

CLINICAL SCIENCE

Cost estimate of hospital stays for premature newborns in a public tertiary hospital in Brazil

Claudia Maria Desgualdo,¹ Rachel Riera,^{II} Paola Zucchi^I^IUniversidade Federal de São Paulo - Centro Paulista de Economia da Saúde, São Paulo, São Paulo/Brazil. ^{II}Universidade Federal de São Paulo - Brazilian Cochrane Center, São Paulo/SP, Brazil.

OBJECTIVES: To estimate the direct costs of hospital stays for premature newborns in the Interlagos Hospital and Maternity Center in São Paulo, Brazil and to assess the difference between the amount reimbursed to the hospital by the Unified Health System and the real cost of care for each premature newborn.

METHODS: A cost-estimate study in which hospital and professional costs were estimated for premature infants born at 22 to 36 weeks gestation during the calendar year of 2004 and surviving beyond one hour of age. Direct costs included hospital services, professional care, diagnoses and therapy, orthotics, prosthetics, special materials, and blood products. Costs were estimated using tables published by the Unified Health System and the *Brasíndice* as well as the list of medical procedures provided by the Brazilian Classification of Medical Procedures.

RESULTS: The average direct cost of care for initial hospitalization of a premature newborn in 2004 was \$2,386 USD. Total hospital expenses and professional services for all premature infants in this hospital were \$227,000 and \$69,500 USD, respectively. The costs for diagnostic testing and blood products for all premature infants totaled \$22,440 and \$1,833 USD. The daily average cost of a premature newborn weighing less than 1,000 g was \$115 USD, and the daily average cost of a premature newborn weighing more than 2,500 g was \$89 USD. Amounts reimbursed to the hospital by the Unified Health System corresponded to only 27.42% of the real cost of care.

CONCLUSIONS: The cost of hospital stays for premature newborns was much greater than the amount reimbursed to the hospital by the Unified Health System. The highest costs corresponded to newborns with lower birth weight. Hospital costs progressively and discretely decreased as the newborns' weight increased.

KEYWORDS: Costs and Cost Analysis; Premature Birth; Infant; Low Birth Weight; Intensive Care Units; Neonatal Public Health; MeSH.

Desgualdo CM, Riera R, Zucchi P. Cost estimate of hospital stays for premature newborns in a public tertiary hospital in Brazil. *Clinics*. 2011;66(10):1773-1777.

Received for publication on May 11, 2011; First review completed on June 14, 2011; Accepted for publication on July 5, 2011

E-mail: rachelriera@hotmail.com

Tel.: 55 11 3188-4310

INTRODUCTION

Among the 130 million children born each year, approximately four million die within the first four weeks of life.¹ Of these deaths, 75% occur within the first week following birth, and 99% of these deaths occur in poor countries. The primary causes are directly related to prematurity (28%), infection (26%), and intrapartum asphyxia (23%).²

About 900,000 premature births occurred in Latin America and the Caribbean during 2005.³ In Brazil, the number of premature births recorded in 2004 was 196,537; in other words, 6.49% of all births that year were premature.⁴ There is no uniformity in the distribution of premature births in the different regions of the country,

with 5.10% premature births recorded in the northern region, 5.52% in the northeastern region, 7.35% in the southern region, 7.27% in the southeastern region, and 6.44% in the central-western region.⁴ It is alarming that more than half of the newborns born prior to 36 weeks gestation in Brazil die within the first week of life.⁴

In Brazil, as in much of the world, the most extreme age groups, infants and seniors, utilize the most health services.⁵ In 2004, hospital stays for prematurity and infant respiratory distress syndrome accounted for 0.5% of all hospital stays within the Brazilian public health system (the Unified Public Health System [*Sistema Único de Saúde*] (SUS)) and 2.05% of the amounts disbursed.⁴

Cost estimates are used as a source of information to manage strategies, develop new public health policies and establish budgetary priorities. Considering the incidence of premature births in Brazil and the morbidity associated with this condition, it is of crucial importance to measure the real costs of premature newborns' hospital stays to aid and guide public health policies in Brazil.

