

# Health Care Delivery

## Outcomes of Regionalized Perinatal Care in Washington State

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*We evaluated the extent to which the regionalization of perinatal care in Washington State has succeeded in concentrating high-risk pregnancies in technologically appropriate referral centers and in reducing differences in neonatal outcome among hospitals. Of all infants weighing less than 1,500 grams born between 1980 and 1983, nearly 68% were delivered in level III hospitals, although only 24% of all babies are born in these hospitals, indicating that the state is highly regionalized. Neonatal outcomes—as measured by standardized mortality ratios—are similar in level I, II, and III hospitals and are not greatly influenced by the rural or urban location of the hospital. The most promising strategy for further reducing neonatal mortality is to decrease the number and proportion of very-low-birth-weight births.*

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Neonatal mortality has declined dramatically in the United States over the past 20 years.<sup>1,2</sup> A major factor contributing to this improvement in infant survival is more effective perinatal technology, particularly in the care of low-birth-weight infants.<sup>3-6</sup> Regionalization of perinatal care has been widely adopted as a strategy to bring high-risk mothers and babies to specialized perinatal centers to reduce regional differences in the availability of sophisticated perinatal care. A major intent of regionalizing perinatal care is to minimize differences in outcome attributable to the geographic location.<sup>2,7-10</sup>

Regionalizing perinatal care is of particular importance in a state like Washington with a large rural population. Washington State has more than 30 small hospitals located in rural counties and only 6 tertiary perinatal centers. In recent years, a statewide system of perinatal regionalization has evolved, with four regional perinatal subsystems covering most areas of the state. This study evaluates the extent to which Washington State's regionalized perinatal care system has been successful in concentrating high-risk pregnancies in technologically appropriate referral centers, reducing disparities in neonatal outcome among hospitals of different types, and eliminating differences that may be attributable to maternal locale.

### Methods

From 1980 to 1983, 90 hospitals in Washington State routinely offered obstetric services. Of all births in the state, 96% occurred in these hospitals, with the remainder in free-standing birthing centers, physicians' offices, hospitals that did not routinely provide obstetric care, in transit to the hospital, or at home. During this four-year period, 264,618 births and 1,571 neonatal deaths—deaths of live-born infants between 0 and 27 days of age—were recorded in the 90 hospitals studied.

### Level of Care Classification

As part of the process of regionalizing, every hospital offering obstetric and neonatal care is assigned to one of the mutually exclusive categories of care, ranging from level I for uncomplicated obstetric and neonatal care to level III for tertiary care requiring sophisticated obstetric and neonatal capabilities. The difference between one level and the next is at times indistinct, and, with the exception of level III nurseries, the state does not formally categorize hospitals. To categorize the level of care available in Washington State obstetric hospitals, we conducted telephone interviews with hospital staff to ascertain the presence of relevant equipment (such as respirators), personnel (such as in-house anesthesiologists or anesthesiologists, neonatologists), and services (such as genetic counseling, short-term versus long-term respiratory support). Based on this information, Washington's hospitals were assigned to level I, II, or III according to guidelines published by the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists.<sup>11</sup> All six level III facilities currently recognized by the state conformed to the published criteria and were assigned level III status. The 11 hospitals classified by our telephone survey as level II had varied levels of respiratory support available, but all had in-house anesthesiologists or anesthesiologists for resuscitation and stabilization, and all had the capability to treat sepsis, do exchange transfusions, and manage intra-arterial lines. The level I hospitals were all those offering routine obstetric care that did not meet the criteria for level II or III designation.

### Rural/Urban Classification

All 39 counties in Washington were categorized as to their relative urban or rural composition based on the percentage of inhabitants living in urbanized areas within the

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county. The counties were divided into four quartiles, with the 25% of counties that were most urbanized designated as urban and the 25% that were least urbanized designated as rural; the two intermediate categories were labeled semi-urban and semirural.

*Data Sources and Analysis*

Data from this study came from the Washington State linked birth and infant death records. Reporting of neonatal deaths is complete in Washington State, and all neonatal deaths are matched with the appropriate birth certificate.<sup>12,13</sup> Information abstracted from the record in each case includes the birth weight of the infant, the hospital of birth, and the age of the infant at the time of death.

