


ORIGINAL ARTICLE

Factors contributing to neonatal readmissions to a level 4 hospital within 28 days after birth

Olivia Jarrett ¹, Daeun Gim,¹ Helen Puusepp-Benazzouz ¹, Anthony Liu^{1,2} and Habib Bhurawala ^{1,2}¹Department of Paediatrics, Nepean Hospital, Nepean Blue Mountains Local Health District and ²Discipline of Paediatrics, The University of Sydney Nepean Clinical School, Faculty of Medicine and Health, The University of Sydney, Sydney, New South Wales, Australia**Aim:** To identify maternal and neonatal factors associated with neonatal readmissions.**Methods:** A case controlled, cross-sectional, retrospective review of neonatal readmissions within 28 days from birth to a level 4 hospital in Western Sydney was conducted from January to December 2018. Maternal and neonatal factors for readmission were assessed. A control group of 122 neonates were randomly selected. Comparative statistics and logistic regression analysis were used to analyse the data.**Results:** Of the 3914 neonatal discharges following birth, there were 129 neonatal readmissions (3.3%). Following regression analysis, gestational age (odds ratio 0.82, 95% confidence interval 0.7–0.97, $P = 0.02$) and intrapartum intravenous (IV) fluids (odds ratio 2.78, 95% confidence interval 1.66–4.67, $P < 0.001$) were associated with readmission. The majority of readmissions were feeding-related (72.9%). Of these readmissions, 29.8% had feeding concerns noted by nursing or midwifery staff during the initial hospital stay. During the initial hospital stay following birth, neonatal feeding issues were significantly associated with primiparous mothers ($P = 0.005$). Mothers who did not receive IV fluids during labour were also more likely to experience feeding issues ($P = 0.015$).**Conclusion:** Our findings indicate that hospital discharge prior to established feeding patterns may be associated with an increased incidence of neonatal readmission. The factors associated with neonatal readmission are earlier gestational age and intrapartum IV fluid administration. These findings suggest that more comprehensive feeding assessment prior to discharge, flexibility of discharge timing and increased community support may reduce neonatal readmission.**Key words:** community; feeding difficulties; general paediatrics; neonatal readmissions; neonatology; newborn.

What is already known on this topic

- 1 Early discharge reduces hospital costs, which may be offset by the cost associated with readmissions.
- 2 Early neonatal discharge following birth may be associated with an increased risk of neonatal readmission.

What this paper adds

- 1 Primiparous mothers had significantly more feeding-related issues identified during the birth admission.
- 2 Feeding-related issues were the commonest cause for neonatal readmission.
- 3 Intrapartum intravenous fluids were significantly associated with increased neonatal readmission rates.
- 4 Intrapartum intravenous fluids were significantly associated with reduced feeding difficulties following birth.
- 5 Better documentation and objective measures for feeding is required.

The purpose of post-natal care is to support the physical and emotional recovery of the mother and infant, to promote parenting confidence and wellbeing, and to establish infant feeding

in the first few days and weeks following birth.¹ However, the routine post-natal length of hospital stay for mothers and newborns has decreased markedly over the past two decades, mainly driven by cost-containment strategies of hospitals.² At our hospital, the average length of stay following a routine vaginal delivery and for an uncomplicated caesarean section is 2.1 days. Mothers known to caseload midwives and their newborns can be discharged at 6 h after birth. This short length of stay allows for only a limited opportunity for potential neonatal issues to present themselves and for medical and midwifery care to be provided.

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After discharge from our hospital, domiciliary care to mothers and their neonates is provided by the Midwifery at Home government-funded service until the infant is 7 days old. On average, 1–2 home visits will occur during this time period. However, some women fall outside the hospital's 'catchment area' and are therefore deemed ineligible for the Midwifery at Home service. Women in this position must rely on local community services such as the General Practitioner and are at risk of receiving no follow-up.³

Typically reducing the length of time that patients stay in the hospital, and increasing bed occupancy, is advocated to achieve service efficiency.¹ Reducing the length of time that mothers and their newborns spend in hospital after birth should theoretically contribute to hospital efficiency and cost. However, in 2018, this hospital reported higher neonatal readmission rates compared to peer hospitals in the state.

