Early Newborn Hospital Discharge and Readmission for Mild and Severe Jaundice

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Objectives: To further explore the relationship of early newborn hospital discharge and readmission for jaundice, and to determine if early hospital discharge was associated with increased severity of jaundice among those readmitted.

Methods: We performed a population-based case-control study using Washington State vital statistics, birth certificates, and hospital discharge abstracts from 1991 to 1995. Cases included 750 infants readmitted to the hospital for jaundice in the first 2 weeks of life; controls included 3192 infants not readmitted. Infants with severe medical conditions and those delivered by cesarean section were excluded. Early hospital discharge was defined as fewer than 30 hours in the hospital; late hospital discharge, 30 to 78 hours. We assessed the risk for hospital readmission for jaundice, for hospital readmissions classified as brief (≤2 days) or prolonged (>2 days), and for hospital readmissions classified as uncomplicated or complicated.

Results: Infants discharged from the hospital early were at increased risk for jaundice (odds ratio, 1.34 [95% confidence interval, 1.10-1.64] adjusted for birth year, gestational age, maternal race and age, parity, payer, and infant sex). The risk associated with early hospital discharge was similar regardless of whether the hospital readmission was brief or prolonged and complicated or uncomplicated. One hundred twenty-two infants would have to stay for longer than 30 hours to avoid 1 jaundice readmission.

Conclusions: While newborns discharged from the hospital early are at increased risk for hospital readmission for jaundice, the clinical significance is limited. Mandating longer neonatal stays may not be the most effective strategy to prevent hospital readmission for jaundice and its complications.


Editor's Note: I still believe the hospital is no place for a person of any age unless he or she is very sick. On the other hand, newborns might be the exception, but for how many days?

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Routine hospital stays for mothers and newborns have decreased markedly over the past 5 years driven largely by cost-containment strategies of hospitals and third-party payers. Although there is no standard definition for early hospital discharge, the American Academy of Pediatrics defines early and very early as 48 and 24 hours, respectively, after an uncomplicated vaginal delivery. Early hospital discharge practices have been associated with increased hospital readmission rates for conditions that may not give rise to symptoms or signs on days 1 to 3 of life, with a high proportion of these hospital readmissions being related to jaundice. The reemergence of kernicterus and other jaundice-related illnesses is concerning and may be related to the result of US policies regarding early hospital discharge. These and other concerns have led to recent legislation at the state and federal levels culminating in the passage of the Newborns’ and Mothers’ Health Protection Act of 1996 mandating insurance coverage for a 48-hour stay for infants and mothers following a normal delivery.

Few studies have examined the potential risk factors and poor outcomes in infants discharged from the hospital early who develop jaundice. Among selected populations at low psychological, socioeconomic, and medical risk, limited data suggest that infants who are discharged from the hospital early are not at an increased risk of readmission for jaundice. Studies of high-risk populations have either found no increased risk of adverse events for infants discharged from the hospital early under restrictive circumstances, or were too small to detect clinically significant effects on impor-
PATIENTS AND METHODS

We conducted a retrospective population-based case-control study using data obtained from the Washington State Birth Events Record Database linked to the Comprehensive Hospital Abstract Reporting System for the years 1991 to 1995. The Washington State Birth Events Record Database file links birth certificate and infant death certificate data with maternal and newborn hospital admission records and provides time and date of birth, date of hospital discharge, and sociodemographic, perinatal, and newborn characteristics. The Washington State Comprehensive Hospital Abstract Reporting System file contains information abstracted from hospital discharge records on all nonmilitary acute care hospitals in Washington State and provides up to 9 International Classification of Diseases, Ninth Revision (ICD-9) diagnostic codes, up to 5 procedure codes, length of stay (LOS), and insurance information.

During the study period, there were 348,493 births with hospitalization in Washington State (Figure 1). Among these, 7388 infants (2.1%) were readmitted to a hospital less than 14 days after the birth date. We defined cases as infants readmitted within the first 14 days of life with jaundice listed as 1 of the first 3 hospital discharge diagnoses. To avoid potential confounding of timing of hospital readmission and physiologic jaundice, we restricted the case definition to hospital readmissions for jaundice occurring after age 72 hours. A total of 4099 infants were identified in this manner as potential cases.

Controls were infants not readmitted to the hospital in the first 2 weeks of life; 4 controls were frequency matched for each case, with matching on year of birth to account for secular trends in the treatment of jaundice.

