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Term Neonates admissions to neonatal intensive care unit: Retrospective study

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Abstract
Background: An increasing number of term infants of appropriate birth weight receive care in neonatal intensive care units (NICUs).
Objectives: This study assessed the prevalence, patterns, and risk factors for admission of term infants to a NICU to identify areas for quality improvement.
Design: Retrospective study.
Patients and Methods: The cases were all term infants (≥ 37 weeks gestational age) admitted to the AJIMS NICU between 1st May 2021 to 30th April 2022, were retrospectively examined from the medical records. Neonates with major congenital anomalies, diagnosed with genetic syndromes, or referred to another hospital for any reason were excluded from the study.
Main Outcome Measures: Prevalence, pattern, and risk factors for admission of term infants to the NICU.
Results: The term infants born in these one year, 12.8% (101) were admitted to NICU. Commonest reason for admission was Respiratory distress syndrome (37%). Others reasons are non-bilious vomiting (20%), congenital anomalies [Surgical conditions and Congenital heart disease] (13%) Hyperbilirubinaemia (8%), Infections (sepsis, pneumonia, meningitis), (4%).
Conclusion: A growing number of term infants are admitted unexpectedly to the NICU. Respiratory distress syndrome and hyperbilirubinaemia and low birth weight being most common causes for NICU admission.

Keywords: NICU, term infants, respiratory distress syndrome, hyperbilirubinaemia, threatened abortion

Introduction

Neonatal intensive care units (NICUs) provide life support to newborns; however, admission to an NICU entails risks for both families and their admitted infants, including high costs [1, 2]. Admission to the NICU interrupts the mother-infant bonding and establishment of breastfeeding [3-5]. In an epidemiologic time trend-analysis in of 38 units in the United States between 2007 and 2012, the overall admission rate increased by 23% after adjusting for maternal and neonatal characteristics [6]. In the same cohort, the admitted neonates were increasingly likely to be full-term and of appropriate weight for gestational age. Similarly, older audits undertaken in the United Kingdom [7] and Ireland [8] have shown that the admission of full-term neonates with ≥2500 gram (g) birth weight is not an infrequent event.

The neonatal period is one when the baby endeavors to adapt to extra uterine life, and when marked physiological changes occur. A significant proportion of deaths in the first year of life are observed during this time when the baby is most defenseless [9]. The fact that three out of four deaths in the neonatal period occur in the first week of life heightens the importance of the care provided for the baby [10]. Infant death rates are one of the criteria used to determine countries level of development and also reflect the accessibility and effectiveness of health services. The risk factors associated with increased odds of admission of term infants to the NICU include the operative method of birth, [11] elective delivery before 39 weeks either vaginally or by cesarean section, [12] maternal diabetes and hypertension, ethnicity, age, and socioeconomic status [13].

The early identification of risk factors, with ensuing synchronized interventions, may contribute to modifying the effects associated with the admission of term infants to the NICU. In the face of national and international neonatal bed crises, we believe that it is crucial to evaluate this. Our objective was to ascertain the prevalence, describe the pattern, and examine the risk factors for the admission of term infants to the NICU at A J Institute of Medical Sciences Hospital between

1st May 2021 to 30th April 2022, were retrospectively examined 1 year medical records in order to identify central areas to focus on for quality improvement strategies.

Materials and Methods

A retrospective chart review was performed to determine the prevalence and pattern of the admission of full-term neonates to the NICU. The NICU at AJIMS Hospital contains 20 beds and is a level III unit and referral center in Dakshina Kannada, Karnataka, with approximately 160 admissions per year.

