Timely Access to Neonatal Intensive Care Units: Non-metropolitan Premature Infants at Risk

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Abstract:

Introduction

Infants born at 34 weeks or less gestation are at increased risk of neonatal mortality and morbidity. Neonatal intensive care units (NICUs) are capable of effectively managing the sequelae of prematurity and improving outcomes. Our objective was to evaluate the proportion of Medicaid-insured infants who delivered in NICU hospitals and determine if maternal residence influenced the ability to access such facilities.

Methods

We linked American Hospital Association annual survey data to an existing health services database that included birth certificate data, CMS State Medicaid Research Files of Georgia and Area Resource Files. Delivery in a NICU hospital was our primary outcome and maternal residence was our main exposure variable. Covariates were constructed to reflect the plethora of risk factors associated with preterm delivery or NICU access including maternal and fetal demographic characteristics, maternal medical conditions and antenatal care factors. We performed Chi-square and Students t tests when appropriate for bivariate comparisons between women living in metropolitan versus non-metropolitan areas. A p value of < 0.05 was considered statistically significant. We calculated risk ratios for delivering in a NICU hospital and each covariate. A multivariate logistic regression model was fit with significant covariates to determine the influence of maternal residence on delivery in a NICU hospital.

Results

All Medicaid-insured women who delivered an infant at 34 weeks or less were included in our study (n=2065). Sixty-seven percent of our population lived in metropolitan areas and nearly 75% delivered in NICU hospitals. Even when adjusting for significant risk factors, non-metropolitan women had 3.16 (95% Confidence interval: 2.72, 3.67) times the risk of not delivering in a hospital without a NICU compared to women living in metropolitan areas.

Discussion

Strengthening regionalized perinatal network systems are crucial to improving access to NICU hospitals for preterm infants born to non-metropolitan mothers. Tailoring current policies and outreach efforts to target this disparity should improve neonatal outcomes and help achieve Healthy People 2010 Goals.

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Introduction:

The complications of premature birth are costly and devastating. Infants born at less than 37 weeks gestation comprise nearly 12% of births in the United States while over two-thirds of the infant mortality rate is attributable to complications of premature birth.[1,2] Short- and long-term morbidities such as respiratory distress syndrome, sepsis, cerebral palsy and retinopathy are more common among preterm infants, particularly those born at 34 weeks or less gestation.[3-5]

One intervention known to improve and effectively manage the sequelae associated with prematurity is delivery in a hospital with immediate access a neonatal intensive care unit (NICU): NICUs are defined as units "separate from the newborn nursery providing intensive care to all sick infants including those with the very lowest birth weight (less than 1500 grams)."[6] Several studies have demonstrated improved neonatal survival when premature infants are born in NICU hospitals compared to premature infants born at non-NICU hospitals who are later transported to

such facilities.[7-10] Not only is mortality improved, but also these studies show decreased incidence of neonatal morbidity such as intraventricular hemorrhage, pulmonary complications and shorter lengths of hospitalization.[9-11]

Both the American College of Obstetricians and Gynecologists (ACOG) and the American Academy of Pediatrics (AAP) recommend the delivery of premature infants "less than 34 weeks gestation in hospitals with NICUs."[12] In addition, these organizations endorse the establishment of perinatal regional networks capable of linking NICU hospitals with community hospitals that service large populations but lack the facilities to manage the complications of prematurity. Because NICUs tend to be clustered in urban areas, these networks are crucial to providing intensive services to isolated regions.

The state of Georgia has a well-established regional perinatal network system connecting community hospitals to NICU hospitals.[13] Their Recommended Guidelines for Perinatal Care in Georgia are "intended to be a blueprint ... that will improve the quality of reproductive health care for women and perinatal health care for pregnant women and infants."[13] In 1995, the Georgia Medicaid program covered approximately 52% of deliveries in the state.[14]

This study had two objectives. The primary objective was to evaluate the proportion of Medicaid-insured women who delivered preterm infants in NICU hospitals in order to determine whether the proportion differed for women living in metropolitan versus non-metropolitan areas. We hypothesized that maternal residence would influence delivery in NICU hospitals. Specifically, we believed that women living in non-metropolitan areas were at increased risk of delivering in hospitals without a NICU. A second objective of this study was to determine if other maternal factors influenced delivery in a NICU hospital. We postulated that certain medical conditions such as pre-eclampsia and preterm labor would predict delivery in NICU hospitals compared to other conditions such as antenatal bleeding or diabetes. We hypothesized that even adjusting for relevant clinical factors associated with preterm delivery, maternal residence would remain a significant influence on delivering in a NICU hospital.