After all public maternity hospitals in Washington State had been aggregated according to their level of care and their geographic location, the number of births and deaths was determined for each hospital level and geographic category. Each neonatal death was assigned to the hospital where the infant was born, regardless of the ultimate place of death. A death that occurred in a level III hospital after a neonatal transfer, for example, would be attributed to the hospital where the infant was born. The proportion of infants weighing less than 1,500 grams at birth, the crude death rate, the birth-weight-specific mortality rates, and the standard-

ized neonatal mortality ratios were then calculated for each hospital in Washington State, for levels I, II, and III hospitals aggregated together into groups, and for hospitals in the four rural-urban categories. Increments of 250 grams were used as birth-weight categories, and the outcome for each hospital was indirectly standardized by birth weight to the combined mortality experience of all the hospitals in this study.<sup>14</sup>

**Results**

From 1980 to 1983, there were 264,618 live births and 1,571 neonatal deaths in the 90 Washington State hospitals that routinely provide obstetric care. The system is highly regionalized; although 45% of all births occurred in level I hospitals, only 16% of the very-low-birth-weight births (less than 1,500 grams) and 35% of the low-birth-weight births (1,500 to 2,500 grams) occurred in those hospitals. Table 1 compares the hospitals grouped according to their designated level of care. The case mix of the hospitals—as measured by the proportion of births of less than 1,500 grams—is related to the level of care. The proportion of infants of very low birth weight born in level III hospitals is almost eight times greater than that in level I hospitals. As expected, crude neonatal mortality rates are correlated with the proportion of infants of very low birth weight born in each group of hospitals.<sup>15</sup> These findings are consistent with a regionalized

TABLE 1.—Neonatal Outcomes in Washington State by Hospital Level, 1980-1983

Hospital Level	No. of Hospitals	Total Live Births	Births < 1,500 grams, %	Crude Neonatal Mortality Rate (per 1,000 births)	Neonatal Deaths		Standardized Neonatal Mortality Ratio (95% Confidence Interval)
					Observed	Expected*	
I . . . . .	73	118,220	0.32	3.82	452	444	1.02 (0.93-1.12)
II . . . . .	11	83,560	0.44	4.55	380	368	1.03 (0.93-1.14)
III . . . . .	6	62,838	2.49	11.76	739	759	0.97 (0.90-1.05)
Total . . . . .	90	264,618	0.87	5.94	1,571	1,571	1.00

\*Based on 1980-1983 Washington State births standardized by birth weight.

TABLE 2.—Birth-Weight-Specific Births, Deaths, and Neonatal Mortality Rates in Washington State by Hospital Level, 1980-1983

Birth-Weight Group, grams	Level I Hospitals, N=73			Level II Hospitals, N=11			Level III Hospitals, N=6		
	Births	Deaths	Rate	Births	Deaths	Rate	Births	Deaths	Rate
< 1,500*	381	177	464.57	368	169	459.24	1,563	496	317.34
1,500-2,499	4,019	84	20.90	3,085	63	20.42	4,495	119	26.47
2,500-4,499	110,512	158	1.43	77,606	124	1.60	55,378	98	1.77
≥ 4,500†	3,308	33	9.98	2,501	24	9.60	1,402	26	18.54

\*Mortality rate for level III hospitals is significantly lower than for level II hospitals ( $P < .0001$ ;  $\chi^2 = 26.56$ ; 2 degrees of freedom (*df*)) and level I hospitals ( $P < .0001$ ;  $\chi^2 = 29.34$ ; 2 *df*).

†The observed number of neonatal deaths differed significantly from that expected by chance across the three hospital levels ( $P < .0225$ ;  $\chi^2 = 7.59$ ; 2 *df*).

TABLE 3.—Neonatal Outcomes in Washington State by Rural-Urban Location of Hospital, 1980-1983

Rural-Urban Location	No. of Hospitals	Total Live Births	Births < 1,500 grams, %	Crude Neonatal Mortality Rate (per 1,000 births)	Neonatal Deaths		Standardized Neonatal Mortality Ratio (95% Confidence Interval)
					Observed	Expected*	
Rural . . . . .	15	7,163	0.25	3.63	26	23	1.15 (0.75-1.68)
Semirural . . . . .	19	19,637	0.32	4.02	79	75	1.06 (0.84-1.32)
Semiurban . . . . .	26	80,710	0.47	4.63	374	345	1.08 (0.98-1.20)
Urban . . . . .	30	157,108	1.18	6.95	1,092	1,128	0.97 (0.91-1.03)
Total . . . . .	90	264,618	0.87	5.94	1,571	1,571	1.00

\*Based on 1980-1983 Washington State births standardized by birth weight.

