0021-7557/07/83-01/27
Jornal de Pediatria

Hospital mortality rates of infants with birth weight less than or equal to 1,500 g in the northeast of Brazil

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Abstract

Objective: To obtain information on the hospital mortality of infants born in Fortaleza with birth weight less than or equal to 1,500 g, and to compare it with data from the Vermont Oxford Network, a center of excellence for neonatal care.

Methods: Prospective cohort study, enrolling all infants with birth weight less than or equal to 1,500 g born in Fortaleza between March 1, 2002 and February 28, 2003 from all the hospitals and maternity units with neonatal intensive care units. Infants were followed from birth until hospital discharge or hospital death, using the Vermont Oxford Network questionnaire..

Results: A total of 774 newborn infants were analyzed. The neonatal mortality coefficient was 477‰, and the postneonatal mortality coefficient was 35‰, taking the hospital mortality coefficient to 512‰. The coefficient of early neonatal mortality was 335‰, and the coefficient of late neonatal mortality was 142‰. Mortality coefficients were higher in Fortaleza for all weight ranges than on the Vermont Oxford Network and were also, with the exception of the less than or equal to 600 g weight range, higher than in Montevideo.

Conclusions: The results demonstrate high rates of hospital mortality among very low birth weight infants, with a greater concentration during the first week of life, suggesting that not only the care provided at the neonatal intensive care units is deficient, but also that prenatal and delivery-room care is inadequate.

J Pediatr (Rio J). 2007;83(1):27-32: Neonatal mortality, very low birth weight infant.

Introduction

Over the last 10 years, neonatal mortality has come to account for a significant fraction of the infant mortality rate. This fraction has increased in proportion with a reduction in the postneonatal component. In the more developed regions of Brazil, the decline in neonatal mortality has taken place slowly, tending towards stability, although levels remain elevated;[1] in the Northeast, this decline has proceeded more slowly, comparatively.[2] it is important to emphasize that mortality rates are related to the three sets of factors: the biological characteristics of the mother, the socioeconomic conditions of the family, and the availability and quality of perinatal medical care.[3]

In the state of Ceará, transformation is in the healthcare sector have contributed significantly to a reduction in infant mortality of approximately 50.%. In 1987, infant mortality was 104/1,000 live births; 7 years later, in 1994, it was 57/1,000 live births.[4,5] In 1987, the neonatal component accounted for 28% of all deaths during the first year of life, in 1990 this had reached 46% and, in 1994, approximately

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Financial support: Secretaria de Saúde do Estado do Ceará (SESA-CE), Fundação Cearense de Apoio ao Desenvolvimento Científico e Tecnológico (FUNCAP), protocol no. 271/01.

Manuscript received April 18, 2007 Mar 20 2006April 18, 2007Oct 04 2006.

Suggested citation: Castro EC, Leite AJ. Hospital mortality rates of infants with birth weight less than or equal to 1,500 g in the northeast of Brazil. J Pediatr (Rio J). 2007;83(1):27-32.

doi 10.2223/JPED.1576

57%.[4] Data for 2002 estimate the infant mortality rate in Ceará at 25/1,000 live births.[6]

When defining strategies to control infant mortality, knowledge of the relative proportions within the subset of newborn infants according to weight ranges, proves to be of fundamental importance. The incidence of very low birth weight infants (VLBWI, less than 1,500 g)[7] is linked to mothers' antenatal health conditions and the quality of care received during the prenatal period. In contrast, the mortality rates for this specific subset are fundamentally the result of the immediate neonatal care they receive in the delivery room and in intensive care units (ICU).[8] It should further be pointed out, that mortality within this subset of newborn infants is related to expectant mothers' realization of imminent premature delivery and their access to an appropriate hospital, with these factors having greater impact in less developed regions.[9]

Despite the reduced incidence of VLBWI (1.5-2%) within the population of live births, they suffer approximately 1/3 of the total infant mortality. Reducing mortality rates within this subset of newborn infants is a major challenge and would, in turn, have a major impact on reducing infant mortality.

