

A Micro-costing Model of Neonatal Intensive Care from a Tertiary Indian Unit: Feasibility and Implications for Insurance

KANNAN VENKATNARAYAN, M JEEVA SANKAR, ASHOK DEORARI, *ANAND KRISHNAN AND VINOD K PAUL

From WHO Collaborating Center for Training and Research in Newborn Care and ICMR Center for Advanced Research in Newborn Health, Newborn Health Knowledge Center, Division of Neonatology, Department of Pediatrics, and *Department of Preventive and Social Medicine, AIIMS, New Delhi, India.

Correspondence to:

Prof Vinod Paul,

Department of Pediatrics,

All India Institute of Medical Sciences,

New Delhi 110 029, India.

vinodkpaul@hotmail.com

Received: July 12, 2013;

Initial review: August 24, 2013;

Accepted: January 21, 2014.

Objective: To calculate and compare costs of neonatal intensive care by micro-costing and gross-costing methods. **Methods:** The costs of resources of a tertiary care neonatal intensive care unit were estimated by the two methods to arrive at specific costs per diagnosis related categories for 33 neonates followed-up prospectively. **Results:** Gross-costing as compared to micro-costing resulted in higher cost per bed (Rs 6315 vs. Rs 4969) and wide variations of costs (-34.8% to +13.4%). Intensity of interventions, relative stay in neonatal intensive care unit compared to the step-down nursery, and total length of hospital admission accounted for these variations. **Conclusions:** Estimates based on micro-costing arrived in this study may be used as a starting point in developing assumptions for insurance models covering neonatal intensive care.

Keywords: Cost, Neonatal intensive care unit, Reference unit prices.

The available studies of cost analysis of neonatal intensive care unit (NICU) have conventionally used gross-costing methodologies, by approximating the costs of various resources, for arriving at costs per weight categories [1-4]. This is not accurate for estimation of costs of sick neonates; the resources used by them, unlike stable growing babies, varies depending on the intensity of various heterogeneous interventions provided for a given diagnosis [5]. Micro-costing entails close examination of actual resources consumed per patient [6], and being specific, aids in arriving at costs per diagnosis related group (DRG) - the foundation for insurance models [7]. With a dearth of insurance in the expensive arena of NICU care, which further the Out-of-Pocket Expenditure [2,8]; micro-costing technique can aid in finance planning from different perspectives. We carried out this limited study to assess feasibility and comparison of micro-costing technique to calculate costs of NICU care for plausible DRGs [6,9,10].

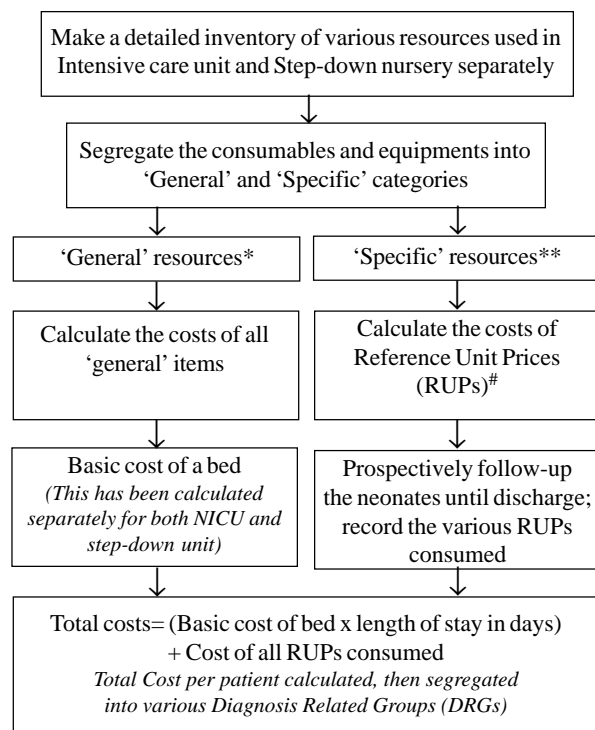
METHODS

The study was conducted in level III NICU and the step down nursery of All India Institute of Medical sciences from October 2010 to January 2011. The institute ethical clearance was obtained. A detailed inventory of all components of costs was made. We used principles of top-down and limited bottom-up micro-costing

techniques [6,9], by pragmatic segregation of resources into two groups: 'General' and 'Specific' (*Fig. 1*).

