Reducing length of stay in hospital for very low birthweight infants by involving mothers in a stepdown unit: an experience from Karachi (Pakistan)

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Abstract

Problem Clinical care of infants with a very low birth weight (less than 1500 g) in developing countries can be labour intensive and is often associated with a prolonged stay in hospital. The Aga Khan University Medical Center in Karachi, Pakistan, established a neonatal intensive care unit in 1987. By 1993-4, very low birthweight infants remained in hospital for 18-21 days.

Strategies for change A stepdown unit was established in September 1994, with mothers providing all basic nursing care for their infants before being discharged under supervision.

Key measures for improvement We analysed neonatal outcomes for the time periods before and after the stepdown unit was created (1987-94 and 1995-2001). We compared these two time periods for survival after birth until discharge, morbidity patterns during hospitalisation, length of stay in hospital, and readmission rates to hospital in the four weeks after discharge.

Effects of change Of 509 consecutive, very low birthweight infants, 494 (97%) preterm and 140 (28%) weighing < 1000 g at birth, 391 (76%) survived to discharge from the hospital. The length of hospitalisation fell significantly from 1987-90, when it was 34 (SD 18) days, to 16 (SD 14) days in 1999-2001 ($P < 0.001$). Readmission rates to hospital did not rise, nor did adverse outcomes at 12 months of age.

Lessons learnt Our results indicate that it is possible to involve mothers in the active care of their very low birthweight infants before discharge. This may translate into earlier discharge from hospital to home settings without any increase in short term complications and readmissions.

Background

Survival and outcome of infants with a very low birth weight (weighing less than 1500 g at birth) have improved tremendously in recent years, and in most developed countries, survival rates are 80-90% for infants weighing 750-1500 g.^{1,2} In contrast, data on very low birthweight infants from the developing world are scarce, and available information is largely restricted to reports from infants admitted to hospital.³⁻⁵ Clinical care of very low birthweight infants in developing countries can be difficult and labour intensive, and with limited resources for intensive care, alternative strategies such as Kangaroo Mother Care have been employed for the care of very low birthweight infants.^{6,7}

Context

The Aga Khan University Medical Center is a 550 bed facility in Karachi where about 3500 births take place

Summary points

Mothers can be motivated and supported to help in the regular care of stable, very low birthweight infants in hospital

The creation of a stepdown unit with mothers looking after stable, very low birthweight infants was associated with a significant reduction in length of stay in hospital and no increase in mortality or rates of readmission to hospital

Such an approach may provide a cost effective strategy for reducing congestion and length of stay in hospital of very low birthweight infants in neonatal intensive care units in an environments with resource constraints

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annually; most of the mothers are booked patients. The neonatal services at the centre are unique for Pakistan, in that full multispecialty facilities and trained staff for secondary and tertiary care of newborns are available. Since the neonatal intensive care unit was commissioned in 1986, a comprehensive data base of all births, antenatal risk factors, clinical course, and outcomes has been maintained. These data are used for a monthly audit of mortality and morbidity of the services.

The problem

By 1993-4, because of the large number of high risk infants born in the Aga Khan Center and external referrals, a major bottleneck to outside admissions was the length of time that such very low birthweight infants stayed in hospital, which averaged 18-21 days.⁸ After stabilisation and graduation from intensive care, most such infants were kept in the transitional care area of the neonatal intensive care unit until they were ready for discharge. Although parents were allowed free access, no facilities were available for "rooming in," and all routine care was provided by the unit's nurses and paramedical staff. The overall cost of intensive care in the neonatal intensive care unit at the centre (average \$90-100/day in 1993-4) was lower than in developed countries,⁹ but prolonged hospital stay was a source of considerable economic burden on families and possible third parties that pay such as corporate groups and local health insurance companies.