Factors contributing to the high readmission rate are unclear, and no prior studies in this population have been conducted. This study aimed to assess maternal, birth and neonatal factors associated with neonatal readmissions.

Methods

Design and subjects

This was a case controlled, cross-sectional, retrospective review of neonates readmitted to a level 4 hospital in Sydney, NSW over a 12-month period (January–December 2018) during the neonatal period (up to 28 days after birth). All readmissions were unplanned via presentation to the Emergency Department or direct to the post-natal ward, if previously discharged within 14 days. No planned readmissions were identified in the randomised selection of readmissions. A level 4 hospital is accredited to deliver and care for neonates from 34 weeks gestation, with at least one dedicated paediatric inpatient unit, intensive care unit and a senior paediatrician available at all hours. Exclusion criteria were neonates born at another hospital. If a neonate required more than one readmission during the neonatal period, each readmission was recorded as a separate event.

A control group was randomly selected from neonates born at the same hospital over the same time period and who did not require readmission during the neonatal period. It is assumed that these neonates did not require readmission at a different hospital. Cases were selected by Excel randomisation from a list of all births (subdivided into those requiring readmission and not) during the study period.

The study was approved by the Nepean Blue Mountains Local Health District Human Research Ethics Committee.

Measurements

Clinical data on both mother and infant were collected by retrospective file review of the hospital's electronic medical record. Three files per readmission were reviewed; firstly, from the infant readmission, secondly, from the infant's birth admission and thirdly, from the mother's delivery admission.

The maternal and delivery factors assessed were: gestation at birth, parity, delivery mode (i.e. normal vaginal delivery, vaginal delivery requiring instrumentation, emergency caesarean section or elective caesarean section), induction needs, syntocinon use during

labour, epidural or spinal anaesthetic administration, the administration of intravenous (IV) antibiotics or fluids, maternal psychosocial issues (i.e. history of depression, anxiety, domestic violence) and maternal medical issues including preeclampsia and diabetes (type I, type II, gestational).

Infant factors assessed were: birthweight, mode of feeding (breastfeed, artificial feed, i.e. formula or expressed breastmilk or a combination of artificial and breastfeeds), Sydney Local Health District sucking code for neonates (which scores six aspects of feeding, and is recorded by midwifery or nursing staff on the post-natal ward), the initial medical officer encounter (birth health check, post-natal ward review or neonatal intensive care unit), whether the infant required phototherapy or had hypoglycaemia, the length of hospital stay and the domiciliary care provided upon discharge (Midwifery at Home, caseload midwife, general practitioner).

The reasons for neonatal readmission were categorised as feeding issues, jaundice requiring phototherapy, weight loss, feeding support, sepsis workup, other (cyanotic episode, coryza etc.), multiple (jaundice and weight loss, jaundice etc.) or maternal reasons (anxiety, infection). Written comments that were recorded in patient files by the medical, nursing or midwifery staff were also collected if deemed to provide insight into the reason for or contributory factors to readmission.

Data analysis

SPSS IBM Corp. Released 2017. IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA) was used for data analysis. Chi-square and Student *t*-tests were used to compare between case and controls for categorical and continuous measures respectively. To explore predictive factors for readmission, backward elimination binary logistic regression was carried out, excluding variables with a significance level of $P \geq 0.05$. All respective assumptions were met and a P value of <0.05 was considered statistically significant.

Results

Between January and December 2018 there were 3914 neonatal discharges following birth and 129 neonatal readmissions (3.3%). The majority of mothers and their neonates (53.5%) were discharged within 24–48 h of birth. Upon discharge, domiciliary care through the Midwifery at Home service was arranged for 84.5% of neonates and their mothers; 5.4% were to receive care from their caseload midwife, and 10% were advised to follow-up with a general practitioner.

