# SURVIVAL OF LOW-BIRTH-WEIGHT INFANTS AT BARAGWANATH HOSPITAL — 1950 - 1996

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*Objectives.* To examine changes in survival rates among low-birth-weight (LBW) infants between the years 1950 and 1996.

*Methods.* Survival figures were analysed for LBW infants managed at Baragwanath Hospital, a tertiary care centre in Soweto, Johannesburg, over four periods spanning five decades.

*Results.* The overall mortality rates of LBW infants decreased markedly between the early 1950s and the period 1995/96. By the mid-1990s approximately four times the number of infants with birth weight less than 1 500 g were surviving compared with the early 1950s. The reduction in mortality rates occurred in all LBW groups during the first three decades. However, since 1981 infants who weighed less than 1 500 g at birth were the major contributors to the overall reduction in mortality. Between the years 1981/82 and 1995/96, survival increased significantly from 64% to 79% for infants with birth weight 1 000 - 1 499 g, and from 14% to 32% for those with birth weight less than 1 000 g. Since infants in the latter group were seldom offered mechanical ventilation or artificial surfactant, a large part of these increases in survival can be attributed to improvement in the general level of care.

*Conclusion.* There have been dramatic improvements in the survival of LBW infants over this time period at Baragwanath Hospital. Although newer interventions such as mechanical ventilation and artificial surfactant have played a significant role, improvement in care at primary and secondary levels has been of major importance.

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In 1950 a unit for premature babies was established at Baragwanath Hospital in Soweto, Johannesburg. Infants were admitted to an open ward heated by coal stoves. They were wrapped in blankets and nursed in wooden box-like cots as incubators were not available. Temperature control was facilitated by the use of electrically heated pads and oxygen was given when necessary. Kahn *et al.*[1] reported on the outcome of the first 1 000 consecutive admissions of premature infants, with results that compared favourably with those reported from Sorrento Hospital in Birmingham, England.

At that time there were approximately 5 000 deliveries annually, but this figure grew rapidly over the years. Progress in the care of premature infants at Baragwanath Hospital followed advances that occurred elsewhere and incubators, intravenous fluids, nasogastric feeding and broad-spectrum antibiotics were introduced. A new maternity hospital for Baragwanath Hospital was opened in 1974 with dedicated wards for neonates requiring special care. A neonatal intensive care unit (NICU) for the ventilation of newborn infants was established in 1979 with the addition of an adjacent high-care area where high-risk non-ventilated infants could be monitored more closely. By this time the number of annual deliveries at Baragwanath Hospital and the surrounding clinics was approaching 30 000, and infant mortality rates in Soweto had fallen substantially.[2]

During the 1980s the intensive care unit (NICU) expanded and had the capacity to ventilate 12 infants, while the high-care area could accommodate 25 - 30 high-risk infants. Artificial surfactant was introduced in 1992. However, owing to limited resources throughout this period, infants with a birth weight less than 1 000 g were rarely ventilated or treated with surfactant. Nevertheless, they were admitted to the high-care area and received all other forms of appropriate care.

In view of these fundamental changes in the management of premature infants and the introduction of new technologies over the past 50 years, the purpose of this study was to assess the change in mortality rates of low-birth-weight (LBW) babies (babies weighing < 2 500 g at birth) at Baragwanath Hospital over the past five decades.

## METHODS

Data for the early 1950s were reported by Kahn *et al.*[1] The collection of birth weight-related survival data over subsequent decades was suboptimal, largely because of the rapid increase in delivery numbers and a poor record-keeping system. A new system of record keeping was introduced in 1979. Although this manual data-collection system was time-consuming and labour intensive, it proved to be reliable and provided comprehensive statistics for the Baragwanath Hospital/Soweto Clinic perinatal service. Data for 1982 were presented by Rissik,[3] and unpublished data for 1981 were also available for this study. Unfortunately, this manual data-collection system was not maintained.

In 1989, a computerised neonatal database was set up using D Base III software (subsequently converted to D Base IV). The first full year of computerised data collection was 1990. Data for the years 1990/91 and 1995/96, the latter representing the post-surfactant era, were collated and compared with those from the earlier time periods.

