

Changing Survival Rate of Infants Born Before 26 Gestational Weeks

Single-centre study

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تغير معدل البقاء للرضع المواليد قبل الأسبوع 26 من الحمل

دراسة مركز واحد

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ABSTRACT: Objectives: This study aimed to evaluate the changing survival rate and morbidities among infants born before 26 gestational weeks at the Sultan Qaboos University Hospital (SQUH) in Muscat, Oman. **Methods:** This retrospective study assessed the mortality and morbidities of all premature infants born alive at 23–26 gestational weeks at SQUH between June 2006 and May 2013. Infants referred to SQUH within 72 hours of birth during this period were also included. Electronic records were reviewed for gestational age, gender, birth weight, maternal age, mode and place of delivery, antenatal steroid administration, morbidity and outcome. The survival rate was calculated and findings were then compared with those of a previous study conducted in the same hospital from 1991 to 1998. Rates of major morbidities were also calculated. **Results:** A total of 81 infants between 23–26 gestational weeks were admitted to the neonatal unit during the study period. Of these, 58.0% were male and 42.0% were female. Median gestational age was 25 weeks and mean birth weight was 770 ± 150 g. Of the 81 infants, 49 survived. The overall survival rate was 60.5% compared to 41% reported in the previous study. Respiratory distress syndrome (100.0%), retinopathy of prematurity (51.9%), bronchopulmonary dysplasia (34.6%), intraventricular haemorrhage (30.9%) and patent *ductus arteriosus* (28.4%) were the most common morbidities. **Conclusion:** The overall survival rate of infants between 23–26 gestational weeks during the study period had significantly improved in comparison to that found at the same hospital from 1991 to 1998. There is a need for the long-term neurodevelopmental follow-up of premature infants.

Keywords: Extremely Premature Infants; Neonates; Survival Rate; Morbidity; Oman.

المخلص: الهدف: تهدف هذه الدراسة إلى تقييم التغيير في معدل البقاء والمرض في الرضع المواليد قبل الأسبوع 26 من الحمل في مستشفى جامعة السلطان قابوس بمسقط، سلطنة عمان. **الطريقة:** قيمت هذه الدراسة الاستيعادية معدل الوفيات والمرض لجميع المواليد الخدج الأحياء في الأسابيع 23–26 للحمل من يونيو 2006 إلى مايو 2013. المواليد المحولون لمستشفى جامعة السلطان قابوس خلال 72 ساعة من الولادة في نفس الفترة تم أيضا إدراجهم في الدراسة. الملفات الإلكترونية تمت مراجعتها وشملت عمر الحمل، الجنس، الوزن عند الولادة، عمر الأمومة، طريقة ومكان الولادة، إعطاء الستيرويد أثناء الحمل، المرضة والنتائج. تم حساب معدل البقاء ومقارنة النتائج مع نتائج دراسة سابقة بالمستشفى من 1991 إلى 1998. تم أيضا حساب معدلات الوفيات الرئيسية. **النتائج:** مجموع 81 رضيعا من 23–26 أسبوع حمل تم إدخالهم إلى وحدة المواليد خلال فترة الدراسة. منهم 58.0% ذكورا و 42.0% إناثا. متوسط عمر الحمل كان 25 أسبوعا و متوسط الوزن عند الولادة كان 770 ± 150 جم. من أصل 81 رضيعا، 49 بقوا على قيد الحياة. معدل البقاء الكلي كان 60.5% مقارنة بـ 41% في دراسة سابقة. كان أكثر الأمراض شيوعا متلازمة الضائقة التنفسية (100%)، اعتلال الشبكية للخدج (51.9%)، خلل التنسج القصي الرئوي (34.6%)، نزف داخل البطين (30.9%)، القناة الشريانية السالكة (28.4%). **الخلاصة:** إجمالي معدل البقاء لمواليد 23–26 أسبوع حمل خلال فترة الدراسة تحسنت بشكل ملحوظ مقارنة مع النتائج المتوفرة من نفس المستشفى من 1991 إلى 1998. هناك حاجة لمتابعة طويلة المدى للنمو العصبي في المواليد الخدج.

مفتاح الكلمات: الرضع شديد الخدج؛ المواليد؛ معدل البقاء؛ المرضة؛ عمان.

ADVANCES IN KNOWLEDGE

- The survival rate of extremely premature infants in a tertiary care centre in Oman was calculated over a seven-year period.
- Improvement in the overall survival rate of premature infants, potentially due to advances in neonatal care, was noted in comparison to a similar study at the same hospital conducted a decade previously.
- Common short-term complications arising among infants admitted to a neonatal intensive care unit are illustrated.

APPLICATION TO PATIENT CARE

- Knowledge of survival rates can advise patient care decision-making and determine whether active resuscitation and management of infants with extremely low birth weight is justified.
- The results of this study may aid in the establishment of guidelines for the care of infants born at the limits of viability.

