Early Readmission of Newborns in a Large Health Care System

WHAT'S KNOWN ON THIS SUBJECT: Early readmission of apparently healthy newborns may result from inadequate assessment of a newborn's readiness for discharge. Knowledge of the frequency, causes, and variation in the rate of newborn readmissions may assist in developing quality improvement interventions.

WHAT THIS STUDY ADDS: Feeding problems and jaundice, both potentially preventable, are the leading causes of readmission. Late preterm and early term newborns are more likely to be readmitted and should have close follow-up after discharge from a well baby nursery.

abstract

BACKGROUND: Early readmissions of apparently healthy newborns after discharge from well baby nurseries (WBN) may reflect an inadequate assessment of the newborn's readiness for discharge.

OBJECTIVE: To determine the frequency, causes, costs, and variations in rates of early rehospitalization of newborns discharged from 21 WBNs in 1 health care system.

METHODS: We queried the Enterprise Data Warehouse of Intermountain Healthcare (IH), a large Utah health care system, to identify newborns with gestational ages of 34 to 42 weeks discharged from an IH WBN between 2000 and 2010. We identified all newborns admitted to an IH hospital within 28 days of discharge and recorded their birth hospital, age, reason(s) for admission, length of stay, and inpatient costs.

RESULTS: During the study period, 296 114 infants were discharged from IH hospital WBNs. Of these, 5308 (17.9/1000) were readmitted within 28 days of discharge. Of the 5308 infants who were readmitted, 41% had feeding problems, 35% had jaundice, and 33% had respiratory distress. The majority of newborns with feeding problems and jaundice were admitted in their first 2 weeks of life. Late preterm and early term newborns had higher rates of readmission than term infants. There were significant variations in readmission rates of newborns born at the 21 hospitals in the IH system.

CONCLUSIONS: Potentially preventable conditions, including feeding problems and jaundice, account for most early readmissions of newborns. Late preterm and early term newborns have higher rates of readmission and should be assessed for other factors associated with early readmission. *Pediatrics* 2013;131:e1538–e1544

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KEY WORDS

early readmission, well baby nursery, late preterm newborns

ABBREVIATIONS

AAP—American Academy of Pediatrics
EDW—Enterprise Data Warehouse
EGA—estimated gestational age
IH—Intermountain Healthcare
LOS—length of stay
LPN—late preterm newborn
OR—odds ratio
WBN—well baby nursery

Dr Young conceptualized and designed the study, conducted the analyses and wrote the initial manuscript, and approved the final manuscript as submitted. Mr Korgenski conducted the query of the Intermountain Data Warehouse and collected all the data. He carried out the initial analyses, reviewed and revised the manuscript, and approved the final manuscript as submitted. Dr Buchi participated in the design of the study and the interpretation of the data analyses; she critically reviewed and approved the final manuscript as submitted.

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Unplanned readmission of a newborn after discharge from the birth hospitalization is described in the American Academy of Pediatrics (AAP) "Policy Statement—Hospital Stay for Healthy Term Newborns" as a potential indicator of an "inadequate assessment" by health care providers of the newborn's readiness for discharge.[1] Listed as indicators of readiness for discharge are "physiologic stability, family preparedness and competence to provide newborn care at home, availability of social support, and access to the health care system and resources."[1] Most studies of the determinants of newborn readmissions have concentrated on assessing the relationship between readmission and nursery length of stay (LOS), typically comparing "early" discharge (ie, before 48 hours) with later discharge. The majority of these studies found that newborns, particularly late preterm newborns (LPN; those born between 34 and 36 6/7 weeks), who were discharged early were at higher risk compared with those discharged later.[2] Several of these studies were done to evaluate the effect of legislation passed in the early 1990s mandating 48-hour stays for uncomplicated deliveries.[3–5] Rates of readmission have varied widely in different studies. One reported a rate of 43 per 1000 in LPN and 27 per 1000 in term newborns.[2] Another reported 10-day readmission rates ranging from 10 to 15 per 1000 with significant variation associated with the day of the week of discharge.[5] Escobar and colleagues found 2-week readmission rates that varied from 10 to 37 per 1000 among 7 hospitals within a single health care system.[6]

