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Risk Factors and Status of Unplanned Readmission of Neonates within Thirty Days of Discharge from NICU at Tertiary Care Hospital of Low Resource Country

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ABSTRACT

Background: 12% out of all neonates born alive, require admission to health care facility mainly NICU (4). Neonate that requires readmissions to NICU poses a universal health concern, with frequency as much as 10.1% outside the USA, creating load on health care facilities and parents. **Objective:** To investigate the risk factors associated with unplanned readmissions of newborns after discharge from the Neonatal Intensive Care Unit (NICU). **Methods:** A total of 572 neonates who were readmitted to the NICU throughout the study period were also included in this retrospective observational analysis. Data on these readmitted neonates, including gestational age, birth weight, diagnosis, and other factors, were retrieved and evaluated. The chi-square test was applied to see whether there was a relationship between problems and hospital status and newborn demographics. To calculate adjusted odds ratios (ORs) and their 95% confidence intervals (CI), the logistic regression technique using univariate and multivariate data was applied. **Result:** Out Of 572 study participants, 317(55.4) were male and 255(44.6) were female. The median age of the sample was 1 day (inter-quartile range [IQR]: 0-5 days) with their median length of the NICU stay was 3.00 (2.00 -5.00) days. 78 percent of participants were in born and 22 percent were out born. Most of the newborns during this study were admitted only once (n=496,86.7%) in comparison readmission status was (n=76,13.3%). Among these participants 45 percent were normal birth weight,39 percent were LBW, 10percent ere VLBW and around 6 percent were ELBW. Univariate logistic regression showed that younger age (OR: 1.07, 95% CI: 1.05-1.09) patients who had lesser length of NICU stay were at increased risk of readmission (OR: 0.73, 95% CI: 0.62-0.87). Newborns with very low and low birth weight were had increased odds of NICU readmission in contrast to those whose weight is normal (OR: 4.03, 95% CI: 1.92-8.44, (OR: 2.22, 95% CI: 1.25-3.92). **Conclusion:** Newborns discharged from NICU are at high risk of readmission, especially in settings with weak community care like Pakistan. Strengthening discharge protocols, caregiver education, and post-discharge follow-ups can reduce readmissions and improve outcomes.

INTRODUCTION

During infancy, neonatal age group (first 28 days of life) is the most crucial & sensitive time that decides future physical and mental health (1). Around 3 million neonates die in this period of worldwide, constituting 45% of under-five mortalities (2). Of these neonatal population, high rate of premature birth (born before 37 completed weeks gestation) remains an enormous cause of morbidity and mortality, involving substantial medical cost and significant burden on public health(3). 12% out of all neonates born alive, require admission to health care facility mainly NICU (4). Neonate that requires readmissions to NICU poses a global health concern, with frequency as high as 10.1% outside the United States, creating burden on health care facilities and parents (5). The major risk factors leading to admissions and then readmission in neonates are mainly prematurity, sepsis, respiratory distress syndrome (RDS) and birth asphyxia (6). Mortality rate of admitted neonates in NICU setting is around eight percent. Neonatal resuscitation programs along with good antenatal surveillance has brought a significant decline to the deaths and readmission rate of neonates in recent past, yet frequent readmissions are still observed. Readmission rate for developing countries like that of India is 16.4% (7), significantly higher than the developed countries like that of Croatia, which is 4.0%. Owing to the scarcity of resources in low- and middle-income countries, preterm neonates have a different

discharge criteria from NICU settings that includes any preterm who is medically fit, feeding well and gained weight of at least 1200 grams, able to maintain body temperature independently and family educated for supportive care and feeding at home (8). In under resourced regions like Pakistan, majority of admitted newborns are sent home early, causing increase in the readmission risk to NICU , and ultimately increased newborn mortalities (1)

One of the associated risk factors in readmitted neonates is length of stay on first admission In Pakistan, Diseases like asphyxia, prematurity and infections result in around 87% of neonatal mortality (9)

This research will help to elucidate the key risk factors contributing to admissions and readmission, evaluate their impact on our healthcare system.

METHODOLOGY

Over a period of Eight months, from December 2020 to July 2021, this retrospective observational study was carried out at the NICU at the Sheikh Saeed Memorial Campus (SSMC) of the Indus Hospital and Health Network (IHHN) in Karachi. All newborns admitted and discharged on physician's decision were included. Exclusion criteria applied to patients who left against medical advice or who were discharged on demand.

