

# Admission of term infants to the neonatal intensive care unit in a Saudi tertiary teaching hospital: cumulative incidence and risk factors

Heidi Al-Wassia, Mafaza Saber

From the Department of Pediatrics, King Abdulaziz University Faculty of Medicine, Jeddah, Saudi Arabia

Correspondence: Dr. Heidi Al-Wassia · Department of Pediatrics, King Abdulaziz University, Jeddah 80215, Saudi Arabia · T: +966-12-6401000, ext 20208 · halwassia@kau.edu.sa · <http://orcid.org/0000-0002-8208-4986>

Ann Saudi Med 2017; 37(6): 420-424

DOI: 10.5144/0256-4947.2017.420

**BACKGROUND:** An increasing number of term infants of appropriate birthweight 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:** Cross-sectional analytical study.

**SETTING:** An academic and referral center in Jeddah, Saudi Arabia.

**PATIENTS AND METHODS:** The cases were all term infants ( $\geq 37$  weeks gestational age) admitted to the NICU between 1 January and 31 December 2015. The controls were term infants who were not admitted to the NICU. Cases and controls were matched in a 1:1 ratio according to the date of birth (within one day).

**MAIN OUTCOME MEASURES:** Prevalence, pattern, and risk factors for admission of term infants to the NICU.

**RESULTS:** The rate of admission of term infants to the NICU during the study period was 4.1% (142 of 3314 live births in that year). Respiratory complications accounted for 36.6% (52/142) of admissions, followed by hypoglycemia (23/142, 16.2%) and jaundice (11/142, 7.7%). Premature membrane rupture and non-Saudi national status were the risk factors that remained significant after adjusting for confounders.

**CONCLUSION:** A growing number of term infants are admitted unexpectedly to the NICU. The risk factors and pattern of admission of term infants to the NICU should receive more attention in quality improvement and management agendas.

**LIMITATIONS:** This was a single-center study with limited access to information about unbooked mothers and details of the hospital stay of the admitted neonates.

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.<sup>1,2</sup> Admission to the NICU interrupts the mother-infant bonding and establishment of breastfeeding.<sup>3-5</sup> 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.<sup>6</sup> 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<sup>7</sup> and Ireland<sup>8</sup> have shown that the admission of full-term neonates with  $\geq 2500$  gram (g) birthweight is not an infrequent event. The risk factors associated with increased odds of admission of term infants to the NICU include the operative method of birth,<sup>9</sup> elective delivery before 39 weeks either vaginally or by cesarean section,<sup>10</sup> maternal diabetes and hypertension, ethnicity, age, and socioeconomic status.<sup>11</sup>

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.

To our knowledge, no previous national studies have examined the patterns and risk factors of the admission of term infants to NICUs. 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 King Abdulaziz University (KAU) Hospital between 1 January and 31 December 2015, in order to identify central areas to focus on for quality improvement strategies.

## PATIENTS AND METHODS

A retrospective chart review was performed to determine the prevalence and pattern of the admission of full-term neonates to the NICU. We also conducted a case-control study to determine the risk factors associated with the admission of full-term neonates to the NICU. The cases were full-term infants born and admitted to the NICU at KAU Hospital. We randomly selected controls from all full-term infants who were not admitted to the NICU. Cases and controls were matched in a 1:1 ratio according to the date of birth (within one day). The NICU at KAU Hospital contains 36 beds and is a level III unit and referral center in the western region of Saudi Arabia, with approximately 350-400 admissions per year.

All term infants ( $\geq 37$  weeks gestation age) admitted to the NICU at KAU Hospital between 1 January and 31 December 2015 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.<sup>12</sup> 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 nonadmitted 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 birthweight.<sup>13</sup> 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.<sup>14</sup> 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.<sup>15,16</sup> 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 unit of biomedical ethics at KAU Hospital approved the study.

IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. 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 KAU Hospital. The continuous variables were compared using the t-test and Mann-Whitney U tests for normal and skewed data distributions, respectively. Fisher's exact tests were used to compare categorical variables between groups. In a multivariate logistic regression, NICU admission was the dependent variable. Variables that were significant in the univariate analysis, and which may have differed between the groups, were used as independent variables in the multivariate analysis. Multivariate logistic regression was used to determine potential risk factors for admission of term infants to the NICU. *P* values  $< .05$  were considered statistically significant.