Readmission of Medicare patients has received considerable attention from the Centers for Medicare and Medicaid Services as a reflection of poor quality of care and a source of excess health care cost.[7,8] Approximately 20% of Medicare patients are readmitted within 30 days of discharge. High readmission rates are viewed as a negative indicator of the quality of care during a hospitalization and, particularly, of the discharge assessment and process.[7,8] In an effort to reduce these high rates, Centers for Medicare and Medicaid Services will impose financial penalties on hospitals that have higher than acceptable rates of readmission for myocardial infarction, pneumonia, and congestive heart failure.[9] Similar penalties are included in the provisions of the Affordable Care Act.[9]

There have been a few studies of readmission of pediatric patients.[10–12] Gay reported that 8.4% of patients who were discharged from the Monroe Carell, Jr. Children's Hospital at Vanderbilt (Nashville, TN) were readmitted within 15 days. Of the 1455 patients who were readmitted, 11.1% were newborns; the most common reason for readmission was treatment of hyperbilirubinemia.[10] Berry studied readmissions to 37 US children's hospitals and found that 21.8% of discharged patients were readmitted within 1 year of discharge. In this study, a high proportion of children with chronic complex conditions experienced ≥4 readmissions in the year after their index admission.[11] In another study, Berry and colleagues reported substantial variation in 30-day pediatric readmission rates for both common and uncommon conditions among 71 children's hospitals.[12]

From the perspectives of parents, physicians, and payers, an unplanned, unexpected readmission within a few weeks after discharge of an ostensibly healthy newborn from a well baby nursery (WBN) is an undesirable event. As suggested in the AAP statement, such a readmission may reflect an inadequate assessment of the newborn's readiness for discharge, a lack of resources and/or an inability of a parent to provide early newborn care, or inappropriate and/or untimely availability of, or access to, outpatient care.[1] Factors such as gestational age or initial LOS may be associated with different risks of readmission. Variations in readmission rates among hospitals may suggest differences in nursery and/or outpatient care practices. An understanding of these factors and of the diagnoses and timing of readmissions is necessary to develop strategies to reduce the risks of readmissions.

In this article, we report the results of a study conducted in a large health care system in Utah. The first objective of our study was to determine the frequency of readmissions of newborns after discharge from WBNs. Second, we sought to identify the diagnoses associated with readmission with the goal of determining whether any of these might be preventable. The final objective was to determine whether there were differences in readmission rates associated with the particular hospital nursery from which the baby had been discharged.

METHODS

To conduct the study we used the Intermountain Healthcare (IH) Enterprise Data Warehouse (EDW). IH is a large, vertically integrated health care system that includes hospitals in Utah and Idaho, 21 of which have maternity services. There are between 25 000 and 30 000 births each year at IH. The EDW contains data related to the newborn's gestational age, LOS, and any diagnoses made during the birth hospitalization. The EDW also contains information regarding admissions to an IH hospital or observation unit, including the reason for hospitalization, the LOS, and the cost of the hospitalization. Approximately 95% of infants who are hospitalized in Utah are admitted to an IH hospital.

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We queried the EDW to identify all newborns with gestational ages between 34 and 42 weeks who were discharged alive between 2000 and 2010. Newborns who stayed >24 hours in or were discharged from a NICU were excluded. From this cohort, we identified all newborns who had been admitted to an IH hospital or observation unit within 28 days of their discharge date, the age and reason(s) for the admission, the LOS, and inpatient costs. Comprehensive financial data are provided in the IH EDW. Individual standardized charges are defined by each IH facility for the supplies and services provided. Additionally, total cost data are calculated based on the sum of the actual fixed and variable costs for all charges posted to the patient's account receivable file for the encounter. The IH budgeting department updates and restates standard costs quarterly.

Statistical Analysis

We used descriptive statistics to summarize the readmission rates and the causes, timing, and costs of readmissions for each birth hospital and for each year. We compared newborns who were readmitted with those who were not in terms of gestational age, initial LOS, birth hospital, and year of birth, using χ^2 and t tests as appropriate. We used multivariate logistic regression to calculate the odds ratios (ORs) and 95% confidence intervals for readmission for various combinations of independent variables. Statistical analyses were performed by using Stata 12; P values <.05 were considered statistically significant.