All term infants (≥ 37 weeks gestation age) admitted to the NICU at AJIMS Hospital between 1st May 2021 to 30th April 2022 were eligible for inclusion. The gestational age was determined according to the first day of last menstrual period if known or/and first trimester ultrasound [31]. There were no exclusion criteria for participation in this study. The admission book of the NICU and the nursery's admission records were reviewed to determine the admission rate. The hospital records of the admitted and non-admitted infants were reviewed to determine the reasons for admission and the risk factors associated with an increased odds of admission. The collected data included maternal age, nationality, parity, history of diabetes or hypertension, premature rupture of membrane (PROM) before 37 weeks of gestation, mode of delivery, and whether the delivery was spontaneous or elective. We also collected information from maternal charts about any associated pregnancy complications or fetal anomalies for which postnatal admission to the NICU was expected. Unbooked mothers were those who did not attend the prenatal clinic in the hospital or any other healthcare facility. The reasons for admission were determined from the admission notes in the infants' charts. Small for gestational age was defined as infants below the 10th centile for birth weight [13]. Respiratory distress requiring admission to the NICU was defined by signs of labored breathing that required respiratory support using oxygen or non-invasive or invasive ventilation. Hypoglycemia was defined as blood glucose less than 2.6 mmol/L measured after two hours of life that did not improve with feeding and which required intravenous glucose infusion [14]. Hypoxic-ischemic encephalopathy was defined according to the American Academy of Pediatrics and American College of Obstetrics and Gynecology criteria that mandate the use of hypothermia for management [15, 16]. Perinatal depression was defined as the need for resuscitation beyond gentle stimulation, but did not fulfill the criteria for the diagnosis of hypoxic-ischemic encephalopathy.

The prevalence of admission was calculated by dividing the number of term live births admitted to the NICU during the year assigned for data collection by the total number of term live births born in that year in AJIMS Hospital. Fisher's exact test, Chi-square test, and unpaired *t* test were used to determine statistically significant associations between the collected factors and admission to NICU. P values < 0.05 were considered statistically significant.

Results

A total of 1281 births were recorded during the selected 1 year. Of these, 920 were term infants. 101(10.9%) of these term births were admitted to NICU. Of the 101 term admissions, 60 (59.4%) were male and 41 (40.6%) were female. The mean gestational age was 39 weeks (95% CI 38.815, 39.284) and mean birth weight was 3.3kg (95% CI 3.196, 3.403). Mean length of stay was 8.8 days (95% CI 7.603, 10.060). Mean maternal age was 29.5 years (95% CI 28.488, 30.502). 8 mothers (7.9%) were Rhesus negative. 60 (59.4%) were primiparous, 35 (34.7%) were multiparous, and 6 (5.9%) had an unknown parity.

Labour onset was spontaneous in 44 mothers (43.6%), induced in 21 (20.8%), via Caesarean section in 30 (29.7%), and unrecorded in 6 mothers (5.9%). More than half of these term neonates had been born by elective and emergency Caesarean section (*n* = 26, 25.7% and *n* =27, 26.7% respectively). The rest were born via normal vaginal delivery (*n* = 41, 41.6%) and by ventouse-assisted vaginal delivery (*n* = 7, 6.9%). 92 neonates (91.1%) were born in the cephalic presentation, 6 (5.9%) in the breech presentation, and in 3 (3.0%) presentation was unknown. 28 neonates (27.7%) were transferred from the Central Delivery Suite, while 19 (18.8%) were transferred from the obstetric wards. Source of transfer was unrecorded for the other 54 neonates (53.5%).

The various reasons for admission are shown as a percentage of the total term admissions in Figure 1.

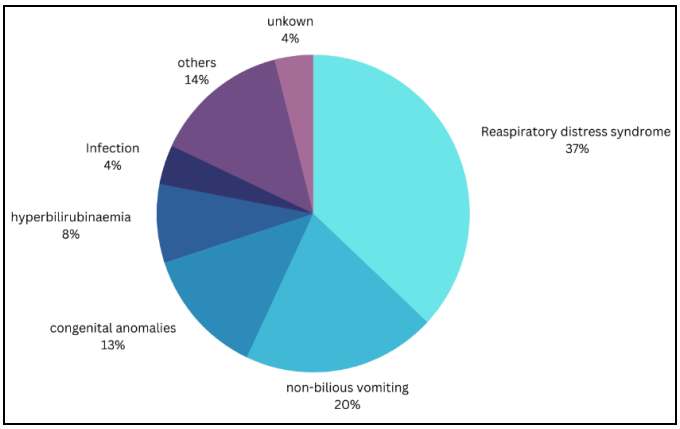

Fig 1: Reason for admission to NICU

The 'Other' category comprised reasons such, bradycardia, hypotonia, and hypoglycaemia.

