Factors associated with length of stay in a neonatal intensive care unit in Iran

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Sri Lanka Journal of Child Health, 2019; **48**(3)**:** 226-232

Abstract

***Background*:** The length of stay (LOS) is a useful indicator of health and prediction of the LOS in the neonatal intensive care unit (NICU) has drawn increasing attention over the past years.

Objectives: To determine factors associated with infant's LOS in the NICU in Bandar Abbas city, Southern Iran, between 2016 and 2017.

***Method*:** This cohort study reviewed 603 medical records of all NICU admitted newborns. Data were collected using data collection forms. The Cox multiple hazards regression model determined the factors associated with the infant's LOS. Data was analysed using SPSS, version 21. The significance level was set at 0.05.

***Results*:** The median LOS in NICU was 9 days. The results of multiple Cox proportional hazards regression model showed that type of feeding, umbilical and central venous catheterization, mechanical ventilation, nosocomial infection, acute renal failure, blood transfusion, and antibiotic therapy were significantly associated with LOS in the NICU (p <0.05).

***Conclusions*:** The type of feeding, umbilical and central venous catheterization, mechanical ventilation, nosocomial infection, acute renal failure, blood transfusion, and antibiotic therapy were significantly associated with LOS in the NICU.

DOI: http://dx.doi.org/10.4038/sljch.v48i3.8757

(Keywords: Hospital, neonatal, Cox multiple hazards regression**,** survival)

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(Received on 28 September 2018: Accepted after revision on 16 November 2018)

The authors declare that there are no conflicts of interest

Personal funding used for the project.

Introduction

Around 38% of all deaths occur in children below 5 years of age in the neonatal period, approximately 75% of them occurring in the first week of birth[1,2]. In the United States, infant mortality rate was 6.7 deaths per 1000 live births in 2011[3]. Prediction of the length of stay (LOS) in the neonatal intensive care unit (NICU) is a major determinant of the cause of infant deaths[4,5]. Such a prediction of LOS facilitates physician-parent communication regarding NICU LOS for infants[6]. Estimation of LOS may reduce parental anxiety during an infant's hospitalization[7]. Further, knowledge about factors associated with LOS may help design strategic plans to reduce hospitalization costs, improve emotional affinity between parents and infants, increase the quality of healthcare services, and thus increase economic benefits for the society[8]. Reduced NICU LOS for newborns leads to reduced burden of medical costs on government and families, and increased hospital capacity to admit new patients[9].

Objective

To determine factors associated with the infant's LOS in the NICU in Bandar Abbas city, Southern Iran, between 2016 and 2017.

Method

This retrospective cohort study reviewed 603 medical records of all NICU admitted newborns. First, 600 infants admitted to the NICU of the Paediatric Department of Bandar Abbas hospital with LOS longer than 24 hours were selected as the target population. Data were gathered using data collection forms on age, gender, type of feeding, gestational age, type of delivery, presence of various infections in infant, umbilical and central venous catheterization, antibiotic therapy, mechanical ventilation, photomicrography, phototherapy, blood transfusion, type of admission, and patient's condition at the time of discharge. The NICU LOS was considered as a survival variable and the desired

outcome was discharge from hospital with physician approval. Infants who died, or who were discharged from hospital against medical advice were considered as censored data. As in other analyses, in survival analysis, multiple regression model can control for confounding variables and form an equation of the factors associated with survival. Variables significantly associated with NICU LOS were selected using Cox multiple hazards regression, and then entered into multiple regression analysis. After evaluation of fitted model, significant variables were analysed through multivariate Cox hazards regression with backward LR. Data was analysed using SPSS, version 21. For best model fitting, the significance level to include and exclude variables were set at 0.02, and 0.05, respectively. The study was approved by the Ethics Committee of the Hormozgan University of Medical Sciences (Ref. no: IR.HUMS.REC.1397.072).

Results

In this study, of 603 patients, 493 (81.8%) were fully treated at the time of discharge, and 110 (18.2%) died or left against medical advice. Demographic characteristics and extracted data on study variables from medical reports are shown in Table 1.