Data was retrieved from electronic medical records and the hospital management information system (HMIS) with permission following Indus Hospital & Health Network's IRB approval. All infants who met the inclusion criteria were assessed for their gestational age, gender, birth weight, admission source, and diagnostic categories, among other factors. The ratio of all re-admissions to all discharges during the study period was used to calculate readmission rates. the re-admissions were also evaluated through the stratification by gestational age, birth weight, length of the stay, diagnosis, number of re-admissions, and cost of re-admissions. Results such as longer duration of stay, mortality, and discharge status were compared to gestational age and discharge weight. In our investigation, we also identified risk indicators for potential readmission. Additionally, our analysis identified risk indicators for potential readmission.

Statistical Analysis

For quantitative variables (age and length of stay), we used mean, standard deviation, or median (interquartile range, or IQR), and for categorical variables (gender, birth weight, gestational age, hospital status, and admission source), we used numbers and percentages. Shipro-Wilk test was used to determine the normality of continuous variables. Chi-square test/fisher exact test was done to determine the relationship between various parameters and hospital status. Additionally, the univariate and multivariable logistic regression technique was used to evaluate unadjusted and adjusted odds ratios (ORs) respectively. For multivariate analysis only those variables were included that had p<0.25 Confidence level was taken at 95% and p A p-value less than or equal to 0.05 was considered statistically significant. SPSS version 26 (IBM, Armonk, NY, USA) software was used for statistical analysis.

RESULTS

Out Of 572 study participants, 317(55.4) were male and 255(44.6) were female. The median age of the sample was 1 day (inter-quartile range [IQR]: 0-5 days) with their median length of the NICU stay was 3.00 (2.00 -5.00) days. 78 percent of participants were in born and 22 percent were out born.

Most of the newborns in the research were admitted only once (n=496,86.7%) as compare to readmission status was (n=76,13.3%). Among these participants 45 percent were normal birth weight,39 percent were LBW, 10percent ere VLBW and around 6 percent were ELBW. In terms of gestational age 50.5 % were term neonates. 21.5 were late preterm, 12 % were moderately preterm, 10% were vert preterm and 6 percent were extremely preterm. (Table-1)

Table 1

Demographic Character of Study

Variables		Value
Age at Admission	Median (IQR)	1(0-5)
	Median (IQR)	3(2-5)
Gender	Female	255(44.6)
	Male	317(55.4)
Birth weight	Extremely LBW (<1000 gram)	32(5.6)
	Very LBW (<1500 gram)	57(10)
	LBW (< 2500 gram)	225(39.3)
	Normal Birth Weight (>2500 gram)	258(45.1)
Gestational Age	Extreme Preterm (<28 weeks)	35(6.1)
	Very Preterm (28-32 weeks)	57(10)
	Moderate Preterm (32-34 weeks)	68(11.9)
	Late Preterm (34-37 weeks)	123(21.5)
	Term (>37 weeks)	289(50.5)
Hospital Admission Status	Admission	496(86.7)
	Readmission	76(13.3)
Type of Admission	Inborn	446(78)
	Outborn	126(22)

Univariate logistic regression showed that younger age (OR: 1.07, 95% CI: 1.05-1.09) patients who had lesser length of NICU stay were at higher risk of readmission (OR: 0.73, 95% CI: 0.62-0.87). Neonates with very low and low birth weight were had increased odds of NICU readmission as compared to those who were normal weight (OR: 4.03, 95% CI: 1.92-8.44, (OR: 2.22, 95% CI: 1.25-3.92). Neonates with Low gestational age were also at increased risk of poor interim outcome, very preterm and moderately preterm neonates were more likely to have higher risk of readmission than those with normal gestation age (OR: 4.9 95% CI: 2.41-9.9 OR: 2.73 95% CI: 1.3-5.72).

However, after adjustment in multiple logistic regression, status of NICU readmission were significant with younger age (p-value <0.001) and lesser NICU stay (p-value <0.001). Patients who were extremely low birth weight (p-value <0.001), extremely preterm (p-value 0.01) and very preterm (p-value<0.001) were at higher risk of readmission than the patient who were normal weight with normal gestational age. (Table. 2)

Table 2

Basic Demographics Associated with Readmission using Logistic Regression (n= 572).

Variables	Groups	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age at admission (days)	-	1.077 (1.055 – 1.099)	**<0.001	0.92(0.89-0.95)	**<0.001
Length of stay (days)	-	0.735(0.621-0.871)	**<0.001	0.65(0.531-0.80)	**<0.001
Gender	Male	Ref		-	-
	Female	1.0(0.621 – 1.640)	0.971	-	-
Birth weight	Normal Birth weight (put here cutt-off)	Ref		Ref	
	Extremely LBW (<1000 gm)	1.167 (0.32 – 4.15)	0.811	0.001(0.000-0.019)	**<0.001
	Very LBW (<1500 gm)	4.03(1.92 -8.44)	**<0.001	0.331(0.48 – 2.2)	0.260
	LBW (< 2500 gm	2.22(1.25 -3.92)	0.006*	0.007(0.00 – 0.16)	0.002*
Gestational age	Term (>37 weeks)	Ref		Ref	
	Extreme Preterm (<28 weeks)	2.39(0.9-6.35)	0.08	56.2(4.75-664.29)	**0.010
	Very Preterm (28-32 weeks)	4.9 (2.41-9.99)	**<0.001	32.94)4.70-230.62)	**<0.001
	Moderate Preterm (32-34 weeks)	2.73 (1.3 – 5.72)	**0.008	2.14(0.65- 7.01)	0.2
	Late Preterm (34-37 weeks)	1.855(0.95 – 3.61)	0.069	2.0(0.80-4.99)	0.13
Admission source	Out born	Ref		Ref	
	In born	2.29(1.11 – 4.75)	*0.025	0.42(0.16-1.099)	0.78

