

## **Cost of Neonatal Intensive Care in a Tertiary Care Center**

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**Background:** The number of neonatal intensive care units (NICUs) in India has increased substantially over the last decade; yet many more are required. There is limited information on the actual costs of setting up and running an NICU in India. **Objective:** Systematic and comprehensive calculation and analysis of the costs of neonatal intensive care in a tertiary care teaching hospital. **Methods:** The costs were compiled by studying the detailed records of various hospital departments and prospectively documenting the costs of drugs, consumables and investigations for a representative group of 30 babies. **Results:** The total cost of establishing a 16 bed level III tertiary care NICU was Rs 3.78 crore (Rs. 37.8 million, US\$ 860,000) (2003). Equipment cost formed two-thirds of the establishment cost. The running cost of NICU care per patient per day was Rs 5450 (US\$ 125). NICU and ancillary personnel salary comprised the largest proportion of the running costs. The average total cost of care for a baby <1000 grams was Rs. 1,68,000 (US\$ 3800), Rs. 88,300 (US\$ 2000) for babies 1000-1250 g. and Rs. 41,700 (US\$ 950) for those between 1250 -1500 g. The family had to bear only 25%; rest was subsidized. **Conclusions:** Equipment and personnel salary form the biggest proportion of establishment and running costs. The costs of treatment for a baby in NICU should be seen in context with costs of other types of health care and the number of useful life- years gained.

**Key words :** Cost, Intensive care, Neonate, NICU.

**I**n this era of increasing healthcare costs, the role of economic evaluations of health-care interventions has become increasingly important. Economic evaluations can be of many types: cost-benefit studies where each outcome is equated in monetary terms, cost-minimization studies where two different methods of achieving the same goal are compared for their costs-utility analysis in which the healthy years of life are taken as the outcome and cost-effectiveness analysis in which natural units like life years gained are used as outcomes(1,2).

Neonatal intensive care stays are among the most expensive types of hospitalizations(3). However, there is little information on the cost of neonatal intensive care from India and other developing countries (4-9). The information would be useful for (i) setting up of a new neonatal unit, (ii) guiding families at the time of neonatal intensive care unit (NICU) admission, and (iii) exploring means of utilizing the limited budget more effectively(10). The aim of this study was to calculate and analyze the actual costs and cost to the family of neonatal intensive care in a

tertiary care teaching hospital in northern India.

### **Subjects and Methods**

This study was conducted in Nehru Hospital, Postgraduate Institute of Medical Education and Research, Chandigarh - a tertiary care teaching hospital catering to northern Indian states. The neonatal unit has 40 beds, out of which, 16 are intensive care beds. Eight of these intensive care beds have provision for mechanical ventilation with separate multi-parameter monitoring equipment and infusion pumps. However, these equipments are shared when the baby is cared in a non-ventilation bed. All the beds have either an incubator or an open care system. Nearly three fourths of equipments used in the NICU are imported. A doctor to patient ratio of 1:5 and a nurse to patient ratio of 1:2 (1:4 for non-ventilation beds) are maintained round the clock.

#### *Admission-discharge policy*

Depending on the availability of beds, attempts are made to admit babies weighing < 1750 g (or < 34 weeks gestation) and all sick babies to NICU. After recovery, they are shifted to intermediate care level II nursery and subsequently they are discharged to home. The mean discharge weight and gestation of very low birth weight (VLBW) babies is 1400 grams and 34 weeks respectively. Discharges are often expedited because of shortage of beds and inability of families to stay away from home for long periods.

#### *Hospital and investigation charges*

A nominal amount is collected from patients towards hospital charges (Rs 325 per day in NICU and Rs 100 per day in level II care nursery) and investigations separately. Since this is a state sponsored tertiary care center, these charges are subsidized and fixed

arbitrarily without any intention of profit or recovery of running cost.

#### *Drugs and consumables*

A limited amount of drugs and consumables are provided by the hospital; most of them have to be purchased by the family.

### **Methods of cost estimation**

The establishment cost and running costs were compiled by consulting various hospital departments, looking at their records, reviewing previous year's unit records and prospectively documenting the cost of drugs, consumables and investigations.

#### *Depreciation cost*

A measure of loss of value of an asset due to general wear and tear or obsolescence was determined to be around 13% after evaluating the initial establishment cost and estimated life span of each asset. Land value was not included, as it does not depreciate.

#### *Operational cost of equipments (replacement of spares)*

The actual amount spent towards replacement of spares for equipments over a period of one year was obtained from the unit equipment maintenance records.