## RESULTS

Of 3314 full-term infants were born at KAU Hospital between 1 January and 31 December 2015, 142 were admitted to the NICU, for a cumulative incidence of 4.1% (142/3314). Only 16% of the term infant admissions were expected (23/142) (**Table 1**). There were no significant differences in maternal age, parity, and body mass index between groups. Furthermore, the rates of hypertension, use of assisted reproductive technology, and multiple pregnancies were comparable between groups. Infants admitted to the NICU were more often the children of non-Saudi national ( $P = .001$ ) and unbooked mothers ( $P < .001$ ). The mothers of infants admitted to the NICU had a significantly

**Table 1.** Maternal and Infants demographic and clinical characteristics.

Maternal characteristics Variable	Cases n=142	Controls n=142	P value
Maternal age (years), mean (SD)	30.5 (6.1)	29.6 (6.4)	.78
Non-national	60 (42.2)	33 (23.2)	.001
Unbooked	32 (22.5)	0 (0)	<.001
Body mass index (mg/kg <sup>2</sup> )	29.4(7.5)	28.4 (5.9)	.51
Parity >2	73 (51.4)	76 (53.5)	.72
Diabetes	36 (25.4)	19 (13.4)	.01
Hypertension	7 (4.9)	6 (4.2)	.78
Preeclampsia	3 (2.1)	4(2.8)	.70
Premature rupture of membrane	9 (6.3)	1(0.7)	.01
Chorioamnionitis	2 (1.4)	0 (0.0)	.16
Assisted reproductive technology	4 (2.8)	2 (1.4)	.41
Multiple pregnancy	3 (2.1)	0 (0.0)	.13
Induced labor	79 (55.6)	47 (33.1)	<.001
Cesarean section	76 (53.5)	43 (30.3)	<.001
Elective cesarean section	33 (23.2)	19 (13.4)	.03
Expected admission	23 (16.2)	0 (0)	<.001
Born outside the hospital	1 (0.7)	0 (0)	.32
Infant characteristics			
Birth weight (g), mean (SD)	2876 (693)	3033 (458)	<.001
Male	88 (62)	74 (52.1)	.09
Small for gestational age	36 (25.4)	22 (15.5)	.04
Apgar score at 1 min, median (IQR)	8 (6,9)	9 (8,9)	<.001
Apgar score at 5 min, median (IQR)	9 (8,10)	10 (9,10)	<.001

Values are n (%) unless noted otherwise. Abbreviations: IQR, interquartile range; SD, standard deviation

higher rate of diabetes ( $P=.01$ ), PROM ( $P=.01$ ) cesarean delivery ( $P<.001$ ) and induction of labor ( $P<.001$ ). Fourteen of the 32 unbooked mothers underwent cesarean delivery (43.8%). Infants admitted to the NICU had a significantly lower birthweight and more were small for gestational age. The reasons for the admission of term infants to the NICU are depicted in **Table 2**. Respiratory distress was most common, with a frequency of 36.6% (52/142) of all admitted term infants, followed by hypoglycemia (23/142, 16.2%) and hyperbilirubinemia (11/142, 7.7%). There was a statistically

significant correlation between non-national and unbooked mothers ( $r=1$ ,  $P<.001$ ); therefore, only non-national status was used in the regression model in order to avoid multicollinearity. When we adjusted for variables that differed statistically between the two groups, only non-national status and patients presenting with PROM remained statistically significant (**Table 3**).

## DISCUSSION

In the present study, the prevalence of admission of term infants to the NICU was 4.1%, less than that reported in other units.<sup>9,17-20</sup> Only 16% of those admissions were expected, similar to that reported previously.<sup>21</sup> Admission of term or normal birthweight infants can be considered as low risk; however, several studies have reported the opposite.<sup>6,18</sup> In a population-based study of infants born to residents of 38 US states, approximately half of all NICU admissions were for infants born  $\geq 37$  weeks of gestational age and/or of normal weight even after adjusting for confounders.<sup>6</sup>

In our study, PROM occurred significantly more frequently in mothers of infants admitted to the NICU compared to the frequency among the infants who were not admitted. The risk of PROM persisted after adjusting for confounders. This finding is in agreement with previous studies.<sup>19,22</sup> Similar to previous studies, the mothers of infants admitted to the NICU had a higher rate of elective cesarean sections. Delivery after cesarean section is a risk factor for the admission of term infants.<sup>9,17,23</sup> However, the effect of cesarean section as a risk factor for NICU admission in our study disappeared after adjusting for other risk factors.

