Deregionalization of Neonatal Intensive Care in Urban Areas

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Objectives. This report describes the extent of deregionalization of neonatal intensive care in urban areas of the United States in the 1980s and 1990s and the factors associated with it.

Methods. We conducted a 15-year retrospective analysis of secondary data from US metropolitan statistical areas. Primary outcome measures are number of neonatal intensive care unit (NICU) beds, number of NICU hospitals, and number of small NICUs.

Results. Growth in the supply of NICU care has outpaced the need. During the study period (1980–1995), the number of hospitals grew by 99%, the number of NICU beds by 138%, and the number of neonatologists by 268%. In contrast, the growth in needed bed days was only 84%. Of greater concern, the number of beds in small NICU facilities continues to grow. Local regulatory and practice characteristics are important in explaining this growth.

Conclusions. Local policymakers should examine the factors that facilitate the proliferation of services, especially the development of small NICUs. Policies that encourage cooperative efforts by hospitals should be developed. Eliminating small NICUs would not restrict the NICU bed supply in most metropolitan statistical areas. (*Am J Public Health.* 2002;92:119–124)

Care for high-risk newborns is provided in neonatal intensive care units (NICUs) in hospitals with obstetric services or in children's hospitals. According to the American Academy of Pediatrics, services in NICUs include "constant nursing and continuous cardiopulmonary and other support for severely ill infants" as well as other specialty services and technology.[1] Generally, this care is provided under the supervision of neonatologists. Not all birth hospitals have NICUs; infants who are born outside of NICU hospitals and who need such services are usually transferred to the nearest NICU facility.

Research has shown that infants who are cared for in NICUs have better rates of survival than those who are not, after infant size and gestation are controlled for (see McCormick and Richardson[2] for an extensive review of this literature). Another body of research has generally shown that infants born in higher-volume NICUs have better survival than those born in lower-volume facilities,[3,4] although results are not completely consistent.[5]

To achieve the goal of optimum care for sick newborns, perinatal regionalization programs were set up around the country beginning in the early 1970s.[6–8] Under a regionalized perinatal system, each facility with an obstetric service is designated as being 1 of 3 levels. Level 1 hospitals are obstetric hospitals without specialized care for newborns. Level 2 facilities, often called "intermediate care facilities," are defined by the American Academy of Pediatrics as being for "sick newborns who do not require intensive care but require 6–12 hours of nursing time each day." Level 3 facilities have NICUs. The criteria for these levels of care vary from state to state. In some states, there is a certification process for level of care, but in others there is none. Thus, the designation may not be a legal one; rather, it may be based on formal or informal agreements among hospitals, or it may be simply a hospital's self-designation.

Schwartz[9] documented the growth in numbers of both intermediate and NICU beds in the 1980s, and anecdotal evidence suggests that patterns in regionalization may have changed. For example, recent case studies by Richardson et al.[10] in Hartford, Conn, Menard et al.[11] in South Carolina, and Yeast et al.[12] in Missouri illustrate the challenges to regionalization as community hospitals add NICUs to compete for obstetric and neonatal patients.

In this study, we develop a concept of "deregionalization" associated with both the amount of NICU services and the concentration of those services. We first examine whether the proliferation of NICU facilities, beds, and physician specialists (neonatologists) is due to increased need for such services. After establishing that the rate of growth exceeds the likely need, we further explore geographic and hospital characteristics associated with growth, placing particular emphasis on whether expansions in services have occurred in smaller-than-optimal NICUs. Where the number of beds in small NICUs continues to grow, we provide evidence of a pattern of deregionalization in which hospitals establish (or maintain) their own small NICU rather than transfer infants to larger NICUs. By describing these patterns, we hope to assist policymakers in understanding the proliferation of neonatal intensive care and the deregionalization of NICU services.

METHODS

In this study we used data for 1980, 1990, and 1995 from the annual survey of hospitals conducted by the American Hospital Association (AHA).[13] Each hospital reports its number of total beds, obstetrical beds, NICU beds, intermediate care beds, and births, as well as (through 1990) the occupancy rate for each unit.

The AHA provides a definition of NICU beds and intermediate beds for purposes of collecting data for the annual survey, a definition that has varied somewhat over time and that is also subject to considerable interpretation. For example, the AHA definition of a NICU in 1980 was as follows: "This unit provides intermediate, recovery, and intensive care." By 1995, the definition had become more specific: "A unit that must be separate from the newborn nursery providing intensive care to all sick infants including those with the very lowest birthweights (<1500 g).

