Access to Neonatal Intensive Care for Low-Birthweight Infants: The Role of Maternal Characteristics

ABSTRACT

Objectives. This study assessed the impact of mother's race, insurance status, and use of prenatal care on very low birthweight infant delivery in or transfer to hospitals with neonatal intensive care units (ICUs).

Methods. Multivariate analysis of Alabama vital statistics records between 1988 and 1990 for infants weighing 500 to 1499 g was conducted, comparing hospital of birth and maternal and infant transfer status, and controlling for infant birthweight and for maternal pregnancy history and demographic characteristics.

Results. With other factors adjusted for, non-White mothers with early prenatal care were more likely than White mothers to deliver their very low birthweight infants in hospitals with neonatal ICUs without transfer. Among the mothers who presented first at hospitals without such facilities, those who had late prenatal care were less likely than those with early care to be transferred to hospitals with neonatal ICUs before delivery. Medicaid coverage increased the likelihood of antenatal transfer for White women. Likelihood of infant transfer was not associated with these maternal characteristics.

Conclusions. Maternal race, prenatal care use, and insurance status may influence the likelihood that very low birthweight infants will have access to neonatal intensive care. Interventions to improve perinatal regionalization should address individual and system barriers to the timely referral of high-risk mothers. (*Am J Public Health.* 1995;85:357–361)

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Introduction

Low-birthweight infants born in hospitals with neonatal intensive care units (ICUs) or transferred to such centers immediately after birth have lower mortality and morbidity rates than comparable infants born and remaining in other settings.[1–5] Effective regionalization (i.e., referrals for appropriate care) of perinatal care services ensures that low-birthweight infants are born in or promptly transferred to appropriate facilities after birth, no matter where their mothers initially sought their obstetrical care.

Regionalization of perinatal care services for low-birthweight infants in the United States became increasingly common in the 1970s and 1980s,[6–9] although rates vary within metropolitan areas,[2] within states,[8] and regionally across the nation.[6] To some extent, variation in regionalization rates is related to variations in how physicians perceive the viability of low-birthweight infants and to the influence these perceptions have on the decisions physicians make about resuscitation and referral.[10,11] It is also related to differences in the strength of referral linkages between subspecialty care and other institutions.[12]

Concern has been expressed recently about the potential for a trend toward perinatal "deregionalization"—that is, a breakdown in the cooperative relationship between less specialized and more specialized centers, which results in a failure to refer high-risk women and low-birthweight infants to technologically appropriate facilities. Two contrasting causes of such a breakdown have been suggested: a tendency among specialized centers to avoid accepting referrals with poor insurance coverage in order to avoid financial losses,[13,14] and a tendency among centers that are only partially equipped to care for high-risk infants to retain such infants in order to maintain patient volume in their facilities.[15]

Regionalization rates have generally been examined across geographic areas although the deregionalization commentaries suggest that regionalization may, in fact, fail for population subgroups, such as poorly insured women, within a region. This study examines the impact of maternal race, insurance status, and use of prenatal care in the first trimester on the likelihood that very low birthweight infants (500 to 1499 g) will be born in or transferred to hospitals with neonatal ICUs. Infant birthweight, maternal age, high school education, residential distance to the closest neonatal ICU, and pregnancy history are controlled in the analysis. In this manner, we examine whether the likelihood of maternal or infant referral to hospitals with neonatal ICUs varies within a state by maternal characteristics. While we do not assess whether this is a new phenomenon caused by a breakdown in preexisting regionalization systems, our study does help to

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Note. The observations and conclusions presented here are the authors' and do not represent those of the agencies that provided support or made data accessible.

pinpoint the nature of current referral failures so that their causes can be more directly addressed.

Methods

Vital records for all infants with birthweights between 500 and 1499 g for the years 1988, 1989, and 1990 in the state of Alabama form the database for this study (n = 2596). Infant birthweight; maternal county of residence, zip code of residence, race, age, and education; month in which prenatal care began; parity; previous post-20-week pregnancy termination; previous infant death; hospital of delivery; and transfer either of the mother prior to delivery or of the infant after delivery are reported on the vital record. The state health department links birth certificate and death certificate records, so date of death within 12 months of birth is also included on the vital record. However, the vital records file does not include data on infants born in out-of-state hospitals to mothers resident in Alabama.