To obtain a representative sample of cases and controls eligible for early hospital discharge, we included singleton births and gestation of at least 36 weeks. Infants were included if the first ICD-9 hospital discharge diagnosis was “healthy infant” and if there was no secondary ICD-9 diagnosis. This excluded infants with a diagnosis of jaundice during the birth hospitalization, infants with longer birth hospitalizations owing to severe medical conditions recognized at birth, and those delivered by cesarean section. Infants transferred from the birth hospital to another hospital were also excluded. This enabled us to include only the healthiest babies for evaluation. Using these inclusion and exclusion criteria, 11,327 infants were eligible for analysis, leaving 2164 potential cases and 9163 controls (Figure 1).

Using the technique defined by Liu et al., we calculated the LOS variable in 2 steps. First, we subtracted the newborn’s date of hospital discharge from the date of birth. If the difference between hospital discharge and birth was zero (same-day hospital discharge or <24 hours), we categorized these newborns as early hospital discharge; if 1 (hospital discharge 1 day after birth or 0-48 hours), indeterminate; and if 2 (hospital discharge 2 days after birth or 48-72 hours), late hospital discharge. However, as is the case with most national hospital discharge data, the time of hospital discharge was unavailable in our data set. Therefore, the early hospital discharge group constituted only those newborns sent home the same day they were born and did not include the many infants discharged from the hospital within 24 hours but on the following day.

In the second step we modified the LOS variable to capture the proportion of infants discharged from the hospital within 24 hours but on the following day. We assumed that most newborns are discharged from the hospital prior to 6 PM on any given day. Therefore, using the hour of birth provided by the Birth Events Record Database file, we added to our early hospital discharge group infants born between 6 PM and midnight who were discharged from the hospital the following day. For example, an infant born after 6 PM on January 1, 1995, and discharged from the hospital on January 2, 1995, was classified as early hospital discharge. We redefined infants in the indeterminate and late hospital discharge groups in a similar fashion. Using this LOS variable, all newborns in our early hospital discharge group were discharged from the hospital within 30 hours and all newborns in the late hospital discharge group were discharged from the hospital between 30 and 78 hours: 2 discrete, nonoverlapping groups.

The indeterminate group consisted of infants discharged from the hospital between 6 and 54 hours. This group has considerable overlap between the early and late hospital discharge groups. Therefore, to most accurately assess the effect of early hospital discharge, we compared children with known early hospital discharge (≤30 hours) with those with known late hospital discharge (>30 hours). Inclusion of the indeterminate group is shown for completeness of descriptive data only. Consequently, among the study population, 750 cases and 3192 controls remained in the analysis (Figure 1).

Data on variables potentially related both to early hospital discharge and to increased risk for hospital readmission were abstracted from the birth certificate and included maternal age, marital status, maternal education, maternal race or ethnicity, insurance status, parity, gestational age, Apgar score, sex, and birth weight. We were interested in the interaction of early hospital discharge and temporary home isolation on the risk of hospital readmission. Because we did not have information on follow-up in this population, we examined the effect of a weekend hospital discharge, when clinics and offices might be closed, as a proxy to decreased access to a health care provider.

tant outcomes. In a recent study by Liu et al., a large database was used to show that infants discharged from the hospital early were at increased risk of readmission in the first 30 days of life with a large number of these admissions owing to jaundice. In contrast, a recent smaller study showed that early hospital discharge after an uncomplicated delivery appears to have little or no independent effect on the risk of hospital readmission.

Because the study by Liu et al did not separate jaundice from other outcomes, we conducted this study to specifically examine subgroups at risk for hospital readmission for jaundice after early discharge. We were also interested in whether being sent home before a weekend, when many clinics and offices are closed, might place infants discharged from the hospital early at particularly increased risk for hospital readmission for jaundice. Finally, once readmitted to the hospital, we were interested in whether infants discharged early were at increased risk for longer hospitalizations and if they had more severe jaundice complications after hospital readmission.
We performed subanalyses to assess the relationship between early hospital discharge and increased severity of illness on hospital readmission. Using the Comprehensive Hospital Abstract Reporting System file, we compiled a jaundice severity variable that included diagnoses known to be associated with more extreme jaundice, including kernicterus, exchange transfusion, sepsis, and death. Created as a dichotomous variable, an infant was classified as having a complicated jaundice hospital readmission if he or she had any one of these diagnoses. In addition, we dichotomized the hospital readmission for jaundice into a brief stay (≤2 days) or a prolonged stay (≥3 days).