The objectives of this study were as follows:

Copyright © 2011 CLINICS – This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

No potential conflict of interest was reported.

- To estimate the direct costs of hospital stays for premature newborns (NBs) in the neonatal ward of the Interlagos Hospital and Maternity Center [*Hospital e Maternidade Interlagos*] (HMI) from January through December 2004.
- To assess the costs according to birth weight and the presence of comorbidities.
- To assess the difference between the amount reimbursed to the hospital by the SUS and the real cost of care for the premature NBs.

MATERIALS AND METHODS

The study was conducted at Centro Paulista de Economia da Saúde, Universidade Federal de São Paulo, with data collected from the HMI, a reference hospital for high-risk births in the city of São Paulo. The study was approved by the Research Ethics Committee of the UNIFESP and by the Medical Ethics Committee of the HMI.

Researchers collected data from medical records (inpatient records) of live newborns that met the following inclusion criteria: born live between the 22nd and 36th week of gestation and admitted to the neonatal ward of the HMI between January and December 2004. Exclusion criteria included death within one hour of birth and births with fatal malformations.

The direct cost of hospital care includes the following:

- Hospital services: medications, parenteral nutrition, medical gases, and nursing care. The Brasíndice was used to determine the cost of medications, parenteral nutrition, and medical gases.⁶ The cost of nursing services was determined on the basis of the average salary of nurses who had been employed for an average of five years. The total number of nurse hours was calculated for the sector, and the total of all tallies was divided by this total number of hours to obtain the cost per hour worked within this category.
- Professional services: neonatal medical services, pursuant to the average salary of neonatal doctors with five years in the field. The salaries of day doctors were calculated in full; on-call doctors' salaries were calculated as half of their salary because in addition to practicing in the neonatal ward at night and on weekends, on-call doctors also deliver newborns in the regular birthing center. For physical and speech therapy, the study used the average salary of professionals with five years in the field divided by the total number of visits/appointments conducted, multiplied by the number of sessions with hospitalized newborns. Appointments with specialists were calculated pursuant to the Brazilian Classification of Medical Procedures [*Classificação Brasileira Hierarquizada de Procedimentos Médicos*] published by the Brazilian Medical Association [*Associação Médica Brasileira*].⁷
- Diagnostic tests: additional exams to aid in clinical diagnosis (blood tests, biochemical profiles, blood gas analyses, immunology tests), x-rays, ultrasounds, and eye exams. The costs of these exams were obtained from the List of Medical Procedures published by the Brazilian Medical Association.⁸
- Orthotics, prosthetics, and special materials: albumin, pulmonary surfactant and others, where applicable,

were calculated according to the purchase price listed in the contract.

- Blood products: costs were calculated according to the tables available from private blood banks for red blood cell concentrate, plasma, platelets and coagulation factors.

Information on costs reimbursed to the hospital by the SUS were based on the SUS procedures list.⁹

To compare the results of this study with those of international studies, the estimated costs in Brazilian reais were converted to US dollars at an exchange rate of 2.9272 Brazilian reais to the dollar (the annual average in 2004).¹⁰

RESULTS

In 2004, there were 189 infants with gestational age of 22 to 36 weeks who survived longer than one hour and were admitted to the neonatal ward.

Of the 189 hospital stays for premature newborns, 159 patient records were found. No patient records could be located for the remaining 30 neonates, all of whom had a birth weight less than 1,500 grams. In other words, severely underweight babies consumed a large quantity of resources. The total number of newborns weighing less than 1,000 g was 32, and 14 corresponding sets of hospital records were found (43.75%). There were 36 newborns who weighed between 1,000 g and 1,499 g, with 24 sets of corresponding hospital records found (66.66%).