TABLE 4.—*Birth-Weight-Specific Births, Deaths, and Neonatal Mortality Rates in Washington State by Rural-Urban Location, 1980-1983*

Birth-Weight Group, grams	Rural Hospitals, N=15			Semirural Hospitals, N=19			Semiurban Hospitals, N=26			Urban Hospitals, N=30		
	Births	Deaths	Rate	Births	Deaths	Rate	Births	Deaths	Rate	Births	Deaths	Rate
<1,500*	18	5	277.77	62	24	387.10	378	176	465.61	1,854	637	343.58
1,500-2,499	229	6	26.20	692	17	24.57	2,930	59	20.14	7,748	184	23.75
2,500-4,499	6,719	15	2.23	18,312	31	1.69	75,017	118	1.57	143,448	216	1.51
≥4,500	197	0	0.00	571	7	12.26	2,385	21	8.81	4,058	55	13.55

\*Mortality rate for urban hospitals is significantly lower than for semiurban hospitals ( $P < .0001$ ;  $\chi^2 = 20.19$ ; 3 degrees of freedom).

system in which prenatal referral and intrapartum transfer of high-risk mothers are commonplace.

Standardized mortality ratios (SMRs) are computed by determining the number of deaths that would be expected if the outcome achieved by the hospital or hospitals in question were applied to the birth-weight distribution of all the babies in the state.<sup>14</sup> As can be seen from Table 1, the SMRs for each level of care are near unity: none of the observed differences are statistically significant.

Table 2 shows the birth-weight-specific neonatal mortality rates for these same hospitals aggregated by level. Although the standardized mortality ratios are similar across the levels, the pattern of birth-weight-specific neonatal mortality rates observed for level III hospitals is notably different from that prevailing in level I and level II facilities. Level III hospitals have significantly lower mortality rates for infants weighing less than 1,500 grams at birth but higher rates for infants weighing more than 4,500 grams. Level I and level II hospitals have outcomes that are similar for all birth-weight groups.

Table 3 analyzes hospital performance by the rural or urban location of the county where a hospital is situated. There is a definite gradient, from the 15 hospitals in the most rural counties to the 30 hospitals in the most urban counties. Rural hospitals—all of which are level I—have few low-birth-weight births and a commensurately low crude neonatal mortality rate. Urban hospitals are at the other end of

the spectrum, with relatively more infants with a low birth weight and a higher crude neonatal mortality rate, reflecting the fact that all the level III centers are located in urban counties.

Analyzing the SMRs for rural-urban location shows that there are only small differences in standardized neonatal mortality. The SMR for the hospitals in the most rural counties is 1.15, in contrast to an SMR of 0.97 in the most urbanized counties. Neither of these differences is statistically significant, however, despite the appearance of a trend. It should be noted that while hospitals in the most rural counties do have a slightly higher standardized mortality, the number of excess deaths—the difference between the number observed and the number expected—is only three and the associated 95% confidence interval is wide, that is, 0.75 to 1.68.

Table 4 lists the birth-weight-specific neonatal mortality figures for hospitals classified according to their rural-urban location. No discernible pattern emerges. The rates for infants of very low birth weights differ substantially, but the lowest rates are at the two ends of the spectrum—the most rural and the most urban counties—with only the difference in rates between urban and semiurban hospitals reaching statistical significance. Only 3.7% of all low-birth-weight babies (less than 2,500 grams) were born in the 34 hospitals of the state's rural counties, while 10.1% of all babies are born in these hospitals, and the outcomes for these infants are similar to the much larger number of babies born in urban

TABLE 5.—*Comparative Neonatal Outcomes in Hospitals With Level II and Level III Obstetric Units, Washington State, 1980-1983*

Hospital Identifier	Hospital Level	Total Live Births	Births < 1,500 grams, %	Crude Neonatal Mortality Rate (per 1,000 births)	Neonatal Deaths		Standardized Neonatal Mortality Ratio (95% Confidence Interval)
					Observed	Expected*	
1	III	8,339	7.79	27.22	227	276	0.82† (0.72-0.94)
2	III	10,351	1.55	7.92	82	85	0.96 (0.76-1.19)
3	III	11,109	1.72	8.91	99	99	1.00 (0.81-1.21)
4	III	9,465	1.02	5.81	55	55	1.00 (0.75-1.30)
5	III	11,005	1.72	10.00	110	102	1.07 (0.88-1.29)
6	III	12,569	2.20	13.21	166	140	1.18† (1.01-1.38)
7	II	8,078	0.28	2.97	24	31	0.77 (0.50-1.15)
8	II	2,740	0.51	3.65	10	11	0.88 (0.42-1.63)
9	II	9,023	0.34	3.21	29	34	0.86 (0.58-1.24)
10	II	5,990	0.30	3.34	20	22	0.89 (0.54-1.38)
11	II	9,159	0.48	4.15	38	41	0.93 (0.66-1.28)
12	II	13,630	0.32	4.26	58	55	1.05 (0.80-1.36)
13	II	6,843	1.23	8.18	56	53	1.06 (0.80-1.37)
14	II	8,669	0.35	4.50	39	35	1.12 (0.80-1.53)
15	II	5,919	0.52	5.07	30	25	1.22 (0.82-1.74)
16	II	7,161	0.42	5.87	42	34	1.22 (0.88-1.65)
17	II	6,348	0.30	5.36	34	27	1.28 (0.88-1.78)