A NICU has the potential for providing mechanical ventilation, neonatal surgery, and special care for the sickest infants born in the hospital or transferred from another institution. A fulltime neonatologist serves as director of the NICU" (M. Janko, AHA, written communication, February 4, 1997). Since the AHA definition of NICU has become more specific over time, some beds that would have been classified as NICU beds in 1980 may have been excluded by hospitals from their NICU bed count later, possibly being reclassified as intermediate-care beds. Since the AHA survey does not specifically ask the hospital about obstetric level of care, we were led to define a "NICU hospital" (most level 3 hospitals in most states are probably included under our definition). For this report, we restricted NICU hospitals to those with at least 1 NICU bed, but we also included both reported intermediate care beds and NICU beds in such hospitals. Hospitals reporting only intermediate care beds, probably classified as level 2 hospitals in most states, were excluded from the study, although our definition may include some level 2 hospitals when they report NICU beds. We excluded level 2 hospitals because they are not clearly identified in the AHA data and the definition of level 2 is more variable from state to state than the definition of level 3. We further defined "small" NICUs, building on the study by Phibbs et al.[4] showing that fragile infants had lower mortality rates in facilities with an average daily census of at least 15. Assuming an average occupancy rate of about 75%, we defined small NICUs as those with 20 beds or fewer.

The AHA survey provides data on certain other hospital characteristics that could affect the hospital's decision to operate a NICU, such as for-profit status, teaching status, and geographic location (zip code and county code). We used Atlas Select software[14] to calculate the proximity of each birth hospital to its nearest NICU hospital. The distance is zero for NICU hospitals.

Metropolitan statistical areas (MSAs) are clusters of counties that are considered to be economic markets by the US Census Bureau. MSAs contained over 85% of all NICU beds in 1995. To examine market characteristics such as managed care penetration, we included only hospitals in MSAs in this study. Thus, while the findings presented here reflect the dominant pattern of NICU growth nationwide, they are not necessarily reflective of the pattern in largely rural areas. MSA boundaries are revised periodically, usually as new counties are added. For this study, we included all hospitals in any county in an MSA in 1995, whether or not the hospital was in an MSA earlier.

MSA characteristics include population size, the percentage of people with household income below the poverty level, and the proportion of the MSA population enrolled in health maintenance organizations (HMOs) in 1995 as reported by InterStudy.[15] (InterStudy does not maintain consistent information for earlier years.) We included the state and census region (Northeast, South, Midwest, and West) for each hospital and MSA.

TABLE 1—Trends in Neonatal Intensive Care Unit (NICU) Hospitals, NICU Beds, and Neonatologists: US Metropolitan Statistical Areas, 1980–1995

	1980	1995	% Change, 1980–1995
Births, thousands	2729	3210	+17.6
No. of hospitals with obstetric beds and children's hospitals	2135	1810	–15.2
No. of hospitals with NICU beds	351	698	+98.9
Obstetric/children's hospitals with NICUs, %	16.8	38.6	+129.8
No. of NICU beds	7021	16 702	+137.9
No. of neonatologists[a]	710	2613	+268.0
NICU beds per 1000 births	2.57	5.20	+102.3
Neonatologists per 1000 births	0.26	0.81	+211.5
Occupancy rate of NICUs	76.4	78.5[b]	+2.7

[a]Data are from the American Board of Medical Specialties for Neonatologists. All other data are from the American Hospital Association (AHA).
[b]Data are for 1990; bed days were not reported to the AHA in 1995.

TABLE 2—Trends in Estimated Need for Neonatal Intensive Care Unit (NICU) Beds: Metropolitan Statistical Areas, 1980–1995

	1980	1995	% Change
Total no. of hospital births, thousands[a]	2729	3210	+17.6
No. weighing <1500 g	31 383	43 335	+38.1
% weighing <1500 g[b]	1.15	1.35	+17.4
Total no. of infants weighing <1500 g who survived	18 830	31 635	+68.0
Proportion surviving[b]	0.60 (1983)	0.73	+21.7
Average length of stay, days	59[c] (1987–1988)	68[d] (1993–1994)	+15.3
Needed NICU bed days	1.11 million	2.15 million	+93.7
Total no. of deaths among infants weighing <1500 g	12 553	11 700	–6.8
Average length of stay, days	15[c] (1987–1988)	19[d] (1993–1994)	+20.0
Needed NICU bed days	0.19 million	0.22 million	+15.8
Total needed NICU bed days for infants weighing <1500 g	1.30 million	2.39 million	+83.8
Available bed days	2.56 million	6.10 million	+138.3

[a]Data are from the American Hospital Association (metropolitan statistical areas only).
[b]Data are from the National Center for Health Statistics, all births.
[c]Data are from the National Institute of Child Health and Human Development (NICHD) Neonatal Research Network (Hack et al.[18]).
[d]Data are from the NICHD Neonatal Research Network (Stevenson et al.[17]).