Strategies for change

In view of the enormous pressure for admissions to the neonatal intensive care unit and limited trained nursing staff, a policy of involving mothers early in the care of the high risk infants with a very low birth weight

Fig 1 Mother feeding her very low birthweight infant in the stepdown unit for mothers and babies at the Aga Khan University Medical Center

and of discharge to the transitional care area was instituted in September 1994. A stepdown unit for mothers and babies was created in a separate area on the paediatric ward. This unit consisted of a dedicated room with five beds where all newborn infants, especially very low birthweight infants recovering from care in the neonatal intensive care unit, were admitted with their mothers (fig 1). The box compares the management strategies and protocols of the transitional care area in the neonatal intensive care unit and the stepdown unit. From 1995 onwards, the transitional care nursery in the neonatal intensive care unit was replaced by the stepdown unit, and all very low birthweight infants and their mothers were transferred there after ventilation and intensive care had been discontinued. The mothers and infants were discharged as soon as regular weight gain, feeding, and normal body temperature at room temperature were established. Mothers received a telephone number to call in case of an emergency. A regular system of at least weekly outpatient visits after discharge was usually instituted for the first four to six weeks, with follow up visits at longer intervals thereafter.

Key measures for improvement

In addition to the existing system of data collection on morbidities and outcomes (survival to discharge and at 12 months of age), we chose length of stay in hospital, cost of care, frequency of readmission to the neonatal intensive care unit from the stepdown unit as well as readmission to hospital in the four weeks after discharge as key measures of improvement.

We analysed the clinical course, morbidity patterns, and outcomes of the entire very low birthweight cohort born at the centre for the time periods before and after the stepdown unit was created (1987-1994 and 1995-2001). We used univariate methods (SPSS for

Windows, version 10) to compare the two time periods for length of stay in hospital, mortality patterns, and outcomes associated with very low birth weight. To categorise the condition at admission and severity of illness objectively, we assigned the clinical risk index for babies (CRIB) score to all very low birthweight infants.¹⁰ We also evaluated the survival of infants in a prespecified, stepwise, logistic regression model including the variables birth weight, sex, birth asphyxia, admission CRIB score, and the time period (before and after the stepdown unit).

Effects of change

A total of 26 375 births took place at Aga Khan University Medical Center over the period (1987-2001). Of the infants, 3030 (11.5%) were of low birth weight (less than 2500 g), and 517 (2.0%) a very low birth weight (less than 1500 g). Five hundred and one (97%) of these very low birthweight infants were preterm (less than 37 weeks' gestation; based on assessment of gestational age by antenatal ultrasonography and postnatal clinical examination). We excluded eight very low birthweight infants born in the hospital because the parents refused to have them admitted to the stepdown unit over the period

Standards of care for transitional care in the newborn intensive care unit at the Aga Khan University Medical Centre

- Around the clock supervision by a team of dedicated trained neonatal nurses and trained neonatologists or residents (nursing ratio 1:3)
- Involvement of nurse technicians in the monitoring and care of stable, very low birthweight infants
- All procedures undertaken by trained neonatal nurses with resident backup
- Visiting rights restricted to parents but no "rooming in"
- Exclusive breast milk feeding (baby friendly hospital): direct breast feeding or breast milk feeding through nasogastric tube or with cup and spoon
- Portable radiology, ultrasonography, and echocardiography
- Back up team support by paediatric surgeons and a team of paediatric cardiologist and cardiac surgeon, physiotherapists
- Eye test and hearing test (before hospital discharge and at 3 months and 6 months of age)

Sentinel newborn care policies and procedures in the stepdown unit for mothers and babies

- Supervision generally by a single trained midwife or registered nurse (1:5 ratio)
- Involvement of the mother in regular monitoring of vital signs and temperature (very restricted electronic cardiorespiratory or apnoea monitoring)
- Exclusive breast milk feeding (direct breast feeding or breast milk feeding through nasogastric tube or with cup and spoon)
- Strict hand washing before and after handling
- Minimal visitors other than immediate family
- Co-bedding of mother and infant (use of a heated cot as required and minimal use of incubators)
- Chest physiotherapy and mild suction by parents, postural drainage as required. Parental training in recognition of danger signs and care seeking