THE SURVIVAL OF EXTREMELY PREMATURE infants has improved significantly over the last several decades.^{1–5} The reasons for this improvement are multifactorial—technological advances, use of antenatal steroids, surfactant therapy, improvement in neonatal resuscitation and standard antenatal and postnatal care are major contributing factors. The survival rate of extremely premature infants is much higher in developed countries than in developing countries.^{6–8} However, there is limited information about the survival and long-term outcome of extremely preterm infants in Oman.^{9–11}

Survival and short- and long-term morbidity rates are needed to determine if active perinatal management is rational for preterm infants born at or before 26 gestational weeks.³ The limits of viability and the gestational age at which a neonate can be resuscitated and supported are still a challenge in the Eastern Mediterranean region. Given the limited resources and infrastructure for supporting disabled children, it is very important to know the outcomes of extremely preterm infants in Oman. Sultan Qaboos University Hospital (SQUH) in Muscat, Oman, is a tertiary care centre with an obstetrics unit which accepts high-risk delivery cases from other health institutes in the country. The newborn service operates as a referral neonatal intensive care unit (NICU). A previous study from SQUH indicated much lower survival rates of extremely preterm infants born between 1991 to 1998 compared with other reports from developed countries.⁹

The aim of this study was to determine and evaluate the survival rate and morbidities of preterm infants at 23–26 gestational weeks at SQUH. These were then compared with the results of the study conducted in the same unit approximately a decade previously to ascertain the change in survival rate.⁹ Additionally, survival rates and common morbidities among the infants from the current study were compared with international data.^{12,13}

Methods

All premature infants born between 23–26 gestational weeks and admitted to the NICU at SQUH between June 2006 and May 2013 were included in the study. Infants referred to SQUH 72 hours or later after birth were excluded. Data were collected retrospectively from hospital electronic records, including maternal data, mode and place of delivery, antenatal complications, course of treatment during NICU stay and patient outcome (discharge or death). Standard definitions from the literature were used to define

chorioamnionitis, morbidities and complications.^{14–17} Gestational age was determined from early ultrasound scans or calculated from the date of the last maternal menstrual period.

Data were analysed using the Statistical Package for the Social Sciences (SPSS), Version 20 (IBM Corp., Chicago, Illinois, USA). Descriptive statistics and the incidence of neonatal mortality during the study period and among each gestational age group were calculated. For categorical variables, frequencies and percentages were reported. For numerical variables, the mean \pm standard deviation or median and ranges were reported according to a normal distribution. A comparison of categorical data was performed using Chi-squared or Fisher's exact tests as appropriate. Numerical variables were compared using the Student's t-test for continuous data and the Mann-Whitney U test for non-continuous data. An *a priori* two-tailed value (*P* value) of ≤ 0.05 was considered significant.

Ethical approval for this study was obtained from the Medical Research & Ethics Committee of the College of Medicine & Health Sciences at Sultan Qaboos University (MREC#898).

Table 1: Maternal demographic characteristics, complications and mode of delivery of infants born before 26 gestational weeks (N = 81)

Characteristic	n (%)
Demographic variables	
Age in years, mean \pm SD	27 \pm 5
Gravidity, median (IQR)	2 (1–3)
Parity, median (IQR)	0 (0–2)
Admission	36 (44.4)
Steroid administration	43 (53.1)
Complication	
Hypertension	1 (1.2)
Diabetes mellitus	5 (6.2)
Cervical cerclage	7 (8.6)
Antepartum haemorrhage	18 (22.2)
<i>Abruptio</i> placenta	10 (12.3)
Ruptured membrane >18 hours	21 (25.9)
Chorioamnionitis	8 (9.9)
Mode of delivery	
Vaginal	55 (67.9)
Caesarean section	26 (32.1)

SD = standard deviation; *IQR* = interquartile range.

Table 2: Demographic characteristics of infants born before 26 gestational weeks (N = 81)

Characteristic	
Birth weight in g, mean ± SD	770 ± 150
Gestational age in weeks, median (range)	25 (23–26)
Male, n (%)	47 (58.0)
Female, n (%)	34 (42.0)
Apgar score at 1 minute, mean ± SD	4 ± 2
Apgar score at 5 minutes, mean ± SD	7 ± 2

SD = standard deviation.

