Original article

Neonatal care cost of "adverse neonatal outcome" following term deliveries in SriLanka

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Abstract:

Objective*:** To analyse the neonatal care cost of 'adverse neonatal outcome' following term deliveries (37 completed weeks - 41 completed weeks and 6 days) at Teaching Hospital Kandy. ***Method*:** This study was conducted from the 26th of February to the 20th of May 2015. This is a cost analysis to explore the neonatal care cost of term neonates with 'adverse neonatal outcome'. 'Adverse neonatal outcome' was defined as a composite measure of neonatal death and morbidity, which needed admission to a neonatal care unit or neonatal intensive care unit before the initial discharge point. The perspective taken was that of the Ministry of Health Sri Lanka (MOHSL). One hundred and seventy-five eligible term neonates with 'adverse neonatal outcome' were recruited for the study consecutively until the required sample size is fulfilled. ***Results: Out of all term neonates delivered during the study period, 15.84% (n=175/1105) were admitted to the Neonatal Care Unit (NCU). During the study period, the total neonatal care cost(for 175 term neonates) was LKR. 12,140,040 (USD 89305),of which 69.0% was due to staff salaries and allowances. The median total neonatal care cost per term neonates with 'adverse neonatal outcome' was LKR. 50,193 (USD369) with an interquartile range of LKR. 39,047 (USD 287) to LKR. 79,638 (USD 586) Respiratory distress syndrome was the condition that required the most significant proportion (25%) of total neonatal care cost of term neonates with 'adverse neonatal outcome'. Birth asphyxia was the most costly neonatal condition to manage as per the neonate median neonatal care cost (LKR.71278, USD 524).***Conclusion:*** Expenditure on the 'adverse neonatal outcome' of term neonates was considerable. Birth asphyxia was the most costly neonatal condition to manage as per the median neonatal care cost. So, it is essential to strengthening the preventive strategies to reduce the 'adverse neonatal outcome' among term neonates.

Keywords: Term; Neonatal; Cost; Sri Lanka

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Introduction:

Sri Lanka is a country that has successfully reduced neonatal mortality rate over the years and is on track to achieve Millennium Development Goal (MDG) 4. Sri Lanka reduced the under-five mortality rate from 22.2 to 11.3 and the infant mortality rate from 17.7 to 9.7from 1991 to 2009, with a neonatal mortality rate of 6.4 in 2009 [1]. Neonatal mortality, on the other hand, account for more than 80% of infant mortality. As a result, increasing neonatal health will be the only way to further reduce infant mortality. [2]. Significant causes of neonatal mortality in Sri Lanka are prematurity, congenital anomalies, birth asphyxia, neonatal sepsis, meconium aspiration syndrome [3].Among all neonatal deaths, 40 – 70 % are among term neonates [4,5]. Even though preterm neonates' neonatal outcomes have been extensively studied, term neonates' neonatal outcomes are

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scarce [6]. The increasing number of term newborn admissions to neonatal care units emphasizes the necessity of examining neonatal outcomes and resource utilization among term neonates. [7]. The proportion of term neonates who required admission to neonatal special care units may vary from 10-15%.On the other hand term neonates may make up even 40-70% of neonatal intensive care unit (NICU) population[4,8,9]. A study undertaken to determine the cost of initial hospital care for newborn infants according to gestational age at birth and survival status found that the total cost of initial care for the US population of neonates is $10.2 billion annually. Out of which, 42.7% were spent on those born at ≥37 weeks gestation [10]. Although cost evaluations of newborn care are increasingly available from other countries,[11,12] costing data on Sri Lankan neonatal care services are largely unavailable[13]. With that background, this study was conducted to describe the neonatal care cost of 'adverse neonatal outcome' following term deliveries at National Hospital Kandy.

Method:

This study was conducted at the Neonatal Care Units (NCUs) in National Hospital Kandy. At present, there are two units. This study is a cost analysis study to determine the cost of adverse neonatal outcomes among term neonates delivered at National Hospital Kandy. The perspective taken was that of the Ministry of Health Sri Lanka (MOHSL). This is justified since the government of Sri Lanka provides all the health care services at government hospitals free of charge.