Table 1 Clinical characteristics of admitted infants with very low birth weight before and after opening of the stepdown unit. Data are numbers (%) of infants unless otherwise indicated

	Before (1987-94)	After (1995-2001)	P value (t test)
Total births	12 121	14 254	
Births <2500 g	1576 (13.0)	1454 (10.2)	NS
Births <1500 g:	191 (1.6)	318 (1.7)	NS
Births 1000-1499 g	157 (1.3)	225 (1.2)	NS
Births <1000 g	34 (0.3)	93 (0.5)	NS
Ratio of male to female infants	100:91	164:154	NS
Mean gestational age in weeks (SD)	31.0 (3.0)	29.9 (3.2)	<0.001
Mean birth weight in g (SD)	1170.7 (242.1)	1147.3 (272.5)	0.33
Mean clinical risk index for babies score (SD)	3.8 (3.9)	4.6 (5.0)	<0.05
Emergency lower segment caesarean section	102 (53.0)	221 (69.5)	1.31 (1.12 to 1.53)*
Asphyxiated at birth	47 (24.6)	60 (18.9)	0.87 (0.73 to 1.05)*
Intubated at birth	98 (51)	118 (37.1)	0.80 (0.69 to 0.92)*

*Relative risk (95% confidence interval).

1995-2001, for various social reasons. Because of the wide variation in the condition for referral and the absence of the mother in many cases, we excluded from our analysis an additional 170 very low birthweight infants born outside the hospital who were admitted to the neonatal intensive care unit over this time period.

Table 1 shows the births at the centre, delivery characteristics, and condition at birth for the very low birthweight infants born in hospital for the two time periods. Of the 509 very low birthweight infants, 412 (81%) were booked; the remaining ones were emergency presentations to the hospital or referrals from other hospitals. Many very low birthweight infants 316 (62%) were delivered operatively, as a reflection of either maternal indications such as uncontrolled pre-eclampsia or fetal distress after premature labour. Many of the infants had low Apgar scores at birth, and overall 214 (42%) needed intubation and resuscitation.

Table 2 shows the clinical course and complications encountered during the course of hospitalisation for the two time periods. A total of 118 (23.2%) newborn infants died during the course of their initial stay in hospital. Table 3 lists the various indicators of the clinical course among the very low birthweight cohort and the death rates over the two time periods. Figure 2 shows the mean discharge weight and length of stay in hospital for surviving very low birthweight infants over the various time periods between 1987 and 2001. Length of stay in hospital fell significantly from mean 34 (SD 18) days in 1987-1990 to 16 (SD 14) days between 1999 and 2001.

Fig 2 Length of stay in hospital and discharge weight of surviving very low birthweight infants among births at Aga Khan University Medical Center (1987-2001)

This fall was also associated with a reduction in mean weight at discharge from 1600 (SD 155) g to 1289 (SD 193) g for the same time periods ($P < 0.001$). Given the average daily cost of care for neonatal intensive care over this period, this represented net savings of seven days' stay in hospital or about 38 000 rupees (\$700) per admission. Overall rates of survival over these time periods also improved, from 65% to 84% ($P < 0.05$), the rates of overall nosocomial infections among infants admitted to the neonatal intensive care unit dropped significantly (fig 3).

Overall, 27 very low birthweight infants who had been transferred to the stepdown unit required readmission to the neonatal intensive care unit for a range of problems including suspected sepsis (14, 52%), aspiration (7, 26%), apnoeic spells (5, 19%), and seizures (one child). The logistic regression analysis indicated that the following variables were independently associated with an increased risk of mortality (birthweight category 500-749 g, adjusted odds ratio 6.0, 95% confidence interval 1.8 to 20.4; 750-1000 g, 4.7, 2.0 to 10.8; 1000-1250 g, 2.6, 1.2 to 5.8), CRIB score 1.3 (1.2 to 1.4), and the time period before the stepdown unit was created (3.2, 1.4 to 7.3).

Although we did not collect objective data on mothers' perceptions of the stepdown unit, mothers and families accepted the concept and participation almost universally. In 19 instances, a mother's illness or death prevented her participation in the newborn infant's care, and care in the stepdown unit was provided by a female member of the immediate or extended family.