#### *Ancillary services and ancillary personnel salary cost*

Ancillary services include services provided by other hospital departments for running of NICU. It involves expenditure towards materials and supplies for ancillary services and salary of ancillary personnel. Some of these ancillary services include electricity, water, telephone, laundry, central sterilization, radiology, laboratory, hospital administrative and engineering branches, and hospital drug, medical and surgical stores. The

actual cost of ancillary services was arrived at by the method of apportionment(4). The NICU has 1.26% of hospital beds and thus 1.26% of the hospital's expenditure on ancillary services and ancillary personnel salary was taken as expenses for NICU.

#### *Drugs, consumables and investigation cost*

Use of drugs and requirement of consumables and investigations were prospectively recorded in 30 babies admitted consecutively to NICU in the month of March 2003, by meticulously following them till discharge. The total consumables and investigation cost involved in taking care of these 30 representative babies was divided by the number of NICU patient days to obtain the cost per patient per day in NICU. This amount was multiplied by 5480 (16 patients × 365 days) to obtain the annual drugs, consumables and investigation cost of our 16-bedded NICU. The median length of stay, incidence of prematurity, mean birth weight and gestation, and proportion of babies requiring mechanical ventilation in this representative study group were similar to the characteristics of babies admitted to NICU during 2002(11). The differences were tested using continuous variable independent 't' test and discrete variable Chi square test.

#### *Cost of care in intermediate level II care nursery*

The running cost during intermediate care nursery stay (level II) was calculated by giving it 1:5.5 weightage in comparison with NICU care as has been done in earlier studies(12-13).

### **Results**

The present study was conducted between February and April 2003. *Table I* shows the characteristics of the patient population of the unit in the year 2002. The total cost of establishing a 16 bedded level III tertiary care

neonatal unit was Rs 3.78 crore (R 37.8 million, US\$ 860,000) (2003). The establishment cost for a ventilation bed was Rs 30.5 lacs (Rs 3.05 million, US\$ 70,000) and Rs. 16.9 lacs (Rs 1.69 million, US\$ 38,500) for a non-ventilation intensive care bed. Equipment cost formed the major portion (two thirds) of the establishment cost (*Table II*). The yearly running cost of Rs 3.18 crore (Rs 31.8 million, US\$ 725,000) includes the expenses involved in providing intensive care for 16 babies in NICU for 365 days (5840 patient days). From this data the cost of NICU care per patient per day to the unit was calculated as Rs 5450 (US\$ 125) (*Table III*). NICU and ancillary personnel salary was the largest expense accounting for 55%, followed by drugs and consumables accounting for 15% of the annual running cost. To have a quantitative measure of the extent of subsidization, the daily cost of NICU care to the family was calculated. The median daily cost of NICU care to the family was Rs 1350 (range Rs 876-1734) per patient per day. This was approximately 25% of the actual daily cost of NICU care.

**TABLE I—Patient Population Characteristics (2002).**

• Total live births:	3224
• Booked	33.2%
• Gestation	<37 wks : 1101 (34%) <33 wks : 336 (10.4%) <28 wks : 37 (1.1%)
• Birth weight	<2500 g : 1385 (43%) < 1500 g : 323 (10.1%) <1000 g : 80 (2.6%)
• NICU admissions	: 733
• No. ventilated	: 161 (HMD 98, Pneumonia 26, MAS 11, others 26)
• Total no. of ventilation days:	1256
• Birth asphyxia (5 min Apgar <6)	: 69 (2.1%)

**TABLE II**—Establishment Cost of a 16-bed NICU.

Component	Cost in Rs (thousand)	% of total establishment cost
Equipment	25,623	67
Land cost*	7,500	20
Building cost**	4,384	12
Furniture	320	1
Total	37,827	

\* Real estate rates, Chandigarh city @ Rs 15000/ square yard.

\*\* Estimate inclusive of civil, public health, water, electricity, lab gases, air conditioning etc. @ Rs 1200 / square feet.

The total cost of neonatal care for surviving babies in different birth weight categories is depicted in *Table IV*. The median total cost of neonatal care for a baby with birth weight of less than 1000 g was Rs 1,68,600. For each subsequent 250 g increments in birth weight, the cost of care decreased by about 50% amongst babies < 1500 g. For a baby weighing less than 1000 g at birth, a family spent about Rs 39,000 on hospital charges, drugs, consumables and investigations. This amounted to nearly 75% subsidy by the hospital.

Table V depicts the total cost of neonatal care for babies needing mechanical ventilation versus those not requiring mechanical ventilation. The total cost of caring for a baby weighing less than 1000 g and needing ventilation was Rs 2,37,100. The requirement of mechanical ventilation increased the total cost of care by 1.6 times in babies weighing less than 1000 g. However, in babies weighing more than 1000 g, this increase was 2.6 to 3.2 times.

