

Biliblanket Utilization for Outpatient Treatment of Newborn Jaundice

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Abstract

Hyperbilirubinemia is a common neonatal diagnosis. Biliblankets have the potential to reduce readmission for hyperbilirubinemia. The study purpose was to characterize home biliblanket treatment for hyperbilirubinemia using retrospective medical record review of newborns with total serum bilirubin of 0.1 to 3 mg/dL below inpatient threshold seen at 9 pediatric clinics (N = 359). The main outcomes were whether a biliblanket was used and whether the usage impacted readmissions. Home biliblankets were used for 44% of newborns. Nine percent of newborns were readmitted for hyperbilirubinemia. Four percent of newborns treated with a biliblanket were readmitted compared with 13% of those not treated with a biliblanket ($P = .002$). Newborns treated with a biliblanket (odds ratio [OR] = 0.16; 95% confidence interval [CI] = 0.06–0.44) and newborns 3 days or older (OR = 0.16; 95% CI = 0.06–0.43) were less likely to be readmitted than newborns not treated with a biliblanket and 2-day-old newborns. We found that home biliblanket use was associated with lower odds of hospital readmission for newborn jaundice.

Keywords

hyperbilirubinemia, jaundice, newborn, phototherapy, biliblanket

Introduction

Physiologic jaundice appears in 60% to 80% of well newborns.¹ It typically develops between the second and fourth day of life, peaking between days 4 and 5. This peak generally occurs after hospital discharge.² As such, hyperbilirubinemia is the most common diagnosis for newborn readmission within the first 10 days of life.^{3,4} While usually benign, untreated severe hyperbilirubinemia poses potential devastating risks including developmental delay, bilirubin encephalopathy, kernicterus, and death. Thus, newborn jaundice should be closely monitored.

The 2004 American Academy of Pediatrics (AAP) hyperbilirubinemia guideline incorporates risk factor analysis and is widely used for neonatal hyperbilirubinemia management.^{5,6} The goal is to ensure each newborn is evaluated systematically and treated appropriately to reduce the risk of severe hyperbilirubinemia while also minimizing risks of unintended harm (family anxiety, decreased breastfeeding, unnecessary costs or treatment, potential risk of phototherapy). The AAP guideline recommends inpatient phototherapy for

neonatal hyperbilirubinemia when total serum bilirubin (TSB) is at or above the treatment threshold. It suggests that home phototherapy, mainly the use of a biliblanket, “may be considered” for use in low-risk newborns when TSB is 2 to 3 mg/dL below the inpatient treatment threshold.⁵

Biliblankets have been available in the United States for almost 30 years as an adjunct or alternative to inpatient phototherapy.⁷ Biliblankets have potential advantages over hospitalization, including fewer disruptions to maternal-infant bonding and lower cost.^{6–8}

