

**ORIGINAL RESEARCH**

# Clinician Adherence to Guideline for Phototherapy Use in Newborns

*Diane J. Madlon-Kay MD, MS*

**Objectives:** The objectives of this study were (1) to determine clinician adherence to the 2004 American Academy of Pediatrics guideline for phototherapy use in newborns; (2) to compare adherence to the guideline in 2 different hospitals; and (3) to determine whether adherence to the guideline improved after the phototherapy nomogram was available in newborn charts.

**Methods:** This study was a retrospective review of medical records of 1160 newborns receiving care at the normal newborn nurseries at 2 Twin City, MN, hospitals. Four hundred thirty-six infants received phototherapy.

**Results:** When phototherapy was administered, it was indicated in 37% of cases and not indicated in 8%. In 56% of cases it was considered subthreshold. When phototherapy was not administered, it was appropriate in 99% of cases but was inappropriate or missed in 1% of cases. There was a significant difference in clinician adherence to the phototherapy guidelines between the hospitals. The addition of the phototherapy nomogram to the newborn charts did not change adherence to the guideline.

**Conclusions:** Clinicians infrequently missed providing phototherapy when it was indicated. Most infants received phototherapy when their bilirubin level was in the “optional” range. The interhospital variability of guideline adherence confirms results found in other studies. Because the addition of the phototherapy nomogram alone did not improve adherence to the guideline, alternative interventions targeted at nurseries should be considered. (J Am Board Fam Med 2012;25:437–441.)

**Keywords:** Clinical Practice Guideline, Hyperbilirubinemia, Newborns, Phototherapy, Retrospective Study

In 2004, the American Academy of Pediatrics (AAP) released revised recommendations for the management of hyperbilirubinemia in newborns of  $\geq 35$  weeks' gestation.<sup>1</sup> The guideline recommends that every newborn be assessed for the risk of developing severe hyperbilirubinemia by using measurements of total serum bilirubin (TSB) or transcutaneous bilirubin (TcB) or assessment of clinical risk factors before discharge. The new guideline for phototherapy is more complex because of the need

to interpret bilirubin levels by the infants' risk factors and age in hours, rather than days.

There seems to be only one report of the effect of the 2004 guidelines on clinical practice.<sup>2</sup> In a report from 11 Northern California Kaiser Permanente hospitals, the new guideline was associated with a substantial increase in the use of phototherapy, often in newborns with bilirubin levels lower than those recommended by the AAP.

The purpose of this study was to determine clinician adherence to the 2004 phototherapy guideline at 2 hospitals in the Twin Cities of Minnesota. An additional objective was to determine whether adherence improved when the AAP phototherapy nomogram was added to the newborn charts.

## Methods

The study was a retrospective review of medical records from 2 hospitals in the Twin Cities metropolitan region of Minnesota, to be referred to as hospitals A and B. The normal newborn nurseries

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From the Department of Family Medicine and Community Health, University of Minnesota Medical School, Minneapolis.

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**Corresponding author:** Diane J. Madlon-Kay, Department of Family Medicine and Community Health, University of Minnesota Medical School, 2020 E. 28th Street, Minneapolis, MN 55407 (E-mail: madlo001@tc.umn.edu).

in the 2 hospitals use the same orders and charts. Newborn care is provided by pediatricians and family physicians in both hospitals. Pediatric nurse practitioners also provide care to newborns in hospital B. Newborns at both hospitals routinely have TcB measured at 24 hours of age. The results are documented on the AAP predischarge nomogram in the chart. In October 2007, the AAP phototherapy nomogram also was placed in each newborn chart.

Newborns who received phototherapy at hospital A were identified from the Patient Administrative Services and Systems computer database. Infants receiving phototherapy with a gestational age of  $\geq 35$  weeks who were delivered from October 2006 through September 2008, a year before and after the addition of the phototherapy nomogram to the chart, were eligible for inclusion in the study.

To have an adequate sample size of infants receiving phototherapy, newborns receiving phototherapy at hospital B were included in the study. These infants also were identified from the Patient Administrative Services and Systems computer database. A random sample of 250 infants receiving phototherapy, with a gestational age of  $\geq 35$  weeks, and who were delivered from October 2006 through September 2008 was identified using a random number generator.

Newborns who did not receive phototherapy at hospital A were identified from the Patient Administrative Services and Systems computer database. A simple random sample of 724 infants with a gestational age of  $\geq 35$  weeks was identified using a random number generator. Newborns born from January through June 2007 and from January through June 2008 were included because much of their data were available from another study.<sup>3</sup>

Infants were excluded if they received care in a neonatal intensive care unit. The principal investigator (DJM-K) trained the chart reviewer. For quality assurance, a random sample of 10% of the charts was examined by both the reviewer and the principal investigator. No discrepancies were found. The study was approved by the University of Minnesota Institutional Review Board.

