Original Article

Surfactant Replacement Therapy–Economic Impact

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Abstract. Surfactant replacement is an effective treatment for neonatal respiratory distress syndrome. (RDS). As widespread use of surfactant is becoming a reality, it is important to assess the economic implications of this new form of therapy. A comparison study was carried out at the Neonatal Intensive Care Unit (NICU) of Northwest Armed Forces Hospital, Saudi Arabia. Among 75 infants who received surfactant for RDS and similar number who were managed during time period just before the surfactant was available, but by set criteria would have made them eligible for surfactant. All other management modalities except surfactant were the same for all these babies. Based on the intensity of monitoring and nursing care required by the baby, the level of care was divided as : Level IIIA, IIIB, Level II, Level I. The cost per day per bed for each level was calculated, taking into account the use of hosptital immovable equipment, personal salaries of nursing, medical, ancillary staff, overheads and maintenance, depreciation and replacement costs. Medications used, procedures done, TPN, oxygen, were all added to individual patient's total expenditure. 75 infants in the Surfactant group had 62 survivors. They spent a total of 4300 days in hospital. (av 69.35) Out of which 970d (av 15.65 per patient) were ventilated days. There were 56 survivors in the non-surfactant group of 75. They had spent a total of 5023 days in the hospital (av 89.69/patient) out of which 1490 were ventilated days (av 26.60 d). Including the cost of surfactant (two doses), cost of hospital stay for each infant taking the average figures of stay would be SR 118, 009.75 per surfactant treated baby and SR 164,070.70 per non-surfactant treated baby. The difference of 46,061 SR is 39.03% more in non-surfactant group. One Saudi rial = 8Rs (approx at the time study was carried out.) Medical care cost varies from place to place. However, it is definitely cost-effective where surfactant is concerned. Quality adjusted life years (QALY) for NICU care compares favourably with cost per QALY of several forms of adult health interventions. Audit, both medical and financial, of these services, at regular intervals is essential. **[Indian J Pediatr 2001; 68 (6) : 501-505]**

Key words **:** *Surfactant; Cost benefit; Quality adjusted life year*

Surfactant replacement is an effective treatment for neonatal respiratory distress syndrome (RDS). Several randomised controlled trials have shown that surfactant treatment reduces neonatal mortality, reduces the incidence of pulmonary air leaks and increases the number of babies surviving with minimal or no bronchopulmonary dysplasia.[1,2,3] As in many neonatal units all over the world, surfactant replacement has now become a routine treatment for babies with moderate to severe RDS even in our institution.

Neonatal intensive care is expensive but there is evidence that caring for babies weighing more than 1000gms is cost-effective.[4] Few studies have specifically addressed the economic impact of surfactant replacement therapy.[5,6] As widespread use of surfactant is a reality, it is important to assess the economic implications of this new therapy. Medical costs vary from one environment to another due to various reasons. Hence, while considering the studies conducted in other centres as reference/guideline we felt that we ought to look at our own experience regarding economic implications of this therapy. We have studied the cost and the cost effectiveness of treating a group of babies who had moderate to severe RDS.

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MATERIALS AND METHODS

In a comparison study carried out in our hospital (unpublished data) it was found that when two groups of 75 infants each, those who received surfactant and those who did not, comparing them with regard to their clinical outcome, there was statistically significant differences, favourable to surfactant group in the following aspects :

(1) duration of ventilation, (2) total duration of oxygen dependence and (3) duration in hospital. The case notes of very same infants were looked at. The total cost of providing neonatal care was calculated using a detailed survey of facilities used for each of these infants. Cost of the surfactant was included for those infants who had received them.

Calculation of Cost of Care

The cost of medical care was determined by observing the level of activity around the patient during the time they spent in the hospital. This calculation took into account :

* the use of hospital immovable equipment for general care, special care, and intensive care.
* medications, procedures
* total parenteral nutrition(TPN), oxygen therapy
* salaries of personnel
* overheads
* depreciation

Levels of Care

Based on the intensity of nursing care required for the baby, the level of caring and activity were divided as follows.

Level III A : Highest level of care in the neonatal intensive care unit, (NICU) where in the baby was on a ventilator and often unstable, requiring repeated medical interventions. A nurse was assigned exclusively, 24 hours a day.

Level III B : Care was still in NICU, for babies who were more stable (mostly not on ventilator) but needed intense care and close observations. The nurse patient ratio could be 1: 2.

Level II : Care was when babies improved and were transferred to step down nurseries called as special care baby unit (SCBU) in our set up. These are babies on oxygen by headbox, receiving IV antibiotics and TPN along with oral feed may be the pattern of intake. Though they needed monitoring, the nurse patient ratio of 1:3 was sufficient.

Level I : Nursing was mainly for babies who were not on TPN, who may be on low levels of oxygen by nasal cannula, or out of oxygen and did not need constant monitoring. They could be managed in nurseries or general ward set-up.