The risk for hospital readmission for jaundice within the first 2 weeks of life after early hospital discharge was calculated using stratified analysis. Cross tabulations were performed using the SAS computer program (SAS Institute, Cary, NC) and the odds ratio (OR) for early hospital discharge as a risk factor for hospital readmission was estimated with the Mantel-Haenszel test using Epilinfo (Centers for Disease Control and Prevention, Atlanta, Ga; World Health Organization, Geneva, Switzerland). After examination of the data, the adjusted ORs did not differ appreciably from unadjusted ORs. Therefore, for the analyses of subpopulations of interest only, the unadjusted ORs are presented. The association between early neonatal hospital discharge and hospital readmission for jaundice was further evaluated using logistic regression with maximum likelihood estimation of ORs and associated 95% confidence intervals (CIs). The final OR was adjusted for birth year, gestational age, maternal race and age, parity, payer, and infant sex.

To translate the association between early neonatal hospital discharge and hospital readmission for jaundice into a more clinically useful measure, the number needed to treat (NNT) was calculated. The NNT provides an understandable measure of the magnitude of effect and helps the clinician determine the usefulness of a potential intervention. In this case, the NNT estimates the number of infants an individual clinician would need to keep for longer than 30 hours (the late hospital discharge group) to save one additional hospital readmission for jaundice. The NNT was calculated based on the prevalence of jaundice during the study period and the risk for hospital readmission after early discharge.21

Finally, the risk for an increased LOS on hospital readmission for jaundice after early hospital discharge and the severity of jaundice complications after early hospital discharge were calculated using cross tabulation obtaining a χ² value. The study was approved by the Human Subjects Committee at the University of Washington, Seattle, and the Human Research Review Board at the Washington State Department of Health.

**RESULTS**

Early hospital discharge practices dramatically increased over the 5-year study period, with the proportion of early hospital discharges in cases and controls ranging from 36% of all hospital discharges in 1991 to 88% in 1995 (**Figure 2**). Characteristics of all 2164 infants readmitted for jaundice within the first 2 weeks of life compared with the 9163 controls are summarized in **Table 1** (including the indeterminate LOS group). A greater proportion of infants who were readmitted within the first 2 weeks of life for jaundice had mothers who were younger than 18 years, primiparous, or covered by Medicaid. Although most cases and controls were white, the proportion of Hispanic, Asian, and Native American infants among cases was relatively higher than controls. Infants who were readmitted were more likely than controls to have been male, born at 36 weeks' gestation, and had labor complications, but were similar to controls with respect to other neonatal characteristics.

**RISK FOR HOSPITAL READMISSION AFTER EARLY DISCHARGE**

Newborns sent home early were more likely than those discharged from the hospital late to be readmitted for jaundice in the first 2 weeks of life (OR, 1.34 [95% CI, 1.10-1.64] adjusted for year of birth, type of payer, infant sex, maternal age and race, gestational age, and parity). None of the independent variables confounded the relationship between early hospital discharge and hospital readmission for jaundice. Although not confounders, we chose...
to include year of birth, type of payer, infant sex, maternal age and race, gestational age, and parity in the final model to be consistent with prior work.

SUBSET ANALYSIS

The risk for hospital readmission after early hospital discharge was elevated for mothers who were younger than 18 years compared with older mothers (OR, 2.50 [95% CI, 1.00-6.41]; OR, 1.32 [95% CI, 1.11-1.58], respectively. The result of the \( \chi^2 \) test comparing these 2 ORs was 0.11 (Table 2). Though statistically significant, the risk of early hospital discharge among mothers who were of Hispanic or Asian race, primiparous, unmarried, did not graduate from high school, or had a Medicaid payer status was not heightened above that of the group as a whole.

We hypothesized that infants discharged from the hospital early who were sent home before a weekend (Thursday through Saturday) might be at especially increased risk for rehospitalization compared with those discharged from the hospital early and sent home at the beginning of the week. (We did not consider Sunday a high-risk day since a provider would potentially be available over the next 3 days following hospital discharge.) There was no difference in risk for hospital readmission between the 2 subsets of infants (OR, 1.43 [95% CI, 1.11-1.85] for infants discharged from the hospital Thursday through Saturday compared with OR, 1.31 [95% CI, 1.04-1.66] for those discharged from the hospital Sunday through Wednesday). Note that although the ORs are statistically significant, they are similar between the subgroups.

