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Process and Outcome Measures for Moderate and Late Preterm Infants in Tertiary Canadian Neonatal Intensive Care Units

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Abstract

Objective To describe the prevalence of and between-center variations in care practices and clinical outcomes of moderate and late preterm infants (MLPI) admitted to tertiary Canadian neonatal intensive care units (NICUs).

Study design A retrospective cohort study including infants born at $32^{0/7}$ through $36^{6/7}$ weeks' gestation and admitted to 25 NICUs participating in the Canadian Neonatal Network between 2015 and 2020. Patient characteristics, process measures represented by care practices, and outcome measures represented by clinical in-hospital and discharge outcomes were reported by gestational age weeks. NICUs were compared using indirect standardization after adjustment for patient characteristics.

Results Among 25,669 infants (17% of MLPI born in Canada during the study period) included, 45% received deferred cord clamping, 7% had admission hypothermia, 47% received non-invasive respiratory support, 11% received mechanical ventilation, 8% received surfactant, 40% received antibiotics in the first 3 days, 4% did not receive feeding in the first 2 days, and 77% had vascular access. Mortality, early onset sepsis, late onset sepsis, or necrotizing enterocolitis occurred in <1% of the study cohort. Median (IQR) length of stay was 14 (9-21) days among infants discharged home from the admission hospital, and 5 (3-9) days among infants transferred to community hospitals. Among infants discharged home, 33% were discharged on exclusive breastmilk and 75% on any breastmilk. There were significant variations between NICUs in all process and outcome measures.

Conclusions Care practices and outcomes of MLPI varied significantly between Canadian NICUs. Standardization of process and outcome quality measures for this population will enable benchmarking and research, facilitating systemwide improvements.

Abbreviations:

MLPI	moderate and late preterm infants
NICU	neonatal intensive care unit
QI	quality improvement
CNN	Canadian Neonatal Network
SGA	small for gestational age
SNAP-II	Score of Neonatal Acute Physiology version 2
DCC	deferred cord clamping
EOS	early onset sepsis
LOS	late onset sepsis
NEC	necrotizing enterocolitis
SR	standardized ratios
UVC	umbilical venous catheter
UAC	umbilical arterial catheter
PICC	peripherally inserted central catheter
PN	parenteral nutrition
PMA	postmenstrual age
VON	Vermont Oxford Network
Baby-MONITOR	Measure Of Neonatal InTensive care Outcomes Research
RDS	respiratory distress syndrome
TTN	transient tachypnea of the newborn
CPAP	continuous positive airway pressure

Moderate and late preterm infants (MLPI) born between $32^{0/7}$ and $36^{6/7}$ weeks' gestation represent 85% of all preterm births in high income countries and account for a high proportion of resource use for neonatal care.[1] Although the mortality rate for MLPI is generally low (<1%) when compared with very preterm infants born <32 weeks' gestation, they remain at risk for short and long-term complications.[2, 3] Common short-term morbidities of MLPI include hypothermia, respiratory distress, hypoglycemia, oral feeding challenges, jaundice, and early onset sepsis (EOS).[4-6] Compared with term infants, MLPI have higher neonatal intensive care unit (NICU) admission rates, longer length of stay, and higher risk of rehospitalization within 30 days of discharge.[7-9] In addition, they have an increased risk of long-term motor and cognitive impairments and learning difficulties compared with term infants.[10-13]

The study of variations in care practices and outcomes across units is the foundation for quality improvement (QI) initiatives, which have subsequently led to improved outcomes in different settings.[14-16] Most NICU based quality improvement (QI) initiatives have focused on very preterm infants born at <32 weeks' gestation or weighing <1500g and morbidities specific to those infants.[17-20] Recent publications have suggested specific process and outcome measures for MLPIs and showed variations between institutions in the United States.[21] However, less is known about the variations in care practices and outcomes for MLPI between tertiary NICUs in a highly regionalized perinatal care system like Canada, where the majority of MLPI are born in Level II NICUs in community hospital; except those with high risk conditions or those who live in the geographical area of a tertiary care center. In addition, most MLPI born in tertiary centers are transferred to Level II NICUs in community hospital when available. Given the lack of population-representative data on MLPI that can be used for benchmarking, we aimed to

describe the prevalence of and between-center variations in care practices and clinical outcomes in MLPI in tertiary Canadian NICUs.