Methods:

Data Source

We used a population-based retrospective cohort study design to determine the influence of maternal residence on delivery in an NICU hospital. We merged American Hospital Association (AHA) annual survey data[6] with an existing database that linked birth certificate data, CMS State Medicaid Research Files (SMRFs) for Georgia claims information and Area Resource Files (ARF).[15] The linked database provided

comprehensive information on both maternal and hospital characteristics for nearly 90% of women whose deliveries were covered by the Georgia Medicaid program during 1995 (total deliveries = 51,525).

Outcome and Exposure Variables and Covariates

Our main outcome variable was delivery in a NICU hospital. We used birth certificate information to identify delivery hospitals. The AHA annual survey, which is completed voluntarily by hospitals, provides descriptive information about hospital characteristics and services. The survey allows determination of which hospitals have on-site NICU facilities. Furthermore, we used AHA data to supplement our knowledge of other services offered in the hospital including intermediate newborn services, obstetrical services, designated obstetrics level unit and emergency department facilities.[6]

The 1995 AHA survey was matched to delivery hospitals identified from birth certificate data. We were able to link information to 75 of 99 delivery hospitals. Additional information on eighteen hospitals was matched with AHA survey data from 1993-1994 and 1996-1997. Three hospitals not completing an AHA survey during these five years were contacted by an author (AG) for hospital information. We excluded three delivery hospitals because we were unable to obtain any information on the services offered by the facility (total births=6). Thus, we had 96 hospitals in our study.

Twenty-eight percent of participating hospitals met AHA standards for NICU designation (Table I). While all offered obstetrical services, only 55% offered services for complicated pregnancies. Eighty-one percent of hospitals equipped with an NICU were located in metropolitan areas.

Table I: Hospital Characteristics* (n = 96)

Characteristic	Percent
NICU facility	28
Obstetric Services	
- Level I (uncomplicated cases)	45
- Level II (some complicated cases, special care nursery available)	45
- Level III (all complications with staff perinatologist)	10
Delivery hospital in metropolitan area	44
NICU hospital located in metropolitan areas	81

* Based on American Hospital Association survey data

Our main exposure variable, metropolitan versus non-metropolitan location of maternal residence, was derived from birth certificate information. County of residence was recorded for each mother and linked to ARF data. Geographic designation was assigned using rural-urban continuum codes. Using standard reduction methodology, we dichotomized the rural-urban continuum codes into metropolitan versus non-metropolitan status. Thus, a mother was classified as living in a metropolitan area if the county population was 250,000 or greater and a non-metropolitan area if the population in the county was less than 20,000.

We postulated there were several covariates representing identifiable risk factors for preterm delivery that could also influence delivery in an NICU hospital. Birth certificate data provided pertinent maternal demographic and antenatal care information. Age, ethnicity and education were identified from birth certificate information; as was obstetric history such as parity, prior pregnancy losses and gestational age at delivery. Tobacco use was identified via self-reported information on birth certificate data, although we suspected underreporting to interfere with accuracy.

Using the SMRF we were able to formulate variables reflecting maternal medical conditions that might contribute to early delivery and/or necessitate delivery in an NICU hospital. The SMRF data identifies chronic and/or pregnancy-related medical conditions in inpatient and outpatient claims. We classified chronic medical conditions such as diabetes mellitus if the mother was diagnosed at anytime during the pregnancy or the delivery episode. Similarly, we used combined antenatal care and delivery episode claims information to identify the following pregnancy-related conditions: multiple gestation, and premature rupture of membranes. For other pregnancy-related conditions such as vaginal bleeding/placental previa, pre-eclampsia, and preterm labor, we used delivery episode-only SMRF claims data.