Statistically significant factors associated with admission of term infants to NICU are shown in Table 1. Table 2 shows the factors for which no significant association with admission to NICU was found.

Table 1: Statistically significant factors associated with NICU admission

Contributing factor	P-Value	Odds Ratio	95% CI
Operative delivery	< 0.001	2.865	1.904, 4.313
Threatened abortion	0.014	2.621	1.266, 5.424
Maternal infection	0.042	1.943	1.034, 3.652
Maternal IDDM*	0.035	9.242	1.672, 51.091
Low Apgar at 1 minute*	< 0.001	7.100	4.137, 12.187
Low Apgar at 5 minutes*	< 0.001	15.429	5.620, 42.359

Table 2: Non-statistically significant factors potentially contributing to admission

Contributing factor	P-Value	Odds Ratio	95% CI
Maternal cardiovascular disease	1.000	1.059	0.061, 18.481
ART	0.118	2.208	0.924, 5.275
Gestational hypertension	0.339	1.478	0.666, 3.280
Pre-eclampsia	0.313	3.047	0.363, 25.562
Gestational diabetes	0.254	1.624	0.636, 4.145
Suspected IUGR	0.767	0.630	0.152, 2.618
Twin delivery	0.489	1.373	0.417, 4.518
Antepartum haemorrhage	1.000	1.200	0.068, 21.178
Threatened labour	1.000	0.781	0.046, 13.358

Discussion

In the present study, the prevalence of admission of term infants to the NICU was 10.9%, less than that reported in other units [11, 17-20]. Admission of term or normal birth weight infants can be considered as low risk; however, several studies have reported the opposite [6, 18]. In a population-based study of infants born to residents of 38 US states, approximately half of all NICU admissions were for infants born ≥ 37 weeks of gestational age and/or of normal weight even after adjusting for confounders [6].

Using a 2-sample z-test, the local rate of term admissions to intensive care of 42.6% for the 6 month period studied was found to be lower than the rates for England in 2011, 2012, and 2013 (56.6%, 58.3%, and 59.8% respectively, $p < 0.001$).10 However, since the Maltese unit is both a neonatal and pediatric intensive care unit, catering for children up to three years of age, this rate of 42.6%, though reflecting the local burden on the unit, cannot be used to compare with rates in the UK which take into account only admissions to a neonatal unit. Indeed the rate of 55.2% which represents the term admissions as a percentage of only neonatal admissions is comparable to the rates in England between 2011 and 2013 ($p = 0.705$, $p = 0.397$, $p = 0.203$ respectively). It is also important to point out that in Malta, when compared to the UK, access to a neonatal unit might relatively be easier, there being only one general hospital and one unit in the same hospital catering for the whole population.

The commonest reason for admission in the studied 12 months period was respiratory distress, accounting for 37.6% of admissions. Respiratory distress was also the commonest reason for admission of term infants in the UK with 25% of admissions having this listed as their main reason for admission.6 A quarter of these respiratory distress admissions in both Malta and the UK had been delivered by elective Caesarean section.6 The risk of respiratory morbidity is known to be increased in babies born by Caesarean section before labour, but this risk is decreased if elective Caesarean section is performed after 39 weeks.11 Thus NICE guidance recommends that elective Caesarean section is not performed prior to 39 weeks.12

Admission due to non-bilious vomiting was also another important reason for admission locally, at 19.8% of all term admissions. Non-bilious vomiting may indicate a primarily feeding problem, ranging from normal variation to overfeeding, to gastro-oesophageal reflux disease. Further evaluation of such admissions to determine what management was required would be necessary to properly classify the reason for admission.

The 12.9% admitted due to congenital anomalies can be said to be expected admissions to intensive care. There was no data regarding the severity and type of congenital anomaly, and whether this had been diagnosed antenatally and if admission had been planned beforehand.