The contribution to reducing infant mortality that can be made by the care provided to low birth weight infants (LBWI, less than 2,500 g)[7] is one of the fundamental characteristics of the epidemiological scenario in which the city of Fortaleza is currently placed. Within the subset of LBWI, the VLBWI assume ever growing importance. The VLBWI account for around 80% of all LBWI who die before 1 month of life.[9] If VLBWI death rates could be cut in half, the infant mortality rate would fall by approximately 17.5%.

Currently, several initiatives are being developed towards the formation of multicenter neonatal networks, with the objective of improving the quality of neonatal care. In Brazil the Rede de Pesquisas Neonatal (Neonatal Research Network) has been founded, involving neonatology services in the South and Southeast regions, being the regions with the lowest mortality rates in the country; in the USA, there are the Vermont Oxford Network[10] (VON) and the National Institutes of Health and Child Development (NICHD) Neonatal Network.

The objective of this research project was to compile information on the hospital mortality of infants born in the city of Fortaleza with birth weights less than or equal to 1,500 g, and to compare it with data from the VON, considered a reference standard for neonatal care.

Methods

A prospective cohort was studied, made up of all infants born live with birth weights less than or equal to 1,500 g between March 1, 2002 to February 28, 2003 at all hospitals and maternity services with neonatal intensive care unit (NICU) in the city of Fortaleza (three public hospitals and five private ones). The VLBWI category definition had not included infants with birth weights of 1,500 g; however, for this study they were included in order to allow comparison with the VON. Therefore, in this study he abbreviation VLBWI will be used to denote infants with birth weights less than or equal to 1,500 g. Infants born weighing less than 500 g were excluded.

Infants were enrolled at birth, with data collected in the delivery room and from an active search of the medical records of the NICUs of participating hospitals. They were then followed from this point up until they were either discharged from hospital or died there. These data were recorded on a standardized questionnaire, adapted from the form used by the VON NICUs.

Data were collected by specially trained nurses and doctors at each participating institution and were coordinated by the lead researcher who verified that everything was filled-out correctly and that data was coherent. Data was "cleaned" in order to identify errors in either consistency or magnitude. After this process data was double-input. The start of this research was preceded by a pilot study that lasted 2 months.

The study was approved by the Research Ethics Committee at the Universidade Federal do Ceará and formal consent was granted by the directors of the hospitals involved.

Data were stored in an Epi-Info version 6.0 database, and analyzed with the aid of the statistical program SPSS for Windows version 10.0.

Data from the VON were obtained from information published in their 2002 annual report.[11]

in order to analyze intrahospital mortality, VLBWI birth weights were broken down into 100 g categories, because these divisions are associated with significant changes in mortality, and they were also classified into 250 g weight ranges (501-750 g, 751-1,000 g, 1001-1,250 g, 1,251-1,500 g), since these are the divisions adopted by the VON, thus making comparisons possible. The current study adopted the database standards defined by the VON to define and collect variables and to calculate the principal outcome indicators.

Excess mortality in Fortaleza was calculated by direct standardization, defining the standard population as the sum of the two populations (VON and Fortaleza). Excess risk of death in Fortaleza was calculated by applying the mortality rate obtained by the VON in 2002 for each weight category to the children born in Fortaleza. Deaths that occurred in

Fortaleza were considered avoidable if they would not have occurred if the VON mortality rates for each birth weight division had been achieved.

Survival was analyzed according to birth weight and hospital death. Live birth, early neonatal death and late neonatal death were defined according to the World Health Organization.[7]

The variable death in hospital was analyzed as follows:

- deaths on days 0-6: early neonatal hospital mortality;
- deaths on days 7-27: late neonatal late hospital mortality;
- deaths on days 0-27: neonatal hospital mortality;
- deaths after day 27: postneonatal mortality while in hospital.

Results

A total of 817 VLBWI were born in Fortaleza. Of these, 19 were excluded because they did not meet inclusion criteria, i.e. they were born weighing less than 500 g, and a further 24 were excluded because they were born in maternity hospitals without NICUs, being treated at a public tertiary hospital with significant demand from infants originating from other municipalities and with inadequate neonatal transport. The final analysis included 774 VLBWI.

