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Perinatal morbidity and health utilization among mothers of medically fragile infants

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Abstract

Objective: To determine the burden of perinatal morbidity among mothers of medically fragile infants.

Study Design: We conducted a retrospective cohort study of 6849 mothers who delivered liveborn infants at a quaternary care hospital during a two-year period. We compared mothers of well babies with mothers of infants admitted to the Neonatal Intensive Care Unit (NICU), and we used logistic regression to model predictors of postpartum acute care utilization among NICU mothers.

Results: Rates of obstetric morbidity were highest for mothers of infants staying ≥72 hours in the NICU; 54.2% underwent cesarean birth, 7.5% experienced severe maternal morbidity, and 6.6% required a blood transfusion. Factors independently associated with postpartum acute care use included gestational age <28 weeks, ever smoking, non-Hispanic Black race, temperature >38C and receiving psychiatric medication during the birth hospitalization.

Conclusion: Focused support for mothers of NICU infants has the potential to reduce maternal morbidity and improve health.

Introduction

The United States continues to have the highest rate of maternal mortality among high income countries, with 40% of deaths occurring more than one week after birth (1).

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Data availability: Deidentified individual data that supports the results will be shared beginning 9 to 36 months following publication provided the investigator who proposes to use the data has approval from an Institutional Review Board (IRB), Independent Ethics Committee (IEC), or Research Ethics Board (REB), as applicable, and executes a data use/sharing agreement with UNC.

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Preventing severe maternal morbidity and mortality thus requires attention to the postpartum period.

For the 7% of women whose infant is admitted to neonatal intensive care (2), postpartum recovery is further complicated by attending to a critically ill newborn. Although the mental health burden for mothers with infants in intensive care has been described (3–6), less is known about their physical health needs. As underlying maternal diseases are risk factors for preterm birth and congenital anomalies, these mothers would be expected to have a higher burden of physical health needs. Moreover, although neonatal intensive care units (NICUs) provide complex neonatal care, they are not equipped for maternal health needs. Barriers to care among mothers of medically fragile infants may thus contribute to preventable maternal morbidity.

We hypothesized that compared with mothers of well babies, mothers of medically fragile infants would have greater perinatal maternal morbidity and postpartum acute care utilization and would be less likely to receive recommended postpartum services. The overarching goal of this work was to provide data to inform improvements in health care services for the mothers of infants in intensive care.

Subjects and Methods

Our objective was to quantify the burden of perinatal morbidity among mothers of medically fragile infants, as well as assess their health utilization in the postpartum period. We conducted a retrospective cohort study of women with a live birth at a Level IV (2019) institution in the southeastern United States from July 1, 2014 through June 30, 2016 (7). Mothers of infants born alive (n=6897) were eligible. We excluded from our analysis mothers of infants who were admitted to the postpartum floor for palliative care (n=13) and those whose infants were not admitted to the NICU and died prior to discharge (n=35, previable or complex anomalies with decision to forgo a trial of intensive care). For women with more than one pregnancy during the study period, we excluded the second pregnancy, and for multiple gestations, we considered the length of stay of the infant with the longest NICU stay. The final sample size was 6,849 women (Figure 1).

We used our institution’s Perinatal Database (PNDB) to identify women with births during the study period. The PNDB was populated by trained nurse abstractors who reviewed the prenatal and peripartum record for women birthing at our institution and entered medical history, pregnancy and birth complications, mode of delivery, and birth data.

Medical records data from the Epic electronic medical record (EMR) are available for query through the Carolina Data Warehouse for Health (CDWH). The CDWH extracts data from the Epic@UNC Clarity database for use in research studies. Using mother and infant medical record numbers obtained from the perinatal database, the CDWH was queried for discrete data, including admission, discharge and delivery dates and times, outpatient visits, diagnosis and procedure codes, flow sheet data, such as vital signs and pain scores, medications administered and prescribed, and laboratory test results. Smoking status was defined as recorded in the EMR social history closest to the time of delivery.

Our a priori hypothesis was that mothers of infants with a brief NICU stay, defined as ≤72 hours, would be more similar to mothers of well babies than to mothers of infants with a NICU stay >72 hours, as transiently ill infants would be discharged home within a day of their mothers. In our primary analysis, we therefore compared mothers of infants with a NICU stay >72 hours with two groups: 1) mothers of well babies and 2) mothers of infants with a NICU stay ≤72 hours.

Maternal sociodemographic characteristics, including age, race/ethnicity, marital status, primary language and insurance type were determined from EMR data. Maternal census tract was used to ascertain neighborhood information, including the educational status and income of census tract residents (8). Neighborhood level information was used to create dichotomous variables, including whether participants lived in a neighborhood with <20% college graduates or with a median household income < $50,000. We calculated driving distance and time to UNC Hospital using Geographic Information System (GIS) data through ArcGIS software's network (9).