Non-Saudi national mothers were mostly unbooked mothers; their infants constituted more than half of those admitted to the NICU. KAU Hospital is a public hospital and mothers present to the hospital at the time of delivery for financial reasons. We had limited information about the pregnancy of the unbooked mothers; however, this risk factor remained significant after controlling for other confounders. Low socioeconomic status is an independent risk factor for NICU admission.<sup>24</sup> Unbooked mothers are reportedly of lower socioeconomic status and are considered to have higher risks of pregnancy complications including pre-eclampsia, postpartum hemorrhage, uterine rupture, and mortality compared to booked mothers.<sup>25</sup> Moreover, in our study and consistent with other studies, there was a high rate of unbooked mothers who underwent emergency cesarean sections (43.8%), highlighting the importance of this

variable as a risk factor for the admission of term infants to ICUs. In addition, infants born to unbooked mothers have a higher risk of low birthweight, prematurity, and birth asphyxia.<sup>26</sup> In our study, one of the three infants with hypoxic ischemic encephalopathy was born to an unbooked mother.

In our study, we were able to discern the cause of admission in most infants. Analogous to previous studies, respiratory complications were the predominant causes of NICU admissions, accounting for 36.6% of all term admissions in our unit.<sup>20</sup> Similarly, in a retrospective cohort study of infants more than 36 weeks gestational age, 49.3% were admitted to the NICU because of respiratory distress.<sup>19</sup> Hypoglycemia and jaundice were responsible for 16.2% (23/142) and 7.7% (11/142) of admissions, respectively. Unspecified reasons accounted for almost 6% (8/142) of admissions in our study; these included infants admitted for less than 24 hours for observing hypoglycemia, respiratory distress, or perinatal depression and those who received no intervention. In a retrospective cohort study of all term admissions over one year in a NICU in the United Kingdom, only 20 infants out of 174 (11.5%) admitted with hypoglycemia met the recommended standard for a level III NICU admission.<sup>21</sup> Moreover, and in the same study, 105 of 389 (27%) admitted infants at term were discharged or transferred within six hours of admission.<sup>21</sup> Similarly, in a retrospective cohort study of 19 NICUs in the United States that evaluated the admission of infants between 35 and 42 weeks gestational age, the mean frequency of admissions without a perceptible cause was 10.8%.<sup>27</sup>

The present study had several limitations. First, it was a single-center experience. A single center serves a population that might have different characteristics from others, thus limiting the generalizability of the results of this study. Furthermore, gestational age was not included in the regression model to test its confounding effect on the risk of NICU admission. We also had limited access to information about the unbooked mothers and could not ascertain whether they received antenatal care in another center in order to better understand how the booking status affected the risk of admission of infants to the NICU. Moreover, we also did not have details about the neonatal hospital stay and interventions received. This information would help in identifying key areas on which to focus on when carrying out quality improvement plans.

In conclusion, we identified areas that should be targeted for the improvement of care as well as more effective and efficient utilization of resources. First,

**Table 2.** Reasons for admission of term infants to NICU between 1 January 2015 to 31 December 2015.

Reason for NICU admission	Number (%)
Respiratory distress	52 (36.6)
Hypoglycemia	23 (16.2)
Jaundice	11 (7.7)
ABO incompatibility	10 (7)
Rh incompatibility	1 (0.7)
Congenital anomalies	27 (19)
Congenital heart disease	6 (4.2)
Surgical anomalies	6 (4.2)
Diaphragmatic hernia	2 (1.4)
Imperforate anus	2 (1.4)
Duodenal atresia	1 (0.7)
Others	10 (7)
Intrauterine growth retardation	10 (7)
Necrotizing enterocolitis	1 (0.7)
Sepsis	4 (2.8)
Hypoxic ischemic encephalopathy	3 (2.1)
Perinatal depression	2 (1.4)
Thrombocytopenia	1 (0.7)
Unspecified	8 (5.6)