Table 3: Morbidities of infants born before 26 gestational weeks (N = 81)

Morbidity or treatment	n (%)
Respiratory distress syndrome	81 (100.0)
Surfactant therapy	
One dose	37 (45.7)
Two or more doses	39 (48.1)
Patent ductus arteriosus	23 (28.4)
Intraventricular haemorrhage	
Grade I	7 (8.6)
Grade II	5 (6.2)
Grade III	4 (4.9)
Grade IV	9 (11.1)
Pneumothorax	3 (3.7)
Pulmonary haemorrhage	7 (8.6)
Bronchopulmonary dysplasia	
Moderate	17 (21.0)
Severe	11 (13.6)
Retinopathy of prematurity	
Any stage	42 (51.9)
Stage 3	4 (4.9)
Necrotising enterocolitis	10 (12.3)

Results

Between June 2006 and May 2013, a total of 81 extremely preterm infants were admitted to the NICU at SQUH. Only 44% of mothers were admitted to SQUH and received antenatal follow-up. A total of 14 mothers (17.3%) received one dose of antenatal steroids, 29 (35.8%) received two doses of antenatal steroids, 21 (25.9%) had prolonged rupture of the membranes (>18 hours) and eight (9.9%) had chorioamnionitis [Table 1]. Table 2 shows the demographic characteristics of

Table 4: Comparison of demographic and clinical characteristics of infants born before 26 gestational weeks by patient outcome (N = 81)

Characteristic	Outcome, n (%)		P value
	Died (n = 32)	Survived (n = 49)	
Admission	11 (34.4)	25 (51.0)	0.119
Received antenatal steroids	10 (31.3)	33 (67.3)	0.001
Born outside the delivery room	5 (15.6)	1 (2.0)	0.016
Antepartum haemorrhage	5 (15.6)	13 (26.5)	0.229
Ruptured membrane >18 hours	20 (62.5)	11 (22.4)	0.331
Chorioamnionitis	5 (15.6)	3 (6.4)	0.256
Caesarean section	6 (18.8)	20 (40.8)	0.071
Birth weight in g, mean ± SD	710 ± 160	810 ± 85	0.002
Gestation age in weeks, mean (range)	24 (23–26)	25 (23–26)	<0.001
Male	18 (56.3)	29 (59.2)	0.794
Female	14 (43.8)	20 (40.8)	-
Apgar score at 1 minute, mean ± SD	3 ± 2	4.5 ± 2	0.014
Apgar at 5 minutes, mean ± SD	6 ± 2.5	7 ± 2	0.029
Received two or more doses of surfactant therapy	15 (46.9)	26 (53.1)	0.586

SD = standard deviation.

preterm infants admitted to the NICU during the study period. Out of the 81 neonates, 47 were male (58.0%) and 34 were female (42.0%). The median gestational age was 25 weeks and the mean birth weight was 770 g.

The infants were assessed for common morbidities [Table 3]. All of the infants were diagnosed with respiratory distress syndrome on the basis of clinical and radiological findings. A total of 37 infants (45.7%) received one dose of surfactant and 39 (48.1%) received two doses or more; five (6.2%) did not receive surfactant treatment. A total of 62 infants (76.5%) were screened for intraventricular haemorrhage (IVH) using cranial ultrasonography. Of these, 25 developed various degrees of IVH (seven neonates with grade I, five with grade II, four with grade III and nine with grade IV). A total of 10 infants (12.3%) developed necrotising enterocolitis while 17 (21.0%) and 11 (13.6%) infants developed moderate and severe

Table 5: Comparison of survival rates of preterm infants in Oman and the USA

Author and year of study	Location	Study period	Gestational age							
			23 weeks		24 weeks		25 weeks		26 weeks	
			n	Survived, n (%)	n	Survived, n (%)	n	Survived, n (%)	n	Survived, n (%)
Stoll <i>et al.</i> ⁵ 2010	NICHHD centres, USA	2003–2007	871	226 (25.9)	1,370	748 (54.6)	1,498	1,078 (72.0)	1,576	1,319 (83.7)
Manzar ⁹ 2000	SQUH, Muscat, Oman	1991–1998	2	0 (0.0)	4	1 (25.0)	1	1 (100.0)	25	11 (44.0)
Current study	SQUH, Muscat, Oman	2006–2013	8	1 (12.5)	15	5 (33.3)	29	21 (72.4)	29	22 (75.9)

NICHHD = Eunice Kennedy Shriver National Institute of Child Health & Human Development Neonatal Research Network; SQUH = Sultan Qaboos University Hospital.

bronchopulmonary dysplasia, respectively.

A total of 49 infants survived (survival rate: 60.5%). The demographic and clinical characteristics of preterm infants who survived were compared with those who died during the NICU stay [Table 4]. Among the fatality group, fewer infants received antenatal steroids (31.3% versus 67.3%; $P = 0.001$) and the mean birth weight was significantly lower (710 versus 810 g; $P = 0.002$) compared with the survivors. Gestational age was also lower in comparison with those who survived (24 versus 25 weeks; $P < 0.001$). Apgar scores were significantly higher in the group that survived, both at one and five minutes ($P = 0.014$ and 0.029 , respectively). Although pneumothorax and IVH occurred more frequently in the group of preterm infants who died, these differences were not significant.