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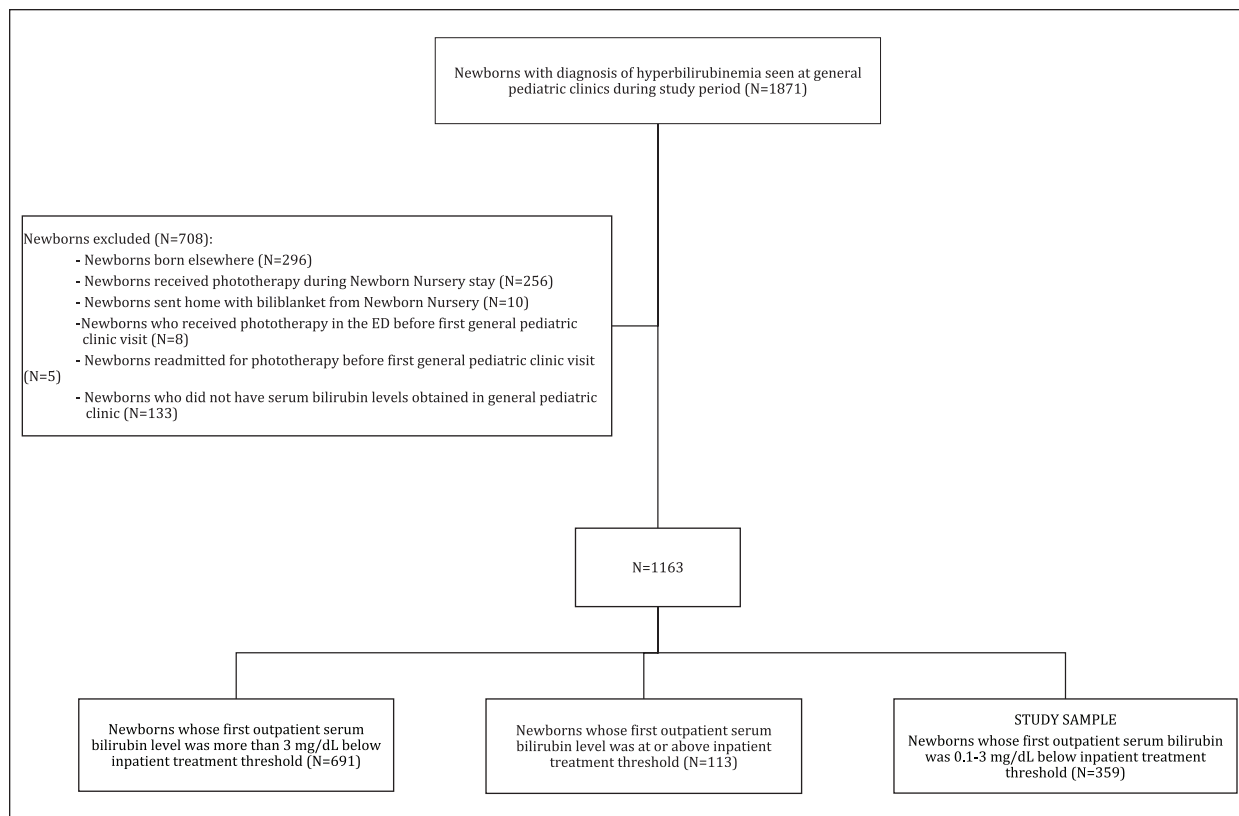


Figure 1. Inclusion/exclusion criteria.

However, compared with inpatient phototherapy, biliblankets may take longer to bring down TSB levels and infants cannot be monitored as closely.⁹ A 1993 survey found that about 1 in 3 pediatricians ever used biliblankets for neonatal hyperbilirubinemia. However, current biliblanket utilization is unknown.¹⁰ Moreover, biliblankets' role in reducing hyperbilirubinemia readmissions is unclear, lacking high-quality evidence to support or refute its use to treat hyperbilirubinemia.^{11,12} The purpose of our study was to characterize current patterns of biliblanket utilization to treat hyperbilirubinemia for neonates with TSB levels within 0.1 to 3 mg/dL below inpatient treatment threshold and to evaluate its impact on readmission, if any.

Methods

Study Design and Sample

We conducted an electronic medical record review of newborns (2-8 days old) with a clinic visit diagnosis of hyperbilirubinemia (primary or secondary diagnoses) at their newborn visit at 1 of 9 general pediatric clinics

affiliated with a single academic medical center (AMC) over a 2-year period (October 1, 2016, to September 30, 2018). (See the appendix for hyperbilirubinemia diagnosis codes.)

During the study period, the durable medical equipment (DME) department at our institution closed (October 1, 2017) due to organizational restructuring. As a result, biliblankets became less readily available. Therefore, using a dichotomous variable that reflects timing of newborn clinic visit (before/after) relative to DME closure, we included DME closure as a potential confounding variable.

Inclusion/Exclusion Criteria

We excluded newborns (1) not born at our affiliated AMC as details of birth history and nursery course including bilirubin levels were not reliably available; (2) who received phototherapy (including biliblankets) prior to their first clinic visit; and (3) who did not have a TSB level drawn in the clinic (Figure 1). The study was approved by our medical school's institutional review board.

Variables

Management of neonatal hyperbilirubinemia. We used Bilitool, an online resource based on the AAP hyperbilirubinemia guidelines, to assess neonatal hyperbilirubinemia risks and inpatient treatment thresholds. We assessed the management of hyperbilirubinemia for newborns with first outpatient TSB 0.1 to 3 mg/dL below inpatient treatment threshold. We assessed each medical record to determine the following: (1) outpatients who used biliblanket; (2) readmission for hyperbilirubinemia; (3) outpatients who obtained repeat TSB; (4) no further management or follow-up. The main outcome of our study was whether a home biliblanket was used for newborns whose first outpatient TSB was 0.1 to 3 mg/dL below the inpatient treatment threshold. Our secondary outcome was readmission for treatment of hyperbilirubinemia.