**Table 3.** Adjusted and crude odds ratios for NICU admission of term infants and associated factors.

Covariate	Crude OR (95% CI)	P value	Adjusted OR (95% CI)*	P value
National (Saudi citizen)	0.41 (0.25, 0.69)	.001	0.39 (0.23, 0.68)	.001
Diabetes	2.19 (1.19, 4.06)	.01	1.88 (0.98, 3.59)	.06
Premature rupture of membrane	9.54 (1.19, 76.32)	.03	10.27 (1.21, 86.92)	.03
Induced labor	2.54 (1.57, 4.10)	<.001	1.43 (0.29, 6.89)	.65
Cesarean section	2.65 (1.63, 4.31)	<.001	1.96 (0.40, 9.57)	.41

\*Adjusted for being non-Saudi, diabetes, premature rupture of membrane, induction of labor and cesarean delivery. Abbreviation: CI, confidence interval; OR, odds ratio. Comparing the observed and predicted numbers of observation in each group using Hosmer and Lemeshow goodness of fit test was not significant (chi-square 9.46,  $P=.09$ ) indicating that the model fit the observed data well.

the population of non-nationals and unbooked mothers should be embraced by a health care system that can accommodate them and afford appropriate antenatal and perinatal care for better outcomes. Second, we believe that NICUs must review all admissions and audit potentially avoidable admissions. Those admissions might be managed in an intermediate

care or observation unit in order to alleviate some of the workload in the NICU, free more beds for admitting high-risk neonates, and reduce the associated costs.<sup>28,29</sup>

#### Conflict of interest

None.

