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# Length of Stay, Jaundice, and Hospital Readmission

M. Jeffrey Maisels, MB, BCh, and Elizabeth Kring, RN

**ABSTRACT.** *Objective.* To evaluate the effect of post-natal age at the time of discharge on the risk of readmission to hospital with specific reference to readmission for hyperbilirubinemia.

*Design.* Case-control study based on chart review.

*Setting.* Large suburban community hospital in southeastern Michigan, delivering more than 5000 infants annually.

*Patients.* Newborn infants, born between December 1, 1988, and November 30, 1994, who were readmitted to hospital within 14 days of discharge, were compared with a randomly selected control group who were not readmitted.

*Results.* Of 29 934 infants discharged, 247 (0.8%) were readmitted by the age of 14 days. One hundred twenty-seven (51%) were admitted because of hyperbilirubinemia and 74 (30%) with the diagnosis of "rule out sepsis." The factors associated with an increased risk of readmission to the hospital were: infant of diabetic mother [odds ratios (OR), 3.45; 95% confidence limits (CL), 1.39 to 8.60]; gestation  $\leq 36$  weeks (OR, 4.56; CL, 1.45 to 14.33), and 37½ to 38 weeks (OR, 2.95; CL, 1.63 to 5.35) versus  $\geq 40$  weeks; presence of jaundice in the nursery (OR, 1.73; CL, 1.14 to 2.63); breastfeeding (OR, 1.78; CL, 1.13 to 2.81); male sex (OR, 1.58; CL, 1.07 to 2.34); length of stay <48 hours (OR, 1.91; CL, 1.15 to 3.16) and 48 to <72 hours (OR, 2.09; CL, 1.25 to 3.50) versus  $\geq 72$  hours. Factors associated with readmission for jaundice were gestation  $\leq 36$  weeks (OR, 13.2; CL, 2.70 to 64.6), 36½ to 37 weeks (OR, 7.7; CL, 2.69 to 22.0), 37½ to 38 weeks (OR, 7.2; CL, 3.05 to 16.97) versus  $\geq 40$  weeks; jaundice during nursery stay (OR, 7.80; CL, 3.38 to 18.0); length of stay <48 hours (OR, 2.40; CL, 1.09 to 5.30) and 48 to <72 hours (OR, 3.15; CL, 1.40 to 7.09) versus  $\geq 72$  hours; male sex (OR, 2.89; CL, 1.46 to 5.74); and breastfeeding (OR, 4.21; CL, 1.80 to 9.87). Infants whose length of stay was <48 hours were at no greater risk for readmission for jaundice or other causes than those whose length of stay was  $\geq 48$  hours to <72 hours.

*Conclusions.* Discharge at any time <72 hours significantly increases the risk for readmission to hospital and the risk for readmission with hyperbilirubinemia when compared with discharge after 72 hours. The American Academy of Pediatrics recommends that infants discharged <48 hours should be seen by a health care professional within 2 to 3 days of discharge. Our observations, as well as those of others, suggest that this recommendation should also be extended to those discharged at <72 hours after birth. One approach to de-

creasing the risk of morbidity and readmission, particularly from hyperbilirubinemia, would be to help mothers to nurse their infants more effectively from the moment of birth. *Pediatrics* 1998;101:995-998; length of stay, early discharge, newborn infant, hospital readmission, jaundice, hyperbilirubinemia.

ABBREVIATIONS. OR, odds ratio; CL, confidence limit.

Notwithstanding recent legislative action, early discharge from well-baby nurseries (defined by the American Academy of Pediatrics as discharge from hospital <48 hours after birth<sup>1</sup>) is now the rule in the United States. It is not clear, however, whether this is associated with an increased risk of morbidity.<sup>2,3</sup> A population-based study from Ontario, Canada, found an association between a decreased length of stay from 4.5 to 2.7 days and the risk of readmission during the first 2 weeks of life,<sup>4</sup> whereas a hospital-based study from Ann Arbor, Michigan, found that newborns whose hospital stay was  $\leq 72$  hours were at a significantly greater risk for readmission than those whose stay was >72 hours.<sup>5</sup> A consistent finding is that the most common cause for readmission within the first 2 weeks of life is hyperbilirubinemia.<sup>2,4,5</sup> We therefore examined the effect of the infant's age at discharge on the risk of readmission to our hospital with specific reference to readmission for significant jaundice.