OR: Odds Ratio using binary logistic regression, C.I: Confidence Interval, Ref: Reference category, LBW= Low birth weight, *significance at 5%, **significant at 1%

Our result also showed that neonates admitted with acute gastroenteritis (AGE) had a higher risk of readmission to NICU (p- value 0.012). Infant with Anemia also had high risk readmission (p=value<0.001). Patients admitted with congenital heart diseases (CHD) were more likely to readmitted (p- value <0.001). Patients with hypernatremic dehydration (p-value <0.001), hypoxic ischemic encephalopathy (p-value 0.002), infant of diabetic mother (IDM) (p-value<0.001), neonatal jaundice (NNJ) (p-value<0.001), pneumonia (p=value<0.001), prematurity (p-value<0.001), urosepsis (p-value 0.002), sepsis(p=value<0.001) and respiratory distress syndrome(RDS) (p-value 0.014) had higher odds of readmission in univariate and also in multivariate model. (Table-3)

Table 3

Factors Associated with Readmission Using Logistic Regression (n= 572).

Variables	Groups	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Acute Gastro enteritis (AGE)	No	Ref		Ref	
	Yes	3.32(0.59 – 18.47)	0.17	0.016(0.001-0.40)	0.012*
Acute Kidney Injury(AKI)	No	Ref		-	
	Yes	1.4(0.31 – 6.9)	0.63	-	-
Anemia	No	Ref		Ref	
	Yes	18.6(5.68 – 61.11)	*<0.001	258(18.48-3622.82)	*<0.001
Congenital heart disease (CHD)	No	Ref		Ref	
	Yes	4.0(.63 – 10.0)	*0.002	861.74(51.28-14480.62)	*<0.001
Feeding Problem	No	Ref		Ref	
	Yes	4.6(1.6 – 13.42)	*0.005	1.4(0.31-62.93)	0.86
Hypernatremic Dehydration	No	Ref		Ref	
	Yes	4.0(1.55 – 10.74)	*0.004	1055.17(69.83-1594-.2)	*<0.001
Hypoxic Iscemic encephealopathy (HIE)	No	Ref		Ref	
	Yes	0.25(0.03 – 1.88)	0.179	0.10(0.00-0.08)	*0.002
Infant of Diabetic mother (IDM)	No	Ref		Ref	
	Yes	0.42(0.177 – 1.00)	*0.050	(0.01(0.00-0.013)	*<0.001
Meconium Aspiration Syndrome(MAS)	No	Ref		Ref	
	Yes	0.52(0.13 – 2.52)	0.47		
Neonatal Jaundice(NNJ)	No	Ref		Ref	
	Yes	1.63(1.00– 2.66)	0.048*	43.57(7.21-263.45)	*<0.001
Intrauterine Growth Restriction (IUGR)	No	Ref		Ref	
	Yes	1.09(0.31– 3.7)	0.89		
Neural tube Defects (NTDS)	No	Ref		Ref	
	Yes	1.46(0.31– 6.90)	0.63		
Necrotizing Enterocolitis (NEC)	No	Ref		Ref	
	Yes	0.40(0.05– 3.06)	0.37		
Pneumonia	No	Ref		Ref	

	Yes	2.61(0.90– 7.56)	0.076	26(94.48-7175.8)	*<0.001
Prematurity	No	Ref		Ref	
	Yes	0.59(0.35– 1.00)	0.052	0.006(0.001-0.04	*<0.001
Large of gestational age (LGA)	No	Ref		Ref	
	Yes	1.0(0.23– 4.9)	0.911		
Urosepsis	No	Ref		Ref	
	Yes	2.8(0.97– 8.30)	0.056	224(7.68-6535.9)	*0.002
Sepsis	No	Ref		Ref	
	Yes	0.50(0.28– 0.91)	0.025*	0.13(0.043-0.40	*<0.001
Surgical Causes	No	Ref		Ref	
	Yes	0.29(0.06– 1.23)	0.094	0.32(0.02-4.15)	0.38
Respiratory Distress Syndrome (RDS)	No	Ref		Ref	
	Yes	0.18(0.04– 0.77)	0.021*	0.4-(0.001-0.32)	0.014*
Syndromic Baby	No	Ref		Ref	
	Yes	1.64(0.18– 14.87)	0.66		