Of the 159 infants, 96 survived to discharge. Among the premature infants who survived to discharge, the average length of stay in the neonatal ward was 14 days.

Tables 1 and 2 show the costs of hospital services. From an accounting point of view, the costs related to electricity, water, phone, administrative expenses, general expenses, cleaning, maintenance, laundering, and diet and nutritional expenses, including the human milk bank, are considered indirect costs and comprise the hospital's overhead. These costs were not calculated.

The total cost of professional services in the neonatal ward was almost \$70,000 USD, and the average per newborn was \$437 USD (Table 3). The total cost of professional services amounted to 22.16% of all costs for neonatal hospital stays.

The costs of auxiliary diagnostic tests, blood products and hospital stays for newborns varied by birth weight, as shown in Tables 4, 5, and 6.

The average direct cost of treating a premature newborn in the neonatal ward was \$2,017 USD in 2004. The average reimbursement of hospital stays for premature newborns paid by the SUS in 2004 totaled \$594 USD (when the costs of hospital and professional services were pooled), corresponding to approximately 25% of the average monies disbursed by the hospital. The hospital's total expenses for treating premature newborns in 2004 were 3.6 times higher than the amount reimbursed by the SUS to the hospital (Table 7).

DISCUSSION

The weight of the neonatal component of infant mortality is ever greater in countries where post-neonatal mortality is still high, as is the case in Brazil. The literature shows an upward trend of this coefficient as well as a high proportion of avoidable deaths.¹¹ In this study, the average cost of hospital stays for the long-term (more than one day) treatment of newborns totaled \$2,017 USD, while the total

Table 1 - Cost of hospital services for premature newborns by birth weight.

HOSPITAL SERVICES	<1000 g	1,000 g to 1,499 g	1,500 g to 1,999 g	2,000 g to 2,499 g	>2,500 g	Total/ average
NUMBER OF NB	14	24	50	50	21	159
Medicinal Gases						
Days of O ₂ use	310	354	232	220	91	1207
Cost of O ₂ therapy (by days of use)	\$5,844	\$6,674	\$4,374	\$4,147	\$1,715	\$22,757
Cost of O ₂ per NB	\$417	\$278	\$87	\$82	\$33	\$143
Parenteral Nutrition (PN)						
Use of PN (no. of requests)	121	137	88	98	27	471
Cost of PN (individual)	\$5,785	\$6,550	\$4,207	\$4,686	\$1,291	\$22,521
Cost of PN per NB	\$413	\$272	\$84	\$93	\$61	\$141
Nursing Materials						
Use of nursing materials	\$8,828	\$18,680	\$18,847	\$11,988	\$4,423	\$62,769
Cost of nursing materials per NB	\$630	\$778	\$376	\$239	\$210	\$394
Medications						
Antibiotics	\$26	\$2,298	\$160	\$178	\$134	\$2,797
High-cost medications	\$5,092	\$5,016	\$2,665	\$1,204	\$295	\$14,274
Other medications (R\$12,917.86)	\$313	\$662	\$669	\$425	\$156	\$2,226
Total cost of medications	\$5,432	\$7,976	\$3,494	\$1,808	\$586	\$19,298
Cost of medications per NB	\$388	\$332	\$69	\$36	\$27	\$121
Nursing Care						
Total cost of nursing staff care	\$14,023	\$29,670	\$29,936	\$19,042	\$7,026	\$99,699
Costs of nursing care per NB	\$1,001	\$1,236	\$598	\$380	\$334	\$627
Total	\$39,912	\$69,550	\$60,858	\$41,671	\$15,041	\$227,046
cost per newborn	\$2,850	\$2,897	\$1,217	\$833	\$716	\$1,427

NB: premature newborn; O₂: oxygen; PN: parenteral nutrition. Costs listed in US dollars.

cost for the neonatal ward was \$320,800 USD, nearly 46% of the hospital's budget ceiling.