To measure the distance from a woman's residence to the closest neonatal ICU, commercially available geographic data files were used to calculate the shortest straight-line distance between her zip code and the target hospital. The more accurate alternative measures—road miles or time of travel from point to point—were not available for the entire state. While straight-line zip code–to–zip code distances underestimate actual road miles, empirical comparisons have shown that these underestimations tend to be consistent. Thus, straight-line distances are useful for comparing the effect of distance on location and travel decisions across a group of people.[16,17]

Medicaid claims for delivery services in 1988 through 1990 were linked to identifying variables on the vital record so as to determine whether mothers of infants were covered by Medicaid at the time of delivery. Approximately 98% of Medicaid delivery claims were matched by this method. Medicaid covered 18% of all very low birthweight births in 1988, 34% in 1989, and 43% in 1990. The increase in Medicaid coverage over this period was owing to expansion of eligibility for Medicaid, first between July 1988 and March 1990 to include pregnant women under 100% of the federal poverty level, and again after April 1990 to include pregnant women under 133% of the federal poverty level. No other information on maternal insurance coverage was available for this study, so it is not known whether the mothers without Medicaid coverage had private insurance or no insurance.

Infants were identified as having been born in or transferred to hospitals with subspecialty-level neonatal intensive care services if Alabama State Health Planning Agency reports indicated that the delivery or referral hospital had high-risk newborn beds in the year of the infants' birth. Of the 17 hospitals reporting these beds over the 3-year period, 13 reported receiving infant transfers, and 8 of these reported receiving maternal transfers. Because the 4 hospitals that reported no transfers were all small hospitals located in cities where university-affiliated hospitals operate neonatal ICUs, it is quite possible that their reports are accurate and that they really did not receive any infant or maternal transfers. Thus, there is no clear indication from the data that any hospitals systematically failed to report maternal or infant transfers. However, the occurrence of a random failure to designate an infant or maternal transfer on a birth certificate cannot be ruled out.

Maternal and infant characteristics were compared across four groups: infants born in hospitals with neonatal ICUs with no indication of transfer (termed here as inborn with neonatal ICU–no transfer), infants born after maternal transfer from another hospital (maternal transfer), infants born in other hospitals and then transferred to hospitals with neonatal ICUs (infant transfer), and infants born in other hospitals with no transfer shown on the birth certificate (inborn without neonatal ICU–no transfer). Three logistic regression analyses were then performed to assess the impact of race, insurance status, and use of prenatal care on regionalization. To estimate the impact of maternal characteristics on inborn with neonatal ICU–no transfer status, the first analysis compared the records of inborn, nontransferred infants with those of all other very low birthweight infants. To estimate the impact of maternal characteristics on maternal transfer, the second analysis compared the records of those infants born after maternal transfer with those of all very low birthweight infants born at hospitals without neonatal ICUs. To estimate the impact of maternal characteristics on infant transfers, the third analysis compared the records of infants who were transferred with those of infants who were born at hospitals without neonatal ICUs and were not transferred.

These three sets of delivery and transfer decisions are sequential choices made over time about a single population of mothers and infants. The group of women available for maternal transfer is a selected subset of the total population of mothers of very low birthweight babies: they are the subset who present in labor with such infants (most likely preterm) at hospitals without neonatal ICUs. A woman's absolute likelihood of having a maternal transfer is then influenced both by factors associated with the maternal transfer decision and by factors associated with the previous decision not to go directly to a hospital with a neonatal ICU—in other words, her selection into the relevant subset of the population. In this text are reported the results of correcting for the selection bias inherent in sequential events using the Inverse Mill's Ratio technique, which weights each record in subsequent regression analyses by the likelihood that it remained in the pool.[18,19] However, the Discussion emphasizes the results of simple regressions not corrected for selection so as to present a clearer picture of the separate role that demographic factors in particular play in each of the three delivery/transfer decisions.