We also evaluated the follow up information on all very low birthweight survivors for up to 12 months after discharge (until December 2002). Although we did not undertake systematic neurodevelopmental assessment, we made a broad classification of status at 6 months and 12 months of age. These included the documentation of abnormal outcomes such as bronchopulmonary dysplasia, motor dysfunction such as cerebral palsy or monoplegias, and hearing and visual deficits with standardised criteria. In all cases a member of the team (FR and a developmental specialist) assessed these outcomes, who remained blinded to infants' initial status at birth and course during their stay in hospital. Of the 391 survivors, detailed follow up information up to at least 12 months of age was available in 308 (79%) cases, whereas 26 (7%) were followed up to six months only and a further 33 (8%) died during infancy, 24 (74%) within the first six months of life.

Fig 3 Trends of nosocomial neonatal infections in the neonatal intensive care unit at Aga Khan University Medical Center after the creation of the stepdown unit

Sixteen (4%) newborn infants who were seen on only two or three occasions during the first 12 weeks after discharge were found to be normal but were lost to subsequent follow up. Figure 4 indicates the rates of hearing, vision, and gross motor dysfunction among the survivors over sequential time periods assessed.

Lessons learnt

Our experience shows that it is possible to motivate and involve mothers in the care of very low birthweight infants in hospital, with early discharge home. Our data also show that the creation of a stepdown unit with maternal involvement in the care of very low birthweight infants was associated with a shorter stay in hospital and fewer nosocomial infections in the neonatal intensive care unit.

Limitations

Notwithstanding the above, several limitations must be recognised in reviewing these data. This was not a randomised controlled trial of the impact of a stepdown unit on outcomes of very low birth weight, as the facility

was largely created because of pressing clinical needs and admission bottlenecks. We cannot entirely exclude the possibility of a systematic selection bias. However, we found no indication of a selection bias as our analysis includes information on the clinical course and outcome to discharge for 509/517 very low birthweight infants born in hospital, as well as follow up data during infancy on 79% of the survivors. Although some newborn infants exhibited evidence of growth restriction, 97% of the very low birthweight infants were preterm. Our data on overall rates of live births of infants with a very low birth weight and prematurity in the birth cohort are comparable to those reported from other centres in India¹¹ and Brazil,¹² although they are higher than those reported from the West.¹³ The prevalence of respiratory distress syndrome in these infants was also similar to that reported from the large Vermont-Oxford Trials Network Database Project from a comparable time period.¹⁴

Another issue concerns a possible secular trend in improvement of the quality of neonatal care over this time period. Although this may be possible, no major change occurred in staffing ratios and treatment protocols over this time period except for the introduction of surfactant therapy for respiratory distress syndrome in 1990. The proportion of high risk preterm births increased in the period after the stepdown unit opened, and the respective CRIB scores indicated increasing severity of illness and instability at admission. Other surrogate markers of severity of illness and complications remained the same over the time periods reviewed, except for comparatively lower rates of birth asphyxia. The latter did not, however, emerge as a significant factor in the logistic regression model.

A major coincidental finding after the creation of the stepdown unit was the dramatic reduction of rates of overall nosocomial infections among infants admitted to the neonatal intensive care unit, which was possibly related to reduced congestion and relatively reduced handling of infants by multiple care providers. Similar findings have also been reported by Callaghan

Table 2 Comparison of morbidity patterns before and after opening of the stepdown unit. Values are numbers (%) of infants unless otherwise indicated