\*Based on 1980-1983 Washington State births standardized by birth weight.  
†Difference between observed and expected deaths significant at the  $P < .05$  level.

hospitals in the state. The data presented in Table 4 reinforce the conclusion that possible geographic differences in hospital outcomes have been largely mitigated by the regionalization of perinatal services.

Table 5 explores differences among individual level II and level III hospitals within the state. It is clear that hospital 1 occupies a unique position within the state, with almost 8% of all births occurring here being infants weighing less than 1,500 grams. The next highest proportion of very-low-birth-weight infants in an individual hospital is less than a third that percentage. Of all neonatal deaths occurring in the state, 14% are assigned by birth to this facility, which obviously has a tertiary referral role unlike that of the other level III centers. It is interesting to note that this hospital's SMR is the lowest of the level III hospitals and is the only outcome in any of the level II or level III hospitals that is significantly lower than the population experience.

By contrast, hospital 6 has an SMR that is significantly higher than that for the population as a whole. Although it has a high proportion of very-low-birth-weight infants, the outcomes in this institution are not as good as those achieved in the other level III facilities in the state. The number of excess deaths in this hospital is 26, more than the number of excess deaths that occurred in all the level I and level II hospitals in the state.

The state's level II hospitals are relatively homogeneous, with one exception. Hospital 13 resembles a level III hospital with a relatively large proportion of infants with very low birth weights, nearly three times that of the average level II hospital. None of the SMRs for the level II hospitals are significantly different for the experience of the state's hospitals as a whole. As noted earlier, level II hospitals are similar to level I hospitals, the major difference noted in this study between the two groups being the larger number of deliveries in level II hospitals.

## Discussion

The objective of regionalizing perinatal care is to improve outcome by matching the clinical requirements of the mother and infant with the technologic capacity of the hospital and professional staff. Because only a relatively small proportion of infants requires neonatal intensive care—usually for problems associated with a low birth weight—and because perinatal outcome improves with clinical experience and volume, regionalization provides a way to concentrate these cases in a small number of institutions that have the expertise needed to care for these children.<sup>2</sup>

The regionalization of perinatal care has two central features: categorizing individual hospitals according to their technical and professional capacity to deal with cases of varying complexity, and linking individual hospitals and physicians within specific geographic areas into regional systems that facilitate the referral and transfer of mothers and babies to locations with the appropriate level of care.

In the ideal regionalized system, high-risk babies would be born predominantly in level II and level III hospitals, while level I hospitals would concentrate on the care of low-risk mothers and babies. To accomplish this result, high-risk mothers living in areas served by level I hospitals—particularly those living in rural areas—would be identified and transferred to higher level facilities before delivery, thus benefiting from the technical capacity at the more technically sophisticated hospital.

## *The Extent of Perinatal Regionalization in Washington State*

The location of the births of very-low-birth-weight infants provides a direct measure of the extent of perinatal regionalization. In the ideal system there would be no births of infants weighing less than 1,500 grams in level I hospitals, particularly those in rural areas. By this criterion, Washington State has made substantial progress in creating a successful regionalized perinatal care system. Only 16% of these infants are born in level I facilities, and only 3.5% are born in rural hospitals, although these facilities are responsible for 45% and 10.1% of all births in the state, respectively.

These data indicate that referral or transfer of high-risk mothers is the rule rather than the exception. Most of the transfers appear to flow directly to level III facilities. Of all infants with very low birth weights, 68% are born in the state's level III hospitals, although only 24% of all births occur in these facilities. The birth-weight distribution of infants born in level II hospitals is much more similar to that in level I than it is to that in level III facilities. These data suggest that level II hospitals play only a limited role as the destination of maternal transfers from level I institutions.