## REFERENCES

- Hynan MT, Mounts KO, Vanderbilt DL. Screening parents of high-risk infants for emotional distress: rationale and recommendations. *J Perinatol*. 2013 Oct;33(10):748-53.
- Polin RA, Denson S, Brady MT, Committee on F, Newborn, Committee on Infectious D. Epidemiology and diagnosis of health care-associated infections in the NICU. *Pediatrics*. 2012 Apr;129(4):e1104-9.
- Crenshaw JT. Healthy Birth Practice #6: Keep Mother and Baby Together- It's Best for Mother, Baby, and Breastfeeding. *J Perinat Educ*. 2014 Fall;23(4):211-7.
- Bigelow A, Power M, MacLellan-Peters J, Alex M, McDonald C. Effect of mother/infant skin-to-skin contact on postpartum depressive symptoms and maternal physiological stress. *J Obstet Gynecol Neonatal Nurs*. 2012 May-Jun;41(3):369-82.
- Dumas L, Lepage M, Bystrova K, Matthiesen AS, Welles-Nystrom B, Widstrom AM. Influence of skin-to-skin contact and rooming-in on early mother-infant interaction: a randomized controlled trial. *Clin Nurs Res*. 2013 Aug;22(3):310-36.
- Harrison W, Goodman D. Epidemiologic Trends in Neonatal Intensive Care, 2007-2012. *JAMA Pediatr*. 2015 Sep;169(9):855-62.
- Hubbard M. Reducing admissions to the neonatal unit: A report on how one neonatal service has responded to the ever increasing demand on neonatal cots. *Journal of Neonatal Nursing*. 2006;12(5):172-76.
- Rohininath T, O'Connell LA, Sheehan K, Corcoran D, Matthews TG, Clarke TA. Workload and short-term outcome of babies weighing 2,500 grams or more at birth admitted to the paediatric unit of the Rotunda Hospital. *J Matern Fetal Neonatal Med*. 2005 Feb;17(2):139-43.
- Tracy SK, Tracy MB, Sullivan E. Admission of term infants to neonatal intensive care: a population-based study. *Birth*. 2007 Dec;34(4):301-7.
- Hoffmire CA, Chess PR, Ben Saad T, Glantz JC. Elective delivery before 39 weeks: the risk of infant admission to the neonatal intensive care unit. *Matern Child Health J*. 2012 Jul;16(5):1053-62.
- Horowitz K, Feldman D, Stuart B, Borgida A, Ming Victor Fang Y, Herson V. Full-term neonatal intensive care unit admission in an urban community hospital: the role of respiratory morbidity. *J Matern Fetal Neonatal Med*. 2011 Nov;24(11):1407-10.
- Lynch CD, Zhang J. The research implications of the selection of a gestational age estimation method. *Paediatr Perinat Epidemiol*. 2007 Sep;21(Suppl 2):86-96.
- Battaglia FC, Lubchenco LO. A practical classification of newborn infants by weight and gestational age. *J Pediatr*. 1967 Aug;71(2):159-63.
- Screening guidelines for newborns at risk for low blood glucose. *Paediatr Child Health*. 2004 Dec;9(10):723-40.
- Executive summary: Neonatal encephalopathy and neurologic outcome, second edition. Report of the American College of Obstetricians and Gynecologists' Task Force on Neonatal Encephalopathy. *Obstet Gynecol*. 2014 Apr;123(4):896-901.
- Committee on Fetus and Newborn, Papile LA, Baley JE, Benitz W, Cummings J, et al. Hypothermia and neonatal encephalopathy. *Pediatrics*. 2014 Jun;133(6):1146-50.
- Quinn CE, Sivasubramaniam P, Blevins M, Al Hajajra A, Znait AT, Khuri-Bulos N, et al. Risk factors for neonatal intensive care unit admission in Amman, Jordan. *East Mediterr Health J*. 2016 Jun 15;22(3):163-74.
- Battersby C, Michaelides S, Upton M, Rennie JM. On behalf of the Jaundice Working Group of the Atain (Avoiding Term Admissions Into Neonatal units) programme, led by the Patient Safety team in NHS Improvement. Term admissions to neonatal units in England: a role for transitional care? A retrospective cohort study. *BMJ Open*. 2017;7:e016050.
- Burgess AP, Katz J, Pessolano J, Ponterio J, Moretti M, Lakhi NA. Determination of antepartum and intrapartum risk factors associated with neonatal intensive care unit admission. *J Perinat Med*. 2016 Jul 01;44(5):589-96.
- Alkiaat A, Hutchinson M, Jacques A, Sharp MJ, Dickinson JE. Evaluation of the frequency and obstetric risk factors associated with term neonatal admissions to special care units. *Aust N Z J Obstet Gynaecol*. 2013 Jun;53(3):277-82.
- Granger C, Okpapi A, Peters C, Campbell M. G578(P) Potentially preventable unexpected term admissions to neonatal intensive care (nicu). *Archives of Disease in Childhood*. 2015;100:A263.
- Dare MR, Middleton P, Crowther CA, Flenady VJ, Varatharaju B. Planned early birth versus expectant management (waiting) for prelabour rupture of membranes at term (37 weeks or more). *Cochrane Database Syst Rev*. 2006 Jan 25(1):CD005302.
- Grace L, Greer RM, Kumar S. Perinatal consequences of a category 1 caesarean section at term. *BMJ Open*. 2015 Jul 29;5(7):e007248.
- Ruth CA, Roos N, Hildes-Ripstein E, Brownell M. The influence of gestational age and socioeconomic status on neonatal outcomes in late preterm and early term gestation: a population based study. *BMC Pregnancy Childbirth*. 2012 Jun 29;12:62.
- Chigbu B, Onwere S, Kamanu CI, Aluka C, Okoro O, Adibe E. Pregnancy outcome in booked and unbooked mothers in South Eastern Nigeria. *East Afr Med J*. 2009 Jun;86(6):267-71.
- Tucker A, Ogotu D, Yoong W, Nauta M, Fakokunde A. The unbooked mother: a cohort study of maternal and foetal outcomes in a North London Hospital. *Arch Gynecol Obstet*. 2010 Apr;281(4):613-6.
- Ziegler KA, Paul DA, Hoffman M, Locke R. Variation in NICU Admission Rates Without Identifiable Cause. *Hosp Pediatr*. 2016 May;6(5):255-60.
- Busse M, Stromgren K, Thorngate L, Thomas KA. Parents' responses to stress in the neonatal intensive care unit. *Crit Care Nurse*. 2013 Aug;33(4):52-9 (quiz 60).
- Vanderbilt D, Bushley T, Young R, Frank DA. Acute posttraumatic stress symptoms among urban mothers with newborns in the neonatal intensive care unit: a preliminary study. *J Dev Behav Pediatr*. 2009 Feb;30(1):50-6.