The AAP phototherapy nomogram recommends phototherapy be started at different TSB levels, depending on whether an infant is at high, medium, or low risk. The risk status of the infant was determined on the basis of the estimated ges-

tational age and whether the infant had a positive direct antigen result from a test of the cord blood.<sup>1</sup>

For infants who did not receive phototherapy, the highest TcB or TSB level and the infant's age in hours were determined from the predischarge nomogram. When a TSB was obtained within 2 hours of a TcB, the TSB was used for analysis. The software program BiliTool (available at [bilitool.org](http://bilitool.org)) was used to determine the bilirubin level at which phototherapy was recommended for the infant.<sup>4</sup> These infants were classified into 2 mutually exclusive groups:

1. Appropriate: TSB or TcB level below the level at which AAP recommends treatment.
2. Missed: TSB or TcB level at or above the level at which AAP recommends treatment.

For infants who did receive phototherapy, the TSB and the age of baby when the decision was made to start phototherapy was determined from the predischarge nomogram and the orders. BiliTool was used to determine the bilirubin level at which phototherapy was recommended for the infant. These infants were classified into 3 mutually exclusive groups:

1. Recommended: TSB at or higher than the level at which AAP recommends treatment.
2. Subthreshold: TSB  $\leq 3$  mg/dL below the level at which AAP recommends treatment.
3. Not recommended: TSB  $> 3$  mg/dL below the level at which AAP recommends treatment.

Note that the subthreshold category reflects the AAP guideline statement that it is an option to provide phototherapy at TSB levels 2 to 3 mg/dL below those shown in the phototherapy nomogram.

### **Statistical Analysis**

Demographics and characteristics about the infants and parents were summarized with descriptive statistics (means, standard deviations, and ranges for continuous measures; counts and percentages for categorical measures). The Fisher exact test was used to compare rates of phototherapy treatment groups between hospitals. Fisher exact tests also were used to compare rates of determination before and after nomogram in infants who did not receive phototherapy and those who did. *P*

less than .05 was deemed statistically significant. Using a 2-group Fisher exact test, a sample size of 436 infants receiving phototherapy has greater than 90% power to detect the difference between a before-nomogram group rate of “not recommended” phototherapy of 9% and an after-nomogram rate of “not recommended” phototherapy of 1% (with a .05, 2-sided level of significance). SAS version 9.1.3 (SAS Institute, Cary, NC) was used for the analyses.

## Results

A total of 1160 infants’ records were reviewed. The demographics of the infants are shown in Table 1. Seven hundred twenty-four infants did not receive phototherapy. In 99% of cases, this was “appropriate.” In 8 infants (1%), phototherapy was “missed,” that is, the infants should have received phototherapy per the AAP guideline but did not.

Four hundred thirty-six infants received phototherapy. Phototherapy was “recommended” for 37% of these infants according to the AAP guidelines. Phototherapy was started at a subthreshold bilirubin level for 56% of the infants. Thirty-three infants (8%) received phototherapy at bilirubin levels at which phototherapy was “not recommended.” Infants receiving phototherapy at hospital A were significantly more likely than infants at hospital B

**Table 1. Infant Demographics (N = 1160)**

Female, n (%)	571 (49)
Mean gestational age, weeks (SD)	39.2 (1.5)
Mean mother’s age, years (SD)	35.0 to 43.6
Mean birth weight, pounds (SD)	29.8 (6.1)
Range	15 to 50
Plurality, n (%)	7.5 (1.1)
Single	4.2–11.1
Multiple	1130 (97)
Mean APGAR score (SD)	30 (3)
1 minute	8 (1.2)
Range	2–10
5 minutes	8 (1.2)
Range	2–10
Method of birth, n (%)	9 (0.3)
Vaginal	6–10
Assisted vaginal	765 (66)
Caesarean section	73 (6)
	322 (28)

**Table 2. Infants Receiving Phototherapy by Location**

Phototherapy	Hospital A (n = 186)	Hospital B (n = 250)	Total (n = 436)
Recommended	80 (43)	80 (32)	160 (37)
Subthreshold	96 (52)	147 (59)	243 (56)
Not recommended	10 (5)	23 (9)	33 (8)

Values provided as n (%).  $P = .0389$  (Fisher’s exact test).

to receive phototherapy at recommended TSB levels, as shown in Table 2 ( $P < .05$ ).