Each regression controlled for infant birthweight, maternal age, and distance from the mother's residential zip code to the closest hospital with a neonatal ICU, all included as continuous variables in the multivariate models but shown in dichotomous form in the descriptive data tables for ease of interpretation. The regressions also controlled—as dichotomous variables—for whether the mother graduated from high school, was primipara, began prenatal care in the first trimester, and had a previous post-20-week fetal or infant death, as well as for whether this was a multiple birth. Initial estimates of the regression models showed that the measure of race of the mother (White vs non-White) interacted significantly with the measures of Medicaid coverage and use of first trimester prenatal care, indicating that the impact of these variables differs according to maternal race. The results of the logistic regressions are reported here in the form of odds ratios (ORs) and confidence intervals (CIs) for the various combinations of race, first trimester prenatal care use, and Medicaid coverage, adjusted for the other factors included in the models. For comparison, the odds ratios for these characteristics

are also presented without interactions with race.[20] Also included in presentation of the descriptive data on group differences is a measure of whether the infant expired within 24 hours of birth, as calculated from the birth and death dates on the vital records. This measure is not included in the regression model since it may be an outcome rather than a factor influencing the transfer decision.

Results

Birth records for 1118 very low birthweight White infants (0.97% of all White infants born in these years) and for 1478 very low birthweight non-White infants (2.3% of all non-White infants born in these years) were identified from Alabama birth records for 1988 to 1990. We identified a total of 110 records with missing data on either residential zip code or month that prenatal care began. We compared these 110 records with the 2486 complete records and found no statistically significant differences in demographic characteristics, birthweight, or previous pregnancy characteristics. Records with missing data are included in the descriptive tables but are excluded from the multivariate analyses.

Tables 1 and 2 show that infants in the maternal transfer, infant transfer, and inborn without neonatal ICU–no transfer groups differ from infants who were born in hospitals with neonatal ICUs. As would be expected, their birthweight distributions differ, and outborn infants who were not transferred were much more likely to expire within 24 hours of delivery. Mothers of infants born in hospitals without neonatal ICUs, both those transferred as infants and those not transferred, had first trimester prenatal care less often, had finished high school less often and were under age 18 more often than mothers of infants who were born in hospitals with neonatal ICUs without maternal transfer. The maternal transfer, infant transfer, and inborn without neonatal ICU–no transfer groups all lived farther away from hospitals with neonatal ICUs than the inborn with neonatal ICU group. Finally, the maternal transfer group included significantly fewer non-White women than the inborn with neonatal ICU group. The other two groups did not differ from the inborn group on this measure.

Table 3 shows the odds ratios calculated from logistic regressions examining the likelihood of direct delivery and of maternal transfer. None of the maternal or infant characteristics tested was associated with the likelihood of infant transfer at the conventional 95% confidence level, so these results are not shown here. We focus on the relationship between these likelihoods and mother's race, insurance coverage, and trimester of prenatal care, adjusting for other demographic, pregnancy, and infant characteristics.*

The top section of Table 3 shows the odds ratios and confidence intervals for the three maternal characteristics of interest, without tests for interactions. It is clear that, across the whole population, non-White women were more likely than White women to have their very low birthweight infants born in hospitals with neonatal ICU without transfer, while women receiving prenatal care beginning

TABLE 1—Pregnancy and Infant Characteristics (%), by Place of Delivery and Transfer Status

	Inborn with Neonatal ICU–No Transfer (n = 1536)	Maternal Transfer (n = 325)	Infant Transfer (n = 476)	Inborn without Neonatal ICU–No Transfer (n = 259)	Total (n = 2596)
Birthweight					
500–749 g	17.8	15.4	12.8*	32.8**	18.1
750–999 g	22.1	28.3*	27.7*	13.1**	23.0
1000–1499 g	60.0	56.3	59.4	54.0	58.9
Infant dies <24 hours	8.4	5.8	4.8*	35.1**	10.1
First trimester care[a]	73.0	77.5	55.2**	61.5**	69.3
Primipara	45.0	48.0	44.5	42.9	45.1
Singleton	83.9	79.1*	79.2*	86.1	82.7
Previous loss	6.4	6.5	8.2	9.6	7.0

Note. ICU = intensive care unit.
[a]Excludes 70 records with missing values.
*$P < .05$, chi-square test, compared with inborn with neonatal ICU–no transfer.
**$P < .01$, chi-square test, compared with inborn with neonatal ICU–no transfer.