METHODS

Study Sample

We conducted a retrospective cohort study of infants born at $32^{0/7}$-$36^{6/7}$ weeks' gestation between January 2015 and December 2020. The infants included in the study were admitted to Canadian tertiary NICUs that had been contributing data to the Canadian Neonatal Network (CNN) across all gestational ages for a minimum of 4 years during the 6-year study period. Six centers were excluded for not meeting data contribution criteria. Moribund infants (admitted for palliative care only), those with major congenital anomalies or chromosomal abnormalities, and outborn infants admitted >3 days after birth were excluded. We excluded late preterm infants who received therapeutic hypothermia for hypoxic ischemic encephalopathy as their course reflected the hypoxic ischemic encephalopathy rather than preterm birth. The site investigator of each participating NICU provided the gestational age (GA) and birth weight criteria for mandatory admission to their NICU.

Data Collection

The CNN maintains a national database for all tertiary NICUs in Canada.[22] Trained abstractors collected data at each center according to a standard protocol.[23] The information from patient charts was entered electronically into a database that previously showed high reliability and consistency.[22] Approval for data collection was granted at each center by the local research ethics board. This study was approved by the CNN Executive Committee and the University of Calgary Conjoint Health Research Ethics Board (REB21-1220).

Variable Definitions

Although we did not report structure dimension, we used the Donabedian quality care model[24] to report 3 groups of variables: patient characteristics, process measures represented by care practices, and outcome measures represented by clinical in-hospital and discharge outcomes. Patient characteristics included demographics, pregnancy, and birth information. Maternal diabetes and hypertension included gestational or pre-existing conditions. Small for GA (SGA) was defined as birth weight <10th percentile on the Population-Based Canadian Reference for Birth Weight for Gestational Age.[25] Score of Neonatal Acute Physiology version 2 (SNAP-II) more than 20 was used to compare severity of illness.[26-28]

Process measures included deferred cord clamping ≥30 seconds from birth, admission hypothermia (temperature <36°C), surfactant use (proportion of infants who received surfactant irrespective of type, method of administration, or number of doses), deferred feeding (delaying initiation of feeding, i.e., nil per os (NPO) for >2 days), respiratory support type, vascular access, antimicrobial utilization rate (calculated per 100 patient days):

$$\frac{\text{number of days a patient received systemic antimicrobial agents (irrespective of types or doses)}}{\text{Patient hospital days}} \times 100)$$[29], and prolonged antibiotics administration (antibiotics initiated in the first 3 days and continued for > 3 days without positive culture).[30]

Clinical in-hospital outcomes included EOS, positive blood or cerebrospinal fluid culture within 2 days after birth, late onset sepsis (LOS), positive blood or cerebrospinal fluid culture after 2 days of age, and necrotizing enterocolitis (NEC), Bell's stage 2 or higher.[31] We did not report neurological injury in this study due to the low screening rate in this population.[32] Discharge destination was classified as home, death, another ward in the same hospital, another CNN-participating NICU which is usually done to provide a specific service, or a Level II neonatal

unit in a community hospital. Length of stay was equal to the total number of days spent in the admission CNN NICU. Among infants discharged home, discharge on exclusive breastmilk was counted if the patient received breastmilk and no formula in the 24 hours prior to discharge. Fortification of breastmilk with powder supplement or liquid human milk fortifier was not counted as formula feeding. Discharge home on oxygen or gavage feeding was counted if the patient received oxygen via nasal cannula or feeding through naso- or oro-gastric tube on the day of discharge home.