The gap between hospital costs and reimbursement from SUS is likely even larger than estimated here because these estimates do not include the hospital overhead costs or any of the costs for the 30 infants with birth weight less than 1,500 grams.

The results of this study parallel a recent study of initial hospital costs for premature infants in California: neonatal hospital costs increased with decreasing birth weight, with an average of \$224,400 for each newborn weighing 500-750 g, \$4,300 for each newborn weighing 2250-2500 g, and \$1000 for each premature newborn weighing more than 3000 g.¹² The current study demonstrates that the costs of neonatal care are much higher in the United States than in Brazil (50-fold higher for the smallest premature infants). There is no record of similar studies elsewhere in Brazil.¹³

Costs resulting from premature newborns with comorbidities also seem to be greater over the long term; these costs are 4.4 times greater in the fifth year of life than for children born at full term in the same year.¹⁴

This study has some limitations. Although some hospital sectors have a methodology for collecting data on the costs of medications and materials remitted to patient care wards

(overnight through long-term stays), such as those collected by the storeroom and pharmacy, there are no cost centers in operation that allow for a calculation of the final cost of the hospital stay. The hospital has a management report that incorporates information regarding production and some utility expenses, such as water, electricity, gas, and phone. However, this report does not itemize the operational costs and the final costs for patients' total hospital stay.

This study opted not to include the hospital's overhead, which accounted for an estimated 15.7%, in the cost calculations because the hospital is small and specializes in maternity.

The ability to trace costs requires a sophisticated accounting system that is not always available for hospital wards, especially those in public hospitals. Nevertheless, patient records have proven to be a better source of data and information than the authorization for hospitalization form (AIH) from the perspective of hospital care.¹⁵

The total number of hospital stays was included in the calculations, including those patients who were admitted for only one day. This allowed the study to include premature newborns that used high-cost medications, such as surfactant. Nevertheless, the newborns whose stays were

Table 2 - Proportional composition of hospital services (total costs).

HOSPITAL SERVICES	Cost (USD)	Percentage (%)
Medicinal gases	\$22,757	10.02
Parenteral nutrition	\$22,521	9.92
Nursing materials	\$62,769	27.65
Medications	\$19,298	8.5
Nursing staff	\$99,699	43.91
Total	\$227,044	100
Percentage of hospital services on the total expenditure on premature		70.7

USD: US dollars.

Table 3 - Costs for professional services to treat premature newborns by birth weight.

PROFESSIONAL SERVICES	<1,000 g	1,000 g to 1,499 g	1,500 g to 1,999 g	2,000 g to 2,499 g	>2,500 g	Total/ Average
Number of newborns	14	24	50	50	21	159
Neonatal doctors	\$8,546	\$18,083	\$18,263	\$11,605	\$4,282	\$60,781
Cross-consultations	\$146	\$213	\$1,995	\$213	\$79	\$852
Physical therapy sessions	\$1,712	\$1,769	\$1,730	\$720	\$274	\$6,208
Speech therapy sessions	\$229	\$604	\$697	\$98	\$26	\$1,656
Total	\$10,633	\$20,669	\$20,889	\$12,636	\$4,661	\$69,497
Cost per newborn	\$759	\$861	\$417	\$252	\$221	\$437

Costs listed in US dollars.

Table 4 - Costs for diagnostic tests in premature newborns.

ADT	<1,000 g	1,000 g to 1,499 g	1,500 g to 1,999 g	2,000 g to 2,499 g	>2,500 g	Total/ Average
Number of newborns	14	24	50	50	21	159
Blood tests	\$478	\$817	\$1,052	\$881	\$317	\$3,546
Biochemical blood tests	\$1,628	\$2,406	\$2,266	\$1,872	\$707	\$8,882
Immunological blood test	\$2	\$52	\$160	\$128	\$37	\$381
Microbiology tests	\$254	\$385	\$226	\$199	\$5	\$1,071
Imaging	\$848	\$1,883	\$1,910	\$930	\$243	\$5,816
Auxiliary diagnostic methods	\$19	\$76	\$100	\$50	\$33	\$281
X-Rays	\$512	\$652	\$533	\$566	\$192	\$2,457
Total	\$3,741	\$6,271	\$6,247	\$4,626	\$1,534	\$22,434
Cost per newborn	\$267	\$261	\$124	\$92	\$73	\$141

Costs listed in US dollars.