Of the neonates requiring readmission ($n = 129$), 84.5% were readmitted within the first week following discharge, and 13.2% were readmitted within 24 h of discharge (Fig. 1). Approximately, 50% were readmitted to the post-natal ward, 44% to the paediatric ward and 5% required readmission to the neonatal intensive care unit.

Initially, the control group comprised a random selection of 129 neonates who were born at the same hospital over the same time period and who did not require readmission. Incomplete patient files meant that seven cases were excluded from the audit. Finally, the control group comprised of 122 cases. There was no significant variation in admission or discharge data between the control and readmission groups.

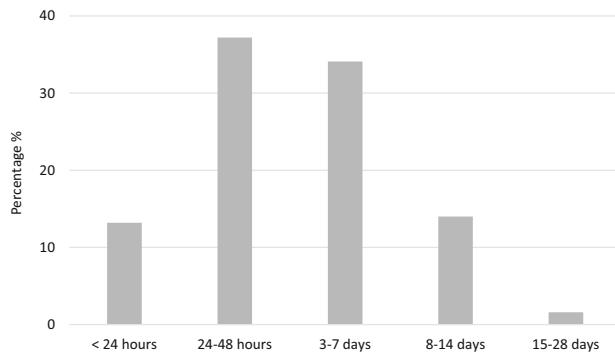


Fig. 1 Time between birth admission and readmission.

The maternal and delivery factors assessed are presented in Table 1. Of the 251 mothers in the control and readmission groups, 91 (36%) were primiparous and 160 (64%) were

multiparous. The majority of mothers had no history of medical issues or identified psychosocial problems. The neonatal factors assessed are presented in Table 2. The majority of neonates were delivered at full term (67%), weighed ≥ 2500 g (94%), were initially exclusively breastfed (69%) and their first medical officer encounter was at the time of the routine birth health check. Following regression analysis, the only significant variables for readmission were gestational age at birth (odds ratio 0.82, 95% confidence interval 0.70–0.97, $P = 0.02$) and intrapartum IV fluid administration (odds ratio 2.78 95% confidence interval 1.66–4.67, $P < 0.001$).

Figure 2 outlines the reasons for neonatal readmission. Jaundice requiring phototherapy was the primary reason for neonatal readmission (44%) followed by weight loss (18%). Readmission specifically for feeding support occurred in 10%. Based on nursing and midwifery documentation in the medical files, feeding difficulties (i.e. poor latch, low milk supply or long gaps between feeds) were commonly identified in neonates presenting with weight loss or jaundice. Grouped together, weight loss, jaundice

Table 1 Maternal and delivery factors for neonatal readmission

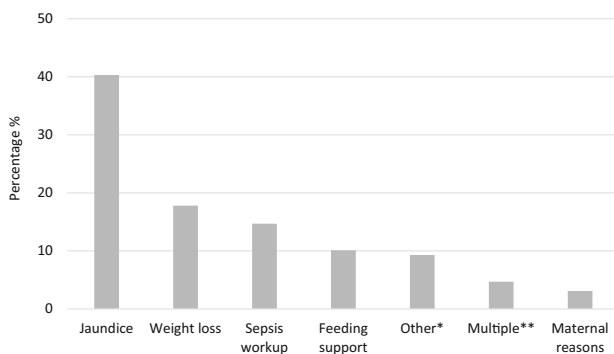
	Readmitted	Control	<i>P</i> value
Mean gestational age at birth (weeks)	38.6 \pm 1.6	39.1 \pm 1.6	0.01
Parity, <i>n</i> (%)			
Primiparous	48 (37)	43 (35)	0.78
Multiparous	81 (63)	79 (65)	
Preeclampsia, <i>n</i> (%)			
Yes	3 (2)	2 (2)	0.70
No	126 (98)	120 (98)	
Diabetes, <i>n</i> (%)			
No	107 (83)	107 (88)	0.39
Gestational	19 (15)	15 (12)	
Type 1	2 (2)	0 (0.0)	
Type 2	1 (1)	0 (0.0)	
Psychosocial issues, <i>n</i> (%)			
Yes	35 (27)	36 (30)	0.65
No	94 (73)	86 (70)	
Delivery, <i>n</i> (%)			
Normal vaginal delivery	78 (61)	77 (63)	0.07
Vaginal delivery with instrumentation	15 (12)	6 (5)	
Emergency caesarean section	12 (9)	22 (18)	
Elective caesarean section	24 (19)	17 (14)	
Induction, <i>n</i> (%)			
Yes	55 (43)	40 (33)	0.12
No	74 (57)	82 (67)	
Epidural/Spinal anaesthesia, <i>n</i> (%)			
Yes	57 (44)	35 (29)	0.01
No	72 (56)	87 (71)	
Labour augmentation with syntocinon, <i>n</i> (%)			
Yes	59 (46)	105 (86)	<0.001
No	70 (54)	17 (14)	
IVF, <i>n</i> (%)			
Yes	85 (65)	49 (40)	<0.001
No	45 (35)	73 (60)	