The Institutional Review Boards of the University of Utah Health Sciences Center and IH approved the study

RESULTS

During the 11-year study period, there were 296 114 babies discharged from 21 IH WBNs. Of these, 5308 (17.9/1000) were readmitted within 28 days of their discharge date. Table 1 shows the 5 most frequent readmission diagnoses. Many babies had >1 reason for readmission, reflected by sum of the percentages being considerably >100%. The timing of readmissions for the 5 most common causes is shown in Table 2. Just under half occurred in the first week, with the remainder being evenly distributed over the following 3 weeks. There were differences in the timing of readmissions associated with the various causes; almost 90% of the newborns admitted for jaundice were admitted in the first week, as were nearly 50% of those admitted for feeding problems. Admissions for the other 3 causes were fairly evenly distributed over the 4-week period.

As shown in Tables 3 and 4, gestational age was strongly associated with the likelihood of readmission. Both late preterm and early term newborns (37–38 weeks estimated gestational age [EGA]), compared with term newborns, were significantly more likely to be readmitted, and, as shown in Table 4, ORs for readmission were significantly greater for all gestational ages <40 weeks. Table 5 compares the nursery LOS of newborns who were readmitted with those who were not. Late preterm newborns who were readmitted had a significantly shorter LOS than those who were not readmitted. There was a slight but significantly longer LOS for term newborns who were readmitted compared with the LOS for those who were not. A similar slightly longer LOS was seen in early term newborns who were readmitted, but this difference was not statistically significant.

Table 6 lists the readmission rates and the ORs for readmission for each of the 21 IH hospitals with maternity services. Readmission rates varied between 7.9 and 44.6 per 1000 live births with a mean of 17.9. Seven of the hospitals had rates that were significantly different from the mean; 5 were lower and 2 higher. Table 7 shows the ORs for readmission for each of the hospitals adjusted for the EGAs and LPN status of the newborns born at that hospital. There were no appreciable differences with the adjustments suggesting that the differences in readmission rates are not explained by differences in the EGAs or LPN status of the babies who were born at the hospital.

TABLE 1 Causes of Readmissions, N = 5308 (17.9/1000 WBN Discharges)

Cause	N (%)
Feeding problems	2170 (40.9)
Jaundice	1873 (35.3)
Respiratory distress	1753 (33)
Rule out sepsis	1193 (22.5)
Infection	1124 (21.2)

The mean rehospitalization LOS for infants who were readmitted was 68 ± 77 hours, with a range of 12 to 345 hours. The mean cost of a readmission hospitalization was $4548.00 ± $8893 with a range of $382 to $ 31 784.

DISCUSSION

Readmission of newborns within a month after discharge, although infrequent, is an undesirable event from the point of view of the newborn's parents, doctors, and payers. We found a 1-month readmission rate of 17.9 per 1000 discharges from 21 WBNs in a large health care system in Utah. We also found considerable variation in readmission rates among the hospitals, suggesting that there may be differences in care practices in the nurseries and/or in the newborn's medical home.

The AAP Policy Statement "Hospital Stay for Healthy Term Newborns"[1] suggests that readmission is an indicator of an "inadequate" assessment of a newborn's readiness for discharge. The assessment is to include, in addition to determining physiologic stability, family preparedness, availability of social

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TABLE 2 Readmissions by Week, n (%)

	Week 1	Week 2	Week 3	Week 4
Total *N* = 5308 (%)	2358 (44)	946 (18)	966 (18)	1038 (20)
Feeding problem, *n* = 2170 (%)	1057 (49)	346 (16)	364 (17)	403 (19)
Jaundice, *n* = 1873 (%)	1664 (89)	116 (6)	53 (3)	40 (2)
Respiratory distress, *n* = 1753 (%)	367 (21)	446 (25)	460 (26)	480 (27)
Rule out sepsis, *n* = 1193 (%)	392 (33)	256 (21	263 (22)	282 (24)
Infection, *n* = 1124 (%)	247 (22)	255 (23)	305 (27)	317 (28)

TABLE 3 Readmission Rates by Gestational Age Category

Gestational Age Category	*n* (%)	Readmission Rate per 1000
Late Preterm (34–36 wk)	19 081 (6.4)	34.6[a]
Early Term (37–38 wk)	94 178 (31.8)	20.6[a]
Term 39–42 wk	180 144 (60.8)	14.8
Total Births	296 114	17.9

[a] $P < .000$ compared with term readmission rate per 1000.