Health utilization was ascertained from EMR encounter. Using the location and clinical service, we classified encounters as maternity, ultrasound, psychiatric or other specialty visits. We defined women with three or more maternity visits during their pregnancy as having received prenatal care at our institution. Completion of a postpartum visit within 21–56 days postpartum, a Healthcare Effectiveness Data and Information Set (HEDIS) quality measure (10), was ascertained by a completed encounter with an obstetric, midwifery or family medicine provider in that time period.

Acute care visits were classified as emergency room, OB triage, or inpatient admission. Severe maternal morbidity was defined using Alliance for Improving Maternal Health (AIM) criteria (11) with final coded diagnoses and procedures for the birth hospitalization. We similarly used AIM criteria to ascertain severe maternal morbidity for patients readmitted in the 90 days postpartum.

Febrile morbidity was defined as a maternal temperature ≥ 38.0 C. Oxygen desaturation was defined as peripheral capillary oxygen saturation < 90%. Severe hypertension was defined as systolic blood pressure ≥ 160 or diastolic blood pressure ≥ 110. Mild depression symptoms were defined as Edinburgh Postpartum Depression Scale (EPDS) score ≥ 10 and <13, and major depression symptoms were defined as EPDS ≥ 13(12).

Medication data included inpatient administration and outpatient prescriptions ordered. To quantify receipt of recommended postpartum services, we considered documentation in the EMR and relevant CPT codes. Receipt of contraception during the postpartum period was determined through procedure, device, diagnosis and prescription data. Tubal ligation was ascertained by CPT codes (Postpartum: 58605, At c-section: 58611, Interval tubal: 58670 or 58671). IUD or Nexplanon placement was identified through CPT codes or medication orders for the LARC device accompanied by a procedure code for LARC placement. Charts with a diagnosis code for LARC insertion without an accompanying procedure or device code were reviewed to determine whether or not the device was placed. Provision of hormonal contraceptives was defined as either administration of medroxyprogesterone

acetate or a prescription for a progesterone-only or combined oral contraceptive pill, patch or ring. A composite measure of effective contraception included women who underwent tubal ligation, had LARC placed, or were prescribed a hormonal contraception method. Depression screening was determined by documentation of an EPDS score between delivery and 90 days postpartum.

ACOG guidelines recommend that women with hypertensive disorders undergo evaluation of blood pressure within 10 days of delivery. Assessment of blood pressure was defined as documentation of systolic and diastolic blood pressure between hospital discharge and 10 days postpartum. Women with gestational diabetes are recommended to undergo screening with a fasting or fasting and 2-hour load glucose at 6–12 weeks postpartum. We identified whether women underwent a timed glucose test during the postpartum period, and also whether they had any assessment of glucose status, including random glucose or hemoglobin A1c, between hospital discharge and 90 days postpartum.

Infant birth defects were determined by diagnosis codes in the infant record, using ICD9 and ICD10 codes for the National Birth Defects Prevention Network Core and Recommended conditions (13). Because the ICD 9 and 10 codes for patent foramen ovale and atrial septal defect are the same (ICD9: 745.5, ICD10: Q21.1), we excluded isolated atrial septal defect from our definition of birth defects.

Infant illness acuity was defined using the SNAPPE-II score (14), calculated from discrete EMR data for infant mean arterial blood pressure, temperature, partial pressure of oxygen, fraction of inspired oxygen, serum pH, urine output, birthweight, gestational age and 5 minute APGAR score. Because infant seizures in the first 12 hours of life were not reliably documented as discrete data, we excluded seizures from our score calculation. We defined a high SNAPPE-II score as >90% for medically fragile infants.

In our a priori power analysis, we anticipated that about approximately 1000 mothers of NICU babies and 6000 mothers of well babies would be included in our study sample. With >80% power and an alpha of 0.05, this sample size would allow us to detect a difference in rates of severe maternal morbidity of 1% among mothers of well babies vs. 3% among mothers of NICU babies. For our analysis, we conducted bivariate analyses using chi square tests, comparing our referent group, mothers of medically fragile infants, with that of 1) mothers of well babies and 2) mothers of transiently ill infants. We found that there were similar rates of postpartum acute care utilization among mothers of NICU infants, independent of infant length of stay. We therefore further evaluated clinical factors associated with postpartum acute care utilization among all mothers of infants admitted to the NICU. Factors that were associated with acute care use in bivariate analysis were included in a logistic regression model, and backward selection was used to identify independent predictors. To test whether NICU length of stay (<72 hours vs. ≥72 hours) modified the association between predictors and acute care utilization, we added an interaction term to the prediction model. In a sensitivity analysis, we restricted our sample to women with at least one encounter in our system between discharge and 90 days of delivery. The study was approved by the Institutional Review Board of the University of North Carolina (IRB# 16–0980) and performed in accordance with the Declaration of

Helsinki. Because there was no contact with participants for this retrospective cohort study, we requested and were granted a HIPAA waiver for the analysis of medical records data. Informed consent was obtained from all participants in the qualitative arm of the study.

