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M. Jeffrey Maisels and Elizabeth Kring
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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 after 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.” Discharge diagnoses in the 127 infants who were readmitted were: infant of diabetic mother (OR, 7.7; CL, 2.69 to 22.0), 37 1/7 to 38 weeks (OR, 7.2; CL, 1.39 to 8.60); gestation < 36 weeks (OR, 4.56; CL, 1.45 to 14.33), and 37 1/2 to 38 weeks (OR, 2.95; CL, 1.63 to 5.35) versus ≥ 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 ≥ 72 hours (OR, 2.09; CL, 1.25 to 3.50) versus ≥72 hours. Factors associated with readmission for jaundice were gestation ≤36 weeks (OR, 13.2; CL, 2.70 to 64.6), 36 1/2 to 37 weeks (OR, 7.7; CL, 2.69 to 22.0), 37 1/2 to 38 weeks (OR, 7.2; CL, 3.05 to 16.97) versus ≥ 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 ≥ 72 hours (OR, 3.15; CL, 1.40 to 7.09) versus ≥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 ≥ 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 decreasing 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.

N owithstanding recent legislative action, early discharge from well-baby nurseries (defined by the American Academy of Pediatrics as discharge from hospital <48 hours after birth[4]) is now the rule in the United States. It is not clear, however, whether this is associated with an increased risk of morbidity. 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,[1] whereas a hospital-based study from Ann Arbor, Michigan, found that newborns whose hospital stay was ≤72 hours were at a significantly greater risk for readmission than those whose stay was >72 hours.[2] A consistent finding is that the most common cause for readmission within the first 2 weeks of life is hyperbilirubinemia.[2,4,5] 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 χ² 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 to the hospital within 14 days of discharge. 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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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 ± 2.7 mg/dL (range, 14.5 to 28.9 mg/dL). Forty infants (31%) had bilirubin levels ≥20 mg/dL and 4 infants (3%) ≥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 ≥72 hours were delivered vaginally and 86.8% of those discharged at ≥24 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 at ≥72 hours (Table 2). If the mother was a smoker or membranes were ruptured for ≥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 ≥48 to <72 hours (P = .689; OR, 0.91; 95% CI, 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 ≤38 weeks gestation (versus ≥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 ≥48 to <72 hours. These findings are similar to those of Soskolne et al 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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Study Group (%)</th>
<th>Control Group (%)</th>
<th>Odds Ratio</th>
<th>95% Confidence Limits</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDM</td>
<td>8.5</td>
<td>3.2</td>
<td>3.45</td>
<td>1.39, 8.60</td>
<td>.011</td>
</tr>
<tr>
<td>Gestation (wk)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤36†</td>
<td>6.1</td>
<td>1.6</td>
<td>4.56</td>
<td>1.45, 14.33</td>
<td>.005</td>
</tr>
<tr>
<td>36‡/37–37†</td>
<td>8.9</td>
<td>5.7</td>
<td>1.91</td>
<td>0.86, 4.26</td>
<td>.082</td>
</tr>
<tr>
<td>38‡/39†</td>
<td>20.7</td>
<td>8.5</td>
<td>2.95</td>
<td>1.63, 5.35</td>
<td>.000</td>
</tr>
<tr>
<td>39‡/40‡</td>
<td>20.2</td>
<td>22.3</td>
<td>1.11</td>
<td>0.66, 1.86</td>
<td>.698</td>
</tr>
<tr>
<td>≥40‡</td>
<td>14.23</td>
<td>25.5</td>
<td>0.68</td>
<td>0.39, 1.17</td>
<td>.135</td>
</tr>
<tr>
<td>Jaundice in nursery</td>
<td>29.6</td>
<td>36.4</td>
<td>0.75</td>
<td>0.50, 1.11</td>
<td>.126</td>
</tr>
<tr>
<td>Breastfeeding</td>
<td>72.9</td>
<td>56.7</td>
<td>1.73</td>
<td>1.14, 2.63</td>
<td>.006</td>
</tr>
<tr>
<td>Male sex</td>
<td>63.6</td>
<td>49.8</td>
<td>1.58</td>
<td>1.07, 2.34</td>
<td>.013</td>
</tr>
<tr>
<td>Maternal smoking</td>
<td>6.5</td>
<td>14.2</td>
<td>0.36</td>
<td>0.18, 0.71</td>
<td>.005</td>
</tr>
<tr>
<td>ROM ≥ 18 h</td>
<td>1.2</td>
<td>5.7</td>
<td>0.09</td>
<td>0.02, 0.38</td>
<td>.001</td>
</tr>
<tr>
<td>Meconium</td>
<td>8.1</td>
<td>19.0</td>
<td>0.53</td>
<td>0.29, 0.96</td>
<td>.035</td>
</tr>
<tr>
<td>LOS &lt;48 h§</td>
<td>45.8</td>
<td>42.1</td>
<td>1.91</td>
<td>1.15, 3.16</td>
<td>.011</td>
</tr>
<tr>
<td>LOS ≥ 48 h–&lt;72 h§</td>
<td>40.9</td>
<td>34.4</td>
<td>2.09</td>
<td>1.25, 3.50</td>
<td>.005</td>
</tr>
<tr>
<td>LOS ≥ 72 h</td>
<td></td>
<td></td>
<td>13.4</td>
<td>23.5</td>
<td>0.50</td>
</tr>
</tbody>
</table>

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

*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 $\geq 18$ hours, and fetal passage of meconium were associated with a decreased risk of readmission to hospital. Rupture of membranes for $\geq 18$ 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, and it is also possible 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.

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.

There is also evidence that mothering competence may be affected by early discharge. Eidelman et al 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 rely on the guidance 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 ± 4.36% versus 3.97 ± 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.

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), 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, 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

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

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

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


ACKNOWLEDGMENT

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REFERENCES

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