The AAP phototherapy nomogram was added to the infants’ charts in October 2007 to try and improve appropriate phototherapy use. As seen in Table 3, the rates of appropriate avoidance and use of phototherapy did not change significantly with the addition of the nomogram to the chart. One percent of infants who should have received phototherapy did not, both before and after the phototherapy nomogram was added to the chart. There was a nonsignificant increase in the percent of infants receiving phototherapy at subthreshold levels, from 51% to 60%, after the nomogram was added.

## Discussion

The 2004 AAP hyperbilirubinemia guideline made major new recommendations, including a systematic predischarge risk assessment, ideally with a TcB or TSB measurement; use of a predischarge nomogram to guide timing of repeat bilirubin testing and follow-up after discharge; and the use of a new phototherapy treatment nomogram with the infants’ age in hours and 3 risk categories.<sup>1</sup> Little is

**Table 3. Use of Phototherapy before and after Phototherapy Nomogram in Chart**

	Before Nomogram	After Nomogram
No phototherapy*		
Missed	4 (1)	4 (1)
Appropriate	363 (99)	353 (99)
Phototherapy given†		
Recommended	86 (39)	74 (34)
Subthreshold	112 (51)	131 (60)
Not recommended	20 (9)	13 (6)

Values provided as n (%).

\* $P = 1.000$  (Fisher’s exact test).

† $P = .1570$  (Fisher’s exact test).

known about the effect of these new guidelines on clinical practice.

The hospital nurseries in this study routinely obtained a TcB for newborns at 24 hours and plotted the results on the predischarge nomogram. The phototherapy nomogram also became available in the charts in October 2007. Phototherapy was missed relatively infrequently (in 1% of infants who did not receive phototherapy). However, when phototherapy was initiated, in only 37% of infants was the TSB at a level at which the AAP recommended phototherapy. In most of the infants receiving phototherapy (56%), phototherapy was started at a TSB level at which the AAP considers phototherapy “optional.” Phototherapy was initiated in 8% of infants at levels at which the AAP does not recommend phototherapy.

A strength of this study is that the bilirubin levels were determined at the time the decisions were made to start phototherapy, rather than at the peak. Therefore, the phototherapy categories truly reflect the clinicians’ thinking at the time phototherapy was ordered. Because the peak bilirubin level was not used, it is possible that infants whose phototherapy was started at a “subthreshold” bilirubin level may have subsequently had a bilirubin level in “recommended” level. However, the TSB of many of these infants would never have reached a level for which treatment was recommended.

An increase in the proportion of infants receiving phototherapy at subthreshold TSB levels was noted in the one previous report of practice change associated with the 2004 AAP guideline.<sup>2</sup> The investigators speculated that physician concern about hyperbilirubinemia, coupled with increased testing, could lead to subthreshold use of phototherapy. They also noted that some neonatologists reported starting phototherapy for infants at subthreshold levels with the hope of preventing readmissions for phototherapy. Other suggested reasons for starting phototherapy at subthreshold levels included a high rate of increase in TSB levels and concern about the availability of postdischarge monitoring. Although phototherapy is generally considered safe, increased subthreshold use of phototherapy has the disadvantages of increasing costs and possibly decreasing breastfeeding rates.<sup>5</sup>

Significant differences in phototherapy use in different hospitals within the same health care system has been reported previously.<sup>2,6</sup> In a study of 11 Kaiser Permanente hospitals, the single most

important predictor of phototherapy use, according to AAP guidelines, was hospital of birth.<sup>6</sup> In this study, infants at the hospital that uses pediatric nurse practitioners received phototherapy less often according to the guideline. Although this may be a factor in the interhospital variation in this study, it does not explain the variation in the Kaiser Permanente study.<sup>6</sup>

It was disappointing that the addition of the phototherapy nomogram to the predischarge nomogram was not associated with improved adherence to AAP phototherapy guidelines. Confusion regarding the predischarge nomogram and clinician misuse of it to initiate phototherapy has been reported previously.<sup>7</sup> Mistaken use of the predischarge nomogram to guide phototherapy frequently would result in initiation at subthreshold bilirubin levels.

Increasing adherence to clinical practice guidelines is difficult, with 7 types of barriers described as affecting physicians’ adherence.<sup>8</sup> Clinician education traditionally has been recommended to try and improve compliance. It also has been suggested that interventions to increase adherence to phototherapy guidelines be targeted at hospitals rather than at individual clinicians.<sup>6</sup> Fortunately, the AAP recently developed a “Safe and Healthy Beginnings Toolkit” for the sole purpose of helping hospital nurseries implement the AAP hyperbilirubinemia guideline.<sup>9</sup>

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