### LOS ON HOSPITAL READMISSION AND Complications

No difference in the LOS on hospital readmission for jaundice was found between infants discharged from the hospital early and those discharged late (OR, 1.35 [95% CI, 1.12-1.63] for infants staying \( \geq 2 \) days compared with OR, 1.43 [95% CI, 1.01-2.04] for infants staying \( > 2 \) days). Again note that although the ORs are significant, they are similar between the 2 subgroups. Infants discharged from the hospital early compared with those discharged late had a similar risk of complicated (OR, 1.44 [95% CI, 1.17-1.78]) and uncomplicated hospital admissions for jaundice (OR, 1.23 [95% CI, 0.93-1.62]). Although it is notable that all of the infants with kernicterus (n = 3), sepsis (n = 4), and death (n = 2) came from the early hospital discharge group, the small number of cases precluded finding a risk of adverse events associated with early hospital discharge (\( P > .05 \), Fisher exact test).

### NNT ANALYSIS

Based on a 2.5% prevalence of jaundice in healthy infants during the study period (including all healthy infants, even those with minor secondary diagnoses) and the risk for hospital readmission after early discharge (adjusted OR, 1.34), 122 infants would have to stay for longer than 30 hours to avoid 1 jaundice hospital readmission owing to early discharge.

### COMMENT

With the increasing number of infants being sent home early after birth (Figure 2), it is crucial that we understand the effect of such a widespread practice on the health of these newborns. Our data indicate that healthy infants sent home at younger than 30 hours were between 10% and 64% more likely to be readmitted to the hospital for jaundice than similar infants with longer neo-
Natal stays. This is consistent with the study by Liu et al\textsuperscript{6} which examined the overall risk for hospital readmission after early discharge. The recent study by Maisels and Kring\textsuperscript{10} also found a similar increased risk of hospital readmission after early discharge (infants discharged from the hospital \(48\) hours: \(\text{OR}, 1.91 [95\% \text{ CI}, 1.15-3.16]\)). The NNT is illustrative: using our data, \(122\) infants would have to stay in the hospital for longer than \(30\) hours to potentially avoid \(1\) hospital readmission for jaundice owing to the early discharge. Newborns readmitted to the hospital for jaundice were more likely to have been born to young mothers; however, other risk factors previously associated with early postpartum hospital discharge and hospital readmission, such as infants of poorly educated and unmarried mothers,\textsuperscript{6,16} were not identified in the current study.

We hypothesized that infants who were discharged from the hospital early before a weekend may have been at greater risk of hospital readmission for jaundice owing to the lack of access to a provider over a weekend. However, infants who were discharged from the hospital early before a weekend (Thursday through Saturday) did not appear to be at an increased risk for hospital readmission compared with infants who were discharged from the hospital early at the beginning of the week (Sunday through Wednesday). This result may suggest that follow-up over weekends is adequate for infants discharged from hospitals in Washington State, or that provider follow-up is not an influential factor in jaundice hospitalization and that early hospital discharge before a weekend does not place infants at increased risk above the mild increase already seen from the early hospital discharge.

Although this study has the advantage of large numbers for risk analysis, it also has several limitations. The exact time of hospital discharge was not recorded; thus, a large number of potential cases and controls were excluded owing to the inability to classify them as either early or late hospital discharges. Second, breastfeeding status was not available. The study by Maisels and Kring\textsuperscript{10} found a strong association between breastfeeding and jaundice (OR, 4.21