On the other hand, the focus of this analysis is to support the policy decisions of decision-makers in the MOHSL. Costs borne by the patients, including direct non-treatment costs (e.g., transport to hospital), indirect costs (e.g., lost work time), and intangible costs (eg-pain and anxiety) were excluded in this analysis. In addition cost of buildings and lands was also excluded since the government-owned all those. The study was conducted forthree months, from the 26th of February to the 20th of May 2015.

With an anticipated standard deviation of Rs.1346.48 (particular neonatal care cost of neonates (80% of neonates are >37 weeks of POA) at Vaishali hospital, India) [12] with a tolerable error of Rs.200 at a 95% confidence level, the sample size for the analysis was found to be 175[14].

Delivery occurred during gestation from 37 completed weeks (259days) up to and including 41 completed weeks and 6 days (293days), based on the gestational age at delivery, is defined as a term delivery. Gestational age at delivery was taken as decided by an Obstetrician based on the LMP, USS and other antenatal factors.

One hundred and seventy-five eligible term neonates with 'adverse neonatal outcome', which is a composite measure of neonatal outcomes, which needed admission to a neonatal care unit before the initial hospital discharge point, were recruited for the studyconsecutively until the required sample size is fulfilled, with the maternal written consent.

Two types of data were collected, Clinical data and Costing data (Direct and Indirect costs), by using data extraction forms.

Costing method

In this study, the bottom-up costing methodology was mainly used rather than the top-down costing principles since there could be considerable variance in the neonatal care cost of term neonates with 'adverse neonatal outcome'.This approach identifies costs for each neonate and neonates with common conditions,which utilise a significant share in the total cost. The top-down costing approach was used to analyse overhead costs, where the bottom-up approach was not feasible. At the end of every 24 hours until the time of initial discharge or death, neonates were followed up prospectively. In the study, direct and indirect costs referred to how these costs are related to the neonatal care of term neonates with 'adverse neonatal outcome'.

Cost Centres

First, cost centres were classified following organisation analysis into Final Cost Centres (FCCs) and Supportive Cost Centers (SCCs). FCCs were two neonatal care units, postnatal wards and lactation management centre, which can be directly attributed to term neonates' neonatal care. SCCs provide support for patient care in the FCCs. Following SCCs were identified in the present study; administration and finance department, medical store department, central sterile supplies department, infection control unit, public health unit, Health information unit and general stores. Utilities and contracted services (e.g. water, electricity, telephone, security and cleaning) are also identified as overhead costs.

Calculation of direct costs

Direct costs were divided into two groups; Direct cost items shared between all the neonates and direct cost items that can be identified at the individual level.

Direct cost items shared between all the neonates

a) Cost of salaries and allowances of staff working in the neonatal units

First, all the staff members were classified into either full or part-time worker categories. Total staff cost of full-time workers was given the time equivalent of 1. For those who work part-time, data on their rosters were collected. These data were then translated into time equivalent labour costs based on their contribution within the neonatal units. Subtotals for each staff category were calculated by multiplying the time equivalent, number of staff members in the category and the monthly average salary and allowances of that staff category.

b) Cost of surgical consumables and oxygen

This study calculated total surgical consumable and oxygen cost by considering all surgical consumable items and oxygen used in the specific unit during March 2015 and total inpatient days of that month to calculate the unit price for one inpatient day.

c) Cost of shared equipment used in the neonatal unit

All the capital equipment (including donated equipment) used in the neonatal units with a unit price of more than $100 and a useful life of more than one year will be identified and included in the cost analysis [15]. In the calculation involving the annualising cost of equipment, the current cost (Replacement cost) of purchasing such equipment was used. The current price of the equipment was obtained from the annual procurement plan of the division of biomedical engineering services for the years 2014 and 2015. The working life (or useful life) was assumed seven years for all the equipment used in previous studies [16,17]. The simple straight-line method of depreciation was used to estimate the average annual cost of each piece of equipment with an assumption of a zero salvage value [15]. Cost per month was calculated by dividing the annualised cost by 12 months.

d) Total shared direct cost of Neonatal Care Units

Cost of salaries and allowances of the staff, cost of surgical consumables, and shared equipment were sum up to calculate the total cost of direct shared costs. Then the total direct shared cost was divided by the total number of inpatient days to calculate the shared direct unit cost per inpatient day in the specific unit. Shared direct unit costs were calculated for each neonatal unit separately. Then it was multiplied by the length of stay in each unit to obtain the total shared direct cost for each neonate. The calculation was based on the monthly statistics for March.