These set-ups are not much different from the levels of care described by the British Paediatric Association.[7] The costing of hospital resource utilisation by babies in NICU, SCBU and general ward was done by referring to reports of previous work done in the same field : study of cost of neonatal care in the Trent regional health authority.[8] This covered different areas of cost, including salaries of medical and nursing staff, ancillary services (*e.g.*, laboratory tests, radiography etc.), hospital maintenance and overheads, and current equipment replacement costs. Information on day to day workload for each of the levels of care was also considered.

The cost per bed per day for each level of care was calculated from the total expenditure and the number of occupied bed days per level of care.

The cost of each procedure was calculated based on actual time spent by the person doing the procedure, the cost of consumabl and the depreciation of capital equipment used. The cost of medication, TPN and oxygen therapy were calculated on average consumption by a preterm infant on body weight basis. It was not calculated on an individual basis.

In some instances where specific allocations either in terms of personnel or equipment could not be made, weightings derived from a study at the Birmingham Maternity Hospital[9] were used. In calculating level I or nursery day cost is concerned, we referred to data available in the study from West of Scotland.[10] The costs in our hospital for various facilities are given in Table 1.

TABLE 1. Costs of Facilities (SR=Saudi Riyal) At the Time of the Study 1SR=8 Indian Rupees.

NICU cost per day	2946SR with ventilator
NICU cost per day	2795 SR without ventilator
SICU cost per day	900 SR
Nursery/general ward cost per day	350 SR
Cost of surfactant per vial	2500 SR

The total cost per infant per day is the sum of the cost of medical care for the day and the operating cost of the unit per bed per patient per day.

We have taken the cost of surfactant as the 2500 Saudi riyals (SR) which is not much different from that used in a similar study. The cost of each infant in the study was obtained by determining the number of days the infants spent in each level of care and costing them accordingly. The case notes of the infants in the study groups were examined to calculate the number of days they had spent in NICU, SCBU and nursery/ general ward respectively. In the NICU the stay was subdivided to two periods of stay *i.e.* with ventilatory support and without.

RESULTS

Seventy infants in the surfactant group had 62 survivors (Table 2). Hence, 62 infants in the

surfactant group spent a total of 4300 days in hospital. The average length of stay per patient was 69.35 days. The stay in NICU was a total of 1730 days (27.9 per patient) out of which 970 were ventilated days and 760 were non ventilated days. The average ventilation duration per patient is 15.65 days. The babies in this group spent 2101 days (33.88 per patient) in the SCBU and only 469 days in the nursery/general ward. There were 56 out of 75 survivors in the non-surfactant group. They spent a total of 5023 days in hospital. The average stay per patient was 89.69 days. Out of this the days spent in NICU were 2407 days (42.98 days per patient) The total ventilated days were 1490 giving an average of 26.60 ventilated days per patient. The total duration spent in the SCBU by the non-surfactant group was 2400 days (average 42.68 per patient) and in nursery/general ward was 216 days.

A total of 124 doses of surfactant were given to these babies. Average of two per infant. This would amount to a total expenditure of 5000 SR per infant.

If the ward charges are included, then the cost of total hospital stay for each infant taking the average figures of stay would be SR 118,009.75 per surfactant treated baby and 164,070.70 per non-surfactant treated baby. This figure includes the hospital charges and the surfactant cost for the surfactant treated infants. (Table 3)

Table 2. Hospital Stay of Infants in Surfactant and Control Groups (in days)

Details	Surfactant group n=62		Non-surfactant group n=56	
Duration in hospital	4300		5023	
Average per patient		69.5		89.69
Length of stay in NICU	1730		2407	
Average per patient		27.90		42.98
Ventilated days	970		1490	
Average per patient		15.65		26.60
Non ventilated days	760		917	
Average per patient		12.25		16.38
Stay in SCBU	2101		2400	
Average per patient		33.88		42.86
Time spent in nursery/general ward	469		216	
Average per patient		7.5		3.86

Table 3. Costing of Hospital Charges. SR = Saudi Riyals Surfactant Treated Infants

Groups	Length of stay Average/patient in days	Cost per day in SR	Total cost in SR
in NICU ventilated	15.65	2946	46,104.90
In NICU not ventilated	12.25	2795	34238.75
In SCBU	33.38	900	30042.00
In nursery/ward	7.5	350	2625.00
Cost of surfactant	Two doses 2500SR each	5000SR	5000.00

Grand total per person : 118,009.75 SR

Non Surfactant Treated Infants :

Groups	Length of stay Average/patient in days	Cost per day in SR	Total cost in SR
In NICU ventilated	26.60	2946	78363.60
In NICU not ventilated	16.38	2795	45782.10
In SCBU	42.86	900	38574.00
In nursery/ward	3.86	350	1351.00