TABLE 4 ORs for Readmission by EGA

EGA	OR	95% CI	*P* Value
34	2.7	2.1–3.5	.000
35	3.0	2.6–3.6	.000
36	2.5	2.2–2.8	.000
37	1.9	1.7–2.1	.000
38	1.4	1.3–1.5	.000
39	1.2	1.1–1.3	.001
40	1 (ref)		
41	1.0	0.9–1.2	.666
42	0.8	0.3–2.2	.680

CI, confidence interval.

TABLE 5 Differences in Initial LOS for Readmitted and Nonreadmitted for Each Gestational Age Category (Vaginal Births)

Gestational Age Category	LOS (h) Readmitted	LOS (h) Not Readmitted	*P* Value
Late preterm	66.8	79.7	.0026
Early perm	44.2	43.1	.08
Term	42.6	41.5	.003

support, and access to follow-up care. Unfortunately, our data do not permit us to assess whether the variations we found were associated with differences in family preparedness or access to follow-up care; future studies should attempt to assess these important factors.

A longer LOS might increase the ability of nursery personnel to assess readiness for discharge. We found that LPN who were readmitted had a LOS that was a little more than half a day shorter; it is possible that the longer LOS in those not readmitted reflects time that was used for additional counseling regarding lactation or other interventions that lessened the risk of a readmission. There were small differences in the LOS for early term and term newborns who were subsequently readmitted. The LOS for those who were readmitted was ~1 hour longer than for those who were not, a difference that was statistically significant for term infants and approached significance ($P < .08$) for early term infants. The large sample size increases the likelihood of finding statistically significant differences that may not be clinically significant. However, it is possible that the extra time is a marker indicating the presence of factors such as feeding problems or waiting for a bilirubin result that might be associated with an increased risk of readmission.

Our finding that the 2 most common reasons for readmission were jaundice and feeding problems may have implications for prevention because these 2 conditions frequently occur together and are both potentially amenable to interventions that could prevent the need for hospitalization. Eggert and colleagues reported that rehospitalization for hyperbilirubinemia dropped from 5.5 per 1000 to 4.3 per 1000 after institution of a program of universal discharge bilirubin screening. Newborns were placed in 1 of 3 risk zones, based on their age and bilirubin levels, and this information was provided to both the parents and the follow-up primary care physician.[13] We are not aware of any studies evaluating outpatient interventions to prevent feeding problems, such as lactation support for breastfeeding mothers, but it is reasonable to speculate that such interventions might reduce the number of infants who require admission because of excessive weight loss secondary to problems with feeding. Because clinicians are more likely to readmit babies with jaundice who also have feeding problems, such interventions might also reduce the number being admitted for jaundice.

The aggregate cost of readmissions for this population is not insignificant. With an average cost of $4500, the total cost of the 5300 readmissions over the 11-year study period was almost $24 million. These estimates reflect actual costs of care rather than charges. Interventions designed to reduce readmissions such as a longer LOS for LPN, earlier and more frequent outpatient visits, universal bilirubin screening, or more intensive lactation counseling would all be associated with increased costs. The figures from our study could provide a preliminary estimate on which to base a cost-benefit analysis of interventions such as more intensive lactation support or universal bilirubin screening. Assuming that future studies suggested that these or other interventions resulted in a reduction in rehospitalizations, policy makers might use our figures to inform decisions about how much they would be willing to spend to prevent 1 rehospitalization.