Statistical Analysis

The study sample was summarized using descriptive statistics. Infants were grouped based on GA weeks at birth. Patient characteristics, diagnoses, care practices, and discharge outcomes were compared among the five GA groups using chi-square test for categorical variables, F test, or Kruskal-Wallis test as appropriate for continuous variables. To compare care practices and outcomes among centers, we estimated standardized ratios (SRs) using the "indirect standardization" approach.[33] For each NICU, the SR and 95% confidence interval were calculated as the observed number of infants with the outcome or care practice divided by the number of infants expected to develop the outcome. The expected number of infants was computed as the sum of predicted probabilities from a multivariable logistic regression model with adjustment for patient characteristics (GA, SGA, sex, SNAP-II >20, and outborn). The SRs were displayed graphically using Funnel plots to identify centers with outcome rates above and below the average rate of all others at the 95% confidence level. These plots 'test' whether the SR for a center differs from the national rate for Canadian NICUs by more than what would be expected from chance alone.[34] A two-sided p-value of <0.05 was considered statistically

significant. Data management and all statistical analyses were performed with SAS, version 9.4 (SAS Institute Inc., Cary, NC)**.**

RESULTS

The criteria for systematic admission in the participating NICUs varied in GA, range 35-36 weeks, and birth weight, range 1800-2500g (Table I, available at www.jpeds.com). Among 31,706 infants born at 32-36 weeks' gestation admitted during the study period, 25,669 infants were included in the analysis (Figure 1, available at www.jpeds.com). This corresponds to 17% of 152,340 MLPI born in Canada during the study period (7,891 out of 19,460 (41%) infants born at 32-33 weeks, and 17,778 out of 132,880 (13%) of infants born at 34-36 weeks).[1] Maternal and neonatal baseline characteristics are shown in Table II; available at www.jpeds.com. With increasing GA, there was a lower prevalence of exposure to antenatal corticosteroids, antibiotics in 24 hours preceding birth, and the proportion of infants with SNAP-II > 20, but a higher prevalence of infants born SGA.

Table III shows the care practices and in-hospital outcomes. Overall, 45% received deferred cord clamping (DCC), 47% received non-invasive respiratory support, 11% received mechanical ventilation, 8% received surfactant, and 40% received antibiotics in the first 3 days of age, of whom, 18% received prolonged antibiotics. Among the study cohort, 77% had vascular access including peripheral venous catheter. Umbilical venous catheter (UVC), umbilical arterial catheter (UAC), and peripherally inserted central catheter (PICC) were used in 13, 4, and 5% of infants; respectively. Only 4% of the study sample had deferred feeding, and 42% received parenteral nutrition (PN). EOS, LOS, NEC, or mortality (which is shown in Table IV) occurred in < 1% of the study cohort.

Discharge outcomes are shown in Table IV. Over half (54%) of infants were discharged home from the admission hospital. Infants of lower GA were more likely to be transferred to a NICU in other non-CNN community hospitals for convalescent care closer to family residence. However, infants of higher GA were more likely to be transferred to another unit in the same hospital which may include postpartum ward (e.g. infant born at 36 weeks and admitted for mild respiratory distress), a step-down unit, or a pediatric ward. Very few infants (<5 in each GA week) were discharged home on oxygen. Nearly 75% of infants discharged home received breastmilk containing diet at discharge.

Comparisons between the participating centers for DCC, admission hypothermia, surfactant use, and mechanical ventilation are shown in Figure 2; and for using vascular access, use of central venous line (UVC or PICC), deferred feeding, and prolonged antibiotics in Figure 3. Comparisons of discharge on any breastmilk, exclusive breastmilk, and at postmenstrual age (PMA) <36 weeks are presented in Figure 4; available at www.jpeds.com. There were significant variations between centers in all reported measures.

DISCUSSION

In this national multicenter study, we found that rates of major adverse outcomes such as mortality, NEC, EOS, and LOS were relatively low (<1%) among MLPI admitted to tertiary NICUs. The rate of respiratory disease requiring respiratory support on admission was high (49%). We found significant between-center variations in care practices and outcomes of MLPI including DCC, admission hypothermia, surfactant administration, use of mechanical ventilation, use of vascular access and central lines, use of antibiotics, time to initiate feeding, discharge on breast milk, and discharge at PMA <36 weeks.