Table1: ***Demographics and records of patients included in this study (n=603)***

Variable		Median (IQR)	Frequency (%)	LOS (IQR)
Age (days)		02 (06)		
Weight (g)		2600 (1350)		
Gender				
Male			360 (59.7)	09 (12)
Female			243 (40.3)	11 (13)
Type of delivery				
Vaginal			298 (49.4)	09 (13)
Caesarean Section			305 (50.6)	10 (12)
Type of feeding				
Breast feeding			340 (56.4)	07 (12)
Formula			263 (43.6)	11 (12)
Cause of hospitalisation				
Hospital Infection	Yes		327 (54.2)	12 (18)
	No		276 (45.8)	08 (08)
Gastrointestinal disorders	Yes		132 (21.9)	09 (16)
	No		471 (78.1)	10 (11)
Respiratory disorders*	Yes		440 (73.0)	10 (13)
	No		163 (27.0)	08 (09)
Heart disorders	Yes		129 (21.4)	09 (15)
	No		447 (78.6)	09 (11.25)
Genetic disorders**	Yes		61 (10.1)	11 (18)
	No		542 (89.9)	09 (12)
Metabolic disorders	Yes		51 (08.5)	12 (25)
	No		551 (91.5)	09 (12)
Acute renal failure	Yes		42 (07.0)	11.5 (22.5)
	No		561 (93.0)	09 (11)
Pneumothorax***	Yes		53 (08.8)	10 (16)
	No		550 (91.2)	09 (12)
Intraventricular haemorrhage	Yes		76 (12.6)	12.5 (13.7)
	No		527 (87.4)	09 (12)
Antibiotic therapy	Yes		588 (97.5)	9.5 (12)
	No		15 (02.5)	05 (09)
Umbilical venous catheterization	Yes		54 (09.0)	05 (14.25)
	No		549 (91.0)	10 (12)
Umbilical arterial catheterisation	Yes		06 (01.0)	05 (14)
	No		597 (99.0)	10 (12)
Central venous catheterization	Yes		38 (06.3)	03.5 (33.75)
	No		565 (93.7)	10 (12)
Mechanical ventilation	Yes		163 (27.0)	10 (12)
	No		440 (73.0)	05 (11)
Oxygen Therapy	Yes		523 (86.7)	10 (12)
	No		80 (13.3)	07 (08)
Surgery during hospitalization	Yes		83 (13.8)	10 (12)
	No		520 (86.2)	09 (13)
Blood transfusion	Yes		269 (44.6)	14 (20)
	No		334 (55.4)	07 (08)
Phototherapy	Yes		257 (42.6)	10 (13)
	No		346 (57.4)	09 (13)
Photomicrography	Yes		526 (87.2)	10 (13)
	No		77 (12.8)	08 (07)
Type of admission				
Emergency admission			163 (27.0)	09 (12)
Admission from other units			87 (14.4)	11 (09)
Referral from other hospitals			353 (58.5)	09 (14)

IQR: Interquartile range, LOS: Length of stay

**excluding pneumothorax, **congenital deaf-blindness & cardiac abnormalities and Down syndrome (trisomy 21) ***excluding respiratory disorders*

The median LOS in NICU was 9 days with a hospital interquartile range (IQR) of 12 days. The median and IQR of LOS were 9 and 12 days for male infants, and 11 and 13 days for female infants. Also, the median and IQR of LOS were 10 and 11 days for fully treated infants at discharge, and 4.5 and 9.25 for infants who were dead or discharged with parental consent but without treatment.