IVF, intravenous fluids.

Table 2 Infant factors

	Readmitted	Control
Mean birthweight (g)	3387 ± 575	3373 ± 600
Feeding record, <i>n</i> (%)		
3 × 5–6 score feeds	0 (0)	0 (0)
Incomplete documentation	129 (100)	122 (100)
Feeding mode, <i>n</i> (%)		
Breast	89 (69)	83 (68)
Artificial (bottle, syringe, finger)	13 (10)	20 (16)
Breast and artificial	26 (20)	17 (14)
No documentation	1 (1)	2 (2)
Initial medical encounter, <i>n</i> (%)		
Paediatric assessment on post-natal ward	12 (9)	18 (15)
Birth health check	96 (74)	82 (67)
NICU	17 (13)	18 (15)
None	5 (4)	4 (3)
Phototherapy during birth admission, <i>n</i> (%)	9 (7)	8 (7)
Hypoglycaemia during birth admission, <i>n</i> (%)	21 (16)	11 (9)

NICU, neonatal intensive care unit.

**Fig. 2** Reasons for neonatal readmission. *Reflux, BRUE, respiratory symptoms; **jaundice ± weight loss ± feeding support.

and feeding support accounted for 73% of readmission rates. Almost one-third of these had had feeding concerns noted by nursing or midwifery staff during their initial hospital stay. Of the 57 neonates readmitted for jaundice, 51 received midwifery visits at home and satisfied hospital policy for home phototherapy treatment. However, only five of these were offered or trialed with home phototherapy.

Primiparous mothers were reported to have more feeding issues during the birth admission. During the birth admission, feeding concerns were noted for 36% of primiparous mothers versus 21% of multiparous mothers ($P = 0.006$). The administration of IV fluids to the mother during labour was associated with significantly less feeding issues during the birth admission ($P = 0.009$).

Of the neonates with a birthweight <2500 g ($n = 14$), 50% had feeding concerns during the birth admission. Three had

jaundice requiring phototherapy, two of whom had feeding concerns noted during the birth admission. A fourth infant was readmitted with weight loss of 15% from birthweight, hypoglycaemia and hyponatraemia, which was thought secondary to dehydration. An additional two neonates were readmitted solely for feeding support. This compares to only 25% of neonates with a birthweight >2500 g reported to have feeding concerns during the birth admission.

Discussion

The provision of high-quality maternity care is essential for the health and wellbeing of mothers and neonates and may reduce the need for neonatal readmission. The initial hospital stay following birth provides an opportunity to establish breastfeeding, develop parenting skills and to identify early neonatal health concerns. However, many of these skills require time; well-established breastmilk, which is associated with reduced risk of jaundice, does not usually occur before 3 or 4 days and is less likely to be achieved in cases of early discharge.⁴ This time-reliant care competes with the ever-increasing demands on hospital resources and patient turnover,^{1,5,6} which increases the demands on domiciliary care models.⁷

This study examined the relationship between neonatal readmissions and maternal, birth and infant factors at a New South Wales level 4 hospital. We found that the majority of readmissions were potentially preventable and related to inadequate feeding (jaundice, weight loss and feeding support). There were significant feeding concerns during the birth admission in primiparous mothers, which highlights the need for closer attention to breastfeeding establishment.