## METHODS

We reviewed all discharges from our well-baby nursery throughout a 6-year period (December 1, 1988 to November 30, 1994) and identified all infants (n = 247) who were readmitted to the pediatric service within 14 days of discharge. We compared the infants who were readmitted with a randomly selected control group (n = 247) of similar infants who were not readmitted to the hospital. To ensure an even distribution during the time period, we stratified the groups so that the same number of controls was chosen to match the study patients during each year of the study. The setting for the study is a large community hospital with more than 5000 annual deliveries, 80% of which are cared for by private pediatricians. Continuous data were compared by *t* test and categorical data by  $\chi^2$  analysis. Logistic regression analysis was used to compare the two groups.

## RESULTS

There were 29 934 infants discharged from our well-baby nurseries between December 1, 1988, and November 30, 1994, and 247 (0.8%) were readmitted by age  $\leq 14$  days. The diagnoses for readmission to the hospital are shown in Table 1. One hundred twenty-seven (51%) were readmitted because of hyperbilirubinemia and 74 (30%) with a diagnosis of "rule out sepsis." Discharge diagnoses in the 127

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**TABLE 1.** Diagnosis in 247 Infants Readmitted by Age 14 Days

	n	% of Admissions	Incidence Per 1000 Discharges
Hyperbilirubinemia	127	51	4.2
Rule out sepsis	74	30	2.4
Apnea/cyanosis	16	6.5	0.5
Periorbital infection	7	2.8	0.2
Dehydration/failure to thrive	5	2.0	0.2
Other*	18	7.3	0.6

\*Gastrointestinal reflux (4), seizures (3), cellulitis (1), gastroenteritis (1), malrotation (2), gallstones (1), hematuria (1), pyloric stenosis (2), hypocalcemia (1), urinary tract infection (1).

hyperbilirubinemic infants included 1 with Rh hemolytic disease, 4 with ABO hemolytic disease, and 122 with idiopathic jaundice, 107 of whom were breastfed. The mean bilirubin level in infants readmitted for phototherapy was  $19.3 \pm 2.7$  mg/dL (range, 14.5 to 28.9 mg/dL). Forty infants (31%) had bilirubin levels  $\geq 20$  mg/dL and 4 infants (3%)  $\geq 25$  mg/dL. The factors associated with the risk of readmission to hospital are shown in Table 2. Ninety-eight point three percent of infants discharged at  $\leq 72$  hours were delivered vaginally and 86.8% of those discharged at  $>72$  hours were delivered by cesarean section. The very strong association between length of stay and method of delivery is confounding and, because we were interested primarily in the effect of length of stay on hospital readmission, we omitted the method of delivery from the regression analysis.

An increased risk for readmission was associated with decreasing gestation, infant of (insulin-dependent) diabetic mother, breastfeeding, jaundice while in the nursery (diagnosed clinically by physicians or nurses), male sex, and length of stay  $<72$  hours (Table 2). If the mother was a smoker or membranes were ruptured for  $\geq 18$  hours, there was a decreased risk of readmission to hospital. There was no difference in the risk of readmission in infants discharged

at  $<48$  hours compared with those discharged at  $\geq 48$  to  $<72$  hours ( $P = .689$ ; OR, 0.91; 95% CL, 0.606, 1.38). Only 3 of our readmitted infants were discharged at  $<24$  hours and we could not, therefore, analyze the effect of even shorter nursery stays.

Hyperbilirubinemia accounted for the majority of readmissions and, because it is potentially preventable, we compared 127 infants readmitted for jaundice with a randomly selected control group of infants who were not readmitted. The factors associated with readmission for jaundice in these infants is shown in Table 2.

## DISCUSSION

Of all of the conditions found to account for readmission to the hospital within the first 14 days, only hyperbilirubinemia and dehydration/failure to thrive are susceptible to some kind of intervention that might prevent readmission. Only 5 of our 247 infants were readmitted because of dehydration/failure to thrive and we chose to examine more closely the issue of hyperbilirubinemia. As shown in Table 3, the effect of gestation was striking with odds ratios  $>7$  for infants  $\leq 38$  weeks gestation (versus  $\geq 40$  weeks). The infant's birth weight did not enter into the model as a significant factor, however. The presence of jaundice in the nursery is, not surprisingly, an important risk factor.