The mean weight of the VLBWI sample was 1,098 g, standard deviation (SD) = 266 g. The distribution of the VLBWI by birth weight category, hospital mortality coefficient and days before death is shown in Table 1. The global hospital mortality coefficient for all newborn infants during the study period was 512/1,000 live births. Survival of infants born weighing less than 1,000 g was just 20.7%. Approximately 50% of newborn infants with birth weight of 1,001-1,250 g survived. The highest probability of death was observed for infants with birth weights of 1,251-1,500 g (24%). Two-thirds of all deaths among these infants occurred within 6 days of birth. The greatest concentration of deaths was found on the first day of life, with 92 occurrences (23.3% of all deaths). There were 110 deaths (27.8% of all deaths) during the late neonatal period. Few newborn infants (27, 6.8% overall) died during the postneonatal period.

The neonatal mortality rate was 477/1,000 live births, and postneonatal hospital mortality was 35/1,000, taking total hospital mortality to 512/1,000. The coefficient of early neonatal mortality was 335/1,000, while the late neonatal mortality coefficient was 142/1,000. Observe that early neonatal mortality is 2.4 times late neonatal mortality (Table 2).

Table 3 demonstrates that the excess risk of death in Fortaleza, when compared with the VON, is approximately 3.41. Greatest risk was observed in the 1,001-1,250 g weight band. Deaths that occurred in Fortaleza were considered avoidable if they would not have occurred if the VON mortality rates for each birth weight division had been achieved. It was not possible to compare data from Montevideo with those from Fortaleza in this table because the comparable study from Montevideo did not publish mortality coefficients for 250 g weight divisions.

Figure 1 is an analysis of hospital mortality by 100 g birth weight subsets, since these divisions are associated with significant changes in mortality and make comparative analysis with the data from Montevideo, Fortaleza and VON possible. Mortality coefficients were greater in Fortaleza than in Montevideo for all weights, with the exception of the subset with birth weigh less than or equal to 600 g, all of whom died in both studies. It will, however , be observed that the difference in mortality becomes most evident in the

Table 1 - Distribution of deaths infants with birth weight less than or equal to 1,500 g, according to the day on which death occurred and birth weight ranges (Fortaleza, 2002)

	Hospital mortality coefficient	Early neonatal deaths		Late neonatal deaths	Postneonatal deaths
		1st day	2-6 days	7-27 days	> 27 days
Birth weight (g)	n (‰)*	n (‰)*	n (‰)*	n (‰)*	n (‰)*
501-750 (LB = 102)	97 (951)	37 (363)	46 (451)	11 (108)	3 (29)
751-1,000 (LB = 168)	117 (696)	23 (137)	53 (315)	35 (208)	6 (36)
1,001-1,250 (LB = 246)	120 (488)	19 (77)	56 (228)	34 (138)	11 (45)
1,251-1,500 (LB = 258)	62 (240)	13 (50)	12 (47)	30 (116)	7 (27)
Total (n = 774)	396 (512)	92 (119)	167 (216)	110 (142)	27 (35)

***** Hospital mortality = deaths/1,000 live births.
n = number of deaths; LB = live births.

1,000-1,300 g weight range, where Fortaleza mortality was 2 to 4 times greater than in Montevideo. When mortality figures from the VON are compared with Fortaleza, the greatest difference is also found in the same weight range, being seven to eight times more elevated. Fortaleza also has higher mortality coefficients than the VON does in all other weight ranges.

Discussion

This study analyzed approximately 95% of the VLBWI born alive in Fortaleza. Data from the Fortaleza Department of Health state that the coefficient of infant mortality was 26/1,000 live births. Deaths of VLBWI account for approximately 42% of overall infant mortality. An important point to underscore is that this subset of infants makes this contribution to the infant mortality rate despite its low incidence within overall live births (2%). In Montevideo, in 1999, the infant mortality coefficient was 13/1,000 live births and 52% of this figure that was the result of VLBWI deaths.[12] The lower the overall infant mortality, the greater the relative contribution of this subset of newborn infants to the coefficient will be.[12]

What makes comparison with Montevideo of interest is that it is a Latin-American city with a population that approximates Fortaleza's and a similar study has been carried out there. In contrast, the VON allows comparisons to be made with results from developed countries considered the best reference standard for VLBWI care.