Prenatal care utilization is considered a possible risk factor for preterm delivery. The Georgia Medicaid antenatal and delivery care reimbursement system is based on global fee assessment. Thus, initiation of care and number of visits cannot be assessed from the SMRF data. We used the Revised Graduated Prenatal Care Utilization Index (R-GINDEX) from birth certificate data to assess the initiation of prenatal care, number of visits and adequacy of care.[16] The R-GINDEX is one of several classification tools to describe the quality of prenatal services received. This index uses six categories to describe the quality of prenatal services including a category labeled "intensive" for women who received more than the expected number of prenatal care visits. It has been suggested that the R-GINDEX is best for gestational age-specific research.[16] We grouped our observations into those receiving intensive or adequate care compared to those receiving inadequate care. We postulated that women receiving adequate or intensive care would imply better observation to detect potential pregnancy complications.

Our final covariate was insurance status. Durbin et al. have suggested that insurance status might influence delivery hospital and access to NICU facilities.[17] While all of our participants were Medicaid-insured at the time of delivery, many of the women were not insured at the beginning of their pregnancies. We constructed a variable that identified women who were not insured prior to receiving Medicaid coverage. We postulated that

women who lacked insurance coverage for any period in their pregnancy might be at higher risk for preterm delivery or pregnancy complications that require more intense interventions. In 1995, there was no health maintenance organization penetration. Women who had private insurance prior to Medicaid enrollment or were enrolled in Medicaid for the nine months prior to delivery were considered to have full medical coverage throughout the pregnancy.

Statistical Analysis

We first performed a univariate analysis to describe our study population. We included information on all characteristics that might be associated with preterm delivery. In accordance with our hypothesis, we conducted our bivariate analysis using Chi-square test and Students t test. We considered delivery hospital (NICU versus non-NICU) as the dependent variable. Our bivariate analysis compared the dependent variable to each independent variable postulated to influence delivery location. A p value of < 0.05 was considered statistically significant. Next, we determined the unadjusted risk ratio (RR) of delivering in an NICU hospital between maternal residence and each covariate. A 95% confidence interval was calculated for each bivariate pair.

We formulated a multivariable logistic regression model to examine the risk ratio that maternal residence was the principal factor in determining

delivery in an NICU hospital compared to all other significant variables. Our baseline regression model was fit with covariates that we found to be associated with the dependent variable in bivariate analysis ($p < 0.1$). We checked for interaction between maternal residence and other covariates in the model. The model was reduced by eliminating all non-significant risk factors ($p > 0.1$) by using likelihood ratio tests. The final model included only covariates that significantly influenced the relationship of the dependent variable to the main exposure variable. Thus, covariates that were significant in the model but had minimal effect on the relationship between delivery in an NICU hospital and maternal residence were removed from the model. We calculated a 95% confidence interval for each model. Stata 8.0 (College Station, Texas) was used for statistical analysis.

This study was supported by the Center for Medicaid and Medicare Services and approved by the Internal Review Board at The University of North Carolina School of Medicine.

Results:

For this study, we included all women who delivered an infant greater than 22 weeks gestation but less than 35 weeks gestation (n=2081) as these preterm infants are most likely to benefit from NICU access.[15] We excluded 19 women for missing key information. The main reasons were

lack of delivery hospital information (3 women) and missing maternal residence data (16 women). In total, the analysis included 2,065 women.

The characteristics of the women and infants are shown in Table II. Sixty-seven percent of our study population lived in metropolitian areas. Most often, the women were in their early twenties, African-American and not married. Most women were multiparous and nearly half of whom had experienced a prior pregnancy loss. A large proportion had evidence of spontaneous idiopathic preterm delivery as is evident by 52% having preterm labor and 24% suffering from premature rupture of membranes. Nearly 73% of women initiated prenatal care in the first trimester and received a mean of 8.4 visits during the pregnancy. Sixty-four percent of patients were uninsured and/or enrolled in Medicaid prior to pregnancy.