## Discussion

Although advances in neonatal techno-

**TABLE III**—Annual Running Cost of a 16-bed NICU.

Component	Cost in Rs (thousand)	% of total running cost
NICU personnel salary	9,150	30
Ancillary personnel salary	8,000	25
Drugs and consumables	4,882	15
Depreciation	4,251	13
Ancillary maintenance	3,600	11
Investigations	1,109	3
Operational (Replacement of spares)	839	3
Total cost per year (5840 patient days)	31,832	

logy have improved the survival prospects of premature infants significantly, they have come at a high financial cost(3). Limited resources, widespread poverty and absence of health insurance pose further problems in third world countries(14). Knowledge of establishment and running costs of NICU along with total cost of neonatal care can help in optimizing the inputs required for organization of NICU. We were able to do a comprehensive analysis of the various components of the costs involved in providing NICU care which has not been earlier reported from our country. Though we did not do any cost-effectiveness or cost-utility analysis, this can form the ground for planning further cost-minimization trials. Private set-ups are likely to differ from government set-ups in many ways including salaries, efficiency, use of more contract employees, hiring of equipment, linking of staffing to patient-load *etc.*; hence our results may not be generalizable to them.

The cost of establishing a ventilation bed is higher than a non-ventilation bed because of additional monitoring equipments required in managing a ventilated patient. The high proportion of establishment cost due to

**TABLE IV**—*Cost of Neonatal Care of Survivors According to Birth Weight.*

Birth weight (grams)	Hospital stay (median) (days)		Total Cost (NICU + Level II nursery)*	
	NICU	Level II nursery	[median (range)]	Cost to the family [median (range)]
			1,68,600	39,000
500-999	28	16	(77,150 - 419,300)	(13,350-101,500)
			88,300	20,300
1000-1249	14	12	(16,450-254,450)	(2,450-58,450)
			41,700	9,625
1250-1499	6	9	(10,450-179,450)	(1,850-38,950)
			28,800	6,150
1500-1749	4	7	(9,450-375,150)	(1,750-91,450)
			21,350	4,450
≥ 1750	3	5	(5,450-281,500)	(1,350-68,400)

\* NICU cost was obtained by multiplying the median duration of NICU stay with the daily NICU cost per patient per day. The daily cost of intermediate level II nursery care to the hospital was estimated to be Rs. 1000 per patient per day on the basis of 1:5.5 weightage in comparison with level III NICU care (9,11,13). The daily cost to the family during stay in level II nursery was Rs 100 per patient per day.

equipments can be partly attributed to the use of more expensive imported equipments. The establishment cost of a 28-bedded NICU in a previous study from Chennai(6) was reported as Rs 80 lacs in 1990 [(Rs 1.70 crore; corrected for 2003 at 6% annual inflation rate(15)]. However data on proximity to city center, design, staffing, number of ventilation beds and type of neonatal equipments was not provided. The land cost which formed 20% of establishment cost in our study could vary widely depending on geographic location and so could the equipment cost.

The total cost of hospital care is the sum of direct and indirect costs(4,16). Direct costs are those that can be directly billed to patients *e.g.*, investigations, consumables, drugs *etc.* Indirect costs are those that cannot be billed directly to patients *e.g.*, administrative and clerical staff salaries, cost towards materials

and supplies of ancillary services. Indirect cost allocations are made using arbitrary accounting rules based on the square footage occupied by the unit or proportion of beds out of total hospital beds(4). Thus, ancillary services and ancillary personnel salary were calculated using the strategy of apportionment (based on NICU beds as proportion of hospital beds)(4). However, NICU beds may consume disproportionately larger resources as compared to non-ICU wards. We used 1:5.5 weightage to calculate the level II nursery stay costs as has been used in previous studies(12,13). This method may have its limitations depending on the variations in staffing and transfer policies between level III and II Units.

In our analysis, 55% of running cost was due to personnel salary. Other studies have reported it to be 44% to 75% of running

cost(12,13). These may vary from place to place due to differences in the staffing pattern and salary structure. The drugs and consumables cost (15% of NICU running cost) may differ between units depending on the birth weights, sickness profile and NICU policies(17). The cost towards materials and supplies of ancillary services contributed to 11% of NICU running cost, and was comparable with other studies(17). The proportion of running cost of NICU spent on investigations in our unit (3%) was lower when compared with other studies [5% to 8.5%](4,5,9). This could be partly due to subsidized charges in our hospital(5,7).