The number of neonatologists was obtained from the American Board of Medical Specialties.[16] Data were summarized from individual physician records to the zip code and county level. Those who practice as neonatologists but are not board certified were excluded.

RESULTS

There was dramatic growth nationwide in technology and manpower associated with caring for high-risk infants in the 1980s and 1990s. As shown in Table 1, the number of births in the period 1980 to 1995 climbed by only 17.6%, and the number of hospitals with any obstetric beds and of children's hospitals (the hospitals that may have NICUs) actually declined. By contrast, several measures of specialized services for high-risk infants grew dramatically, including (1) the number of hospitals with NICUs (98.9%), (2) the number of NICU beds (137.9%), and (3) the number of neonatologists (268.0%).

Occupancy rates in NICUs remained essentially stable between 1980 and 1990, despite the dramatic increase in the number of NICU hospitals and beds. This could be due to various factors, such as use of such beds by lower-risk infants or increased need for such beds because of increased survival of infants needing NICUs.

During the period of this study, mortality rates for very-low-birthweight infants declined, and the survivors tended to stay in NICUs for a prolonged period following birth.[17,18] Table 2 derives a partial estimate of the growth in the need for NICU beds due to increased survival of very-low-birthweight infants. It shows trends between 1980 and 1995 in the proportion of infants born weighing under 1500 g (a size that always requires NICU care when the baby survives the delivery), as well as the percentage of those small infants who survived. As shown, the total number of surviving infants under 1500 g is estimated to have risen by at least 68% within the period. Lengths of stay also increased during the period, but precise data on length of stay are not available across the full time period. Still, the growth in the need for NICU services that derives from increased survival of very-low-birthweight infants (83.8%) is substantially less than the growth in the number of available bed days. While it is possible that other changes could have contributed to the growth in need (e.g., increased survival of infants born with congenital anomalies or of higher-birthweight infants), these are unlikely to account for all of the dramatic increase in NICU services. We conclude that a portion of the growth remains unexplained by increased need, leading to a consideration of other regional and market factors that may have led to growth.

Some might argue that much of the growth in NICUs in small MSAs may be justified, since each distinct market "deserves" at least 1 NICU to improve geographic access to needed services. Table 3 shows that the rate of growth in the number of NICU beds was not much greater in small MSAs (147.7%) than in medium-sized (134.3%) and large (144.4%) MSAs. During this time, access to NICUs, as measured by average distance from a birth hospital to the nearest NICU, did improve more in the smallest MSAs, suggesting

TABLE 3—Neonatal Intensive Care, by Size of Metropolitan Statistical Area (MSA)

	Size of MSA (Total Population) in 1995			
	<500 000	500 000–1 499 999	≥1 500 000	Total for All MSAs
No. (%) of MSAs	199 (67.7)	62 (21.1)	33 (11.2)	294 (100)
No. of NICUs				
1980	94	95	162	351
1995	190	180	328	698
Change, %	+102.1	+89.5	+102.5	+98.9
No. of NICU beds				
1980	1562	1997	3462	7 021
1995	3870	4679	8153	16 702
Change, %	+147.7	+134.3	+144.4	+137.9
Average no. of NICUs per MSA				
1980	0.5	1.5	4.9	1.2
1995	1.0	2.9	9.9	2.4
Change, %	+100.0	+93.3	+102.0	+100.0
NICU beds per 1000 births				
1980	2.3	2.7	2.6	2.6
1995	5.5	5.4	5.0	5.2
Change, %	+139.1	+100.0	+92.3	+100.0
Average distance to nearest NICU, miles				
1980	41.6	19.8	13.8	33.6
1995	19.4	13.1	9.8	16.7
Change, %	–53.4	–33.8	–29.0	–50.3
% of NICUs that were small (<20 beds)				
1980	73.4	60.0	57.4	62.4
1995	63.1	46.6	51.5	53.4
Change, %	–14.0	–22.3	–10.3	–14.4
% of NICU beds in small NICUs				
1980	53.1	37.4	31.7	38.1
1995	36.8	20.4	23.1	25.6
Change, %	–30.6	–45.5	–27.1	–32.8
Median NICU size, no. of beds				
1980	16	18	20	18
1995	18	24	18	20
Change, %	+12.5	+33.3	–10.0	+11.1

Note. NICU = neonatal intensive care unit.

improved access to NICU services. There was also considerable equity across MSA size in the NICU bed supply. In 1995, small MSAs had 5.5 NICU beds per thousand births, compared with 5.4 for medium-sized MSAs and 5.0 for larger MSAs.