Delivery room process measures

DCC occurred in 45% of infants, which is lower than the CNN-reported average of 57% in infants <29 weeks' gestation.[35] In a meta-analysis of DCC in term and late preterm infants, DCC compared with immediate cord clamping was associated with higher hematocrit and hemoglobin after birth and at 24 hours of age but did not affect mortality.[36] The International Liaison Committee on Resuscitation (ILCOR) Neonatal Life Support Task Force, the Society of Obstetricians and Gynecologists of Canada, and the Canadian Pediatric Society recommend DCC for ≥60 seconds in term and preterm infants.[37, 38] QI initiatives to standardize cord clamping practices may improve the rates of DCC in MLPI and help understand the barriers to implementation. Admission hypothermia occurred in 7% of infants without significant variation between gestations. Salazar et al. reported an admission hypothermia rate of 5.4% in preterm infants 30-36 weeks' gestation in Vermont Oxford Network (VON).[16] Admission hypothermia is a process measure for very preterm infants in the CNN and a component of the Baby-MONITOR (Measure Of Neonatal InTensive care Outcomes Research) score, a composite index of NICU quality of care used by VON and the California Perinatal Quality Care Collaborative.[18, 39] Admission hypothermia remained a significant process measure when Baby-MONITOR was adapted for MLPI.[16] While our study and others defined admission hypothermia as temperature < 36.0°C, Laptook et al defined it as temperature <36.5°C and reported a prevalence of 34% among moderately preterm infants and significant association with mortality.[40] These findings invite further research to understand the relationship between admission temperature and outcomes relevant to the MLPI population. In this study, we did not report delivery room resuscitative interventions as those were reported in other studies from the CNN and VON.[41, 42]

Respiratory distress syndrome (RDS) or transient tachypnea of the newborn (TTN) are common in MLPI. We reported respiratory support and surfactant use instead of RDS or TTN

diagnosis as there is an overlap between TTN and mild RDS. In a Swedish study of infants born at 30-34 weeks' gestation, continuous positive airway pressure (CPAP) was administered in 53, 38, and 27%, mechanical ventilation in 6.3, 3.6, and 2.4%, and surfactant in 5.0, 3.8, and 1.6% at 32, 33, and 34 weeks' gestation, respectively.[43] Our study cohort had higher utilization of these three care practices at similar gestational weeks which may reflect differences in patient population or practice strategies. Further investigation of indications and oxygen threshold is required to explain the variations in surfactant and mechanical ventilation use between centers. Similarly, a survey in Belgium reported variations in indications, oxygen threshold, and method of administration of surfactant in late preterm infants.[44]

Feeding and nutrition are also important challenges in MLPI.[45] Measures of early initiation of enteral feeding include the requirement of vascular access and the NPO duration after birth. A French study showed variation in the use of PN, use of central venous line, time to initiate feeding, advancement volume, and feeding fortification in MLPI.[46] A British study found suboptimal nutritional intake in the first 3 weeks of age in infants born at 32-34 weeks compared with the World Health Organization (WHO) recommendations.[47] In a randomized trial comparing standard and progressive feeding regimens in SGA MLPI, progressive feeding was associated with lesser need for intravenous fluids, shorter length of stay, and occurrence of hypoglycemia.[48] Standardization of these practices is needed to ensure adequate nutrition and early acquisition of oral feeding in the MLPI population which may impact their hospital length of stay.[45]

Our study reported various indicators of antibiotic use. In a single-center Canadian study, antibiotics were used in the first 48 hours in 65% of preterm infants <34 weeks' gestation compared with 40% in our cohort. Among those who received antibiotics without culture-proven

sepsis, 19.8% continued beyond 48 hours, compared with 18% in our cohort.[49] Although there are limited data on antibiotic exposure in MLPI and short-term outcomes, there is a suggestive association between early-life antibiotic exposure and altered microbiome and allergic disorders.[50-52] The use of antibiotics in infants at low risk of EOS (caesarean birth without rupture of membranes) was 31%. Sonny et al studied late preterm and term infants born by caesarean section without preceding rupture of membranes; 19.7% of infants had a blood culture sample collected, and 14.3% received empiric antibiotics.[53]