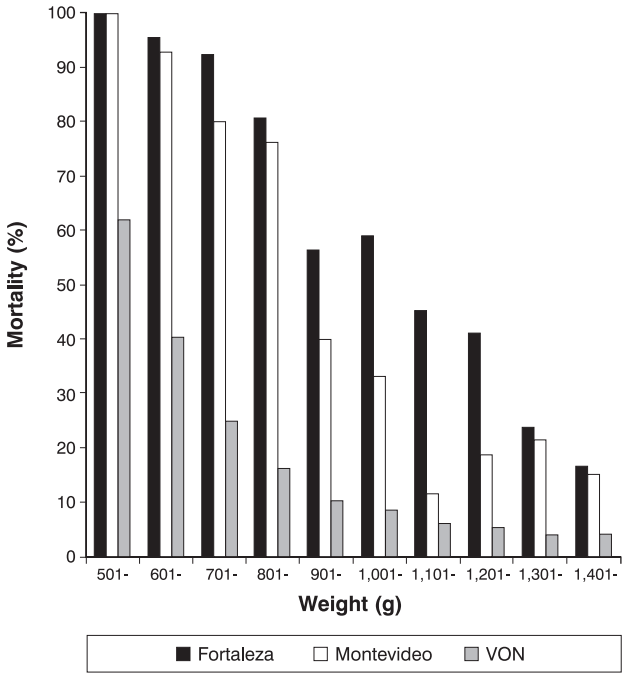

Figure 1 - Specific intrahospital mortality by birth weight (comparison Fortaleza – Montevideo – VON, 2002)
VON = Vermont Oxford Network.

In this study, specific mortality for VLBWI was 512/1,000 live births (396 newborn infants). This coefficient can be considered elevated if compared with the results from Montevideo and the VON. In Montevideo, specific mortality of VLBWI was 383/1,000 live births,[12] while the VON figure was 150/1,000 live births.[11]

Table 2 - Specific mortality by weight and day on which death occurred (Fortaleza, 2002)

		Neonatal ICU				Neonatal mortality		ICU		Hospital mortality	
		0-6 days Rate*		7-27 days Rate*		0-27 days Rate*		> 27 days Rate*		Rate*	
Birth weight (g)	(LB)	n	‰	n	‰	n	‰	n	‰	n	‰
501-600	39	39	1,000	--	--	39	1,000	--	--	39	1,000
601-700	44	34	773	6	136	40	909	2	45	42	955
701-800	57	35	614	11	193	46	807	1	18	47	925
801-900	52	25	481	15	288	40	750	2	38	42	808
901-1,000	78	26	333	14	179	40	513	4	51	44	564
1,001-1,100	88	33	375	15	170	48	545	4	45	52	591
1,101-1,200	104	25	240	15	144	40	385	7	67	47	452
1,201-1,300	97	26	268	13	134	39	402	1	10	40	412
1,301-1,400	101	8	79	13	129	21	208	3	30	24	238
1,401-1,500	114	8	70	8	70	16	140	3	26	19	167
Total	774	259	335	110	142	369	477	27	35	396	512

* per 1,000 live births.
ICU = intensive care unit; LB = live births.

In comparison with Montevideo and the VON, mortality was elevated in all weight ranges, emphasizing the extremely limited survival (approximately 21%) of the under-1,000 g subset; in Montevideo this figure was 31%, and for the VON it is 72%. Nevertheless, the differences in mortality become significantly more accentuated in the weight range from 1,000-1,300 g. This fact is of great importance, since this weight range can exhibit better mortality reductions in response to the introduction of preventative and therapeutic resources that are available in the Fortaleza hospitals, such as the use of surfactant and the administration of antenatal corticoid to mothers.