Results

During the study period, 6849 women delivered liveborn infants, of whom 5768 were mothers of well babies, 338 had an infant with a NICU stay ≤72 hours, and 743 had an infant with a NICU stay >72 hours. Sociodemographic factors associated with having an infant with a NICU stay >72 hours compared with having a well-baby included primiparity, non-Hispanic Black race, primary language of English, and having military insurance. Compared with mothers of well babies, mothers of NICU infants regardless of length of stay were more likely to be tobacco users, to reside in a neighborhood where less than 20% of residents had completed a college degree or had a median income less than $50,000, or to have a body mass index (BMI) ≥30 kg/m^2, as shown in Table 1.

As expected, infants admitted to the NICU delivered at earlier gestational ages. Among infants with a stay >72 hours, 46.0% delivered at <35 weeks, 22.1% had a major birth defect, and 10% had a SNAPPE-II score >90%. Similarly, obstetric morbidity was highest for mothers of infants with a stay >72 hours, among whom 54.2% underwent cesarean birth, 7.5% experienced severe maternal morbidity, and 6.6% required a blood transfusion. Mothers of NICU infants with a short NICU stay were more likely than mothers of well babies to have a temperature>38 C (≤72 hours 22.5, well babies 14.7%, p<.01). Mothers of NICU infants were more likely than mothers of well babies to have a capillary oxygen saturation <90% (>72 hours 17.2, ≤72 hours 14.2, well babies 9.2%, >72 hours vs. well babies p<.01, >72 hours vs. ≤72 hours p=.21), or ≥1 severe-range blood pressure (>72 hours 44.7, ≤72 hours 40.8, well babies 21.8, p<.01). Rates of intravenous cardiac medication during the birth hospitalization were highest among mothers of infants with longer NICU stays (>72 hours 17.9, ≤72 hours 10.1, well babies 2.4%, >72 hours vs. well babies p<.01, >72 hours vs. ≤72 hours p<.01).

Compared with mothers of well babies, mothers of NICU infants had higher rates of antibiotics (>72 hours vs. well babies p<.001), psychiatric medication (>72 hours vs. none p<.001) and opiate medication assisted treatment (>72 hours vs. well babies p=0.02), and they were also more likely to undergo a urine toxicology screen (>72 hours vs. well babies p<.001), and to have a positive urine toxicology screens for cannabinoids (>72 hours vs. well babies p=0.01), amphetamines (>72 hours vs. well babies p=0.003) and cocaine (>72 hours vs. well babies p=0.001). Among mothers of NICU babies, rates for these outcomes did not differ by NICU length of stay (>72 hours vs. ≤72 hours p>.10).

In the 90 days following birth (Table 2), mothers of NICU infants had twice as many visits to OB triage and the emergency department as mothers of well babies (>72 hours vs. well babies, p<.001; >72 hours vs. ≤72 hours p=0.93). NICU mothers were more likely to be readmitted than mothers of well babies: 44/1081 (4.1%) vs. 115/5768 (2.0%), p < .001, and when readmitted, had a longer length of stay (NICU mothers median 3.2 days, IQR 2.0 to 7.4 vs. well babies 2.5 days, IQR 1.8 to 4.3, p=0.03). Mothers of NICU infants also had

more maternity care and psychiatry encounters, regardless of NICU length of stay. Among those screened for depression, mothers of NICU infants were more likely to have EPDS scores ≥13 (>72 hours 12.7, ≤72 hours 11.7, well babies 6.8%; >72 hours vs. well babies, p<.001; >72 hours vs. ≤72 hours p=0.93). They were also more likely receive effective contraception (>72 hours 43.7, ≤72 hours 41.1, well babies 37.5%; >72 hours vs. well babies, p=.001; >72 hours vs. ≤72 hours p=0.42) and more likely to complete an indicated blood pressure check (>72 hours 23.3, ≤72 hours 22.2, well babies 15.1%; >72 hours vs. well babies, p=.004; >72 hours vs. ≤72 hours p=0.84). Although we had hypothesized that mothers of infants with stays >72 hours would be less likely to receive recommended follow-up care than mothers of well babies, among women with gestational diabetes, we found similar rates of follow-up timed glucose screening among mothers of infants staying >72 hours than among ≤72 hours or well babies (>72 hours 21.6, ≤72 hours 13.9, MWB 14.5%%; >72 hours vs. well babies, p=.12; >72 hours vs. ≤72 hours p=0.33). In sensitivity analyses limited to women who had at least one health encounter within our system between discharge from maternity care and 90 days postpartum, patterns of utilization were similar (data not shown).