Over half of the study sample were discharged home from the admitting NICU without transfer. A study that included 9 level 2 and 6 level 3 NICUs in Massachusetts showed mean (SD) PMA at discharge home of 35.6 (0.9) weeks for those born at 32 weeks and 35.9 (0.8) for those born at 34 weeks.[54] This is comparable to our findings; however, they did not include infants born at 35 and 36 weeks. Further research is required to determine patient and organizational characteristics that contribute to hospital length of stay.[55] Salazar and colleagues used extreme length of stay, defined as total hospital stay greater than the 95th percentile for the predicted value based on a multivariable risk adjustment model, as a quality indicator for MLPI.[16] However, extreme length of stay may not explain all variations between centers; particularly Level II units that do not provide care for MLPI with complex conditions. Among those who were discharged home, 75% received any breastmilk, while 33% received exclusive breastmilk at the time of discharge. Brown et al. reported that up to 80% of MLPI received formula at some point during their admission.[47] Not receiving breast milk at discharge was an independent risk factor for neurodevelopmental impairment in MLPI in a UK population-based study.[56] This highlights the need for QI initiatives to support breastfeeding and breast milk use in this population.

Our study demonstrated marked between-center variations in several outcomes and practices. These variations could be attributed to inherent differences in patient population, modifiable care practice variations, and lack of standardized approach to management of MLPI. There are regional variations in MLPI population admitted to the tertiary NICUs in our study. For instance, in less densely populated cities and provinces, tertiary NICUs provide care for lower risk MLPI compared with tertiary NICUs in more densely populated areas where many Level II units exist.[57] This selection bias may explain part of the variations between centers; however, after adjustment for population differences, variations remain significant and highlights opportunities for improvement. There is a need to establish a nationwide QI collaborative for MLPI that allows for benchmarking, implementation of standardized care practices, and targeted QI interventions to improve outcomes. Common benchmarking outcomes used for very preterm infants are inappropriate for MLPIs due to the low prevalence of such morbidities. A study from VON compared the Baby-MONITOR in 57,595 extremely and very preterm (25–29 weeks GA) infants and a modified quality measure for MLPI (MLP-QM) score in 376,219 MLPI (30–36 weeks GA) infants. They found a strong correlation between Baby-MONITOR and MLP-QM in components such as hypothermia and human milk at discharge, but a weak correlation for other components such as mortality, no pneumothorax, and LOS.[16] They recommended MLPI-specific quality measures including oxygen use at 28 days or discharge, extreme length of stay, and greater than median weight z-score change, in addition to hypothermia and human milk at discharge. Additional MLPI-specific outcome measures may include respiratory support duration, time to full oral feeding, and readmission within 30 days. Additional process measures may include DCC, use of vascular access, and prolonged antibiotics. Family engagement is essential in identifying meaningful patient-oriented QI measures.[58]

The strength of our study is the large multicenter sample of MLPI representing the majority of Canadian tertiary NICUs in a highly regionalized healthcare system. It highlighted the significant morbidities that these infants have and the care practices and interventions they receive. The most important limitation of our study is the lack of data on infants admitted to Level II NICUs in community hospitals that are not members of the CNN. However, MLPI account for 35% of admission to the CNN NICUs, and thus, our study provides a reliable and accurate estimate for planning and resource organization for MLPI.[35] A recent large cohort study in the United States showed that MLPI had lower MLP-QM scores in higher-level NICUs, suggesting that MLPI may receive better care quality in NICUs with less complex subspecialty services.[21] Initiatives to establish QI collaboratives that include MLPI admitted to NICUs in community hospitals in Canada are ongoing.[59] A second limitation is the variation between centers in admission criteria of late preterm infants. This variation depends on several factors including the ability to care for late preterm infants in mother-baby units. Similar variations were observed in a survey of admission practices for late preterm infants in England with median (range) of gestational age and birth weight cut offs for direct admission to the NICU being 35 (34–37) weeks and 2 (1.5–2.5) kg, respectively.[60] Thirdly, our study did not account for less frequent diagnoses such as meconium aspiration, pneumonia, persistent pulmonary hypertension of the newborn, or pulmonary hypoplasia. Lastly, we did not account for parental involvement in care and strategies such as family integrated care which was shown to reduce length of stay in MLPI.[61]