| Table 2. Risk for Hospital Readmission for Jaundice Within the First 2 Weeks After Hospital Discharge Among All Newborns Discharged Early Relative to Those Discharged Late for Those With Selected Maternal and Infant Characteristics* |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Characteristic                  | Readmitted (N = 750) | Not Readmitted (N = 3192) | OR (95% CI) |
| Maternal age, y                 | Early | Late | Early | Late | Early | Late | Early | Late |
| <18                            | 24 (4.5) | 8 (1.0) | 80 (2.5) | 47 (1.5) | 2.50 (1.00-6.41) |
| 18-19                          | 47 (6.3) | 16 (2.1) | 167 (5.2) | 68 (2.1) | 1.20 (0.61-2.37) |
| 20-29                          | 293 (39.1) | 126 (16.8) | 1109 (34.7) | 665 (21.0) | 1.39 (1.10-1.77) |
| \(\geq 30\)                     | 129 (17.2) | 97 (12.9) | 554 (17.4) | 502 (15.7) | 1.17 (0.92-1.48) |
| Race                           | White | 353 (47.1) | 184 (24.5) | 1454 (45.6) | 1030 (32.3) | 1.36 (1.10-1.52) |
| Black                          | 7 (1.0) | 4 (1.0) | 44 (1.4) | 43 (1.3) | 1.71 (0.41-7.58) |
| Native American                | 20 (2.7) | 10 (1.3) | 40 (1.3) | 27 (1.0) | 1.35 (0.50-3.67) |
| Asian                          | 20 (2.7) | 28 (3.7) | 81 (2.5) | 64 (2.0) | 0.56 (0.03-1.15) |
| Hispanic                       | 88 (11.7) | 16 (2.1) | 224 (7.0) | 71 (2.2) | 1.74 (0.93-3.31) |
| Marital status                 | Married | 366 (48.8) | 201 (26.8) | 1382 (43.3) | 1037 (32.5) | 1.37 (1.12-1.66) |
| Unmarried                      | 137 (18.3) | 46 (6.1) | 524 (16.4) | 244 (7.6) | 1.39 (0.95-2.04) |
| Maternal education             | \(\leq\)High school | 349 (46.5) | 164 (21.9) | 1239 (38.8) | 884 (28.0) | 1.52 (1.23-1.87) |
| \(>\)High school               | 154 (20.5) | 83 (11.1) | 671 (21.0) | 398 (12.5) | 1.10 (0.81-1.49) |
| Birthweight, g                 | 2500-3500 | 306 (41.0) | 153 (20.4) | 1028 (32.3) | 640 (20.1) | 1.25 (1.00-1.56) |
| 3500-4000                      | 155 (20.7) | 71 (9.5) | 681 (21.3) | 488 (15.3) | 1.56 (1.14-2.15) |
| \(\geq 4000\)                   | 35 (4.7) | 18 (2.4) | 182 (5.7) | 142 (1.30) | 1.52 (0.79-2.92) |
| Labor complications            | No | 365 (48.7) | 175 (23.3) | 1391 (43.8) | 852 (26.7) | 1.28 (1.04-1.57) |
| Yes                            | 135 (18.0) | 62 (8.3) | 486 (64.8) | 355 (11.1) | 1.59 (1.13-2.24) |
| Payer                          | Medicaid | 231 (31.0) | 76 (10.1) | 784 (24.6) | 323 (10.1) | 1.25 (0.93-1.69) |
| HMO                            | 50 (6.7) | 24 (3.2) | 222 (7.0) | 170 (5.3) | 1.60 (0.92-2.79) |
| Commercial                     | 199 (26.5) | 142 (18.9) | 786 (24.6) | 734 (23.0) | 1.31 (1.02-1.67) |
| Other                          | 23 (3.1) | 5 (1.0) | 118 (3.7) | 55 (1.7) | 2.14 (0.72-6.82) |
| Parity                         | Primiparous | 293 (31.9) | 132 (17.6) | 707 (22.1) | 504 (15.8) | 1.29 (1.01-1.66) |
| Multiparous                    | 255 (34.0) | 112 (15.9) | 1160 (36.3) | 767 (24.0) | 1.51 (1.18-1.93) |
| Discharge by day of week       | Thu-Sat | 242 (32.3) | 112 (14.9) | 912 (28.6) | 605 (19.0) | 1.43 (1.11-1.85) |
| Sun-Wed                        | 261 (34.8) | 135 (18.0) | 998 (31.3) | 677 (21.2) | 1.31 (1.04-1.66) |

* Values are expressed as number (percentage). Early indicates hospital stay less than 30 hours; late, hospital stay 30 to 78 hours; OR, odds ratio; CI, confidence interval; and HMO, health maintenance organization. Crude OR for the risk of readmission with jaundice after early neonatal discharge, 1.37 (95% CI, 1.15-1.62). Missing values are excluded.
[95% CI, 1.80-9.87]); therefore, information about breastfeeding would be important in the evaluation of risk factors for hospital readmission for jaundice. Finally, knowledge about infant follow-up and possible use of home phototherapy would have helped us estimate the number of infants who had jaundice but were not readmitted.

The LOS on hospital readmission for jaundice and the risk of complications from jaundice were similar among infants who were discharged from the hospital early and those discharged late. While a prospective study that includes peak bilirubin levels would help to clarify the severity of jaundice in early vs late hospital discharge groups, the low absolute risk of complications would render such a study not feasible.

Our data suggest that while early hospital discharge is associated with a mild increased risk of hospital readmission for jaundice, discontinuing early hospital discharge practices may not be the best means to decrease the risk of hospital readmission for jaundice. Instead, the role of comprehensive follow-up and its effect on health outcomes after early hospital discharge should be investigated. Facilitating a safe transition from the hospital to the home environment and providing adequate support for infants who are discharged from the hospital early may be both medically and economically beneficial. Our finding that the LOS would need to be increased for 122 infants to prevent 1 hospital readmission for jaundice should provide another piece of insight to policymakers considering the optimal length of hospitalization for term newborns.

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