Univariate analysis revealed that gender, type of feeding, gastrointestinal disorder, heart disorders, umbilical and central venous catheterization, pneumothorax, intraventricular hemorrhage, mechanical ventilation, nosocomial infection, acute renal failure, blood transfusion, phototherapy, and antibiotic therapy were significantly associated with LOS in NICU ($p<0.05$). However, multivariate Cox regression model indicated that the type of feeding (HR: 3.6, $p<0.001$), umbilical (HR: 1.67, p=0.023) and central (HR: 2.33, p=0.005) venous catheterization, mechanical ventilation (HR:4.12, p<0.001), nosocomial infection (HR:1.6, p=0.04), acute renal failure (HR: 2.06, p =0.003), blood transfusion (HR:1.86, p=0.021), phototherapy (HR:2.02, p=0.001) and antibiotic therapy (HR:2.64, p= 0.027) were significantly associated with LOS in NICU (p <0.05). (Table 2)

Table 2: Univariate analysis and multivariate regression model of Cox

Variable		Univariate analysis			Multivariate analysis		
		Hazard ratio	**95% CI**	***p* value**	**Hazard ratio**	**95% CI**	***p* value**
Gender							
Male		1	-	-	1	-	-
Female		0.54	0.36-0.82	**0.004**	0.72	0.47-1.12	0.15
Type of delivery							
Vaginal		1	-	-	NI*	-	-
Caesarean Section		1.03	0.71-1.51	0. 84	-	-	-
Type of feeding							
Breastfeeding		1	-	-	1	-	-
Formula		2.41	1.11 – 3.82	**<0.001**	3.6	2.02-4.83	**<0.001**
Hospital Infection:	No	1	-	-	1	-	-
	Yes	2.10	1.31-3.25	**0.001**	1.6	1.40-2.07	**0.04**
Gastrointestinal disorders:	No	1	-	-	1	-	-
	Yes	1.53	1.02-2.29	**0.03**	0.85	0.54-1.34	0.55
Respiratory disorders:	No	1	-	-	NI*	-	-
	Yes	1.52	0.91-2.53	0.1	-	-	=
Heart disorders:	No	1	-	-	1	-	-
	Yes	2.31	1.56 - 3.42	**<0.001**	1.10	0.71-1.77	0.64
Genetic disorders:	No	1	-	-	1	-	-
	Yes	1.80	1.10 - 2.93	**0.01**	1.41	0.82-2.41	0.20
Metabolic disorders:	No	1	-	-	NI*	-	-
	Yes	1.29	0.74 - 2.24	0.35	-	-	=
Acute renal failure:	No	1	-	-	1	-	-
	Yes	5.14	2.08-0.48	**<0.001**	2.06	1.20-3.31	**0.003**
Pneumothorax:	No	1	-	-	1	-	-
	Yes	2.28	3.56 - 7.84	**<0.001**	1.22	0.78-1.91	0.37
Intraventricular hemorrhage:	No	1	-	-	1	-	-
	Yes	1.71	1.01 - 2.67	**0.01**	1.46	0.88-1.44	0.14
Antibiotic therapy:	No	1	-	-	1	-	-
	Yes	3.31	1.44-7.60	**0.005**	2.64	1.11-6.24	**0.027**
Umbilical venous catheterization:	No	1	-	-	1	-	-
	Yes	5.32	3.54-7.90	**<0.001**	1.67	1.07-2.64	**0.023**
Umbilical arterial catheterization:	No	1	-	-	NI*	-	-
	Yes	4.17	0.56-5.8	0.16	-	-	=
Central venous catheterization:	No	1	-	-	1	-	-
	Yes	2.12	1.21 – 3.71	**0.009**	2.33	1.21-4.25	**0.005**
Mechanical ventilation:	No	1	-	-	1	-	-
	Yes	2.25	1.2-4.63	**<0.001**	4.12	1.21-5.17	**<0.001**
Oxygen therapy:	No	1	-	-	NI*	-	-
	Yes	0.77	0.44-1.33	0.35	-	-	=
Surgery during hospitalization:	No	1	-	-	NI*	-	-
	Yes	0.82	0.47-1.43	0.49	-	-	=
Blood transfusion:	No	1	-	-	1	-	-
	Yes	3.64	2.24-5.90	**<0.001**	1.86	1.09-3.15	**0.021**
Phototherapy:	No						
	Yes	0.56	0.38-0.82	**0.003**	2.02	1.35-3.03	**0.001**
Photomicrography:	No	1	-	-	1	-	-
	Yes	4.34	1.37-13.7	**0.01**	1.41	0.43-4.59	0.56
Type of admission							
Emergency admissions		1	-	-	NI*	-	-
Admission from other units		0.19	0.04-0.82	0.22	-	-	-
Referral from other hospitals		1.34	0.82-2.19	0.23	-	-	-