In summary, there are significant variations in care practices and outcomes of MLPI between Canadian centers with respect to admission criteria; management strategies for respiratory illness, nutrition, and antibiotics utilization; and discharge practices. Considering the

very large proportion of MLPI among all preterm infants, there is a need for a national QI collaborative to identify a set of core processes and outcome measures that will allow for appropriate benchmarking, standardization of care, and implementation of QI initiatives in various settings where MLPI may be born and receive care.

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Figure 2: Adjusted standardized ratio and expected number of infants exposed to (A) lack of DCC, (B) admission hypothermia, (C) use of surfactant, and (D) use of mechanical ventilation. X-axis: Expected number of infants with outcome. Y-axis: Adjusted standardized ratio (SR). Dark points with numerical notation: Site and its location matching x and y axis values. Red funnel shaped lines: 95% confidence limits based on entire study sample. Sites outside of red lines represent higher or lower adjusted standardized ratio. The prediction model was adjusted for gestational age, SGA status, sex, outborn status, and SNAP-II >20 (SNAP-II was not included in the model for DCC and admission hypothermia). *Fig B: four centers cannot be visualized as they are outside the graph limits; center I is below the 95% CI and centers J, N, and S are above the 95% CI.

Figure 3: Adjusted standardized ratio and expected number of infants exposed to (A) use of vascular access, (B) use of central venous line (CVL), (C) deferred feeding (NPO > 2 days), and (D) prolonged antibiotics (antibiotics use for > 3 days). X-axis: Expected number of infants with outcome. Y-axis: Adjusted standardized ratio (SR). Dark points with numerical notation: Site and its location matching x and y axis values. Red funnel shaped lines: 95% confidence limits based on entire study sample. Sites outside of red lines represent higher or lower (depending upon position in graph) adjusted standardized ratio. The prediction model was adjusted for gestational age, SGA status, sex, outborn status, and SNAP-II >20. *Fig C: center Y cannot be visualized as it is outside the graph limits above the 95% CI. Fig D: center J cannot be visualized as it is outside the graph limits above the 95% CI.

Figure 4: Adjusted standardized ratio and expected number of infants exposed to (A) discharge home on any breastmilk, (B) discharge home on exclusive breastmilk, and (C) discharge at PMA <36 weeks for those born at < 36 weeks GA (online only). X-axis:

Expected number of neonates with outcome. Y-axis: Adjusted standardized ratio (SR). Dark points with numerical notation: Site and its location matching x and y axis values. Red funnel shaped lines: 95% confidence limits based on entire study sample. Sites outside of red lines represent higher or lower (depending upon position in graph) adjusted standardized ratio. The prediction model was adjusted for gestational age, SGA status, sex, outborn status, and SNAP-II >20.

