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Opportunities for maternal transport for delivery of very low birth weight infants

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Abstract

Objective—To assess frequency of very low birth weight (VLBW) births at non-Level III hospitals.

Study Design—Retrospective cohort study using linked California birth certificate and discharge data 2008–2010 for deliveries of singleton or first-born infant of multiple gestations with birth weight 400–1500g. Delivery rates by neonatal level of care were obtained. Risk of delivery at non-level III centers was estimated in univariable and multivariable models.

Results—Of 1,508,143 births, 13,919 (9.2%) were VLBW; birth rate at non-Level III centers was 14.9% (8.4% in Level I, and 6.5% in Level II). Median rate of VLBW births was 0.3% (range 0%–4.7%) annually at Level I and 0.5% (range 0%–1.6%) at Level II hospitals. Antepartum stay >24 hours occurred in 14.0% and 26.9% of VLBW births in Level I and Level II hospitals, respectively.

Conclusion—Further improvement is possible in reducing VLBW infant delivery at suboptimal sites, given the window of opportunity for many patients.

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Conflicts of interest: None.

Introduction

Since its first formal introduction in the 1976 March of Dimes publication, "*Toward Improving the Outcome of Pregnancy,*" the concept of regionalized perinatal care has functioned as the core model by which hospitals and physicians strive to promptly provide the most risk-appropriate care to every infant and mother. This system stratified perinatal care into three levels of complexity: Level I - uncomplicated maternity and newborn care, Level II - uncomplicated and majority of complicated care, and Level III - uncomplicated and all serious complications (1, 2). Prior to its initial proposal and throughout the last four decades, the application of regionalized perinatal care has contributed to a decrease in morbidity and mortality for high-risk infants born prematurely or with severe medical or surgical conditions (3–5).

In the case of very low birth weight (VLBW) infants (birth weight <1500g), delivery at non-Level III centers is not desirable and can often lead to neonatal transport to a higher level of care. Given the increased morbidity and mortality for VLBW infants born at non-level III centers, maternal transport is favored over neonatal transport as it leads to more favorable outcomes (3, 6–9).

The importance of reducing neonatal transport is emphasized by the Healthy People 2020 goal of reducing VLBW births at non-Level III centers to below 16.3% by 2020.(10) In this study, we assessed the frequency of VLBW births at non-Level III hospitals in California in order to better understand the size and characteristics of this at-risk population, and evaluated the duration of their antepartum admission to assist in identifying opportunities for improvement in maternal transport prior to delivery of at risk neonates.

Materials and Methods

We performed a retrospective cohort study using de-identified, linked birth certificate and discharge diagnosis data from the California Office of Statewide Health Planning and Development for the years 2008–2010. This dataset includes maternal and neonatal variables from the birth certificate and hospital discharge data.

Levels of neonatal care classification have been defined by the American Academy of Pediatrics.(11, 12) Briefly, Level II units are designed to primarily care for infants > 32 weeks gestational age and weighing greater than 1500 grams; Level III units are capable of providing comprehensive care for infants born < 32 weeks gestational age and < 1500 grams, including mechanical ventilation; Level IV units (introduced as a classification in 2012) have all of the capabilities of a Level III unit, but also have a full range of pediatric medical and surgical specialists. We used the equivalent of the most recent levels of care classification to apply to the study period.

The study population included mother/infant pairs of either singleton or the first-born infant of multiple gestations, between 22 0/7 and 42 6/7 weeks, with BW 400–1500g, and maternal admission on or before infant date of birth. Although there may have been errors in coding, we considered that birth weights would be more accurate than gestational age coding and therefore did not exclude records based on improbable gestational age. Maternal and

neonatal variables were characterized by level of care. As a hospital could change level of care from year to year, we considered hospital-year as the unit of analysis.

To evaluate the frequency of VLBW births by center level of care, we calculated the absolute number of VLBW births by hospital and the percent of VLBW births over all births by hospital, for all hospitals in California during the study period. Descriptive statistics were calculated including mean, standard deviation, mode, median, range, and interquartile range. We also calculated descriptive statistics for the antepartum length of stay in days in order to assess the opportunity for potential transport prior to delivery when indicated. As the length of stay was not measured by hours, we considered that a length of stay greater than 1 day would constitute a time period of at least 24 hours in which maternal transfer could have been arranged.

Data analysis was conducted using SAS 9.4 (SAS Institute, Cary, NC). The study was approved by the Institutional Review Board of Stanford University.

Results

Of 1,508,143 births in the study period, 13,919 (9.2%) were VLBW births, with 14.9% of the VLBW births occurring in non-Level III centers – 8.4% in Level I and 6.5% in Level II centers (Table 1). There was a higher proportion of White and Hispanic VLBW births at Level I centers. Level III centers had higher proportions of mothers with pregnancy-associated morbidities such as hypertension and diabetes compared to both Level I and Level II centers. VLBW deliveries at Level I centers were more likely to be covered by Medi-Cal (state-funded insurance) compared to other levels of care, while Level III centers had the highest proportion of privately insured patients compared to other levels.