Discussion

Results from the Cox regression model suggest that type of feeding, umbilical and central venous catheterization, mechanical ventilation, nosocomial infection, acute renal failure, blood transfusion, and antibiotic therapy were significantly associated with LOS in NICU. The median LOS in NICU was 9 days (9 in males vs. 11 in females). A similar study conducted in Iran reported the median NICU LSO as 9 days, which is in accordance with the present study[8]. Results show that the majority of the NICU admitted infants are male. A study showed that male infants are more likely to be admitted in NICU[8,10]. However, the LOS was higher among female infants than in male infants, which is supported by previous studies[8]. It appears that male infants are more susceptible during the first days of birth compared with female infants.

In addition, infants with exclusive breastfeeding displayed lower LOS in NICU, whereas formula fed infants displayed prolonged LOS in NICU. A number of studies showed the protective effect of exclusive breastfeeding on respiratory infectious diseases including allergies, asthma, pneumonia and bronchiolitis[11,12], and gastrointestinal infections with acute diarrhoea[12,13]. Besides, a study revealed that exclusive breastfeeding significantly reduced the risk of necrotizing enterocolitis among premature infants in NICU[14,15]. Thus, infants deprived from breastfeeding are more likely to develop various infections.

Infants admitted to NICU with nosocomial infection normally have higher LOS. Kandi Kele and colleagues stated that infections increased NICU LOS among infants[8]. Another study in Rasht city showed that 16.3% of NICU admitted infants reported nosocomial infection[16]. Joseph and colleagues also reported a higher prevalence of nosocomial infection in low birth weight and NICU admitted infants[17]. Infants who received antibiotic therapy during their stay in NICU, reported higher NICU LSO. As such, patients with nosocomial infection require antibiotic therapy, which considerably increases LOS in NICU[18]. Further, umbilical and central venous catheterisation and mechanical ventilation have been shown to increase NICU LOS. A study conducted in Iran showed that infants with respiratory disorders require mechanical ventilation during stay in NICU, as use of mechanical ventilation devices increases LOS in NICU, which is compatible with the findings of our study[19].The results of several studies showed higher mortality rates among infants who used mechanical ventilation[20,21].

According to the literature, infants with severe conditions and respiratory disorders need special medical care and services such as mechanical ventilation and NICU admission to prevent death due to these complications. Kandi Kele and colleagues also revealed that central venous catheterization increased LOS in NICU[8]. The findings of previous studies have shown that renal failure is associated with outcomes[22] and infant mortality[23,24]. In addition, factors such as sepsis, congenital renal anomalies, asphyxiation, drug poisoning[25], and prematurity are associated with renal failure in newborns and significantly increase the LOS in NICU[24]. Unlike our study, these factors such as sepsis, congenital renal anomalies, asphyxiation and drug poisoning, were not confirmed as an effective factors in LOS in Lee[26] and Altman's[27] studies.

The findings of the present study suggest that blood transfusion and phototherapy are positively associated with LOS among infants. The majority of newborns develop jaundice within a few days of birth, and mostly receive phototherapy with a special light. These infants require hospitalization to receive treatment. These findings were consistent with the results of previous studies[28,29]. Moreover, a number of previous studies have shown that premature or low birth weight infants who are more likely to have prolonged LOS need blood transfusion several times during hospital stay[30,31]. These results were not achieved in Bender[32] and Manktelow's[33] studies. As a result, various regression models show different effectiveness in the analysis of different data sets and we need to evaluate the different parametric and semi-parametric models to find the most effective model[34,35].

The study had some limitations. The required data were extracted from the hospital information system, and some of the study variables may not be accurately documented. Besides, this study reviewed medical records of one single hospital and results may not be applicable to other hospitals in Bandar Abbas city.

Conclusions

The type of feeding, umbilical and central venous catheterization, mechanical ventilation, nosocomial infection, acute renal failure, blood transfusion, and antibiotic therapy were significantly associated with LOS in the NICU.

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