Table 3: Care practices and outcomes during hospital stay

	32 weeks (N = 3554)	33 weeks (N = 4337)	34 weeks (N = 6281)	35 weeks (N = 5784)	36 weeks (N = 5713)	Total (N = 25669)	P value
DCC	1745/3443 (50.7)	2015/4180 (48.2)	2924/6021 (48.6)	2324/5440 (42.7)	2020/5479 (36.9)	11028/24563 (44.9)	<0.0001
Admission hypothermia	250/3502 (7.1)	301/4286 (7.0)	401/6191 (6.5)	441/5705 (7.7)	425/5630 (7.5)	1818/25314 (7.2)	0.07
Respiratory support on admission day	2628/3554 (73.9)	2483/4337 (57.3)	2727/6281 (43.4)	2454/5784 (42.4)	2329/5713 (40.8)	12621/25669 (49.2)	<0.0001
CPAP/NIV/HFNC	2586/3554 (72.8)	2412/4337 (55.6)	2606/6281 (41.5)	2311/5784 (40.0)	2134/5713 (37.4)	12049/25669 (46.9)	<0.0001
CPAP/NIV/HFNC days	3 (2 - 5)	2 (2 - 4)	2 (1 - 4)	2 (1 - 3)	2 (1 - 3)	2 (2 - 4)	<0.0001
Mechanical ventilation	684/3554 (19.2)	572/4337 (13.2)	573/6281 (9.1)	534/5784 (9.2)	536/5713 (9.4)	2899/25669 (11.3)	<0.0001
Surfactant	590/3554 (16.6)	447/4337 (10.3)	407/6281 (6.5)	355/5784 (6.1)	297/5713 (5.2)	2096/25669 (8.2)	<0.0001
Antibiotics in the first 3 days of age	2023/3554 (56.9)	2125/4337 (49.0)	2466/6281 (39.3)	1757/5784 (30.4)	1774/5713 (31.1)	10145/25669 (39.5)	<0.0001
Prolonged antibiotics	392/1994 (19.7)	390/2098 (18.6)	398/2422 (16.4)	333/1737 (19.2)	284/1755 (16.2)	1797/10006 (18.0)	0.0079
Cesarean birth without ROM	1813/3396 (53.4)	2054/4112 (50.0)	2860/5989 (47.8)	2706/5521 (49.0)	2610/5389 (48.4)	12043/24407 (49.3)	<0.0001
Antibiotics in the first 3 days of age after cesarean birth without ROM	763/1813 (42.1)	746/2054 (36.3)	853/2860 (29.8)	642/2706 (23.7)	677/2610 (25.9)	3681/12043 (30.6)	<0.0001
AUR (per 100 patient days)	9.7 (0 - 28.6)	7.4 (0 - 26.9)	0 (0 - 25.8)	0 (0 - 25)	0 (0 - 30.8)	0 (0 - 27.3)	<0.0001
Use of vascular access	3166/3554 (89.1)	3754/4337 (86.6)	4857/6281 (77.3)	3993/5784 (69.0)	4016/5713 (70.3)	19786/25669 (77.1)	<0.0001
UVC	829/3554 (23.3)	657/4337 (15.1)	655/6281 (10.4)	566/5784 (9.8)	657/5713 (11.5)	3364/25669 (13.1)	<0.0001
UAC	196/3554 (5.5)	166/4337 (3.8)	179/6281 (2.8)	157/5784 (2.7)	216/5713 (3.8)	914/25669 (3.6)	<0.0001
PICC	329/3554 (9.3)	247/4337 (5.7)	204/6281 (3.2)	180/5784 (3.1)	188/5713 (3.3)	1148/25669 (4.5)	<0.0001
Vascular access days	4 (3 - 6)	4 (2 - 6)	3 (1 - 5)	3 (0 - 4)	3 (0 - 4)	3 (1 - 5)	<0.0001
Age at discontinuation of vascular access (days)	5 (4 - 7)	4 (3 - 6)	4 (3 - 5)	4 (3 - 5)	4 (3 - 5)	4 (3 - 6)	<0.0001
NPO > 2 days	217/3554 (6.1)	211/4337 (4.9)	215/6281 (3.4)	179/5784 (3.1)	171/5713 (3.0)	993/25669 (3.9)	<0.0001
PN use	2689/3554 (75.7)	2530/4337 (58.3)	2408/6281 (38.3)	1734/5784 (30.0)	1431/5713 (25.0)	10792/25669 (42.0)	<0.0001
PN days	4 (1 - 6)	3 (0 - 5)	0 (0 - 3)	0 (0 - 2)	0 (0 - 1)	0 (0 - 4)	<0.0001
Early onset sepsis	29/3554 (0.8)	27/4337 (0.6)	44/6281 (0.7)	20/5784 (0.3)	48/5713 (0.8)	168/25669 (0.7)	0.002
Late onset sepsis	52/3554 (1.5)	35/4337 (0.8)	36/6281 (0.6)	35/5784 (0.6)	48/5713 (0.8)	206/25669 (0.8)	<0.0001
NEC stage 2 or higher	20/3554 (0.6)	21/4337 (0.5)	19/6281 (0.3)	23/5784 (0.4)	14/5713 (0.2)	97/25669 (0.4)	0.08