DISCUSSION

Our study revealed that 13.3% of all the neonates initially admitted to NICU included in the study required readmissions within the neonatal period of 30 days. Lee KS et al(10). also reported that the neonatal readmission rate was 20percent in their study which is higher than the result of our study. In contrast to our finding, a study conducted at Saudi Arabia reported a readmission rate of only 2.1 %. The relatively high prevalence of newborn readmissions seen in our analysis was explained by the inclusion of all preterm and low birth weight infants who also had several medical conditions, as these patients were already at a higher risk of readmission. Due to the high readmission trend and severe lack of hospital beds in NICUs in low-resource countries, readmissions have an overall negative impact on the health system. Additionally, the disruption that each family experiences as a result of the neonatal readmission is a crucial element.

The median age of neonates in our study was 1 (0-5)**,** In agreement to our result a study conducted at Karachi reported that the average age of participant admitted to NICU was 3.5 days(11). Our study also reported that short length of NICU stay was associated to higher risk of readmission. These results agreed with the study conducted by Luciano R. et al. They also noted how a brief hospital stay can increase the risk of readmission for conditions like jaundice, feeding issues, hypernatraemic dehydration, sepsis, congenital heart abnormalities, and gastrointestinal tract obstruction(12).

In our study the most common causes which are significantly associated to high readmission rate were prematurity, neonatal jaundice, sepsis and anemia. In agreement to our result Eyeberu at el reported that that neonatal sepsis and infection was the most common cause of neonatal admission followed by low birth weight and prematurity(13). In contrast to our findings, a research done in Croatia found that the top five causes for readmission were respiratory infections, jaundice, feeding troubles or vomiting, urinary tract infections, and umbilical cord problems(14). One of the most prevalent causes of readmission listed previously is difficulty with feeding(15) . However, in our analysis, the association between feeding problems and readmission was insignificant after controlling for confounders because it was only significant at the univariate level.

Other factors like as congenital heart disease (CHD), hypoxic-ischemic encephalopathy (HIE), meconium aspiration syndrome (MAS), and pneumonia are regarded as secondary causes of newborn morbidity rate, mortality and readmission to the NICU(9). This finding is in agreement to our result except MAS as this factor is not significantly associated to readmission rate in univariate model as well as in multivariate model also.

Preterm newborns are also one of the causes of hospital readmissions, earlier research studies also reported that preterm birth as the main reason for admissions. Preterm neonates made up 20% of average neonatal admissions, according to Ali et al. (16). Our findings also showed that readmissions were more common in preterm infants, which is in line with past studies. We can roughly compare our findings with those of Hannan KE et al. who found that the rate of readmission to hospital in low birth weight infants approaches to 45% in the first 18–22 months(17). Our results also revealed that the readmissions were significantly associated with babies who fall into the categories of very low birth weight (1500 gm) and also low birth weight (2500 gm).

According to our study, inadequate home care and low mother education levels are to blame for the higher readmission rate. Additionally, it has been noted that the parents of these newborns commonly skip follow-up appointments despite the fact that such babies require close follow-ups to assess prematurity-related problems and track weight developments.

Our study has some restrictions because it was conducted retrospectively in a single center, thus the results may not apply to all local practices. In this study, there was also no follow-up following discharge. The conclusions of our investigation are constrained by its short time span. Additionally, our setup is free of charge, making it more accessible to those from lower socioeconomic classes, however the results might not be generalizable to the entire community. To draw firm conclusions about causal relationships, future prospective should be conducted.

CONCLUSION

After leaving the NICU, newborns are most likely to bounce back and require re-admission. In Pakistan, community care is unpromising, and a lack of house visits by medical professionals could put further on hospitals. A comprehensive program for the care of newborns should exist, requiring the healthcare professionals to pay attention to the associated factors for readmission, such as maintaining good hygiene, understanding and supervising caregivers in the proper management and feeding of preterm, low birth weight babies, and formulating key

interventional steps in order to reduce the rate of readmissions and the physical and financial burden on healthcare professionals and improve patient outcomes. The rates of readmission can be reduced by evaluating the risk factors for re-admission prior to the initial discharge and by doing post-discharge follow-ups. This emphasizes the need for enhanced discharge protocols, which center upon comprehensive family training, regular frequent follow-up visits, and home team visits, and are specifically focused for preterm and low birth weight neonates. The likelihood of re-admission might be decreased with proper teaching of mothers on feeding the premature baby.

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