TABLE 2—Maternal Demographic Characteristics (%), by Place of Delivery and Transfer Status

	Inborn with Neonatal ICU–No Transfer (n = 1536)	Maternal Transfer (n = 325)	Infant Transfer (n = 476)	Inborn without Neonatal ICU–No Transfer (n = 259)	Total (n = 2596)
Distance to closest neonatal ICU[a]					
<10 miles	61.0	11.1**	17.0**	20.6**	42.9
10–24 miles	13.9	17.3	15.3	16.5	14.8
25–44 miles	10.7	29.3**	20.3**	23.0**	16.0
>44 miles	14.4	42.3**	47.4**	39.9**	26.3
Age under 18	14.2	17.5	21.8**	20.1*	16.6
Not high school graduate	29.1	32.4	40.6**	36.2*	32.3
Race non-White	57.7	48.3**	61.1	55.6	56.9
Medicaid coverage	31.5	28.6	33.2	28.6	31.2

Note. ICU = intensive care unit.
[a]Excludes 40 records with missing values.
*$P < .05$, chi-square test, compared with inborn with neonatal ICU–no transfer.
**$P < .01$, chi-square test, compared with inborn with neonatal ICU–no transfer.

*The regression model of inborn with neonatal ICU–no transfer also showed statistically significant associations between the dependent variable and birthweight (positive), residential distance (negative), and multiple birth (negative). The regression model of maternal transfer showed no significant associations between the dependent and the other adjusting variables. Complete regression results are available from the authors upon request.

TABLE 3—The Impact of Race, Insurance, and Prenatal Care on Direct Delivery and Maternal Transfer: Adjusted Odds Ratios[a]

	Inborn with Neonatal ICU–No Transfer (n = 2486)		Maternal Transfer (n = 986)	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Model without interaction				
Non-White compared with White	1.353*	1.636, 1.119	0.820	1.102, 0.609
Medicaid compared with no Medicaid	1.104	1.352, 0.901	0.968	1.328, 0.705
Late prenatal care compared with first trimester care	0.676*	0.827, 0.552	0.436*	0.605, 0.314
Model with interaction[b]				
White, no Medicaid, late prenatal care	0.903	1.255, 0.650	0.419*	0.719, 0.244
White, Medicaid, early prenatal care	0.874	1.227, 0.623	1.818*	2.972, 1.112
White, Medicaid, late prenatal care	0.790	1.238, 0.504	0.761	1.523, 0.383
Non-White, no Medicaid, early prenatal care	1.406*	1.796, 1.100	1.092	1.590, 0.750
Non-White, no Medicaid, late prenatal care	0.807	1.063, 0.613	0.469*	0.722, 0.305
Non-White, Medicaid, early prenatal care	1.733*	2.283, 1.316	0.697	1.083, 0.449
Non-White, Medicaid, late prenatal care	0.995	1.342, 0.738	0.300*	0.722, 0.180

[a]Logistic regressions controlled for birthweight, maternal age, high school graduation, primiparous status, multiple birth, previous fetal or infant loss, and distance to closest neonatal intensive care unit (ICU).
[b]All groups are compared with mothers who were White, who were not on Medicaid, and who had first trimester prenatal care.
*Different from reference group at 95% confidence interval.

after the first trimester were less likely to deliver in this location than those receiving first trimester care. Among the 986 women whose infants were not born in hospitals with neonatal ICUs without transfer, those receiving late prenatal care were less likely to be maternal transfers and thus were more likely to deliver their infants in hospitals without neonatal ICUs. In the regression model without interactions, race and insurance coverage appear unrelated to maternal transfer.

The bottom section of Table 3 shows the odds ratios and confidence intervals for the various combinations of mother's race, insurance status, and timing of prenatal care. All the odds ratios for these combinations are compared with those of White women who were not on Medicaid and who received first trimester prenatal care. When interactions among race, insurance status, and prenatal care are examined in this manner, it becomes clear that early prenatal care increased the likelihood of infants being born in hospitals with neonatal ICUs without transfer only for non-White women. Non-White women with early prenatal care were more likely than any group of White women to deliver their infants in hospitals with neonatal ICU without transfer, while non-White women with late prenatal care were as likely as any White women to deliver in this location. Among White women, prenatal care timing and insurance coverage were unrelated to the likelihood of infants being born in hospitals with neonatal ICUs without transfer.

Examining the likelihood of maternal transfer while taking interactions into account reveals that late prenatal care is associated with lower likelihood of maternal transfer for all non-White women and for White women who are not covered by Medicaid, all in comparison with the reference group of White women not on Medicaid who received first trimester prenatal care. However, White women who were on Medicaid and received first trimester prenatal care had a greater likelihood of maternal transfer than the reference group. White women on Medicaid who received late prenatal care were as likely as the reference group to be transferred before delivery. Thus, Medicaid coverage increased the likelihood of maternal transfer for all White women, although this coverage did not cancel out the negative effect of late prenatal care. Medicaid coverage had no significant impact on the likelihood of maternal transfer for non-White women.