Data are presented as n/N (%) or median (IQR). DCC: deferred cord clamping; CPAP: continuous positive airway pressure; NIV: noninvasive ventilation; HFNC: high flow nasal cannula; ROM: rupture of membranes; AUR: Antibiotics utilization rate (duration antibiotics/duration of hospital stay per 100 patient days); UVC: umbilical venous catheter; UAC: umbilical arterial catheter; PICC: peripherally inserted central catheter; NPO: nil per os; PN: parenteral nutrition; NEC: necrotizing enterocolitis.

Table 4: Discharge characteristics

	32 weeks (N = 3554)	33 weeks (N = 4332)	34 weeks (N = 6280)	35 weeks (N = 5783)	36 weeks (N = 5703)	Total (N = 25652)	P value
Discharge destination							
Death in hospital	45 (1.3)	28 (0.6)	45 (0.7)	29 (0.5)	29 (0.5)	176 (0.7)	
Home	1567 (44.1)	2150 (49.6)	3394 (54.0)	3300 (57.1)	3315 (58.1)	13726 (53.5)	<0.0001
Another unit - same hospital	240 (6.8)	323 (7.5)	640 (10.2)	1059 (18.3)	1390 (24.4)	3652 (14.2)	
Other NICU in the CNN	41 (1.2)	40 (0.9)	61 (1.0)	47 (0.8)	67 (1.2)	256 (1.0)	
Non-CNN Community Hospital	1661 (46.7)	1791 (41.3)	2140 (34.1)	1348 (23.3)	902 (15.8)	7842 (30.6)	
Length of stay							
Length of stay in infants discharged home	28 (23 - 36)	20 (16 - 27)	15 (11 - 19)	11 (7 - 15)	8 (6 - 12)	14 (9 - 21)	<0.0001
PMA at discharge home	36.1 (35.3 - 37.3)	36 (35.3 - 36.9)	36.1 (35.6 - 36.7)	36.6 (36.1 - 37.1)	37.3 (36.9 - 37.9)	36.6 (35.9 - 37.3)	<0.0001
Length of stay in infants discharged to another unit or hospital	9 (6 - 16)	7 (4 - 12)	5 (3 - 9)	4 (3 - 7)	4 (2 - 6)	5 (3 - 9)	<0.0001
PMA at discharge to another unit or hospital	33.3 (32.9 - 34.3)	34 (33.6 - 34.7)	34.9 (34.4 - 35.3)	35.6 (35.4 - 36)	36.6 (36.4 - 36.9)	35.3 (34.3 - 36.3)	<0.0001
Support in infants discharged home							
Exclusive breastmilk	529 (33.8)	791 (36.8)	1226 (36.1)	1075 (32.6)	946 (28.5)	4567 (33.3)	<0.0001
Any breastmilk	1147 (73.2)	1594 (74.1)	2595 (76.5)	2506 (75.9)	2402 (72.5)	10244 (74.6)	0.001
Home gavage feeding	71 (4.5)	53 (2.5)	49 (1.4)	57 (1.7)	29 (0.9)	259 (1.9)	<0.0001

Data are presented as n (%) or median (IQR). Discharge destination was missing for 17 infants; 5 (33 week), 1 (34 week), 1 (35 week), and 10 (36 week). NICU: neonatal intensive care unit; CNN: Canadian Neonatal Network; PMA: postmenstrual age.