f) Direct shared cost of postnatal ward care

For the neonates who were cared for in the postnatal ward before or after admission to a neonatal care unit, the inpatient day cost of the postnatal ward was considered when calculating the cost.Shared direct unit cost per inpatient day was calculated similarly to the neonatal care units.

g) Direct cost of lactation management

The cost of lactation management was calculated using the staff cost to obtain the direct cost of this cost centre. Then direct costs of the centre were divided by the total no of visits to calculate the direct cost per visit. This cost will be include when the mother of the newborn received lactation management services based on the number of visits.

Direct cost items that can be identified at the individual level

To obtain a more accurate cost estimate, all the possible cost items were trace down to the individual level. This includes the cost of drugs, laboratory tests, diagnostic imaging, equipment used for special therapeutic modalities, surgical operations and blood products.

The quantity and its unit price give the cost of an item identified. The unit costs were obtained from the annual price list issued by the Medical Supplies Division of the MOHSL. These were available for most of the items identified in this study except for few, where the current market price was used.

Calculation of indirect costs

a) Cost of utilities, contracted and other overhead services

Information on the total cost for the hospital for these services and utilities was obtained from the hospital's expenditure records. Since floor area was not available,the proportion of staff out of the total number of staff in the hospital was used as the allocation basis of these overhead costs. Allocation rules related to patient care cannot be used because the non-clinical cost centres also use these overhead services. This cost category was included the following services; water, electricity, telephone and postal, stationaries and general supplies, machine repair, maintenance and other contracted services.

b) Cost of supportive cost centres and final cost centres

The cost of all the supportive cost centres was calculated separately. These costs were included direct costs of those units, such as staff cost and

indirect allocated costs from the other indirect cost centres.Allocation rules used for supportive cost centres were given in the Table -1.

Table 1 - Allocation rules used for supportive cost centres

Supportive cost centre	Allocation rule
Administration and finance department	The proportion of staff over the total number of staff of the hospital
Medical records department	The proportion of admissions of the unit over the total admissions of the hospital
Infection Control Unit	The proportion of beds of the unit, over the total bed strength of the hospital.
Medical stores department	The proportion of inpatient days of the unit over the total inpatient days of the hospital
Central sterile supplies department	
Public health unit	
Health Information unit	
General stores	

After allocating the costs of supportive cost centres to the final cost centres, indirect cost per inpatient day was calculated for eachfinal cost centre.

Then this was multiplied by the length of stay (or the number of visits for LMC) of each neonate to calculate the indirect costs for each neonate based on the units (Final cost centres) they had obtained the care.

All costs are valued in the year 2015 (USD 1= 135.94 based on annual average[18]).

Ethical Clearance

Obtained from Faculty of Medicine, Colombo. Sri Lanka (Protocol No EC-14-153)

Results:

Out of all term neonates delivered during the study period, 15.84% (n=175/1105), neonates required admission to NCUs. Only one death occurred among term neonates before the initial discharge point. The distribution of total neonatal care cost for all term neonates with adverse neonatal outcomes is given in Table 2.The most significant contribution (75.1%) to the total neonatal care cost of term neonates with 'adverse neonatal outcome' was by the shared direct costs, including staff salaries and allowances ,surgical consumables, and shared equipment costs. Nearly 90 percent of shared direct cost consisted of staff salaries and allowances, accounting for almost 70 percent of the total neonatal care cost.

Table 2 -Distribution of total neonatal care cost for all term neonates with adverse neonatal outcomes

Cost component	LKR	USD	%
Shared direct cost			
Salary and allowance	8,373,128	61,595	69.0%
Surgical consumerbles	231,022	1,699	1.9%
Shared equipments	507,737	3,735	4.2%
Drugs	885,106	6,511	7.3%
Laboratory tests	553,338	4,070	4.6%
Diagnostic imaging	37,550	276	0.3%
Blood products	26,000	191	0.2%
Surgery	8,500	63	0.1%
Special theraputic modalities	753,151	5,540	6.2%
Indirect / overhead costs	764,508	5,625	6.3%
	12,140,040	89,305	100%

Neonates admitted to an NCU on the first day of life had accounted for 74 percent of the total neonatal care cost, and term neonates with bodyweight more than 2500g also accounts for a similar percentage of the total cost. The four most prevalent neonatal conditions among term neonates with 'adverse neonatal outcome' contributed to 69.59 percent of the total cost. Out of them,Respiratory distress syndrome was responsible for the most significant proportion of the total neonatal care cost of term neonates with 'adverse neonatal outcome' at term. (Table 3).