As noted above, the women who were available to receive maternal transfer are a selected subset of the total group of mothers of very low birthweight infants. Non-White women with early prenatal care are underrepresented in this group because they are so much more likely than other women to deliver their infants in hospitals with neonatal ICUs without being transferred. Consequently, the odds ratios for likelihood of maternal transfer for non-White women with early prenatal care, derived from logistic regressions corrected for selection bias (OR = 0.562, CI = 0.963, 0.328 for those not on Medicaid; OR = 0.203, CI = 0.088, 0.467 for those on Medicaid), indicate that their overall likelihood of maternal transfer is quite low. Correcting for selection bias, the likelihood of maternal transfer for non-White women with no Medicaid coverage and late prenatal care rises to a level not significantly different from that of the reference group. Likelihoods for the other subgroups are not significantly affected by correcting for selection bias. By taking previous decisions into account, this correction provides a more accurate overall estimate of the likelihood that subgroups of women will be transferred before delivery. This overall likelihood is quite low for non-White women with first trimester prenatal care because they are less likely in the first place to be among the subset of women who present in labor to hospitals without neonatal ICUs. However, if we assume that all women presenting in labor with very low birthweight infants would benefit from transfer to hospitals with neonatal ICUs, then the uncorrected regression results shown in Table 3 are more useful for identifying the factors associated with the transfer decision.

Discussion

Examination of maternal characteristics that are associated with timely referrals of mothers of very low birthweight infants to hospitals with neonatal ICUs can help to target the true barriers to perinatal regionalization. The Alabama data examined here suggest that maternal characteristics are significantly associated

with the likelihood that women will have their infants born in hospitals with neonatal ICUs without transfer and the likelihood that women will receive maternal transfers. Maternal characteristics do not appear to affect the likelihood that infants born in hospitals without neonatal ICUs will be transferred to hospitals with such facilities after delivery.

Previous research[21,22] indicates that residential distance is an important predictor of choice of hospital for maternity care, as well as of a low-birthweight infant being born in a hospital with a neonatal ICU.[23] However, once distance to the facility was controlled in regression analysis in this study, non-White women with early prenatal care were most likely to have their very low birthweight infants born in hospitals with neonatal ICUs. Medicaid coverage did not affect this association. It could be that these women were identified as being at high risk for premature delivery early in their pregnancies and had arranged to deliver their babies at these hospitals. This would imply that prenatal risk screening is used more often or is more predictive of high-risk pregnancies for non-White women than for White women.

The women who go to hospitals without neonatal ICUs when in labor with very low birthweight infants are those who live farther from hospitals with neonatal ICUs and/or whose high-risk status was not identified early in pregnancy. In this situation, both White and non-White women who receive early prenatal care are more likely to be transferred to such hospitals before their babies are born. We can speculate that these women are able to contact their care providers sooner if they go into labor prematurely, or that they are part of care systems with established referral relationships for emergency situations.

There is no intuitively obvious reason why Medicaid coverage would increase the likelihood of maternal transfer for White women. However, we can also think of this finding as suggesting that maternal transfer rates for White women without Medicaid coverage are unusually low. This would support the observation of those concerned with trends toward deregionalization that some hospitals selectively retain privately insured women for high-risk deliveries but refer less well insured women on to subspecialty regional centers.[15] It is possible that the same effect is not observed for non-White women because, in this state in this time period, non-White women without Medicaid coverage were not, on the whole, privately insured.

On an analytic note, this study illustrates the value of taking potential interactions between women's racial or ethnic background and other social and demographic features into account when examining access to and use of health care. In US society, racial or ethnic background is related simultaneously to socioeconomic status, residential location, choice of care provider, and assumptions made by care providers about the likely outcomes of treatment decisions. Such complex relationships are not identified when racial background is treated simply as an independent maternal characteristic.[24,25]

Nationally over the past 2 decades, both outreach education efforts by perinatal centers and the establishment of official catchment and referral areas for perinatal care have been adopted to increase the likelihood that low-birthweight infants will receive care in hospitals with appropriate equipment and personnel. This study indicates that barriers to regionalization remain. More attention should be paid to the nature of these barriers, particularly at the level of the individual patient within systems of care. □

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