A length of stay of  $<72$  hours was also an important factor associated with the risk of readmission and, in particular, readmission for jaundice. However, although the American Academy of Pediatrics recommends closer follow-up for infants discharged  $<48$  hours we found no increase in risk of readmission to hospital for those infants whose length of stay was  $<48$  hours compared with  $\geq 48$  to  $<72$  hours. These findings are similar to those of Soskolne et al<sup>5</sup> and suggest that undue emphasis has been placed on the 48-hour time period. It seems that discharge at any time  $<72$  hours significantly increases the risk

**TABLE 2.** Factors Associated With Readmission to Hospital\*

Variable	Study Group (%)	Control Group (%)	Odds Ratio	95% Confidence Limits	P Value
IDM	8.5	3.2	3.45	1.39, 8.60	.011
Gestation (wk)					
$\leq 36\ddagger$	6.1	1.6	4.56	1.45, 14.33	.005
$36^{1/7}-37\ddagger$	8.9	5.7	1.91	0.86, 4.26	.082
$37^{1/7}-38\ddagger$	20.7	8.5	2.95	1.63, 5.35	.000
$38^{1/7}-39\ddagger$	20.2	22.3	1.11	0.66, 1.86	.689
$39^{1/7}-40\ddagger$	14.23	25.5	0.68	0.39, 1.17	.135
$\geq 40\ddagger$	29.6	36.4	0.75	0.50, 1.11	.126
Jaundice in nursery	72.9	56.7	1.73	1.14, 2.63	.006
Breastfeeding	80.6	65.9	1.78	1.13, 2.81	.000
Male sex	63.6	49.8	1.58	1.07, 2.34	.013
Maternal smoking	6.5	14.2	0.36	0.18, 0.71	.005
ROM $\geq 18$ h	1.2	5.7	0.09	0.02, 0.38	.001
Meconium	8.1	19.0	0.53	0.29, 0.96	.035
LOS $<48$ h§	45.8	42.1	1.91	1.15, 3.16	.011
LOS 48 h- $<72$ h§	40.9	34.4	2.09	1.25, 3.50	.005
LOS $\geq 72$ h	13.4	23.5	0.50	0.31, 0.82	.005

Abbreviations: IDM, infant of insulin-dependent mother; ROM, rupture of membranes; LOS, length of stay.

\* Stepwise logistic regression analysis.

† Compared with gestation  $\geq 40$  weeks.

‡ Compared with gestation  $<40$  weeks.

§ Compared with length of stay  $\geq 72$  hours.

|| Compared with length of stay  $<72$  hours.

**TABLE 3.** Factors Associated With Readmission for Jaundice\*

Variable Gestation (wk)	Study Group (%)	Control Group (%)	Odds Ratio*	95% Confidence Limits	P Value
≤36†	9.5	1.6	13.2	2.70, 64.6	.000
36 <sup>1/7</sup> –37†	16.5	4.7	7.7	2.69, 22.0	.000
37 <sup>1/7</sup> –38†	28.4	8.7	7.2	3.05, 16.97	.000
38 <sup>1/7</sup> –39†	20.5	24.4	1.94	0.86, 4.40	.104
39 <sup>1/7</sup> –<40†	9.5	26.0	0.84	0.33, 2.14	.605
≥40‡	15.8	34.7	0.38	0.21, 0.70	.001
Jaundice in nursery	90.6	55.9	7.80	3.38, 18.0	.000
LOS < 48 h§	47.2	46.5	2.40	1.09, 5.30	.027
LOS ≥ 48 h–<72 h§	44.1	33.1	3.15	1.40, 7.09	.005
LOS ≥ 72 h	8.7	20.5	0.37	0.16, 0.83	.009
Male sex	74.8	49.6	2.89	1.46, 5.74	.007
Breastfeeding	89.0	63.8	4.21	1.80, 9.87	.000
Meconium	3.2	22.8	0.16	0.04, 0.59	.006
ROM ≥ 18 h	1.6	7.1	0.08	0.01, 0.51	.004

Abbreviations: LOS, length of stay; ROM, rupture of membranes.

\* Stepwise logistic regression analysis.

† Compared with gestation ≥40 weeks.

‡ Compared with gestation <40 weeks.

§ Compared with length of stay ≥72 hours.

|| Compared with length of stay <72 hours.

for readmission with hyperbilirubinemia when compared with discharge after 72 hours.

Maternal smoking, rupture of membranes for ≥18 hours, and fetal passage of meconium were associated with a decreased risk of readmission to hospital. Rupture of membranes for ≥18 hours (but not maternal smoking) was also associated with a decreased risk of readmission for jaundice. An association between maternal smoking and lower neonatal serum bilirubin levels has been described previously,<sup>6,7</sup> although this has not been a consistent finding.<sup>8</sup> It is plausible that maternal smoking and prolonged rupture of the membranes could stress the fetus sufficiently to increase the production of glucuronosyl transferase. On the other hand, it is also possible that these are chance associations. Early meconium passage is associated with lower bilirubin levels presumably as a result of a decrease in the enterohepatic circulation of bilirubin.<sup>9</sup>