Numerous studies^{8–10} have also found that a younger gestational age is a risk factor for neonatal readmission. Interestingly, Lain *et al.* and Tomashek *et al.* also identified breastfeeding an additional risk factor; Lain *et al.* looked at risk factors only for readmission for jaundice. Whilst our study did not draw the same significance, it did find that there was increased prevalence of feeding issues for younger gestational age and that the majority of readmissions were feeding-related (Fig. 2).

Additionally, the reduction of feeding concerns during the birth admission was associated with IV fluids to the mother during labour highlights the possible benefit of adequate hydration of the mother in the peripartum period. The effect of increased oral or IV fluid intake on breastmilk supply is, however, not well established and there are competing hypotheses that IV fluids may increase breastmilk supply, and also may contribute to breast tissue engorgement and latching difficulty.^{11–13} This hospital does not have a policy on IV fluid administration during labour. The need for IV fluids is a clinical judgement made by medical or nursing staff, for example if the woman appears dehydrated or in response to a non-reassuring cardiotocography. The administration of an epidural or spinal for caesarean section also requires IV fluids; the impact of opioid medication, local anaesthetic and decreased mobility of the mother on successful breastfeeding would require further assessment.

During the birth admission, feeding concerns were reported more in primiparous versus multiparous women but, once initial feeding concerns were identified, there was a high prevalence of readmission for feeding issues (jaundice, weight loss and feeding support) regardless of parity. This highlights the importance of

feeding assessment by midwives and nurses during the birth admission. Primiparous and multiparous mothers had similar lengths of stay in hospital following birth, but multiparous mothers may have received less feeding support due to an assumption of feeding proficiency from previous experience. Currently, no hospital policy exists to influence discharge planning if feeding concerns are present.

These findings are consistent with previous studies of primiparous mothers, which found that a significant proportion of patients were not meeting their goals for breastfeeding exclusivity¹⁴ and were not exclusively breastfeeding by 8 weeks postpartum.^{14–16} The most common breastfeeding problems identified were latch problems, pain and perceived insufficient milk supply.^{14,15,17} Collectively, this research underscores a critical need to address modifiable barriers to breastfeeding among primiparous women.

The main cause of jaundice requiring phototherapy was physiological, including breastfeeding jaundice, and all readmissions for jaundice were considered to be related to feeding issues. All neonates were managed with single or double phototherapy and topped up feeds of either formula or expressed breastmilk, which saw the resolution of jaundice in all neonates before their discharge.

The vast majority of neonates who were eligible for home phototherapy were not offered this treatment option and were advised to present to hospital for readmission. The poor compliance with the hospital policy for home treatment of jaundice highlights a potential poor understanding of the policy by staff or low staff confidence in-home treatment options and therefore, the need for staff education.

One limitation of this study is the lack of data on maternal socioeconomic status and the presence of a partner or family support, which may have contributed to the rate of hospital presentations and readmission rates. In addition to the authors' assessment of feeding during the birth, admission was limited due to inadequate documentation of the Sydney Local Health District sucking code. For this study, nursing and midwifery documentation was the primary method of determining feeding concerns.

Conclusion

The findings of this study suggest that adequate maternal hydration during labour may improve breastmilk supply and further research into this topic is required. Existing studies into the relationship between maternal IV fluids during labour, breastfeeding issues and readmission is limited, and is a suggested area of focus for future research. The need for more significant feeding support during the birth admission and increased domiciliary feeding support has been highlighted. This study has identified a need for policy development on breastfeeding assessment and discharge requirements. Furthermore, we suggest further research to better understand why there is poor adherence to home phototherapy policy with eligible neonates.

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