Out of eight infants born at 23 gestational weeks, only one survived. Survival rates among the cohort at 24, 25 and 26 gestational weeks were 33.3%, 72.4% and 75.9%, respectively. These rates were compared with those from a multi-centre study performed

by the Eunice Kennedy Shriver National Institute of Child Health & Human Development Neonatal Research Network (NICHD) in the USA as well as those reported in a previous study from SQUH [Table 5].^{5,9} There were more hospital admissions of infants born <26 gestational weeks between 2006–2013 ($n = 81$) in comparison to 1991–1998 ($n = 32$).⁹ The overall survival rate for the present cohort had increased to 60.5% from 41%, the rate observed a decade previously at the same institution.⁹ There was an improving survival trend for infants of 24 and 26 gestational weeks. In the current study, survival rates for infants at 25 and 26 gestational weeks (72.4% and 75.9%, respectively) were comparable to those observed in the USA study (72.0% and 83.7%, respectively); however, decreased survival was noticed at 24 gestational weeks for the Omani infants at SQUH (33.3% versus 54.6%).⁵ Overall, survival rates increased with gestational age in both the comparative studies and present research.^{5,9}

Common short-term morbidities among the

Table 6: Comparison of morbidities of preterm infants in Oman with very low birth weight infants in the USA and Saudi Arabia

Author and year of study	Location	Study period	Morbidity or treatment, %					
			Mean birth weight in g	Antenatal steroids	Bronchopulmonary dysplasia	Severe IVH	Necrotising enterocolitis	PDA
Al Hazzani <i>et al.</i> ¹² 2011	KFSH, Riyadh, Saudi Arabia	2006–2008	1,062	74.2	17.7	8.1	7.5	31.2
Fanaroff <i>et al.</i> ¹³ 2007	NICHHD centres, USA	1990–2002	1,033	79.0	22.0	10.0	7.0	29.0
Current study	SQUH, Muscat, Oman	2006–2013	770	53.0	34.6	14.0	12.0	28.0

IVH = intraventricular haemorrhage; PDA = patent ductus arteriosus; KFSH = King Faisal Specialist Hospital; NICHD = Eunice Kennedy Shriver National Institute of Child Health & Human Development Neonatal Research Network; SQUH = Sultan Qaboos University Hospital.

current preterm cohort were compared with data from American and Saudi Arabian cohorts of very low birthweight infants between 21 and 36 gestational weeks [Table 6].^{12,13} Incidences of bronchopulmonary dysplasia, severe IVH, necrotising enterocolitis and patent ductus arteriosus were comparable between the present study and the two international cohorts.

Discussion

The survival of extremely preterm infants has significantly improved over last two decades due to improvements in perinatal and neonatal care.¹⁻⁵ Very limited local data are available on the perinatal and neonatal mortality and morbidity rates of extremely preterm infants in Oman.⁹⁻¹¹ Additionally, there is a lack of data from the Middle East regarding common short-term complications and morbidities of infants born <28 gestational weeks.^{10-12,18-21}

The findings of this study indicated a significant increase in the number of admissions of infants born at <26 gestational weeks in comparison to a previous study conducted at the same institution.⁹ Furthermore, the survival rate of preterm infants observed in the current study was comparable with those of extremely preterm infants from multi-centre studies in the USA and Switzerland and very low birth weight infants from another multi-centre study in the USA.⁵⁻⁷

Significant improvement was observed in the survival rate of preterm infants in Oman compared to hospital data from the 1990s.⁹ This may be due to specific institutional improvements in antenatal and postnatal care, staff training and subspecialty support as well as the modernisation of equipment and the implementation of standard international guidelines for the management of extremely premature infants.

One of the limitations of this study was that infants born between 22–24 gestational weeks who were not admitted to the NICU were not included in the sample. This is because it was difficult to retrieve these records retrospectively. However, all infants born at 25 and 26 gestational weeks were admitted to the NICU during the study period according to admission protocol. The exclusion of non-admitted infants between 22–24 gestational weeks may have resulted in a falsely low mortality rate in this cohort. Furthermore, this was a retrospective single-centre study with a small sample size; thus, the results cannot be generalised to all extremely preterm infants in Oman. The results of the current study provided information regarding mortality and the most severe short-term morbidities only. Long-term outcomes—including formal neurodevelopment follow-up data—for the survivors were

lacking. Although major developmental delays are assessed in neonatal follow-up clinics, more resources are needed to ensure thorough follow-up of extremely preterm infants and thus assess the overall survival rate of this patient group.

Conclusion

The overall survival rate of extremely premature infants admitted to the NICU at SQUH improved significantly from a previous study at the same institution, suggesting an improvement in care. This study emphasises the need for long-term neurodevelopmental follow-up of this patient group in order to reveal the true clinical situation concerning preterm survival.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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