Despite their greater utilization of postpartum health care, our results suggest that services were not configured to accommodate NICU families. For example, a maternal blood pressure check within 10 days of birth was indicated for one in three NICU mothers; however, women whose infants were hospitalized throughout this time period were no more likely to undergo a blood pressure check than women whose infants had been discharged from the NICU before 10 days postpartum (23.2 vs. 22.8%, p=0.93). We similarly found that despite their proximity to health care, only half of mothers of NICU infants were screened for depression, and mothers of infants with longer lengths of stay were no more likely to have documentation of depression screening than mothers of infants with shorter stays (NICU LOS <7 days, 49.0%; 7-<14 days, 47.8%, 14-<28 days, 43.7%; 28+ days, 55.1%, p=0.13).

With respect to attending a postpartum visit, we found nearly identical rates of completing a visit with an obstetric provider from 21–56 days postpartum among our three groups (overall 48.1%, p=0.99). When we stratified our analysis by site of prenatal care, we found that women who received prenatal care at UNC had similar rates of postpartum visits (>72 hours 71.9%, ≤72 hours 65.9, well babies 72.8; >72 hours vs. well babies, p=.75, >72 hours vs. ≤72 hours, p=.14); however, among women who did not receive prenatal care at UNC, mothers of NICU infants were far more likely than mothers of well babies to have a postpartum visit in our health system (Figure 2; >72 hours 30.3, ≤72 hours 19.7, well babies 8.8%; >72 hours vs. well babies, p=<.001; >72 hours vs. ≤72 hours, p=0.02), suggesting that mothers of NICU infants who received prenatal care elsewhere were more likely to undergo follow-up care at UNC than mothers of well babies.

Mothers of infants in the NICU were twice as likely as mothers of well babies to utilize acute care by 90 days postpartum (8.1% vs. 15.1%, crude OR 2.03, 95% CI 1.67–2.45). In bivariate analyses (Table 3), factors associated with acute care utilization for NICU mothers included race/ethnicity, past or current maternal tobacco use, maternal BMI ≥ 30 kg/m^2, cesarean birth, temperature greater than 38.0 C or severe-range blood pressure during

the birth hospitalization, administration of intravenous cardiac medication, psychiatric medications or opiate medication-assisted treatment, creatinine ≥ 1.1, hemoglobin <10.0, and documentation of a urine toxicology screen being performed. Infant factors associated with maternal acute care use included gestational age <28 weeks and SNAPPE score >90%. To identify independent predictors of postpartum acute care utilization, we used backward selection, beginning with the factors identified in bivariate analyses. Identified predictors included gestational age <28 weeks, ever tobacco use, temperature greater than 38.0 C during the birth hospitalization, psychiatric medication during the birth hospitalization, and non-Hispanic Black race (Table 4). When we added an interaction term for NICU length of stay to the prediction model, we did not find evidence of effect modification (p>0.20 for all predictors).

Discussion

In a population of women delivering at a quaternary care hospital in the southeastern United States, we found that mothers of medically fragile infants experienced greater peripartum morbidity and had higher utilization of health services following birth. Although we had anticipated that mothers of infants with brief NICU stays would have utilization profiles similar to mothers of well babies, we found that even short NICU admissions were associated with increased postpartum health utilization. These findings suggest that mothers of NICU infants are a population at high risk for maternal morbidity and could benefit from care coordination.

Our findings confirm earlier work showing that mothers of very preterm infants experience greater morbidity (15–17); we extend these findings by considering mothers of all infants admitted to intensive care. In analyses of records sampled from the Maternal-Fetal Medicine Units Network, (15, 16) birth of a preterm infant at 23-<34 weeks was associated with higher rates of pre-gestational diabetes, hypertension, tobacco use during pregnancy, and C-section. Compared with birth at 39-<40 weeks, birth of an infant at 23-<34 weeks was associated with a 9.10-fold odds of severe maternal morbidity (17). Reddy et al. found higher rates of composite serious maternal complications among mothers of infants born at 23–27 weeks (11.5%), compared with 28–31 (9.5%) and 32–33 weeks (6.3%), p <.001 (16). Our study extends this work by including all mothers of medically fragile infants, regardless of gestational age at birth; of note, one in four mothers of medically fragile infants birthed at >37 weeks. We further assessed health utilization in the postpartum period and found mothers of NICU infants utilize more outpatient services during the postpartum period. Despite greater need for care, we found that even while infants were hospitalized, indicated maternal services, such as blood pressure checks and depression screening, were no more likely to be provided. These results suggest that there are important opportunities to modify systems to deliver maternal care at the infant's bedside.

Mothers of NICU infants also utilized more acute care than mothers of well babies. Several clinical factors were associated with acute care utilization, including febrile morbidity, psychiatric conditions, extremely preterm birth and tobacco use. Others have used claims data and found that psychiatric diagnoses are associated with postpartum emergency department utilization (18). Our analysis extends this work by using data from the EMR

that is available at the time of hospital discharge to inform risk stratification and identify candidates for care coordination.