When considering individual hospitals, the median % of VLBW births at Level I hospitals was 0.3% (range 0% – 4.7%) annually, while the median % at Level II hospitals was 0.5% (range 0% – 1.6%) annually (Table 2). This translated to a median of 2 VLBW births and 9 VLBW births annually at Level I and Level II hospitals, respectively (Table 2).

The interval from maternal admission to delivery varied by level of center. Greater than 50% of VLBW deliveries in Level I and Level II hospitals occurred within one day, while 1.6% of Level I and 2.7% of Level II births occurred after 14 days of antepartum stay (Table 3). The median antepartum length of stay was longest for Level III centers at 2 days, with the median length of stay less than 1 day for both Level I and Level II centers. However, length of stay did exceed greater than 1 day for some VLBW births occurring at Level I and II centers. The interval between maternal admission and delivery, antepartum length of stay > 1 day (at least 24 hours) occurred in 14.0% and 26.9% of VLBW births in Level I and Level II hospitals, respectively (Table 3).

Discussion

In this population-based study, we found that the state of California was meeting the Healthy People 2020 goal (16.3%) as early as 2008 to 2010, with 14.9% of percent of VLBW births at non-Level III centers. There was variation across Level I and Level II centers in the

proportion and numbers of VLBW births, which indicates that there may be potential for further improvement. Level I hospitals had 8.4% of VLBW births, which is decreased the 10.5% seen in a California study covering 1989–1993.(13)

Birth and early care at Level III centers is associated with better clinical outcomes for VLBW neonates.(14–18) A retrospective Australian study conducted in 1988 noted that mortality in infants transferred between Level III hospitals was significantly greater than in those who remained at the birth hospital, suggesting that transport alone, and not simply birth at a lower level NICU prior to transport, bears significant risk for the infant (19).

While some maternal transports may not be possible due to the clinical circumstance leading to imminent delivery, our study indicates that there may still be many opportunities for maternal transport in order to avoid neonatal transport. First, variation across centers suggests that some policies at either the institutional or regional level may promote optimal transport practice. Second, the timing of maternal admission to the first hospital and delivery was often prolonged, suggesting that delivery was not imminent (Table 3). Our dataset did not contain granular data about the status of the fetus or mother including fetal heart rate tracing, vaginal bleeding or uncontrolled maternal hypertension to determine the safety and appropriateness of transport in individual cases.

Whether non-medical factors play a role in VLBW births in non-level III centers remains to be determined. Financial incentives that dis-incentivize maternal transport may be a factor in some births occurring at Level I and II centers. If maternal transport means loss of charges for the delivery and the initial critical care of a preterm neonate, some hospitals may not actively seek to transport mothers in some circumstances. Some Level II centers may also wait until the baby is born in order to see whether less critically ill neonates could be cared for at that hospital, and only choose to transport the neonate as needed.

Reaching the Healthy People goal prior to 2020 indicates that progress has already been made in optimizing the location of birth for preterm newborns. Furthermore, the higher risk mother-fetus pairs, such as those having co-morbidities, including hypertensive disorders, were more likely to deliver at Level III centers.

We used the neonatal levels of care as the basis for appropriate birthplace of VLBW infants. Since the time period of the study, neonatal levels of care have been updated to a I to IV system.(11, 12) With this update however, the appropriate location of birth for VLBW infants remains Level III or IV center, due to studies demonstrating better outcomes with this practice.(14, 15)

Furthermore, a system of maternal levels of care has been established by ACOG in order to address appropriate hospital of birth determined by severity of morbidities of mothers.(20) It is possible that these guidelines could help to further improve appropriate birth location of VLBW births as many of the high risk conditions that may lead to more fetal transports, such as preeclampsia and obesity, are also associated with preterm birth.

A limitation of our study is that intention to resuscitate the very preterm newborn was not indicated. In some cases of extreme preterm birth, there may have been a decision to allow

delivery at a non-Level III center to transition to palliative care. In the context of healthcare systems, we do not know the optimal rate at which transfers occur, as trying to have zero VLBW deliveries at non-Level III centers could mean that there may be increased burden on the healthcare system by transferring some mothers who threaten preterm delivery but ultimately do not.

The generally low frequency (0.33% and 0.55%) of VLBW births in Level I and Level II centers (Table 2) is reassuring in the context of the goal of few VLBW births at non-Level III centers. However, it also serves to emphasize that those hospitals would not have appropriate training and equipment to handle such births. The median number of annual VLBW births at Level I centers was 2 births.