While most infants had immediate access to a NICU at birth, 25 percent of preterm infants delivered in a non-NICU hospital. The median gestational age was 32 weeks (Interquartile Range: 28-34) and the mean infant birth weight was 1718 grams (SD ± 732). Eighty-five percent of infants weighed less than 2500 grams, meeting criteria for low birth weight. Thirty-seven percent were thought to have fetal complications such as intrauterine growth restriction, oligohydraminios, chorioamnionitis or fetal distress identified prior to delivery.

There were significant differences among women living in metropolitan and non-metropolitan areas. Women living in metropolitan areas were more likely to be older, unmarried and African American compared to women living in non-metropolitan areas. Non-metropolitan women were more likely to be primiparous and to have a diagnosis of pre-eclampsia. There was no difference in antenatal bleeding, occurrence of preterm labor or premature rupture of membranes. While prenatal care initiation and number of visits were similar, women living in non-metropolitan areas were hospitalized more frequently.

Gestational age at birth was similar in both groups women from non-metropolitan regions had fewer low birth weight infants. Both groups had similar proportions of infants weighing less than 1500 grams. There was a significant difference between the two groups in the occurrence of fetal complications. Women from metropolitan areas were more often diagnosed with fetal complications (41%) than women whose residence was in non-metropolitan areas (30%) ($p < .001$). Finally, metropolitan mothers were significantly more likely to deliver their preterm infants in NICU hospitals (86%) compared to non-metropolitan mothers (53%) ($p < .001$).

Table II: Maternal and Infant Characteristics (n = 2078)

Characteristic		All	Metro (n=1393)	Non-Metro (n=672)
		Percent or Mean (SD)		
Demographic Factors:	Metro Residence†	67.5	***	***
	Mean Age†	23.6 (6.2)	24.0 (6.3)	23.0 (6)
	African-American†	65.1	68.3	59.1
	Less than high school †	40.8	38.4	45.6
	Not married†	72.0	74.2	67.6
Obstetric Factors:	Primiparous†	33.7	30.9	39.4
	Multiparous with prior loss†	46.5	49.2	40.3
	Tobacco use †	17.2	18.6	14.3
	Diabetes Mellitus	7.1	7.0	7.3
	Multiple gestation	9.1	9.1	9.1
	PIH/Pre-eclampsia†	10.8	9.5	13.5
	Antenatal bleeding **	12.4	12.8	11.6
	Preterm labor†	51.7	52.3	50.7
	Premature Rupture of Membranes†	23.5	23.3	24.3
Antenatal Care:	Initiated 1st trimester care†	72.9	73.1	72.3
	Number of visits† (mean)	8.4	8.1	8.9
	Number of antenatal care	5.4	6.1	4.4
	Incomplete antenatal insurance coverage	63.6	64.8	61.0
	Antenatal hospital admission †	18.2	15.4	24.0
Fetal Factors:	Delivery in NICU hospital†	74.9	85.6	52.7
	Mean Gestational Age †	30.6 (3.5)	30.5 (3.5)	30.9 (3.5)
	Mean birth weight (grams)†	1718 (732)	1697 (730)	1754 (738)
	Low birth weight †	85.3	86.8	82.4
	Very low birth weight	38.0	38.6	37.4
	APGAR at 5 minutes ≤ 6 †	18.9	18.5	19.9
	Fetal complications***†	37.2	40.6	30.4

† Statistically significant difference in groups with a p value <.05

* Antenatal bleeding included placenta previa and all episode of bleeding prior to delivery

**R-GINDEX classification system characterizes as intensive, adequate, intermediate and inadequate prenatal services

***fetal complications include intrauterine growth restriction, oligohydramnios, chorioamnionitis and fetal

We performed a bivariate analysis examining the risk ratio for each maternal characteristic identified as a risk factor for preterm birth with delivery in an NICU hospital (Table III). The unadjusted risk ratio indicated that mothers delivering infants prematurely and from non-metropolitan areas had 3.29 (CI: 2.83, 3.83) times the risk of delivering in a non-NICU facility. African American mothers were more likely to deliver in NICU hospitals. Each of the following obstetric factors was significantly associated with delivery in an NICU hospital: lower gestational age, prior pregnancy loss, tobacco use, pre-eclampsia, preterm labor and premature rupture of membranes, and fetal complications. Adequate prenatal care was positively associated with delivery in a NICU hospital. Hospitalization during the pregnancy was not associated with delivery in a NICU hospital.