Our findings must be interpreted within the limitations of our study design. We analyzed births within a single institution, limiting generalizability. Utilization patterns may differ in settings such as freestanding children's hospitals where on-site women's health services are not available. Moreover, data were limited to a single health system, and thus are a conservative measure of services used. To address this issue, we conducted a sensitivity analysis limited to women who accessed care after maternity discharge in our health system and found similar results. Future analyses should harness linkages between EMR and claims data. The association between infant NICU admission and maternal morbidity is a function of selection, not causation. Mothers with significant health problems are more likely than healthy mothers to have infants with health problems, and therefore have greater need for health services following birth. We found higher utilization of acute care among women who are Non-Hispanic Black. This difference likely reflects the legacy of structural determinants of health, "cultural norms, policies, institutions, and practices that define the distribution (or maldistribution) of social determinants of health."(19) Disparate outcomes may also result from inequitable delivery of care: we previously reported that following cesarean birth, Black and Hispanic women at our institution were evaluated for pain less frequently, had higher pain scores, and received less pain medication than white women(20). Given this context, patterns of health utilization should be interpreted with caution, as observed patterns reflect the constraints of insurance coverage, access to care and systemic racism, and using these patterns to inform resource allocation may perpetuate unjust systems (21).

Our findings suggest multiple opportunities for enabling mothers of NICU infants to access care. In qualitative interviews, mothers welcomed approaches that bring care to the crib side, such as having an advanced practice provider or maternal nurse perform blood pressure and wound checks in the NICU (22). Telehealth offers further opportunities to provide support at the location of the mother's choice, including while she is with her infant. NICU mothers may also benefit from tailored guidance on postpartum recovery (23) that addresses the tensions of healing from birth and tending to their critical ill infant.

In this retrospective cohort study of nearly 7000 mothers birthing at a single institution over a 2-year period, we found that mothers of NICU infants have a greater burden of peripartum complications than mothers of well babies. These mothers also utilize more acute care services and have more outpatient visits in the 90 days following birth. Factors that are readily assessed at the time of discharge, such as infant gestational age <28 weeks, febrile morbidity, and psychotropic medication use, predict women at the greatest risk of using acute care. Focused approaches that address the medical needs of these mothers as part of neonatal intensive care unit care and discharge planning have the potential to reduce morbidity and improve maternal health.

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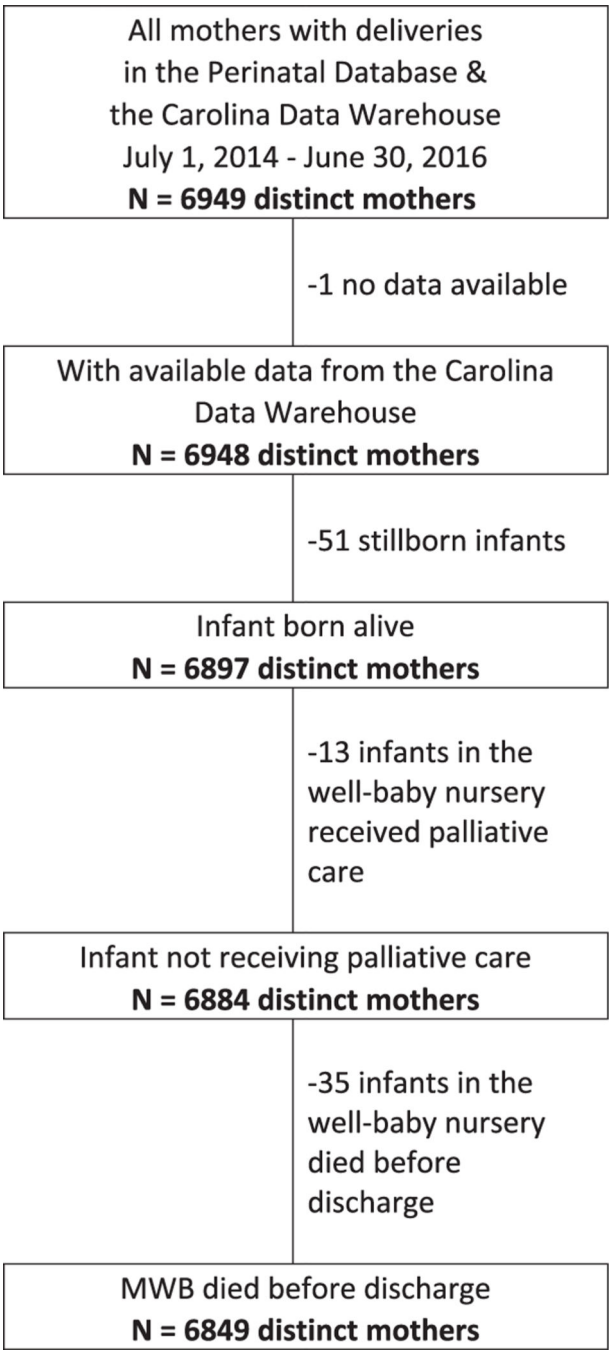