Table 5 - Costs for blood products used to treat premature newborns.

BLOOD PRODUCTS	<1,000 g	1,000 g to 1,499 g	1,500 g to 1,999 g	2,000 g to 2,499 g	>2,500 g	Total/ Average
Number of newborns	14	24	50	50	21	159
Red blood cell concentrate	\$326	\$346	\$226	\$153	\$39	\$1,092
Platelet concentrate	\$218	\$122	\$89	\$49	\$9	\$488
Plasma	\$32	\$78	\$83	\$41	\$13	\$249
Cryoprecipitate	\$0	\$0	\$3	\$0	\$0	\$3
Total	\$576	\$546	\$401	\$243	\$61	\$1,832
Cost per newborn	\$41	\$22	\$8	\$4	\$3	\$11

Costs listed in US dollars.

Table 6 - Direct costs of hospital stays for premature newborns in the neonatal ward.

	<1,000 g	1,000 g to 1,499 g	1,500 g to 1,999 g	2,000 g to 2,499 g	>2,500 g	Total/ Average
Number of newborns	14	24	50	50	21	159
Average hospital stay (days)	34	42	20	13	11	21
Overall total	\$54,874	\$97,044	\$88,404	\$59,184	\$21,307	\$320,813
Total cost per NB	\$3,919	\$4,043	\$1,768	\$1,183	\$1,014	\$2,017
Daily cost in the NW	\$115	\$96	\$87	\$91	\$89	\$96

NB: premature newborn; NW: neonatal ward; costs listed in US dollars.

Table 7 - A comparison between the composition of estimated hospital expenses and the amount reimbursed by the SUS, including doctors' salaries (included in professional services) and nurses' salaries (included in hospital services).

Items	Hospital expense	Percentage (%)	Reimbursed by the SUS	Percentage (%)	Percentage of hospital expenses reimbursed (%)
Hospital services	\$227,046	70.77	\$77,305	87.88	34
Professional services	\$69,498	21.66	\$4,516	5.13	6.5
Diagnostic tests	\$22,437	6.99	\$5,502	6.25	24.5
Blood	\$1,833	0.57	\$648	0.74	35
Total	\$320,813	100	\$87,971	100	27.4

Costs listed in US dollars.

very short (less than one hour) were excluded from the analysis to avoid generating huge discrepancies.¹⁵

The exact calculation of some items consumed by premature newborns could not be assessed. One of the primary difficulties was calculating a newborn's consumption of hospital gases in the neonatal ward because the use of these gases varies widely throughout the day, which makes it impossible to determine an average cost. The cost of parenteral nutrition was also estimated because, during cost calculations, it was only possible to determine the total cost of the contracts and the total cost of each element used in the formulas. Thus, we cannot reject the possibility that costs may have been overestimated or underestimated. The same is true for the calculation of salaries because it is impossible to estimate the real cost of the salaries paid by the state, including employer taxes and social security payments. Salaries were calculated according to base salaries and bonuses. Estimations of the costs of laboratory exams were also ambiguous given the difficulty determining each ward's final calculation. Only the costs of the basic supplies could be used because only some of the operating costs could be calculated.

CONCLUSIONS

The average cost for a newborn's hospital stay was \$2,017 USD, and the average cost for a day in the neonatal ward was \$96 USD. The highest daily cost was attributed to the newborns with the lowest birth weight. This figure progressively and discretely decreased as the newborns' birth weight increased. A difference between the costs effectively disbursed by the hospital and those reimbursed by the SUS was also noted, with the SUS reimbursement covering only 27.42% of the real costs when these reimbursements were the only source of revenue for the services provided.