Grand total per patient : 164,070.70 SR

DISCUSSION

In our study the hospital charges on an average of a surfactant treated patient was 118,009.75 riyals as compared to 164,070.70 riyals for a non-surfactant treated preterm infant. The difference of 46,061 riyals is 39.03% more in the case of non-surfactant treated preterm infants. This is even after surfactant cost has been included for babies who received it. The average cost of neonatal care per day in our hospital at four levels of care is somewhat similar to those reported earlier from Australia.[11] If this is compared to the cost per day of such services at those levels of care in Northern Ireland [6] the charges in our hospital are slightly (10%) high for intensive care unit and higher by 25% for other levels of care. The hospital cost per treated net survivor in the same study was also around 25% less than ours. It has to be mentioned that in our environment, due to lack of environmental safety standards, we do not send babies home on oxygen. Community services are not optimum, parents are not comfortable to give tube feeds, hence we tend to keep them in hospital until all requirements can be taken by breast or bottle and weight gain is appreciated. The babies are discharged when their weight reaches 2 Kgs. This means that hospital stay is definitely longer than those in other similar studies.

It is indeed difficult to work out costing of NICUs, and the price of salvaging low (LBW) or very low birth weight (VLBW) infants. The cost of producing one surviving VLBW baby in Birmingham was estimated to be £5000-10000,[9] in Liverpool £3000-15000,[12] Leeds £8000-10000[13] and Dublin £12000-15000.[14] This demonstrates the wide variation in different centres. Hospital charges for surfactant treated babies when compared to the control group of non surfactant treated babies in the same institution should give a reliable view as is the case with our study. It is even more difficult to apply comparison for surfactant therapy for neonatal RDS. The number of doses, brand, the practices of a given neonatal unit regarding ventilation, frequency of investigations and policy of discharging will all contribute to the total cost. Studies have used single dose[15] and multiple doses[16] to work out the cost effectiveness. However, most of them have recommended that surfactant therapy is cost effective. Phibbs *et al* have gone further to say that rescue treatment is definitely cost effective and prophylactic therapy for smaller infants appeared to yield a reduction in mortality for a small additional cost.[15]

The cost effectiveness study of surfactant therapy ideally should not be restricted to hospital charges just upto the initial discharge of the patient. It should look into the factors in both groups of babies in relation to :
whether there is increased morbidity during following years due to ventilatory support, complications like air leak, PDA, pulmonary haemorrhage etc.
whether there is unfavourable neurodevelopmental outcome leading to increased costs of extra community health support, special schooling and social support.

There are very few long term follow up studies of surfactant therapy.[17,18]

Quality Adjusted Life Years (QALY) : This is the standard method of reporting cost-effectiveness studies.[19] Cost per life year saved is the cost per life saved divided by the remaining years of life. Quality adjusted life year adjusts the life years by discounting years of life that have any limitations. It may be too early to make accurate assessments of the life years saved or QALYs for surfactant. Tubman *et al.*, have reported the cost per additional QALY gained by surfactant therapy as approximately £690.[6] This compares very favourably with the cost per QALY of some forms of adult interventions, renal transplant-£1400[19]; single vessel coronary artery bypass graft-£6000[20]; and hospital haemodialysis £9000.[19]

Other Side of the Coin : The paper on economic consequences of surfactant therapy[21] analysed the QALY cost of the therapy. He pointed out that the reassuring calculations rest on the implicit theoretical global benefit to the total economic system and assume a linkage on the one hand between outlay (expense) of the health care system in general and the individual hospital and on the other hand, the economic and productive contribution (income) to society by the surviving infant patient. This linkage unfortunately does not exist in the real world and thus, we must be concerned that the anticipated increase of cost of caring for the new survivors will be borne by an already strapped health care system with the inevitable trade-offs and unregulated resetting of priorities.

Mugford *et al*[5] in their analysis said that the therapeutic success of surfactant will lead to a total increase in the cost of neonatal care because there will be more expensive very low birth weight survivors plus an increased expense of care for infants who still die but who previously would have died within a few days.

In most of these studies, one factor of potential importance that was not addressed in the analysis was the administration of glucocorticoids to mothers antenatally to accelerate fetal lung maturation. This proven therapy may substantially affect birth weight, specific neonatal morbidity and mortality rates and therefore costs.

CONCLUSION

In our institution, we have found surfactant therapy as a cost-effective modality of treatment. The reduction in hospital cost of a surfactant treated baby as compared to non-surfactant treated infant is>30%. This might be even more when long term needs like increased follow-up, increased costs of special care and special schooling are considered for infants who had not been treated with surfactant and ended up with high morbidity due to complications.

The actual cost of Surfactant is small compared to costs of intensive and special care given to these neonatals.

In our environment, in addition to this tightening of simple measures like antenatal booking, follow-up, education on avoiding consanguinity, nutrition and good antenatal care will further enhance the good results.

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