Table 3 - Total neonatal care cost by characteristics of term neonates with adverse neonatal outcomes

Characteristic	n	LKR (In thousands)	USD	%
Day of Admission				
Day 1	120	9037	66479	74%
Day 2	22	1319	9703	11%
Day 3	17	839	6175	7%
Day 4 or more	16	945	6948	8%
Gestational Age (Weeks)				
37	44	3151	23178	26%
38	43	2485	18282	20%
39	29	2329	17135	19%
40	56	3889	28606	32%
41	3	286	2104	2%
Sex				

Characteristic	n	LKR (In thousands)	USD	%
Male	117	8858	65164	73%
Female	58	3282	24141	27%
Birth Weight				
2000g or Less	16	1028	7559	8%
2001g – 2500g	36	2164	15916	18%
More than 2500g	123	8948	65830	74%
Neonatal condition				
Birth asphyxia	17	1595	11735	13%
Respiratory distress of newborn	34	3070	22584	25%
Bacterial sepsis of newborn	42	2372	17446	20%
Neonatal jaundice from other and unspecified causes	26	1290	9491	11%
All other conditions	56	3813	28049	31%
Total cost	175	12140	89305	100%

Neonates admitted to an NCU on the first day of life had higher median neonatal care costs thanthose admitted later. Delivery at 37 weeks, male sex and birth weight less than 2500 g were also associated with higher median total neonatal care cost per term neonates with 'adverse neonatal outcome'. When considering the average neonatal care cost birth asphyxia became the most costly neonatal condition to manage, followed by the respiratory distress of newborns.Further details are given in Table 4.

***Table 4* - Neonatal care cost by characteristics of term neonates with adverse neonatal outcomes per term neonate**

Characteristic	n	Median	Inter-quartile range	
		LKR (USD)	LKR (USD)	LKR (USD)
Cost per term neonate (Overall)	175	50193(369)	39047(287)	79638(586)
Day of Admission				
Day 1	120	52713 (388)	39562 (291)	83883 (617)
Day 2	22	42434 (312)	33933 (250)	59058 (434)
Day 3	17	46249 (340)	40239 (296)	54043 (398)
Day 4 or more	16	48494 (357)	39580 (291)	85409 (628)
Gestational Age (Weeks)				
37	44	57575 (424)	41465 (305)	84958 (625)
38	43	46236 (340)	36436 (268)	54215 (399)
39	29	50908 (374)	39296 (289)	88002 (647)
40	56	50970 (375)	38274 (282)	79428 (584)
41	3	43513 (320)	41710 (307)	200818 (1477)
Sex				
Male	117	50901 (374)	39580 (291)	86849 (639)
Female	58	47400 (349)	35062 (258)	71217 (524)
Birth Weight				
2000g or Less	16	52612 (387)	42490 (313)	74805 (550)
2001g – 2500g	36	47400 (349)	36042 (265)	66245 (487)
More than 2500g	123	50908 (374)	39544 (291)	85278 (627)
Neonatal Condition				
Birth asphyxia	17	71278 (524)	51665 (380)	137753 (1013)
Respiratory distress of newborn	34	59589 (438)	41796 (307)	124085 (913)
Bacterial sepsis of newborn	42	46844 (345)	41259 (304)	70922 (522)
Neonatal jaundice from other and unspecified causes	26	40239 (345)	34790 (304)	53957 (522)

Discussion:

A review of MDGs achievements depicts that the successes in maternal health have not been achieved for neonatal health[19]. The rate of reduction of neonatal mortality has been slower throughout the world that has paved the way to develop a newborn-specific action plan beyond the MDG era.