Figure 1.
Care4Moms Final Sample

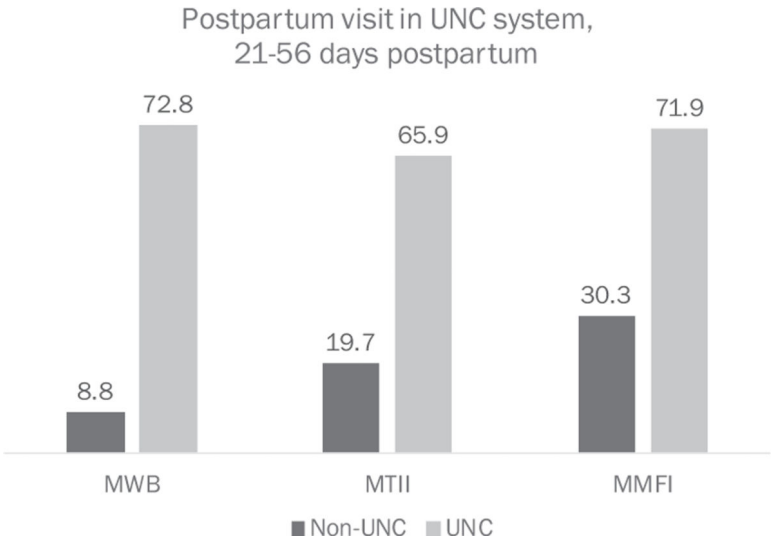

Figure 2.
Postpartum visit utilization within the UNC system

Table 1.

Sociodemographic characteristics, comorbidities, perinatal outcomes and maternal morbidity of mothers of live born infants at UNC Hospital, stratified by infant length of stay in the neonatal intensive care (NICU) (n=6,849)

	None		≤72 hours		>72 hours		None vs > 72 hours	≤72 hours vs. >72 hours
	N	%	N	%	N	%	p*	p*
Maternal Age							0.46	0.82
<20	254	4.4	16	4.7	36	4.8		
20–34	4,216	73.1	234	69.2	527	70.9		
>=35	1,298	22.5	88	26	180	24.2		
Parity							<.001	0.9
1	2,146	37.2	149	44.1	329	44.3		
2	1,843	32	93	27.5	191	25.7		
3	1,036	18	47	13.9	113	15.2		
>=4	743	12.9	49	14.5	110	14.8		
Race-ethnicity							<.001	0.003
Non-Hispanic White	2,551	44.2	140	41.4	358	48.2		
Non-Hispanic Black	929	16.1	77	22.8	191	25.7		
Asian/Pacific Islander	291	5	10	3	7	0.9		
Hispanic	1,546	26.8	76	22.5	114	15.3		
Native American /Other/Refused/Unknown	451	7.8	35	10.4	73	9.8		
Primary language of English	4,485	77.8	280	82.8	648	87.2	<.001	0.11
Insurance at delivery							<.001	0.05
Private	2,676	46.4	138	40.8	319	42.9		
Regular or Pregnancy Medicaid	2,267	39.3	150	44.4	309	41.6		
Presumptive or Pending Medicaid	98	1.7	<10	2.1	13	1.7		
Emergency Medicaid	387	6.7	21	6.2	29	3.9		
Medicare	58	1	<10	1.2	15	2		
Military	163	2.8	11	3.3	51	6.9		
Self/Unknown	119	2.1	<10	2.1	<10	0.9		

	None		≤72 hours		>72 hours		None vs > 72 hours	≤72 hours vs. >72 hours
	N	%	N	%	N	%	p*	p*
Tobacco assessment closest to delivery							<.001	1.0
Never	4,341	75.3	225	66.6	498	67		
Current	279	4.8	32	9.5	71	9.6		
Quit	887	15.4	72	21.3	155	20.9		
Not Assessed	261	4.5	<10	2.7	19	2.6		
Travel Time from Home to Hospital							<.001	0.01
<30 minutes	2,878	54.7	125	40.6	202	32.4		
30–60 minutes	1,759	33.4	123	39.9	252	40.4		
60+ minutes	629	11.9	60	19.5	170	27.2		
Neighborhood characteristics								
Proportion College Degree less than 20%	3,783	74.2	238	80.4	511	83.4	<.001	0.27
Median income less than $50,000	2,576	50.5	174	58.8	363	59.2	<.001	0.9
Body Mass Index (kg/m ^{2})							<.001	0.45
<25	2,484	49.7	109	38.2	247	40.1		
25-<30	1,257	25.1	83	29.1	155	25.2		
30+	1,261	25.2	93	32.6	214	34.7		
Gestational age at delivery							<.001	<.001
>37 wks	5,560	96.4	243	71.9	185	24.9		
34–37 wks	208	3.6	79	23.4	216	29.1		
<34 wks	-	0	16	4.7	342	46		
Multiple Gestation	83	1.4	19	5.6	102	13.7	<.001	<.001
Any major birth defect	159	2.8	28	8.3	164	22.1	<.001	<.001
SNAPPE-II >90%	--	--	13	3.8	74	10	<.001	<.001
Delivery Type							<.001	<.001
Spontaneous Vaginal Delivery	4,148	71.9	148	43.8	325	43.7		
Operative Vaginal Delivery	207	3.6	24	7.1	15	2.0		
Cesarean Section	1,413	24.5	166	49.1	403	54.2		
Hysterectomy	<10	0.1	<10	0.6	12	1.6	<.001	0.17