Table III: Bivariate Comparison of NICU hospital and Preterm Delivery Risk Factors

Characteristic	Risk Ratio	95% CI
Demographic Factors:		
Non-metropolitan maternal residence	3.30	2.83, 3.83
African American race	0.70	0.6, 0.8
Increasing maternal age	0.98	0.97, 0.99
Obstetric Factors:		
Increasing Gestation	1.04	1.02, 1.07
Primiparous	1.06	0.91, 1.25
Prior pregnancy loss	0.79	0.65, 0.94
Tobacco use	1.23	1.03, 1.48
Twins or multiple gestation	0.97	0.74, 1.26
PIH/ Pre-Eclampsia	0.53	0.38, 0.74
Antenatal bleeding or placental bleeding*	1.01	0.81, 1.27
Preterm labor	0.82	0.70, 0.95
Premature rupture of membranes	0.66	0.54, 0.81
Fetal Complications**	0.60	0.51, 0.72
Antenatal Factors:		
Adequate PNC***	1.31	1.12, 1.54
No PNC	1.00	0.72, 1.40
Full insurance coverage	0.97	0.83, 1.13
Antenatal hospital admission	1.06	0.88, 1.29

* Antenatal bleeding included placenta previa and all episodes of bleeding prior to delivery

**Fetal complications include intrauterine growth restriction, oligohydramnios, chorioamnionitis and fetal distress

***R-GINDEX classification system characterizes as intensive, adequate, intermediate and inadequate prenatal services

Our fully adjusted model confirms that living in a metropolitan area was protective for delivering a preterm infant in an NICU hospital (Table IV). Our final model included race, maternal age, gestational age and obstetric complications such as pre-eclampsia, preterm labor, premature rupture of membranes and fetal complications as covariates. This model demonstrated the crude relationship is minimally confounded suggesting that residence is the major determinant to NICU hospital access 3.16 (CI: 2.72, 3.67).

Table IV: Unadjusted and Adjusted Odds Ratio of Delivery in a NICU Hospital for a Mother Living in a Non-Metropolitan Area

		Risk Ratio	95% CI
Unadjusted:	Non-metropolitan vs. Metropolitan	3.29	2.83, 3.83
Adjusted*:	Non-metropolitan vs. Metropolitan	3.16	2.86, 3.85

*Adjusted for gestational age, fetal complications, maternal race, maternal age, the occurrence of preterm labor, premature rupture of membranes and pregnancy induced hypertensive disorders

Discussion:

This study demonstrates that access to NICU facilities is strongly influenced by maternal residence in a Medicaid-insured population of mothers delivering preterm infants. The infants of women living in non-metropolitan areas have over three times the risk of not having access to NICU facilities at birth compared to premature infants of metropolitan women. Certainly, some obstetrical factors such as lower gestational age, pre-eclampsia, preterm labor and premature rupture of membranes were predictors of delivery in NICU hospitals. However, we found that even adjusting for these predictors, maternal residence was the driving force for NICU accessibility.

This study is consistent with a 2001 Georgia Epidemiology Report that evaluated geographic disparities and access to specialized neonatal services for very low birth weight (VLBW) infants.[18] The report used birth

certificate data on infants less than 1500 grams born from 1994-1996. They categorized the infants into three groups based on proximity of maternal residence to a "subspecialty" hospital; defined as hospitals with a state-certified NICU. Their results indicated that 89% of women with VLBW infants and living in counties with NICUs delivered at these hospitals. However, mothers living outside of these counties were less fortunate. Seventy-one percent of VLBW infants from adjacent counties and only 53% of those residing in non-adjacent counties delivered in subspecialty hospitals. The group found similar results when birth certificate data from 1997-1998 was used for analysis.[18]

Identifying risk factors that impede the delivery of preterm infants in NICU hospitals highlights vulnerable populations in need of specific attention as well as establishes new focal points for improvement and resource allocation in the perinatal regional network system. We were fortunate to have access to demographic information from birth certificates as well as information from the SMRF of Georgia, AHA and ARF databases. This information provides a more complete picture of population characteristics then previous studies on this topic. Yet, despite the enhanced patient information regarding medical conditions, insurance status, etc., the proximity of a NICU hospital to maternal residence remains the most important factor.