Whereas the smallest MSAs had an average of only a single NICU in 1995, medium-sized MSAs had an average of 2.9 NICU hospitals and the largest MSAs had an average of 9.9 such hospitals. We investigated whether deregionalization, represented by growth in the number of small NICUs, occurred during the period. Table 3 shows that 62.4% of NICUs were smaller than the optimal size (that is, 20 or fewer beds) in 1980 and that this figure fell to 53.4% in 1995. However, while the median size of NICUs increased over the study period nationwide and in the smallest and medium-sized MSAs, the median NICU size actually declined in the largest MSAs. This suggests that in the larger MSAs, there is an opportunity for further consolidation of services into larger NICUs, where survival has been shown to be better—a process that would be facilitated by the regionalization of perinatal services.

To try to explain why deregionalization has occurred, we conducted a multivariate logistic analysis to control for some of the multiple factors that could explain the decision of a hospital to open and maintain a small NICU. As shown in Table 4, 3 factors were found to significantly reduce a unit's probability of being small: (1) being housed in a teaching hospital, (2) being housed in a relatively large hospital, and (3) being located in a medium-sized or large MSA. Being located in the Northeast increased a unit's probability of being small. Notably, HMO enrollment rate, for-profit ownership, poverty rate, and the number of neonatologists per 1000 births were not associated with a hospital's NICU size. Thus, most of the market-related hypotheses were eliminated as explanations for the existence of small NICUs.

We sought a possible explanation for why hospitals in the Northeast are more prone to establish small NICUs. Table 5 lists all the 28 MSAs in that region that had 1 or more small NICUs in 1995. Four states—Connecticut, New Jersey, New York, and Pennsylvania—account for almost all of the 67 small NICUs in the Northeast. Pennsylvania offers the most striking situation, with 32 small NICUs spread across 11 MSAs. Almost every Pennsylvania MSA with a small NICU has at least 1 other NICU, offering the opportunity for consolidation of services. The city of Philadelphia is the most extreme example, with 16 small NICUs.

TABLE 4—Factors Predicting the Probability of a Neonatal Intensive Care Unit's (NICU) Being Small (≤20 Beds) in 1995

Factor	Odds Ratio	95% Confidence Interval
MSA HMO enrollment, 1995		
Low (<20%)	1.00	. . .
High (≥20%)	0.96	0.62, 1.48
Hospital for-profit status		
Not-for-profit or public	1.00	. . .
For profit	1.37	0.71, 2.74
% of MSA population with household income below federal poverty level (1990)		
<10%	1.00	. . .
≥10%	0.88	0.59, 1.33
Hospital teaching status		
Nonteaching	1.00	. . .
Teaching	0.19	0.12, 0.29
Hospital size		
Small (<350 beds)	1.00	. . .
Large (≥350 beds)	0.28	0.20, 0.40
Region		
South	1.00	. . .
Northeast	3.54	2.05, 6.22
Midwest	1.25	0.77, 2.03
West	1.14	0.65, 2.00
MSA size		
Small	1.00	. . .
Medium	0.44	0.26, 0.72
Large	0.57	0.35, 0.92
No. of neonatologists per 1000 births in MSA, 1995		
Low (≤0.8 per 1000 births)	1.00	. . .
High (>0.8 per 1000 births)	.85	0.59, 1.24

Note. MSA = metropolitan statistical area; HMO = health maintenance organization. Logistic regression model predicts the probability of a NICU's being small (≤20 beds) in 1995. N = 698 (all hospitals with at least 1 NICU bed); $\chi^2_{11} = 190.3$; $P = .0001$.