Independent Variables

Independent variables included: (1) sex; (2) age at first clinic visit (days old); (3) gestational age (GA) in weeks (<38 or ≥38 weeks); (4) family history of sibling with jaundice; (5) feeding type (exclusively breastfed vs some or entirely formula-fed); (6) percent weight loss from birth; (7) ABO blood type compatibility (yes, no, unknown); (8) direct antiglobulin test (DAT) (yes, no, unknown); (9) Bilitool risk level (low, medium, high); (10) difference of TSB from inpatient treatment threshold; and (11) clinic visit date relative to DME department closure (before or after).

Statistical Analysis

Descriptive statistics included simple counts and proportions. We performed simple logistic regression to examine associations between the outcome variables and each independent variable one at a time. We then performed multivariable logistic regression to identify factors associated with biliblanket use and readmission for hyperbilirubinemia adjusted for other variables in the model. We considered P values ≤.05 to indicate statistical significance. All statistical analyses were conducted using STATA 12 (Stata Corp., College Station, Texas).

Results

Sample Characteristics

Sample characteristics of 359 newborns are presented in Table 1. All newborns had lost weight at the first outpatient visit with a mean weight loss of -7.12% (range:

Table 1. Newborn Characteristics.

	Overall (N = 359) N (%)
Sex	
Male	190 (53)
Female	169 (47)
Gestational age, wk	
Preterm (<38)	125 (35)
Term (≥38)	234 (65)
Age at first clinic	
2 days	65 (18)
3 days	180 (50)
≥4 days (maximum age: 8 days)	114 (32%)
Feeding type	
Exclusively breastfed	283 (79%)
Some or all formula-fed	76 (21%)
ABO compatible	
Yes	176 (49)
No	91 (25)
Unknown	92 (26)
Bilitool risk level	
Low	215 (60)
Medium	140 (39)
High	4 (1)
Sibling with jaundice	
Yes	71 (20)
No	287 (80)
Unknown	1 (0)
Clinic visit relative to DME department closure	
Before	226 (63)
After	133 (37)

Abbreviation: DME, durable medical equipment.

-0.2% to -14%). Mean birthweight was 3.289 kg (range: 2.015-4.945 kg). Mean difference of first outpatient TSB from inpatient treatment threshold was 1.77 (range: 0.1-3).

Management of Neonatal Hyperbilirubinemia

Within the group of newborns with a first outpatient TSB within 3 mg/dL below the inpatient treatment threshold, 44% ($n = 159$) were treated with a home biliblanket (Figure 2). Overall, 9% of ($n = 32$) newborns with first outpatient TSB within 3 mg/dL below inpatient treatment threshold were readmitted. Notably, 4% ($n = 6$) of newborns treated with biliblanket were readmitted compared with 13% ($n = 26$) of those not initially treated with a biliblanket ($P = .002$; Table 3).

Among newborns not initially treated with a biliblanket ($n = 200$), 13 newborns were immediately readmitted for hyperbilirubinemia although the first