The running cost of NICU per patient per day (Rs 5,450) was higher in our study when compared to studies from Chennai(6) and Delhi(8) where it was Rs 3960 and Rs 3241 per patient per day respectively [corrected to 2003 at 6% annual inflation rate(15)]. The cost of NICU care to the family was nearly one fourth

of the actual running cost to the unit. Thus about Rs 4100 per patient per day was being subsidized by the hospital. The cost of neonatal care varied inversely with birth weight (*Table IV*). This reflects the differences in the length of stay and intensity of treatment needed for different weight categories. The cost of neonatal care in non-survivors was however not different for different birth weight categories. Similar patterns have been observed in a study from Vermont Oxford network(5).

Increment in the cost of neonatal care due to requirement of mechanical ventilation was lower in babies weighing less than 1000 g, when compared with babies weighing more than 1000 g (*Table V*). Babies weighing less than 1000 g need more intensive monitoring, investigations and numerous consumables irrespective of the requirement of ventilation. However babies weighing more than 1250 g who do not need mechanical ventilation, may

**TABLE V—Cost of Neonatal Care of Ventilated and Non-ventilated Babies (Rs).**

Birth weight (grams)	Ventilated		Non-ventilated	
	Median length of hospital stay (days) (NICU + Level II nursery)	Total cost [median (range)]	Median length of hospital stay (days) (NICU + Level II nursery)	Total cost [median (range)]
500-999	68	237,100 (77,150-419,300)	36	147,250 (125,000-170,500)
1000-1249	48	177,050 (99,200-254,450)	21	65,500 (16,450-152,700)
1250-1499	30	101,200 (27,800-179,450)	15	37,250 (10,450-97,300)
1500-1749	20	77,850 (17,350-375,150)	11	24,350 (9,450-77,300)
>1750	14	51,050 (12,900-281,500)	8	20,350 (5,450-75,400)

### Key Messages

- Equipment and personnel salary respectively, form the biggest proportion of establishment and running costs of a neonatal intensive care unit .
- The average total cost of care for a baby < 1000 grams was Rs. 1,68,000 and Rs. 88,300 for babies 1000-1250 grams. Of this actual cost , the family had to bear only 25%; rest was subsidized.
- To get the real perspective, the costs of NICU care should be compared with the outcomes, number of life-years gained and costs of other critical care procedures.

not require that intensive degree of care.

Personal expenditure of patient attendees is generally not accounted for, when cost estimates of NICU is made. However this can be an additional substantial drain on the family apart from the threat of losing one's job.

#### Can we reduce NICU costs?

Equipment formed two thirds of the establishment cost. By reducing the imported component of equipment, a significant cost reduction may be achievable. However till recently, Indian made equipments have generally suffered from lack of quality and reliability. To decrease the running cost several approaches can be considered. Since personnel salary forms 55% of running costs, rationalization and variation of staff strength in relation to changing patient numbers in NICU may be useful. Minimum staffing pattern for each clinical unit and cross training of nursing staff for utilization on higher patient load days may significantly reduce the costs(18). The ancillary services may sometimes be cheaper and more efficient when run on private contracts. Depending on patient load, procuring equipments like ventilator on hire basis may be more economical and efficient.

Regionalization of health care especially perinatal care has been shown to be an effective way of reducing costs(19,20). Promotion and development of more level II

care units and developing linkages with them so that babies needing simple supportive care (temperature regulation, gavage feeding, antibiotic completion) and basic monitoring can be back-transported, should help in cutting costs. Currently, the numbers of such units are less, the linkages are weak and public confidence in them is lacking.

As per our annual neonatal statistics of 2002(11) three factors *viz.*, requirement of mechanical ventilation, occurrence of sepsis and apnea were found to have a significant association with prolongation of hospital stay across all birth weight categories. Strategies to reduce sepsis including initial 'extra' investment on buying adequate disposables and chemical disinfectants should reduce the overall costs. Similarly, strategies like optimum use of antenatal steroids and prevention of asphyxia may decrease the need for mechanical ventilation. Tolerance of higher PaCO<sub>2</sub> and lower pH to reduce pulmonary barotrauma should also decrease the duration of mechanical ventilation and hence neonatal intensive care costs.

To conclude, neonatal intensive care is expensive. Some cost-cutting can be done by reorganization of staffing and using indigenous equipments. However, to get the real perspective, one should compare the costs of NICU care with the costs and outcomes of other critical care procedures. For example,

coronary artery bypass graft costs Rs 1 to 1.5 lacs and has an average life expectancy of 5-10 years. Whereas neonatal intensive care for a 1000 to 1500 g baby costs Rs 65,000 and is followed by a life expectancy of 50-70 years.

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