We found that newborns with EGAs of 37 to 38 weeks had higher readmission rates than those born at 39 to 42 weeks. The readmission rate of these "early term" newborns was 20.6 per 1000 compared with 14.6 for those born at 39to 42 weeks. Jaundice and feeding problems accounted for 83% of the

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TABLE 6 Readmission Rates for IHs

Hospital	Deliveries	Readmission Rate	OR[a]	95% CI	*P* Value
A	20 637	18.3	1.0	0.90–1.2	.74
B	30 160	13.8	0.77	0.68–0.86	<.001**
C	253	7.9	0.44	0.11–1.8	.244
D	4750	44.6	2.6	2.2–3.0	<.001*
E	27 033	21.9	1.2	1.1–1.4	<.001*
F	371	13.5	0.75	0.31–1.8	.52
G	24 239	10.9	0.60	0.52–0.7	<.001**
H	104	19.2	1.1	0.26–4.4	.92
I	39 857	25.3	1.4	1.3–1.6	<.001*
J	25 353	10.7	0.59	0.52–0.68	<.001**
K	36 807	16.0	0.89	0.8–0.99	.041**
L	13 685	14.7	0.82	0.70–0.96	.012**
M	745	13.4	0.75	0.40–1.4	.36
N	2233	14.4	0.8	0.56–1.1	.22
O	741	20.2	1.1	0.68–1.9	.63
P	1409	18.5	1.0	0.70–1.5	.89
Q	208	9.6	0.53	0.13–2.2	.38
R	43 630	17.9	1.0 (ref)		
S	6699	20.6	1.2	0.97–1.4	.12
T	854	10.5	0.59	0.30–1.1	.11
U	16 626	21.9	1.22	1.1–1.4	<.002*
Total	296 114				
Mean		17.9			

CI, confidence ratio.

[a] Unadjusted OR.

* Readmission rate significantly greater than the mean.

** Readmission rate significantly less than the mean.

TABLE 7 ORs for Readmission Adjusted for EGA and LPN Status at Each Hospital

Hospital	Unadjusted OR	95% CI	OR Adjusted for EGA	95% CI	OR Adjusted for Proportion of LPN	95% CI
A	1.0	0.90–1.2	1.1	0.92,1.2	1.0	0.92–1.16
B	0.77	0.68–0.86	0.79	0.70–0.90	0.77	0.68–0.86
C	0.44	0.11–1.8	0.46	0.11–1.8	0.46	0.11–1.9
D	2.6	2.2–3.0	2.6	2.23–3.01	2.6	2.2–3.0
E	1.2	1.1–1.4	1.3	1.1.1.4	1.2	1.1–1.4
F	0.75	0.31–1.8	0.78	0.32–1.89	0.78	0.32–1.9
G	0.60	0.52–0.7	0.61	0.53–0.70	0.60	0.52–0.69
H	1.1	0.26–4.4	1.1	0.28–4.6	1.11	0.28–4.5
I	1.4	1.3–1.6	1.5	1.3–1.6	1.4	1.3–1.5
J	0.59	0.52–0.68	0.61	0.53–0.70	0.60	0.52–0.69
K	0.89	0.8–0.99	0.90	0.81–1.0	0.89	0.80–1.0
L	0.82	0.70–0.96	0.86	0.73–1.0	0.83	0.71–0.98
M	0.75	0.40–1.4	0.78	0.41–1.5	0.76	0.41–1.4
N	0.8	0.56–1.1	0.82	0.58–1.2	0.80	0.56–1.15
O	1.1	0.68–1.9	1.2	0.70–2.0	1.2	0.71–2.0
P	1.0	0.70–1.5	1.1	0.71–1.6	1.0	0.71–1.6
Q	0.53	0.13–2.2	0.56	0.14–2.2	0.53	0.13–2.1
R	1.0 (ref)					
S	1.2	0.97–1.4	1.2	0.98–1.4	1.6	0.96–1.4
T	0.59	0.30–1.1	0.61	0.32–1.1	0.6	0.31–1.2
U	1.2	1.1–1.4	1.3	1.1–1.4	1.2	1.1–1.4

CI, confidence ratio.