	None		≤72 hours		>72 hours		None vs > 72 hours	≤72 hours vs. >72 hours
	N	%	N	%	N	%	p*	p*
Severe maternal morbidity, AIM criteria	132	2.3	20	5.9	56	7.5	<.001	0.33
General Anesthesia	52	0.9	19	5.6	64	8.6	<.001	0.09
EBL >1000cc	673	11.7	95	28.1	204	27.5	<.001	0.82
Transfusions								
Any packed Red Blood Cells	144	2.5	19	5.6	49	6.6	<.001	0.54
Any Fresh Frozen Plasma, platelets or cryoprecipitate	18	0.3	<10	0.9	14	1.9	<.001	0.22
Abnormal vital signs								
Temperature >38 C	850	14.7	76	22.5	117	15.7	0.47	0.007
Peripheral capillary oxygen saturation <90%	530	9.2	48	14.2	128	17.2	<.001	0.21
Any severe range blood pressure	1,257	21.8	138	40.8	332	44.7	<.001	0.18
Medications during birth admission								
Intravenous cardiac	140	2.4	34	10.1	133	17.9	<.001	<.001
Antibiotics after delivery	702	12.2	72	21.3	173	23.3	<.001	0.41
Psychiatric	336	5.8	43	12.7	120	16.2	<.001	0.14
Opiate medication assisted treatment	65	1.1	10	3	16	2.2	0.02	0.42
Urine Toxicology Screen performed	275	4.8	29	8.6	86	11.6	<.001	0.14
Positive for cannabinoids	63	1.1	<10	1.2	16	2.2	0.01	0.27
Positive for amphetamines	<10	0.1	<10	0.6	<10	0.4	0.003	0.67
Positive for cocaine	21	0.4	<10	0.6	<10	1.2	0.001	0.35

Source: The UNC Perinatal Database and the Carolina Data Warehouse for Health (CDW-H) from July 1, 2014 - June 30, 2016, N = frequency; % = column percent.

*p-value for chi-square test for 2 group comparison. AIM criteria = Alliance for Innovation in Maternal Health.

Table 2:

Postpartum health utilization, 0–90 days postpartum, of mothers of live born infants at UNC Hospital, stratified by infant length of stay in the neonatal intensive care (NICU) (n=6,849)

	None		≤72 hours		>72 hours		None vs > 72 hours	≤72 hours vs. >72 hours
	N	%	N	%	N	%	p*	p*
N	5,768	84.2	338	4.9	743	10.9		
Any visit	3,466	60.1	219	64.8	495	66.6	<.001	0.56
Acute Care								
Obstetric triage visits	160	2.8	20	5.9	45	6.1	<.001	0.93
Emergency department visits							<.001	0.93
0	5,516	95.6	309	91.4	683	91.9		
1	199	3.5	22	6.5	47	6.3		
2+	53	0.9	<10	2.1	13	1.7		
Readmission	115	2	16	4.7	28	3.8	0.002	0.46
Outpatient Care								
Maternity provider visit, 21–56 days postpartum	2,775	48.1	164	48.5	357	48	0.97	0.89
Number of maternity provider visits							<.001	0.11
0	2,524	43.8	134	39.6	290	39		
1	1,960	34	114	33.7	212	28.5		
2	876	15.2	61	18	146	19.7		
3+	408	7.1	29	8.6	95	12.8		
Psychiatry visit	158	2.7	23	6.8	36	4.8	0.001	0.19
Depression screening								
EPDS performed	2,673	46.3	162	47.9	370	49.8	0.08	0.57
EPDS results among those screened							<.001	0.93
<10	2,341	87.6	128	79	287	77.6		
10–12	149	5.6	15	9.3	36	9.7		
13+	183	6.8	19	11.7	47	12.7		
Contraception prescribed							0.005	0.47