Rossello et al.[13] assessed the impact of the use of surfactant on neonatal mortality in Latin America, concluding that its use had reduced first-week mortality by around 50%; after this period it still achieved a significant reduction of 18% in global hospital mortality up to discharge. In the same study, the subset of infants smaller than 1,000 g exhibited a significant increase in complications, such as bronchopulmonary dysplasia, intraventricular hemorrhage and necrotizing enterocolitis, in contrast with developed countries.[13] This fact is probably the result of increased survival among this subset of infants who, thanks to the use of surfactant, had the opportunity to develop later complications and even make possible the displacement of their deaths to a later phase. The impact of surfactant use in real terms (NICUs in Latin-American cities) was greatly reduced in comparison with what was achieved in the first world. Possible explanations are difficulties with controlling infectious complications and prolonged use of mechanical ventilation and its adverse effects.[14]

What may be happening in Fortaleza is the same phenomenon that was studied 10 years ago by Rossello et al.[13] Displacement of the point of death was observed in our study in a higher weight range than in that study, at 1,300-1,500 g (Table 2), with a reduction in early neonatal mortality and a concurrent increase in late neonatal mortality, suggesting a deficiency in the ability of NICUs to provide effective care to these newborn infants.

Another study has already reported that the need for mechanical ventilation is a risk factor for death, although this association may be being confounded by the fact that the children in the most severe situations are those who require mechanical ventilation.[14] One important factor to be taken into account is the care process at NICUs, focused on the training and workload of the healthcare professionals, which is very different in more developed regions.[15]

A pioneering investigation carried out by Lamy in Maranhão[15] studied the care process at NICUs, observing that possible causes of low effectiveness of neonatal intensive care are related to the low rate at which high-impact technologies are incorporated and inadequate use of human resources. Furthermore, the workload of health professionals caused nonspecific failures in the mechanical ventilation process with increased risk of death and loss of venous access, leading to increased risk of nosocomial infection.

Analysis of the mortality figures for VLBWI in Fortaleza makes it possible to draw out certain relevant features, which are described below.

Early neonatal mortality coefficients are elevated in all weight ranges. Only 67 of every 100 VLBWI who are born survive their first week. This mortality rate suggests care deficiencies at the NICUs and also unsatisfactory care conditions during the antenatal period or at the point of birth.

Hospital mortality rates are elevated for all the newborn infants (512/1,000), i.e. for every 100 newborn infants born weighing less than 1,500 g (excluding those below 500 g), just 49 survive to go home. This study has revealed that the capacity to save VLBWI is limited, with improvements observed from 1,250 g onwards.

Table 3 - Hospital mortality coefficients and excess risk by weight (Fortaleza vs. VON, 2002)

	Fortaleza			VON			Fortaleza *vs.* VON
Birth weight (g)	Live births (n)	Deaths (n)	Mortality ‰	Live births (n)	Deaths (n)	Mortality ‰	Excess risk
501-750	102	97	951	6,519	2,868	440	2.16
751-1,000	168	117	696	7,712	1,080	140	4.97
1,001-1,250	246	120	488	8,273	496	60	8.13
1,251-1,500	258	62	240	9,835	393	40	6
Total	774	396	512	32.339	4.837	150	3,41

VON = Vermont Oxford Network.

This study has contributed to the identification of a significant proportion of avoidable infant deaths. Comparison of the mortality rate of VLBWI in Fortaleza with those of the VON demonstrates that 396 deaths occurred, of which 362 would not have occurred if the specific mortality rates by weight were the mean VON rates. Therefore, if mortality in Fortaleza was the same as in NICUs in the United States, 91% of the deaths there would be avoided.

The high mortality rates found by this study suggest that there is a deficiency in the tertiary-level care of VLBWI in Fortaleza, although the basic cause may subsist in prenatal care. Even assuming that the NICUs have sufficient technological resources to provide effective care, it is probable that the care process is disorganized. The causes may also be intimately linked with inadequate use of human resources, such as excessive workload put on healthcare professionals, generating nonspecific process failures and worse results, as was revealed by a study carried out in another state in the region.[15]

This study has also made it possible to gain an understanding of the situation in which the city Fortaleza finds itself in terms of VLBWI mortality, providing evidence of a public health problem of great importance and indicating reference directives for the adoption of effective measures to reduce neonatal mortality. Therefore, efforts should be made to implement changes to hospital practices that will bring better results, with the involvement of the professionals working in the neonatal area.

Acknowledgements

To the researchers at the Centro Latino-Americano de Perinatologia e Desenvolvimento Humano (CLAP), Prof. Dr. José Luiz Diaz Rossello and Prof. Dr. Fernando C. Barros, whose contributions were of inestimable value to the design of this investigation.

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