Morbidity	1987-94 (n=191)	1995-2001 (n=318)	Relative risk (95% CI)
Intraventricular haemorrhage (grade II-IV)	35 (18.3)	79 (24.8)	1.15 (0.99 to 1.33)
Culture proved neonatal sepsis	33 (17.3)	65 (20.4)	1.08 (0.92 to 1.26)
Apnoeic spells	42 (22.0)	62 (19.5)	0.94 (0.79 to 1.12)
Respiratory distress syndrome	120 (62.8)	184 (57.9)	0.93 (0.81 to 1.06)
Ventilated	101 (52.9)	148 (46.5)	0.91 (0.79 to 1.04)
Hyperbilirubinaemia	158 (82.7)	249 (78.3)	0.90 (0.77 to 1.06)
Patent ductus arteriosus	55 (28.8)	57 (17.9)	0.77 (0.64 to 0.94)
Necrotising enterocolitis	17 (8.9)	32 (10.1)	1.05 (0.85 to 1.30)

Table 3 Comparative clinical course and outcomes before and after opening of the stepdown unit. Data are means (SD) unless otherwise indicated

	1987-94 (n=191)	1995-2001 (n=318)	P value (t test)
No of days to oral feed tolerance	16.4 (15.4)	10.1 (14.5)	<0.001
No of days to temperature maintenance	22.3 (17.2)	6.3 (13.3)	<0.001
No of days spent in hospital	22.2 (21.7)	15.4 (15.7)	<0.001
Weight at discharge in g	1489.1 (210.5)	1286.4 (219.6)	<0.001
Gestational age at discharge in weeks	35.3 (2.8)	33.0 (3.3)	<0.001
No of deaths before discharge (%)	63 (33.0)	55 (17.3)	0.69 (0.56 to 0.85)*
No of deaths after discharge (%)	23 (12.0)	10 (3.1)	0.47 (0.28 to 0.79)*

*Relative risk (95% confidence interval).

Fig 4 Trends for rates of adverse outcomes at 12 months of age for surviving very low birthweight infants (n=308)

et al—namely, a higher risk of mortality in very low birthweight infants with increasing ratios of staff to infants.¹⁵ Although the mothers were counselled specifically on the importance of asepsis, we have no objective data on rates of handwashing practices over this period. Among the cohort itself, rates of culture proved neonatal sepsis and necrotising enterocolitis for the two time periods were comparable.

Implications and next steps

Preterm births are recognised as an important cause of neonatal mortality in developing countries.^{16 17} Although improved survival among such high risk infants by provision of neonatal intensive care has been reported,^{18 19} such care facilities are also often under high pressure for admissions. Others have provided data on using mothers to look after infants with a low birth weight²⁰ as well as on the potential benefit of home care and community nursing for larger infants,^{21 22} but these reports include few very low birthweight infants at high risk.

Our data provide encouraging information that mothers can be motivated and trained to look after very low birthweight infants in a specialised unit before discharge from hospital and to look after such infants weighing between 1000–1500 g at home in a satisfactory manner, with reasonably intact outcomes. Although we did not undertake formal neurodevelopmental assessment, the overall rate of adverse outcomes at 12 months among surviving babies with a very low birth weight is low and comparable to data from Malaysia,²³ Spain,²⁴ and South Africa.²⁵ We believe that our experience in Karachi and the concept of involving mothers in the care of some very low birthweight infants, especially those with a birth weight of 1000–1500 g, can be replicated in other settings in Pakistan and developing countries of comparable constraints on resources and staffing. In view of the rising costs of neonatal intensive care,²⁶ these findings may also be of relevance to developed countries.

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Contributors: ZAB conceived the idea of this intervention and was the director of neonatal services at the Aga Khan University

Medical Center from 1989 to 2003. He supervised the data collection, analysis, wrote the manuscript, and is the guarantor. IK and SS contributed to the clinical care of infants in the study and the manuscript review process. FR helped with data collection and analysis and staff nurse HA oversaw the staff training in the stepdown unit and contributed to the manuscript review.

Competing interests: None declared.

Ethical approval: Since the creation of the stepdown unit was not a formal “research” initiative, a specific clearance from the ethics review committee at Aga Khan University was not sought. A prospective system for data collection on all high risk admissions to the neonatal care unit was already in place since 1987, and the protocol for the analysis of outcomes of babies with a very low birth weight was approved by the Departmental Research committee. All parents provided written consent for the anonymised use of clinical information for research and audit purposes at admission.

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