DISCUSSION

Our data show rapid and continued growth in neonatal intensive care in urban areas of the United States in the 1980s and 1990s. This expansion of services has increased geographic access, especially in smaller MSAs. We have shown that much of this growth occurred in NICUs that are smaller than optimal, rather than in further expansion of optimally sized NICUs, and that such a process continued through the mid-1990s. In excluding hospitals with only intermediate-care beds (i.e., level 2 hospitals) from this study, we may have underestimated the size and scope of this proliferation. Deregionalization of perinatal services is indicated by the existence of small NICUs in relatively geographically compact areas, such as in small states (e.g., Connecticut and New Jersey) and in large cities such as Philadelphia, where effective transfer

TABLE 5—Metropolitan Statistical Areas (MSAs) in the Northeast Region With at Least 1 Small Neonatal Intensive Care Unit (NICU) in 1995

State	MSA	MSA Size	No. of Small NICUs	
Connecticut	Bridgeport	Medium	2	
	Hartford	Medium	3	7
	New Haven	Medium	1	
	New London	Small	1	
Maine	Bangor	Small	1	
Massachusetts	Boston	Large	2	
New Hampshire	Southern New Hampshire	Medium	1	
New Jersey	Atlantic	Small	2	
	Bergen	Medium	2	
	Monmouth	Medium	2	9
	Newark	Large	2	
	Trenton	Medium	1	
New York	Albany	Medium	1	
	Binghamton	Small	1	
	Nassau/Suffolk	Large	3	15
	New York City	Large	9	
	Rochester	Medium	1	
Pennsylvania	Allentown	Medium	3	
	Erie	Small	2	
	Harrisburg	Medium	1	
	Lancaster	Small	2	
	Northern Pennsylvania	Large	1	
	Philadelphia	Large	16	32
	Pittsburgh	Large	2	
	Reading	Small	1	
	State College	Small	1	
	Wilkes-Barre	Medium	2	
	York	Small	1	
Total no. of small NICUs, Northeast Region			67	

Note. Small MSA = population <500 000; medium MSA = population 500 000–1 499 999; large MSA = population ≥1 500 000.

programs should be able to ensure geographic access. Market-level factors, such as HMO enrollment rates, do not explain these patterns, as determined by the rather crude measures that are readily available, although more subtle market competition factors that cannot be measured with existing data may still be important.

State-specific regulatory approaches could have influenced this marked state pattern. For example, in mid-1997, 37 states maintained some form of certificate-of-need program whereby health care providers are required to apply for permission to build or expand facilities. Twenty-four of those programs require certificates of need specifically for neonatal intensive care services.[19] Although certificate-of-need and other regulatory approaches do not offer a panacea for ensuring regionalization of services, it is notable that Pennsylvania is the only Northeast region state with no certificate-of-need program. (The New Hampshire program does not apply specifically to NICU services, but it does apply to medical equipment purchases of more than $400 000.) The effects of state regulatory practices are illustrated by a recent case study in Massachusetts, a state with strict certificate-of-need regulation of perinatal services. Flaherty showed that the proportion of very-low-birthweight births in NICU hospitals rose from 35% to 86% between 1975 and 1994, with a net change of only 3 new NICUs. This was accompanied by a progressive fall in neonatal mortality,[20] and currently Massachusetts has the lowest infant mortality rate in the United States.[21]

Investigating the myriad local factors that could lead to a proliferation of small NICUs, and consequently to the deregionalization of perinatal services, is beyond the scope of this study. These are likely to include local politics, citizen pressures, hospital ownership, the history of cooperation among health care providers, the current competitive environment, and a desire by the expanding pool of neonatologists to have appropriate practice environments. Further case studies such as the one cited earlier for Hartford[10] and the multicity case studies by Allison-Cook et al.[22] will be needed at the local level to tease out these various factors. In particular, a study of the factors leading to a fragmentation of perinatal services in Philadelphia might lend insights for other communities. It is possible that such forces also affect, in a similar manner, other important specialty services, such as cardiac care, that benefit from regionalization.[23]

Currently, policymakers are undergoing an intense process of considering ways to regulate fairly the quality of health care. As part of this process, the issues surrounding regionalization are an important area for examination and possible intervention. The results of this study suggest that health officials should examine why the number of small NICUs has expanded in some cities, counter to the long-standing professional acceptance of the value of regionalization. ■

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Contributors

E.M. Howell designed the study and directed the research, including overseeing the data analysis and writing parts of the manuscript. D. Richardson assisted in synthesizing the literature, interpreting results, suggesting analyses, and writing sections of the manuscript. P. Ginsburg played a substantive review role, providing suggestions about data, methods, and the direction of the analysis. B. Foot performed much of the data analysis and wrote sections of the manuscript.

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