	None		≤72 hours		>72 hours		None vs > 72 hours	≤72 hours vs. >72 hours
	N	%	N	%	N	%	p*	p*
None	3,604	62.5	199	58.9	418	56.3		
Implant	213	3.7	21	6.2	35	4.7		
IUD	639	11.1	29	8.6	85	11.4		
Tubal	310	5.4	28	8.3	58	7.8		
Hormonal	1,002	17.4	61	18	147	19.8		
Any effective method (LARC, Tubal Ligation or Hormonal)	2,164	37.5	139	41.1	325	43.7	0.001	0.42
Follow-up for hypertension								
BP check by 10 days postpartum							0.004	0.84
Indicated, not done	609	84.9	63	77.8	181	76.7		
Indicated, done	108	15.1	18	22.2	55	23.3		
Follow-up for diabetes								
Timed glucose							0.12	0.33
Not performed	331	85.5	31	86.1	58	78.4		
Performed	56	14.5	<10	13.9	16	21.6		
Any glucose test							0.04	0.31
Not performed	276	71.3	25	69.4	44	59.5		
Performed	111	28.7	11	30.6	30	40.5		

Source: The UNC Perinatal Database and the Carolina Data Warehouse for Health (CDW-H) from July 1, 2014 – June 30, 2016, N = frequency; % = column percent.

*p-value for chi-square test for 2 group comparison. Postpartum visit defined as office, maternity care or postpartum care visit to family medicine, midwifery, obstetrics and gynecology or maternal-fetal medicine. EPDS = Edinburgh Postnatal Depression Screen

Table 3:

Maternal and infant factors associated with acute care utilization in the 90 days following birth among mothers of infants who were admitted to neonatal intensive care.

	NICU mothers	Acute Care Use		
	N	N	%	p*
N	1081	163	15.1	
Maternal Characteristics				
Race-Ethnicity				0.02
Non-Hispanic White	498	70	14.1	
Non-Hispanic Black	268	57	21.3	
Asian/Pacific Islander	17	<10	11.8	
Hispanic	190	24	12.6	
Native American/Other/Refused/Unknown	108	10	9.3	
Ever smoker	330	67	20.3	0.001
Body Mass Index, k/m^2				0.01
<25	356	39	11.0	
25-<30	238	33	13.9	
≥30	307	58	18.9	
Maternal risk factors, birth hospitalization				
Cesarean birth	569	101	17.8	0.01
Abnormal vital signs				
Any temperature greater than 38.0 C	193	42	21.8	0.004
Any severe blood pressures	470	87	18.5	0.006
Medications during birth admission				
Intravenous cardiac	167	34	20.4	0.04
Psychiatric	163	33	20.2	0.05
Opiate medication assisted treatment	26	10	38.5	<.001
Lab values				
Creatinine greater than 1.1	29	10	34.5	0.003

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	NICU mothers	Acute Care Use		
	N	**N**	**%**	**p***
Hemoglobin less than 10.0	417	80	19.2	0.003
Urine Toxicology Screen performed	115	31	27.0	<.001
Positive for Cannabinoids	20	<10	40.0	0.002
Infant Characteristics				
Gestational Age				<.001
>37 wks	428	51	11.9	
34–37 wks	295	41	13.9	
28–34 wks	214	35	16.4	
<28 wks	117	32	27.4	
SNAPPE score >90%	87	24	27.6	<.001

Source: The UNC Perinatal Database and the Carolina Data Warehouse for Health (CDW-H) from July 1, 2014 – June 30, 2016, N = frequency; % = row percent.

*p-value from the Pearson chi-square test.

Table 4:

Maternal and infant factors independently associated with acute care utilization in the 90 days following birth among mothers of infants who were admitted to neonatal intensive care.

Variable			
	beta	**Odds ratio**	**95% CI**
Gestational age at delivery, weeks			
<28	0.6475	3.38	(1.74–6.58)
28–34	−0.0643	1.66	(0.92–3.01)
34–47	−0.0134	1.74	(1.01–3)
>37	referent	1.0 (ref)	
Ever vs. never smoker	0.2608	1.69	(1.08–2.64)
1+ temperature > 38.0 C	0.3637	2.07	(1.24–3.46)
Psychiatric medication	0.3424	1.98	(1.16–3.39)
Race/ethnicity			
Non-Hispanic White	referent	1.0 (ref)	
Asian / Pacific Islander	−0.2129	0.88	(0.11–7.36)
Hispanic	0.0807	1.18	(0.61–2.28)
Non-Hispanic Black	0.6007	1.98	(1.21–3.25)
Native American/Other/Refused/Unknown	−0.3855	0.74	(0.31–1.75)

Source: The UNC Perinatal Database and the Carolina Data Warehouse for Health (CDW-H) from July 1, 2014 - June 30, 2016. Logistic regression using backward selection among factors that were associated with acute care use in bivariate analysis.