeconomic status. Due to the limitations of the data source and varying completeness and quality of potential covariates, the authors have presented a comprehensive descriptive analysis in lieu of a regression-based or multivariate analysis. Further, we cannot rule out selection bias as an explanation for findings related to LOS and associated costs, neonatal transfers, and rehospitalizations. Despite these limitations, this analysis provides an important assessment of hospital utilization among preterm/LBW infants by payer type prior to major policy changes. Moreover, the NIS data is population-based and thus inclusive of mothers and infants of varied races and ethnicities and socioeconomic status from all regions of the U.S., underscoring the importance of continued use of national datasets and state-level reporting dashboards to monitor the quality of maternity and infant care.

In spite of declining preterm birth rates, improvements in the care of preterm and low birth weight infants and reductions in the associated costs should remain a priority among private and public insurers, as preterm births account for a substantial proportion of birth-related hospitalizations. Specific areas for improvement within Medicaid and CHIP include reducing newborn rehospitalizations and neonatal transfers. Several coordinated federal- and state-level endeavors are currently underway to further explore and address these issues. Although complex, measuring and evaluating changes in maternal and infant health outcomes, particularly related to these collaborative partnerships and initiatives, is necessary for the advancement of quality improvement efforts.

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