The literature clearly supports the concept that delivery in an NICU hospital can be lifesaving for premature infants.[9-11,19-22] Modanlou et al. designed a prospective study to determine the benefits of delivery in an NICU hospital versus neonatal transport to NICU faciltity after birth.[9] They found a lower incidence of respiratory complications and decreased length of hospitalization compared to neonates transported after birth. The Collaborative Project on Preterm and Small for Gestation Age Infants is a Dutch study that follows a 1983 cohort of infants for long term outcomes.[10] Similar to Modanlou, the Dutch study reported decreased neonatal mortality and morbidity associated with delivery in NICU hospitals in the short term. However, long-term data indicated no significant difference in outcomes such as disability in children born in NICU hospitals versus children managed in non-NICU settings.[10]

Several recent studies have confirmed these earlier findings. Chien et al. examined infants less than 32 weeks gestation in Canada and postulated that severity of illness and maternal risk factors might partially explain the improved neonatal outcome of infants born in NICU hospitals compared to neonates transported to NICU hospitals after birth.[19] Even adjusting for these risk factors, infants born in non-NICU hospitals had increased incidence of intraventricular hemorrhage, respiratory distress syndromes and infection compared to infants born in NICU hospitals.[19]

Warner et al. published a study examining a cohort of VLBW infants delivering in the Cincinnati region.[20] They found that even when controlling for demographic characteristics, VLBW infants were at 2.64 (CI:1.7,4.2) times the odds of dying or suffering major morbidity if delivered in a nonsubspecialty perinatal center. Similarly, Menard et al. examined vital records of VLBW infants from 1993-1995 in South Carolina.[21] Neonatal mortality rates were significantly lower for infants delivered in Level III NICU hospitals compared to either intermediate-NICU or community hospitals. The adjusted neonatal mortality rates were 146 per 1000 live births in NICU hospitals compared to 232 per 1000 live births in intermediate NICU hospitals.[21]

The supply of NICUs and neonatologists has increased exponentially over the past two decades;[23] this suggests improved access for those in need of such services. However, there is evidence that the distribution of providers and units are not based on need.[23,24] David Goodman et al. study the distribution of neonatologists and NICUs with the association of neonatal mortality in the United States. Using birth weight as an indicator of need, they determined that neonatologists were or equitably distributed. Regions with the highest rates of VLBW infants had similar numbers of neonatologists as regions with the lowest rates of VLBW infants.[23] "With neonatal capacity expressed as the number of VLBW infants per bed or neonatologist, the variation across (regions) remained more than

fourfold"[23] Furthermore, in a different study, Goodman et al. explained that increasing neonatalogists beyond a threshold of 4.3 per 10,000 live births did not improve neonatal survival.[24]

Recently, hints of "deregionalization" of perinatal network systems raise concerns regarding access for vulnerable regions lacking NICU facilities.[16,25,26,28] Regionalized perinatal network systems were derived in order to offset disparities in NICU access. These networks offer not only NICU facilities but also "the concept of perinatal regionalization ... includes a large array of services with a fully integrated system of consultation, referral, and transport."[27] Embry Howell and others describe deregionalization in urban areas: Using AHA annual survey of hospitals they found an increase in NICUs in metropolitan areas from 1980-1995 but limited expansion of larger sized NICUs that are best for management of prematurity.[25] The authors suggest the increasing number of NICUs has improved access in smaller geographic areas but disproportionately benefited areas that already had NICU facilities.