The useful life of equipment was taken as seven years and the maintenance cost was calculated at a rate of 5% of the capital cost of equipment. The land cost, being provided by the government of India at a highly subsidized rate to AIIMS, was not taken into consideration for calculation. Data on costs of human resources were deduced from pay-slips of the staff and full time equivalents were calculated for each category of staff. Since the consultants on call were of different cadre, thus having heterogeneous pay scales, an average of their salaries were taken based on the actual time spent in the NICU care.

Thirty-three infants admitted in the intensive care unit within 24 hours of life were followed up till discharge or death with an idea to get adequate case-mix (with respect to the birth weight, gestation, and initial diagnosis) in order to create respective plausible DRGs. For classification of DRGs based on an insurance model, the All Patient Refined (APR) DRG Version 20.0, Medicare, USA was used. The costs per DRGs were also calculated by gross-costing methodology, to highlight the differences. The degree of intensity of interventions was termed "high" when multiple invasive procedures (ventilation, TPN, arterial BP monitoring) were required and "low" when none of these were performed.



*Includes costs of land, fixed assets, salary, electricity, laundry, general stores and stationary stores. Also includes costs of equipments of general use (like radiant warmer, laminar flow etc) and consumables of general nature (such as adhesive plasters, towels, blades, suction tubings, shoe covers etc)

**Includes specific equipments used (like aEEG, Echocardiography etc) and specific consumables (such as gloves, feeding tubes, syringes, needles etc).

The costs of specific equipments per unit use and specific consumables segregated were amalgamated to find costs of **Reference Unit Price (RUP)** for 13 procedural (Oro gastric tube placement, Intravenous catheter placement, Oral/ Endotracheal (ET) Suction, Diaper change, Intravenous fluid administration, Total parenteral nutrition, ET Change, Percutaneously Inserted Central Catheter line placement, Umbilical venous catheter placement, Umbilical Arterial Catheter placement, Arterial line placement, Surfactant administration), 11 investigational (Septic screen, Blood gas analysis, Blood sugar testing by glucostrix, Total serum bilirubin estimation by twin beam method, electrolyte (sodium, potassium, calcium, phosphorus), Liver function tests, Blood culture, Portable X ray, Bed side echocardiography and or cranial Ultrasonography, Amplitude integrated EEG measure per hour) and 12 therapeutic modalities (Ventilator use per hour, High Frequency Oscillatory Ventilation use per hour, Bubble Continuous Positive Airway Pressure use, Free flow oxygen, Phototherapy use per hour per unit, specific drug administration, blood products use (red blood cell/ plasma/ platelets), exchange transfusions (partial/ double volume))

FIG. 1 Steps of micro-costing employed.

Adjustments with inflation rates were done for comparing with studies. The parents were interviewed for direct and indirect medical and non-medical costs, loss of income incurred and knowledge about insurance. All the costs are mentioned in 2010 Indian Rupees (Rs.).

RESULTS

The basic cost of a bed at the NICU and the step-down nursery as calculated by micro-costing method, were Rs. 4969 and Rs 2730 per bed per day. By approximation, the costs were Rs 6315 and Rs 2769, respectively for NICU and step down nursery.

The annual recurring cost for the intensive care and the step-down nurseries were Rs 1.9 crores and Rs 1.7 crores, respectively. Salaries contributed to 68.3% and 81.6% of this cost, respectively. The allocation of various resources into 'general' and 'specific' group were counter checked with those actually consumed and they accounted for more than 97% of total resources used.