Admissions for hyperbilirubinaemia accounted for 7.9% of term admission to the intensive care unit. Other term neonates with hyperbilirubinaemia would have been admitted to the general pediatric wards if less aggressive management was deemed necessary. This is an example of where a transitional care model can be applied. Admission for the indicated medical care may be necessary and unavoidable. However certain services may be provided outside the neonatal unit in a transitional care model where the mother is resident with her child and plays a role in providing care.6 Transitional care, apart from providing an alternative setting for admission, may also lead to earlier discharge from the intensive care unit, acting as a bridge prior to definite discharge home.

4% of admissions were reported to be due to infection. However, other commoner reasons for admission, such as respiratory distress or non-bilious vomiting, could have very well been the first sign of sepsis, and thus this could be an under-estimation. Classifying admissions according to diagnosis on discharge may be more indicative of the true reason why the neonate needed admission to the unit. On the other hand using the recorded reason on admission demonstrates which presenting symptoms are causing term neonates to be admitted in the first place.

Threatened miscarriage during pregnancy, presenting mostly as vaginal bleeding during pregnancy, was also found to be significantly associated with admission to NICU. This has also been demonstrated in studies elsewhere [13, 14]. The category maternal infection during pregnancy in our study included hepatitis C positive mothers, vaginal infections, urinary tract infections, and vulvar warts. However in our study, the 2 mothers that were hepatitis C positive were ex-intravenous drug users on methadone and their babies were admitted to NICU due to neonatal abstinence syndrome rather than due to signs of sepsis. Type 1 diabetes in mothers was also found to be associated with admission to neonatal intensive care. Infants of diabetic mothers can be macrocosmic or small for gestational age, are at an increased risk of neonatal hypoglycaemia, polycythaemia, respiratory distress syndrome, and congenital anomalies. Interestingly however, no significance was found for association between non-insulin dependent diabetes or gestational diabetes and admission to NICU. Since pregnancy is itself diabetogenic, it may be an additional challenge for glucose control in insulin dependent diabetics as insulin requirements will change.

Low Apgar scores indicate inappropriate adaption to extra-uterine life, and thus admission to NICU may be said to be expected in such cases. A low Apgar score may therefore alert the clinician to a possibly at risk neonate. With regards to the other possible contributing factors assessed, significance may have not been achieved due to the small numbers used in the study. No cases of eclampsia in either the cases or controls were reported and this could be due to both the study's small sample size as well as its short time-frame. Other limitations include incomplete medical record-keeping in the patient registers from which the raw data was collected, and confounding variables which might not have been taken into account. Such limitations lead to the recall bias commonly attributed to retrospective studies as well as the inability to predict whether admission of term infants to NICU was in fact preceded by exposure to a risk factor. The first step in overcoming these limitations is the introduction of an electronic database in order to ensure standardization of accurate and timely data compilation.

In order to be able to put all this into practice a targeted working group, made up of a multidisciplinary team involving obstetricians, midwives, neonatal nurses, neonatologists, and pediatricians, is being suggested. Such a working group could review admissions case by case and thus determine what care was provided, what the diagnosis at discharge was, whether admission was justified in retrospect, and whether an alternative setting of admission could have been possible, amongst other aspects. Such an evaluation over a longer time frame may guide the setting up of specific local guidelines (such as guidelines on criteria for admission to NICU) and the implementation of practical strategies to improve neonatal care.

This study has identified a considerable number of term admissions to NICU during the stipulated time period, highlighting respiratory distress as the most common cause of admission. Several factors have been described which have been found to contribute towards these admissions, including

operative delivery, threatened miscarriage, maternal infection, and maternal IDDM. It is advised that a working group is set up which can eventually use this information to suggest practical strategies which will minimise term admissions to NPICU. This will result in keeping mother and baby together, proven to improve health outcomes in the short and long term for both, as well as alleviate some of the burden on our healthcare system.

Conclusion

A growing number of term infants are admitted unexpectedly to the NICU. Respiratory distress syndrome and hyperbilirubinaemia and low birth weight being most common causes for NICU admission. Regular antenatal visits, safe delivery practice and timely referral to tertiary care hospitals may result in decreased burden in NICU and also better outcome. The significant contributing factors should be targeted and further evaluation over a longer time-frame with an interdisciplinary team carried out in an effort to reduce rate of admissions and improve quality of care.

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Conflict of Interest

Not available

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Not available

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