Several studies postulate that deregionalization of perinatal networks might be influenced by managed care organizations, insurance reimbursement patterns and local community forces. Bronstein et al. used vital statistics on VLBW infants in Alabama from 1998-2000 to conduct a multivariate analysis evaluating access to NICU hospitals.[28] They found

that race, prenatal care utilization and insurance status influenced type of delivery hospital.[28] Minority women with early, adequate prenatal care delivered in NICU hospitals and Medicaid-insured women received antenatal transport to NICU hospitals more frequently then other insured women.[27] Durbin et al. report on neonatal interhospital transport rates for all infants born in southeastern Pennsylvania. They question if perinatal network systems are evolving into a financially motivated tool of managed care organizations as they found that Medicaid-insured and self-insured infants were more likely to be transported to NICU facilities compared to privately insured infants.[17]

Our study was able to locate NICU hospitals by regions in Georgia and found further evidence that NICU hospitals are not distributed equally. Only 19% of NICU hospitals were located in non-metropolitan regions. Yet, nearly 33% of our population lived in non-metropolitan areas. The proportion of VLBW infants was equal in both regions. Although our study did not evaluate the number of neonatologist per live birth, we suspect that non-metropolitan areas in Georgia will be below the critical threshold thought to improve neonatal survival. Thus, strengthening instead of weakening perinatal networks are crucial to maximizing access to the best health care.

The application of our study to other populations might be limited since we evaluated only Medicaid covered deliveries. In 1995, Medicaid covered 52% of all deliveries in Georgia.[14] Nationally, over 40% of antenatal services and deliveries are covered by Medicaid which makes it the largest insurer of pregnancy care. We expected our data to have a higher proportion of premature infants since preterm delivery risk factors such as low socioeconomic status, minority race and medical conditions are over-represented in a Medicaid population. Yet, the prevalence of premature delivery was similar to state and national rates. Further studies would be necessary to determine if maternal geographic proximity to NICU hospitals is similar in other regions and populations.

Another potential limitation to our study was the inability to access key patient and physician decision-making factors that surely influence the events surrounding the delivery episode. The literature has shown improved neonatal outcomes associated with immediate NICU access for premature infants. Yet physician awareness of these benefits, efficiency of the perinatal network system to access NICU facilities, urgency of delivery and unique doctor-patient dynamics dictate decisions surrounding delivery. From the patient perspective, delivery in a NICU hospital may lead to isolation from established support systems since access to such facilities usually requires transport long distances from home. These

factors need probing to further the discussion of equal access to care and improve regionalized perinatal network systems.

Our analysis is based on a 1995 cohort of premature infants. It is possible that access to NICU hospitals has improved for non-metropolitan women living in Georgia over the past several years. The 2001 Georgia Epidemiology Report on VLBW infants during the same period suggests similar findings to our study. In addition they found no improvements when they evaluated infants born in the late 1990s.[18] If restructuring of the Georgia perinatal network system to address this disparity has occurred in the interim then it is important to reassess the influence of maternal residence and access to NICU hospitals. Using a comprehensive dataset such as the one used in our study will provide the most information on both maternal and hospital characteristics.

Surely, not all preterm deliveries can be prevented from occurring in non-NICU hospitals. Inevitably women will present in active, rapidly progressive labor or unstable medical condition precluding safe, efficient transfer to NICU hospitals. Yet, the preponderance of NICU hospitals in metropolitan regions exposes non-metropolitan women and infants to disparate health care. Perinatal network systems are designed to increase the accessibility of high risk services to communities without such services. Our study indicates that non-metropolitan women are at high

risk of delivering in non-NICU hospitals. Next steps should begin examining system and provider level factors that impede best medical practice.

Current national survey data indicates that 73% of premature infants are delivered in hospitals with NICU facilities.[29] Healthy People 2010 sets a 90% goal of premature infants delivering in NICU hospitals.[29] Our data show that among a cohort of Medicaid-insured women delivering infants less than 34 weeks gestation, 75% were born in NICU hospitals. Maternal residence significantly influences delivery in a NICU hospital and the ability to achieve Healthy People 2010 goals. The unequal distribution of neonatal intensive services requires coordinated network systems that efficiently link non-metropolitan women presenting to local hospitals with regional NICU facilities. Tailoring current policies and outreach efforts to target this disparity should improve neonatal outcomes.

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