readmissions of early term newborns compared with 66% of those born at term (P = .000). This suggests a need for increased attention to these 2 problems in early term newborns. Although we do not have data regarding the factors that might have resulted in delivery before 39 weeks, it should be noted that IH has had, since 2002, a strong, and largely successful, policy of discouraging elective inductions or cesarean deliveries before 39 weeks.[14] It is likely that the majority of these early term deliveries were unplanned and resulted from conditions affecting either the mother or her fetus. It also appears that the morbidity associated with early term delivery is not limited to the neonatal period. A recent study found that early term newborns were more likely to exhibit delays in reading and mathematics in third grade compared with those born at term.[15] Pediatricians and others caring for early term newborns should view this group as being at higher risk compared with term newborns, just as they now do for late preterm newborns.[15–17]

We found considerable variation in the readmission rates among the 21 IH hospitals. As shown in Table 6, rates varied between 7.9 and 44.6 per 1000 live births with a mean of 17.9. Nine of the hospitals had rates that were significantly different from the mean; 5 were lower and 4 higher. We do not have sufficient information about possible differences in hospital policies and procedures regarding nursery care, discharge criteria or follow-up routines that might be associated with the variation. However, some factors are known. The largest outliers had substantially fewer deliveries than the majority of the hospitals. Hospital C, with a readmission rate of 7.9, had only 253 deliveries during the 11-year study period, and only 3 (1.2%) were LPN. Because of the wide confidence intervals related to the small number of births, the readmission rate was not significantly different from the mean. Hospital D, with a readmission rate of 44.6 (OR = 2.6, P <.001) had 4750 deliveries, with 302 (6.4%) being LPN, a proportion identical to the overall LPN proportion of 6.4%. Hospital I, the only other hospital with a higher than average readmission rate (25.3 per 1000), had the highest proportion of

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LPN at 8.03%. ($P = .000$ for comparison with mean LPN proportion of 6.4%.) However, when we performed multiple logistic regressions adjusting for EGA or for whether the baby was an LPN (Table 7), the ORs were virtually identical to the unadjusted ones shown in Table 6.

Our study has several strengths and several limitations. The large number of infants in the data set and the fact that virtually all infants in Utah who are admitted to a hospital are admitted to an IH facility allows an accurate assessment of the risk of readmission in this population. We also have complete data on the reasons for readmissions, their duration, and their associated costs. However, the study is limited to a single hospital system in Utah, and the results may not be generalizable to other parts of the country. We do not have information regarding possible differences in hospital polices regarding whether all or some apparently well late preterm newborns are routinely admitted to and remain in a NICU for their entire stay. Such babies would have been excluded from our study as noted in the Methods section. This could mean that some or most late preterm newborns would have been excluded from the denominator for some hospitals and could account for some of the observed variation in readmission rates among the hospitals. In addition, we do not have data on outpatient visits to primary care physicians because many infants receive their primary care outside of the IH system, and this information is not available in the EDW.

Our study highlights the point made in the AAP's "Hospital Stay for Healthy Term Newborns"[1] that a newborn readmission may be seen as an "indicator of the quality of the assessment of a newborn's readiness for discharge." The implication in the policy statement that an "adequate" assessment of readiness for discharge might prevent readmission remains to be demonstrated, however. It seems unlikely that readmissions for respiratory distress or possible sepsis can be prevented. However, readmissions for jaundice and feeding problems, which account for most readmissions, are potentially preventable. When health care providers who care for newborns are assessing readiness for discharge, they should look carefully for risk factors for jaundice and feeding problems, particularly in those with an EGA of <39 weeks. If such factors are present, delaying discharge or arranging for outpatient follow-up the next day so that these risk factors can be addressed may prevent readmission.

CONCLUSIONS

In a large health care system in Utah, we found that, over an 11-year period, 18 of 1000 newborns with gestational ages between 34 and 42 weeks who were cared for in WBNs were readmitted within their first 4 weeks of life. Both late preterm (34–36 weeks) and early term (37–38 weeks) newborns were more likely to be readmitted than those born at term. Feeding problems and jaundice were the most common diagnoses associated with readmission, and most of these occurred within 1 to 2 weeks of discharge. These findings suggest that when considering readiness for discharge of a newborn, one should carefully assess whether the infant is at risk for feeding problems and jaundice.

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