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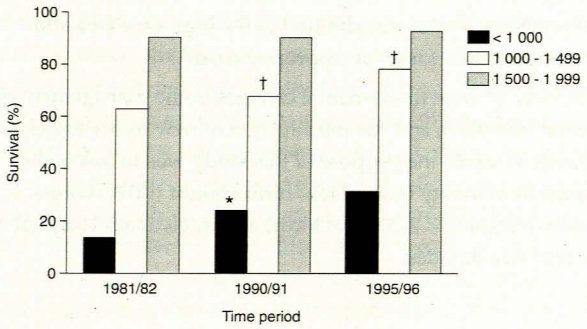
## RESULTS

The results reported by Kahn *et al.*[1] for the early 1950s used pounds and ounces as the measure of weight, and are shown in Table I. Survival for the subsequent time periods in 500 g birth weight categories are shown in Fig. 1.When comparing the survival figures during 1981/82 with those of Kahn *et al.*[1] (although the weight groups were not comparable owing to the use of pounds and ounces in the earlier study), there was clearly a marked improvement in survival of LBW infants at Baragwanath Hospital over the 30-year period. For example, the survival figure during the period 1981/82 for 1 000 - 1 499 g infants was similar to that of infants weighing 1 359 - 1 812 g (3 - 4 lbs) in the early 1950s.

**Table I. Survival of low-birth-weight infants at Baragwanath Hospital in the early 1950s[1]**

| Birth weight (g) (lbs) | Survival (%) |
|---|---|
| < 907 (< 2) | 2 |
| 907 - 1 360 (2 - 3) | 25 |
| 1 361 - 1 813 (3 - 4) | 62 |
| 1 814 - 2 267 (4 - 5) | 89 |



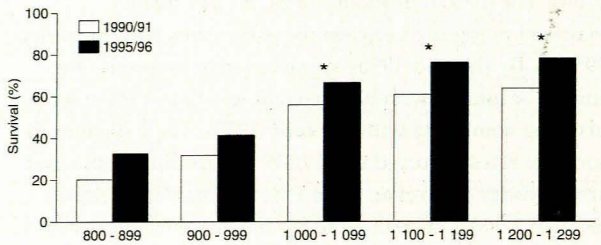

* $P = 0.027$ compared with previous time period.
† $P = < 0.01$ compared with previous time period.

*Fig. 1. Survival of low-birth-weight infants at Baragwanath Hospital over three time periods between 1981 and 1996 by birth weight category.*

Fig. 1 shows that there was a significant increase in survival for infants with birth weights of 1 000 - 1 499 g between each time period, while the increase in survival for those < 1 000 g was significant between 1981/82 and 1990/91, but just failed to reach significance for the periods between 1990/91 and 1995/96 ($P = 0.053$). This was in spite of the fact that infants with birth weights < 1 000 g were still seldom ventilated.

The data for 1981/82 did not divide the weight groups into narrower weight categories. However, with the availability of a computerised database from 1990, it was possible to analyse survival by 100 g weight categories. These are shown in Fig. 2 for infants with birth weights between 800 g and 1 300 g for the time periods 1990/91 and 1995/96. For each 100 g category between 800 g and 1 300 g, there was an increase in survival between the two time periods of 10 - 15%, although this difference was only statistically significant for the 100 g categories between 1 000 g and 1 300 g birth weight ($P < 0.05$ or lower). Survival for infants less than 800 g at birth remained poor, while there was no significant increase for those over 1 300 g whose survival rate was already over 80% by the early 1990s.

To illustrate the improvement in survival since the early 1950s, data for the period 1995/96 were compared with those originally reported by Kahn *et al.*[1] Since the original report was in pounds and ounces, the 1995/96 figures were analysed accordingly. The results are shown in Fig. 3.




* $P < 0.05$.

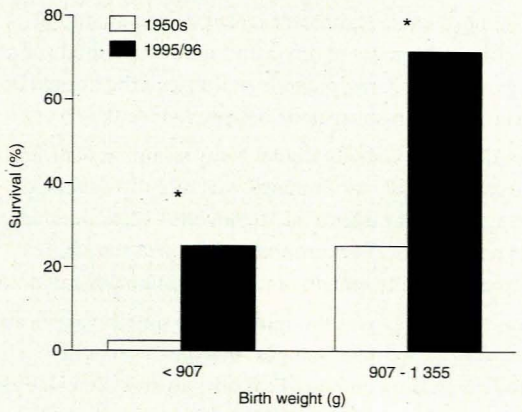
*Fig. 2. Comparison of the survival of infants with birth weight 800 - 1 300 g born during 1990/91 and those born during 1995/96.*