In the Every Newborn Action Plan (ENAP), 2014 targets have been set to achieve ten or fewer neonatal deaths per 1000 live births in every country by 2035. That would necessitate a doubling of current reduction rates on a worldwide scale, and much more in some high-burden countries.[20]. Sri Lanka is different in this respect from many other countries in the South-East Asian Region. Neonatal mortality has been reduced successfully to achieve the current mortality rates almost comparable to some developed countries (6.4/1000 live births in 2009[1]). However, still,deaths are occurring due to preventable causes, as reported.

Therefore the utilisation of limited resources available needed to be done wisely. Even though term neonates may make up 40-70 percent of the neonatal intensive care unit population, no previously published costing studies were done among term

neonates who required admission to special neonatal or intensive care. Available studies mainly focused on highly premature or premature neonates admitted to neonatal care units [13,21]. Further, disease costing studiesconcerning neonatal care has not been conducted in Sri Lanka. So this would be the first one of that kind. Even though an analytical costing study would be a better option, this study was conducted just as a cost analysis due to time constraints and limitations related to available hospital-level data.

With regard to capital costs, the equipment cost of the neonatal units was included in the study. Building costs and equipment costs in other supportive units were not included. Since this study focused on the operational cost, building costs were not included as done in several other studies [16,22]. In addition, most of the buildings are very old and even beyond the conventional useful life of 30 years.Land cost is also excluded since the government owns it.

Costing information related to neonatal care is needed to identify deficiencies in the allocation of resources and to correct them [23].Most of the studies on the cost of newborn care focus on neonatal intensive care, particularly on services for very low birth weight [11,12]. The largest contribution (75.1%) to the government neonatal care cost of term neonates with 'adverse neonatal outcome' was by the shared direct costs, including staff salaries and allowances ,surgical consumables, and shared equipment's. Ninety percent of the shared direct cost consisted of staff salaries and allowances. This finding was compatible with the studies that have been referred [12,23,24]. In the present study cost of drugs was higher than the cost of laboratory tests. The main contributor to that was the antibiotic treatment with the high prevalence of neonatal sepsis. Geitona, et al. [25] and Shweta, et al. [24], also reported a similar finding, but in contrast,Prinja, et al. [12] study reported drug cost of less than 1 percent at Vaishali hospital.

Neonates admitted to an NCU on the first day of life had higher average neonatal care costs thanthose admitted later. Delivery at 37 weeks, male sex and birth weight less than 2500 g were also associated with higher mean total neonatal care cost per term neonates with 'adverse neonatal outcome'. With regard to birth weight and gestational age, similar findings have been reported previously[23,25].

The four most prevalent Neonatal Conditions among term neonates with 'adverse neonatal outcome' were contributed to 69.59 percent of the total cost. Out of them,Respiratory distress syndromeis responsible for the most significant proportion of the total neonatal care cost of term neonates with 'adverse neonatal outcome'. This significant cost among term neonates with respiratory distress syndrome was due toa higher proportion of cases, costly ventilator support, which is also associated with using several other expensive therapeutic modalities, such as a Continuous Positive Airway Pressure Therapy (CPAP) machine and Blood gas analyser.But when considering the neonatal care cost per term, neonate birth asphyxia was the most costly neonatal condition to manage.

Since the costing component was confined to the period before the initial discharge point, the cost beyond that point until the completion of the neonatal period could not be assessed. The present study did not include that part mainly due to time and financial constraints.

There were no Sri Lankan studies to compare the findings of the costing component of this study, since all the available studies were mainly focused on the cost of neonatal intensive care given to preterm neonates.

Conclusions and Recommendation:

Expenditure on the adverse neonatal outcomes of term neonates was considerable. Delivery at 37 weeks, male sex, and birth weight less than 2500 g are associated with higher median total neonatal care cost per term neonates with 'adverse neonatal outcome'. The four most prevalent neonatal conditions (Birth asphyxia, respiratory distress of newborn, bacterial sepsis of newborn and neonatal jaundice from other and unspecified causes) among term neonates with 'adverse neonatal outcome' contributed to 69.59 percent of the total cost. Respiratory distress syndrome was the condition that utilised the most significant proportion of the neonatal care cost at term. Birth asphyxia is the mostcostly neonatal condition to manage among term neonates.

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Authors's contribution:

Data gathering, study design, writing, editing and submitting manuscript: Dr.D.A.Gunawardane

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