As far as the jaundice is concerned, there is no inherent reason why infants discharged after 72 hours should be less likely to develop significant hyperbilirubinemia than those discharged before 72 hours, unless some intervention occurs in the first 72 hours that affects bilirubin levels. Such intervention might include lactation counseling for the mother and lead to more frequent and effective breastfeeding. Eighty-nine percent of the infants readmitted with jaundice were breastfed and increasing the frequency of nursing is associated with a reduced risk of later hyperbilirubinemia.<sup>10</sup>

There is also evidence that mothering competence may be affected by early discharge. Eidelman et al<sup>11</sup> have demonstrated that women on the first postpartum day score significantly lower than nonpregnant women on standardized tests of cognitive function. Although they did not find any significant decrease in cognitive function in parturient women on the 2nd or 3rd day after delivery, it is possible that mothers discharged early on the 2nd day may nevertheless manifest some degree of confusion and forgetfulness. Such mothers will not be able to reliably inte-

grate information given to them by care givers and this could have an impact on the infant's well-being in the next several days. It is likely that the mothers of those infants discharged later have had a greater opportunity to establish good lactation under the guidance of nursing staff and lactation counselors.

To evaluate the possible effects of inadequate nursing, we observed the weight loss of infants readmitted for hyperbilirubinemia in the first 7 days. There were 121 such infants and we compared them with 57 infants who had been readmitted within 7 days for reasons other than jaundice, dehydration, or failure to thrive. The jaundiced babies had a mean weight loss (from birth weight) of  $6.75 \pm 4.36\%$  versus  $3.97 \pm 4.74\%$  in the nonjaundiced babies (a difference of 2.78%; 95% CL, 1.24, 4.15;  $P = .000534$ ). Although the mean weight loss does not seem excessive, the difference between the two groups suggests less adequate fluid and caloric intake in the jaundiced infants which is consistent with previous observations.<sup>7</sup>

There can be no doubt, however, that whether they are discharged at 30 or 60 hours of life, those infants who are readmitted on days 4 to 6 with hyperbilirubinemia have not achieved their peak bilirubin level by the time they leave the hospital. Thus, if we want to be sure we do not miss very severe hyperbilirubinemia (that, even in a healthy term newborn can, on occasion, have disastrous consequences<sup>12,13</sup>), then infants discharged <72 hours after birth should also be seen within 2 to 3 days of discharge. Perhaps current guidelines for the follow-up of infants should be reevaluated.

A weakness of this, and other similar studies, is that we do not have a true measure of morbidity in the early neonatal period. Because of the problem of ascertainment, we are forced to use hospital readmission as a surrogate for morbidity. As pointed out by Beebe et al,<sup>14</sup> the problems leading to admission such as jaundice, fever, or poor feeding often do not lead to a negative outcome even in the absence of intervention. Nevertheless, there is almost certainly a



greater potential for morbidity in this population than in a control group. In addition, the criteria for readmission vary from institution to institution, making comparisons with other studies difficult. It is also possible that admission of some infants to other hospitals, or the use of home phototherapy, could lead us to underestimate the incidence of readmission. During the study period, home phototherapy was rarely used and the known admission patterns of the pediatricians involved indicate that, at most, these would account for a very small proportion of the population and would not affect the conclusions of the study.

We conclude that the major reason for readmission to hospital in the first 2 weeks of life is hyperbilirubinemia (incidence 4.2 per 1000 discharges). Significant jaundice, and dehydration/failure to thrive (0.2 per 1000 discharges) are the only causes of readmission that are potentially susceptible to intervention in the first few days of life. Attempts to decrease the risk of hyperbilirubinemia and dehydration/failure to thrive should be directed at the early establishment of effective lactation and closer surveillance for those infants who have risk factors for readmission such as gestation <38 weeks, jaundice in the nursery, length of stay <72 hours, male sex, and breastfeeding. The risk of readmission is similar for infants discharged <48 hours or ≥48 to <72 hours, suggesting that any infant discharged at <72 hours should be seen by a health care professional within 2 to 3 days of discharge.

#### ADDENDUM

Since this article was submitted for publication, the following related additional studies and a commentary were published: Edmonson MB, Stoddard JJ, Owens LM. Hospital readmission with feeding-related problems after early postpartum discharge of

normal newborns. *JAMA*. 1997;278:299–303; Liu LL, Clemens CJ, Shay DK, et al. The safety of newborn early discharge. *JAMA*. 1997;278:293–298; Braveman P, Kessel W, Egerter S, et al. Early discharge and evidence-based practice. *JAMA*. 1997;278:334–336.

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