REFERENCES

1. Zupan J, Aahman E. Perinatal mortality for the year 2000: estimates developed by WHO. Geneva: World Health Organization, 2005.
2. World Health Organization. Neonatal Survival 1. March 2005. Available from: http://www.who.int/child_adolescent/Neu_publications/the_Lancet_paper1.pdf. Accessed on (Jun 20).
3. Beck S, Wojdyla D, Say L, Betran AP, Merialdi M, Requejo JH, Rubens C, Menon R, Vanlook. The worldwide incidence of preterm birth: a systematic review of maternal mortality and morbidity. Available from: <http://www.who.int/bulletin/volumes/88/1/08-062554/en/>. Bulletin of the World Health Organization. Accessed on 2011 (May 05).
4. Mendonza-Sassi R, Beria JU. Utilización de los servicios de salud: Una revisión sistemática sobre los factores relacionados. *Cadernos de Saúde Pública*. 2001;17:819-32, doi: 10.1590/S0102-311X2001000400016.
5. Guia farmacêutico Brasíndice. São Paulo: Andrei Publicações Médicas; 2005 [cited 2009 Apr 23].
6. Associação Médica Brasileira. Classificação Brasileira Hierarquizada de Procedimentos Médicos [Internet]. 4a ed. São Paulo:AMB;2005 [cited 2009 May 23]. Available from: http://www.portalmedico.org.br/cbhpmp/CBHPM_2005.pdf. Accessed on 2010 (Jun 20).
7. Associação Médica Brasileira. Lista de Procedimentos Médicos 1999. Available from: http://www.connectmed.com.br/amb/novo/inst_Table.php3. Accessed on 2010 (Jun 11).
8. Ministério da Saúde, Departamento de Informática do Sistema Único de Saúde (BR) [Internet]. Brasília: DATASUS; c2009 [cited 2009 Apr 30]. Informações de Saúde; [about 1 screen]. Available from: <http://w3.datasus.gov.br/datasus/index.php?area=02>. Accessed on 2010 (Jun 20).
9. World Bank Database of Gender Statistics ("GenderStats") [Internet]. Washington: World Bank; c2006—[cited 2009 Mar 14]. Available from: <http://genderstats.worldbank.org>. Accessed in 2010 (June 11).
10. Carvalho M, Gomes MASM. Mortalidade do prematuro extremo em nosso meio: realidade e desafios. *J Pediatr*. 2005;81(Suppl. 1):S111-S118.
11. Gilbert WM, Nesbitt TS, Danielsen B. The Cost of Prematurity: Quantification by Gestational Age and Birth Weight. *Obstetrics & Gynecology*. 2003;102:488-92, doi: 10.1016/S0029-7844(03)00617-3.
12. Russell RB, Green NS, Steiner CA, Meikle S, Howse JL, Poschman K, et al. Cost of Hospitalization for Preterm and Low Birth Weight Infants in the United States. *Pediatrics*. 2007;120:e1-e9, doi: 10.1542/peds.2006-2386.
13. Korvenranta E, Lehtonen L, Rautava L, Häkkinen U, Andersson S, Gissler M, et al. Impact of Very Preterm Birth on Health Care Costs at Five Years of Age. *Pediatrics*. 2010; Apr 5. [Epub ahead of print].
14. Escosteguy CC, Portela MC, Medronho RA, Vasconcellos MTL. AIH versus prontuário médico no estudo do risco de óbito hospitalar no infarto agudo do miocárdio no município do Rio de Janeiro, Brasil. *Cad Saúde Pública*. 2005;21:1065-76, doi: 10.1590/S0102-311X2005000400009.
15. Petrous S. Preterm birth – What are the relevant economic issues? *Early Hum Develop*. 2006;82:75-6, doi: 10.1016/j.earlhumdev.2006.01.003.