The costs per diagnosis were calculated, classified as per DRG and compared by both methodologies (**Web Table I**). Compared with micro-costing, gross-costing resulted in a wide variation ranging from -34.8% to +13.4%. The costs were directly proportional to the stay in the NICU in comparison to step-down nursery, intensity of interventions and inversely proportional to birth weight. In other words, if a baby not requiring intensive interventions remains longer in NICU in lieu of step-down nursery, the actual costs of care (by micro-costing) would be lesser than if calculated by gross-costing.

Most of the parents (78%) belonged to upper-middle-class or above. The median Out-of-pocket expense per day incurred to the parents was Rs 538.6 (range: Rs. 87.5 to Rs. 3,772.22). AIIMS gives a subsidy of 85% of direct medical costs. About 70% of parents reported an income loss during hospitalization of babies at NICU, which accounted for 13.6% of their total expenditure and this was most in the lower income group (34.3%). Two-thirds of parents managed finances on their own, while 16% had employers' insurance scheme; another 16% had to take loan for meeting their expenses. Only 50% of parents were aware of existence of insurance policies for health. Of these, only 33% were actually using them.

DISCUSSION

Almost 60% of India's estimated 1.2 billion people pay for medical treatment out of their own pockets and these account for an average increase in poverty by as much as 3.6% and 2.9% for rural and urban India, respectively [8,11]. NICU care of neonates being expensive adds to the cost burden, especially because of paucity of insurance plans and lack of knowledge amongst the users [2]. Our costs per NICU bed seem lesser [1-4] since these have been arrived after appropriate segregation of resources.

Costs per DRG depends on multiple complex interactions of severity of illness, degrees of interventions performed, and the policies of units regarding transfer and care of sick neonates, in various sectors. With the twelfth five-year plans promoting Universal Health Coverage (UHC) efforts by linking public-private facilities, development of DRGs for insurance model based on a homogenous costing methodology which is accurate and feasible is the need of the hour. Further studies with larger case-mix are required to arrive at plausible DRGs and their costs. Estimates based on micro-costing arrived in this study may be used as a starting point in developing assumptions for insurance models covering NICU care.

Acknowledgement: Dr Ramesh Agarwal, Associate Professor, Dept of Pediatrics, AIIMS, for critically reviewing the manuscript.

Contributors: VKP: conceived the study and revised the manuscript for important intellectual content; He will act as guarantor of the study; KV: designed the study, collected and analyzed the data, drafted the paper; MJS: assisted in data analysis and manuscript writing; AK: provided inputs into methodology and revised the final manuscript; AD: contributed in the initial design of study and edited the final manuscript.

Funding: None; *Competing interests:* None stated.

REFERENCES

1. Kannaraj V, Paul VK, Gupta S, Sarma RK, Anand K, Singh M. Cost of Neonatal Intensive care: XVI Annual Convention of the NNF: Nov, 1996 Abstract:10.
2. Shanmugasundaram R, Padmapriya E, Shyamala J. Cost of neonatal intensive care. *Indian J Pediatr.* 1998;65:249-55.
3. Narang A, Kiran PSS, Kumar P. Cost of neonatal intensive care in a tertiary care center. *Indian Pediatr.* 2005; 42:989-96.
4. Rogowski J. Measuring the cost of neonatal and perinatal care. *Pediatrics.* 1999;103:e329.
5. Prinja S, Manchanda N, Mohan P, Gupta G, Sethy G, Sen A, *et al.* Cost of neonatal intensive care delivered through district level public hospitals in India. *Indian Pediatr.* 2013;50:839-46.
6. Finkler SA, Ward DM, Baker JJ. *Essentials of cost accounting for health care organisations.* 3rd ed. New York: Aspen Publishers. 2007.
7. Muldoon JH. Structure and performance of different DRG classification systems for neonatal medicine. *Pediatrics.* 1999;103:302-18.
8. Gupta I. Out-of-pocket Expenditures and Poverty: Estimates From NSS 61st Round. Draft paper. Institute of Economic Growth, New Delhi, 2009.
9. Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. *Methods for the economic evaluation of health care programmes.* 3rd ed. New York: OUP 2005.
10. Shuman LJ, Wolfe H. The origins of hospital microcosting. *J Soc Health Syst.* 1992;3: 61-74.