## DISCUSSION

There has been a dramatic improvement in the survival of LBW infants over the past five decades, demonstrated most clearly in Fig. 3. These changes can be attributed to a number of factors, including: (*i*) improved availability and use of antenatal services by high-risk pregnant women; (*ii*) advances in obstetric care; (*iii*) appropriate training of staff, especially medical and nursing; (*iv*) improvements in all levels of neonatal care, including intensive care; (*v*) progress in technology and equipment; and (*vi*) increased use of artificial surfactant and antenatal steroids.

The increased survival during the first three decades occurred across the weight spectrum of LBW infants and corresponded with improvements in the overall care and general management of these infants as incubators, better oxygen delivery, and fluid and nutritional support were introduced. Since 1981, however, significant improvements in survival have been confined to very-low-birth-weight (VLBW) infants, defined as those with birth weight less than 1 500 g.

The establishment of a NICU must certainly have had a direct effect in reducing the mortality of infants with birth weights between 1 000 g and 1 499 g. For example, during 1990 a total of 566 infants in this birth weight range were admitted to Baragwanath Hospital, of whom 241 were ventilated. Of the




* $P < 0.0001$.

*Fig. 3. Comparison of the survival of very-low-birth-weight infants born in the early 1950s with those born in 1995/96.*

infants ventilated, 103 survived; a small number of those not ventilated also died. Overall survival was 66% in this birth weight category. Owing to the strict admission criteria of the NICU, where only the sickest infants were admitted, it is probable that the majority of these NICU survivors would not have survived without mechanical ventilation, and therefore the overall mortality would have been at least 10% higher.

The more recent improvement in outcome can be attributed in part to the increased use of antenatal steroids and artificial surfactant. While the use of antenatal steroids remained low before the 1990s, this practice has increased greatly during the 1990s (Dr E Buchman — personal communication). The impact of artificial surfactant was not systematically studied at Baragwanath Hospital, but most randomised controlled studies overseas showed an improvement in survival in those infants who were treated with surfactant.[4,5] Although artificial surfactant was used far less liberally in the public sector hospitals in South Africa than was the case in developed countries,[6] it is probable that its use contributed to the improved survival of VLBW infants. It is noteworthy that the greatest improvement in survival between the years 1991/92 and 1995/96 was noted in infants with a birth weight between 1 000 g and 1 300 g, and based on a previous study done at Baragwanath Hospital,[7] it was in this group that surfactant would be expected to be most beneficial.

The improvement in survival of infants < 1 000 g at birth could not be explained, either by the introduction of a NICU or the use of artificial surfactant for the reasons previously outlined. However, such infants were routinely admitted to the high-care area where they received the benefits of all other modalities of care. This demonstrates how improvement in survival of extremely premature infants can be achieved even in the absence of mechanical ventilation and expensive medication.

An ongoing concern in the neonatal literature has been whether improvements in the survival of VLBW infants result in increased handicap rates. However, literature reviews indicate that the rates of handicap in surviving VLBW infants have remained largely unchanged.[8,9] A long-term follow-up study[10] on surviving VLBW infants from Baragwanath Hospital was also reassuring in this regard, since the rate of cerebral palsy and overall handicap was similar to that from developed countries. Furthermore, this study[10] confirmed that the long-term outcome of VLBW infants who did not require mechanical ventilation was particularly good, with such survivors rarely having any significant physical or neurological impairments.

In conclusion, the dramatic improvement in survival of LBW infants at Baragwanath Hospital since the early 1950s demonstrates the enormous progress that has been made in the care of such infants over this time. Even in the relatively short period of 15 years between 1981 and 1996, the improvement in survival has been impressive and can be expected to continue. As with most areas of progress in medical science, it is seldom one particular factor, such as the introduction of mechanical ventilation or the use of artificial surfactant, that is solely responsible for overall improvements in outcomes. Improvements in the care of mothers during the antenatal and perinatal periods and the general supportive care of LBW infants at all levels in the neonatal wards were fundamental to these improvements in outcome. In countries with limited resources such as South Africa, good outcomes can be obtained for LBW infants, and even where facilities for intensive care are not available, substantial improvements in survival, with low rates of morbidity, are possible.

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