## *Level of Care and Neonatal Outcome*

The best available measure of the quality of perinatal care is birth-weight-specific neonatal mortality. In this study, the overall differences between level I, II, and III hospitals—as measured by the standardized mortality ratio—were negligible. Level III hospitals, however, had significantly lower mortality rates for infants weighing less than 1,500 grams and higher rates for infants weighing more than 4,500 grams than those recorded in level I and level II hospitals.

The lower mortality rates in level III hospitals for very-low-birth-weight infants is to be expected. The basic premise of regionalizing perinatal care is that prompt access to an experienced neonatal intensive care unit is associated with higher survival rates, and the data here confirm the findings of other authors.<sup>5,6,16-19</sup> In addition, Horwood and co-workers have shown that selection biases associated with prenatal transfer tend to lead to better apparent outcomes in referral centers, an effect that probably plays a role in explaining the findings noted here.<sup>20</sup> Only population-based studies—rather than center-based studies—can determine the relative importance of these two findings in Washington State.

The higher mortality rates for large infants in level III facilities have been noted previously in other studies and have several possible explanations.<sup>21-23</sup> Maternal referrals and transfers of high-risk patients with relatively large infants to level III centers could lead to higher neonatal mortality rates in these birth-weight groups. Conversely, it is possible that normal- and large-birth-weight children have better outcomes in less technologically intense settings by avoiding potential iatrogenic complications. Comparing birth-weight-specific outcomes for those children who are referred to level III centers with those who receive their prenatal and intrapartum care at level I or level II centers would help to clarify this issue.

## *Rural Obstetrics and Neonatal Outcome*

There are 34 level I hospitals in the predominantly rural counties in Washington State, accounting for 10% of all the

births in the state. The evidence suggests that these hospitals are assiduous in referring high-risk mothers for delivery in more sophisticated facilities: only 80 infants with very low birth weights were born in these hospitals during the four-year study period, and their neonatal mortality rate was similar to that achieved in urban hospitals. It can be argued, however, that any high-risk infant born in these facilities represents a failure of regionalization and that these hospitals, by their very presence, constitute a hazard because not every high-risk mother can be identified and transferred before delivery.

The standardized mortality ratios are reassuring in that rural hospital outcomes, taken as a whole, do not deviate significantly from the population norm.<sup>16,24</sup> Even with meticulous prenatal screening, not all cases of premature labor can be detected in time to arrange for maternal transfer. In addition, rural hospitals are a valuable resource in the management of unanticipated obstetric emergencies. Given that rural hospitals play an important role in stabilizing health care systems in small communities and that exporting all pregnant women to other communities for their obstetric care exacts substantial financial and emotional costs, rural hospitals have an important and legitimate role to play in obstetric care.

#### *Future Improvements in Neonatal Outcome*

The results of this study suggest that Washington State has been successful in implementing a regionalized perinatal care system and that significant geographic differences in neonatal outcome have been virtually eliminated. It appears that most infants have the benefit of neonatal intensive care when indicated and that most transfers of very-low-birth-weight infants occur before birth. Neonatal mortality rates in level I hospitals and in rural hospitals are similar to those in larger, more technologically sophisticated facilities.

The most promising strategy for further reducing the neonatal mortality rate is to decrease the proportion of very-low-birth-weight births. The 0.87% of babies who weigh less than 1,500 grams at birth account for 53.6% of all neonatal deaths in the state. Programs that are effective in preventing preterm births will have an immediate impact on the neonatal mortality rate.

#### *The Future of Regionalized Perinatal Care in an Era of Competition*

Regionalized perinatal care systems depend on cooperation among hospitals and physicians. Each unit is part of a larger system that defines the roles and relationships existing among professionals and institutions. As competition among hospitals becomes more intense and well-trained perinatologists and neonatologists diffuse out from the training centers into community hospitals, community hospitals will tend to retain more high-risk patients. If carried to an extreme, this may frustrate the intent of regionalization: to concentrate large volumes of high-risk patients in a limited number of centers that can develop the expertise and the experience needed to deal with the clinical demands of this group of patients.

There is excellent evidence that outcomes are better, particularly for technically complex clinical undertakings such as neonatal intensive care, in centers with a high volume of patients with special needs.<sup>25</sup> This study adds support to that conclusion: 28% of all the babies weighing less than 1,500 grams were born in one facility, yet the associated neonatal mortality rates for this group of infants were much lower than for other hospitals in the state. To the extent to which the proliferation of neonatal intensive care units in other hospitals limits the number of referrals, or changes referral patterns, neonatal outcomes may deteriorate.

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