Conclusion

Given the percentage of women with an interval greater than 1 day between admission and delivery, opportunities likely remain for reducing the VLBW birth rate at inappropriate centers even further. Optimizing safe transport of high-risk pregnant women to appropriate centers on a state-wide level is likely to require efforts at both the individual hospitals that face challenges in this area, as well as systems and policies at the regional level in order to promote early identification of maternal transport candidates prior to delivery.

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Table 1

Characteristics of very low birth weight (VLBW) infants by NICU level at hospital of birth, 2008–2010

	All Hospitals n=768	Level I n=358	Level II n=85	Level III n=325
VLBW infants, n	13,919	1,164	905	11850
% of total VLBW births		8.4	6.5	85.1
Female, %	47.8	48.4	46	47.8
Birth Weight, %				
<500g	4	5.2	5.3	3.8
500–999g	39.7	41	36.7	39.8
1000–1500g	56.3	53.8	58	56.5
Gestational age in weeks, %				
$22^{0/7}$–$23^{6/7}$	8.6	11.9	10.9	8.1
$24^{0/7}$–$27^{6/7}$	34	34	29.8	34.3
$28^{0/7}$–$31^{6/7}$	40.3	33.7	36.5	41.2
$32^{0/7}$–$36^{6/7}$	14.4	14.4	20.4	13.9
$37^{0/7}$–$40^{0/7}$	2.7	5.8	2.2	2.4
Race, %				
White	67.5	78.5	68.7	66.3
Black	12.8	8.3	13.7	13.2
Native American	0.6	1	0.6	0.5
Asian/Pacific Islander	10.6	5.9	12.6	10.9
Other/Unknown	8.6	6.4	4.4	9.13
Ethnicity, %				
Hispanic	45.1	54.6	47.3	44
Non-Hispanic	53.3	43.7	51.9	54.4
Other/Unknown	1.6	1.6	0.8	1.6
Maternal Factors, %				
Multiple gestation	14.1	8.2	12.3	14.8
Hypertension	3.9	2.6	3.1	4.1
Pregnancy-induced hypertension	26.3	16.7	20.6	27.7
Diabetes mellitus	10.8	5.5	8.6	11.5
Gestational diabetes	8	4.3	6.1	8.5
Maternal age ≥35	22.5	16.2	19.5	23.4
Maternal Insurance Category, %				
Medicare	0.7	0.9	0.2	0.7
Medi-Cal	50.2	60.2	51.2	49.2
Private	45.1	32.5	44.4	46.4
County Indigent	0.1	0	0	0.1
Other Government	1.5	2.2	1	1.5

	All Hospitals n=768	Level I n=358	Level II n=85	Level III n=325
Other Indigent	0.1	0	0	0.1
Self-Pay	2	4.2	3	1.8
Other Payer	0.2	0.1	0.2	0.3
Unknown	0.01	0	0	0.02

Table 2

Annual volume and rates of very low birth weight (VLBW) births by hospital of birth, 2008–2010

	All Hospitals n=768	Level I n=358	Level II n=85	Level III n=325
VLBW births, n	13,919	1,164	905	11850
Total births, n	1,508,143	354,326	164,373	989,444
Rate of VLBW births, %	0.92	0.33	0.55	1.2
Annual number (n) of VLBW births per hospital				
Mean	18.12	3.25	10.65	36.46
Median	8	2	9	27
Mode	0	0	6	26
Standard deviation	24.97	5.06	10.23	28.7
Interquartile range (25–75th percentile)	2.0–25	1.0–4.0	4.0–12	17–46
Total range	0–168	0–50	0–63	0–168
Annual rate (%) of VLBW births per hospital				
Mean	0.75	0.31	0.53	1.29
Median	0.53	0.26	0.47	1.02
Mode	0	0	/	1.31
Standard deviation	1.03	0.37	0.32	1.35
Interquartile range (25–75th percentile)	0.24–0.97	0.08–0.43	0.30–0.71	0.76–1.52
Total range	0–20	0–4.65	0–1.57	0–20

Table 3

Antepartum length of stay for very low birth weight (VLBW) infant births, 2008–2010

	All Hospitals n=768	Level I n=358	Level II n=85	Level III n=325
VLBW births, n	13,919	1,164	905	11850
Statistics				
Mean	4.05	1.17	2.06	4.48
Median	1	0	0	2
Mode	0	0	0	0
Standard deviation	7.48	4.18	5.44	7.76
Interquartile range (25–75th percentile)	0–4	0–1	0–2.0	0–5.0
Total range	0–95	0–63	0–62	0–95
Antepartum length of stay, %				
0 days	37.2	68.4	53.4	32.9
1 day	16.4	17.6	19.8	16
2–7 day	30.9	10.5	20.1	33.8
8–14 days	7.8	1.9	4.1	8.7
> 14 days	7.7	1.6	2.7	8.7