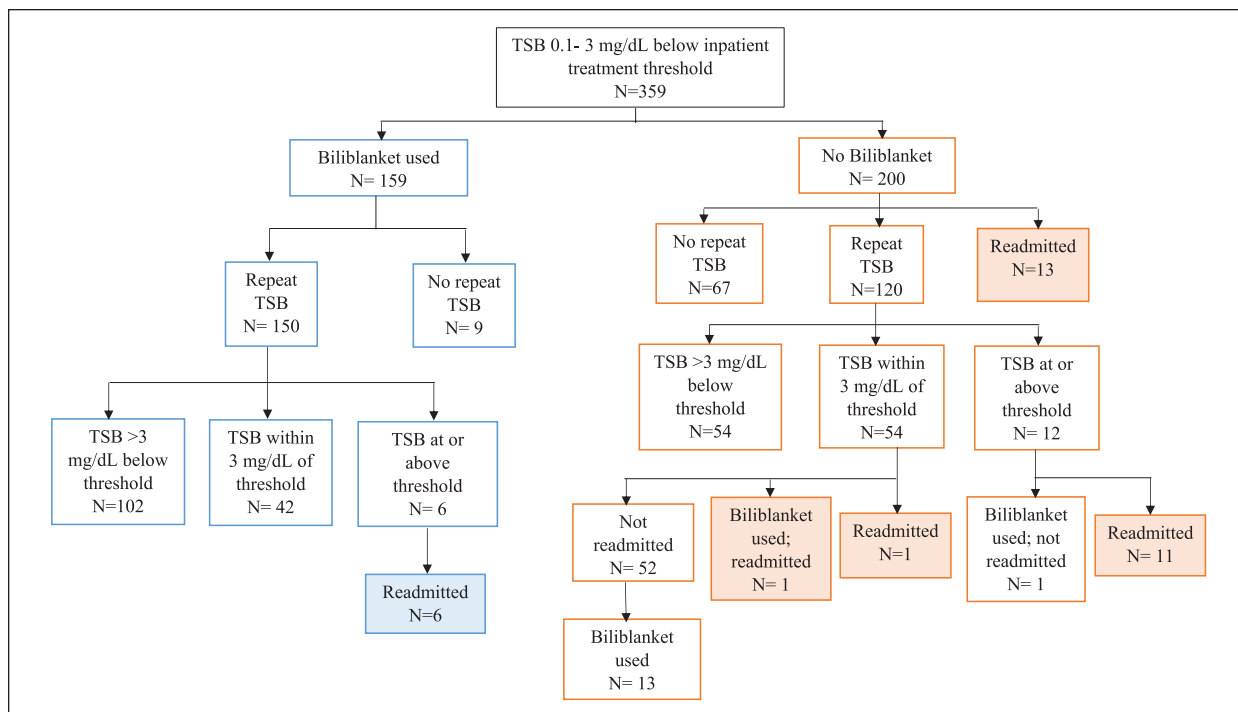


Figure 2. Management of newborns with first outpatient serum bilirubin (TSB) 0.1 to 3 mg/dL below inpatient treatment threshold. Abbreviation: TSB, total serum bilirubin.

TSB was below inpatient treatment threshold. The mean difference of TSB from the treatment threshold for these 13 newborns was 0.6 versus 1.59 for newborns initially treated with a biliblanket ($n = 159$) versus 1.99 for the remainder of the newborns not initially treated with a biliblanket ($n = 187$). Moreover, 7 of the 13 newborns readmitted for hyperbilirubinemia were late preterm newborns at medium or high risk to develop severe hyperbilirubinemia.

Of note, compared with two-third newborns treated with a biliblanket who had a repeat TSB that trended down (102/150), only 45% of newborns not initially treated with a biliblanket had repeat TSB that trended down (54/120). Regardless of the biliblanket use, there were some newborns who were subsequently readmitted with repeat TSB that increased to inpatient treatment threshold.

Factors Associated With Biliblanket Use

Bivariate Analyses

Men were more likely to be treated with a biliblanket than women (49% vs 38%, $P = .036$). Newborns seen before DME closure were more likely to be treated with

a biliblanket than those seen after DME closure (50% vs 35%, $P = .005$) (Table 2). There were no significant differences in biliblanket use by patient age, GA, Bilitol neurotoxicity risk level, feeding type, family history of jaundice, or percent weight loss.

Multivariable Analyses

Men (odds ratio [OR] = 1.56; 95% confidence interval [CI] = 1.01-2.41) and newborns seen before DME closure (OR = 1.84; 95% CI = 1.17-2.88) were more likely to be treated with a biliblanket than women and newborns seen after DME closure controlling for patient age, GA, Bilitol neurotoxicity risk level, feeding type, family history of jaundice, and percent weight loss (Table 2).

Factors Associated With Readmission

Bivariate Analyses

Newborns seen before DME closure were less likely to be readmitted than those seen after DME closure (5% vs 15%, $P = .002$) (Table 3). Two-day-old newborns were more likely to be readmitted than newborns 3 days or older (23% vs 6%, $P < .001$).

Table 2. Results From Bivariate and Multivariable Logistic Regression of Factors Associated With the Use of Home Biliblankets for Treatment of Neonatal Hyperbilirubinemia (N = 359).

Predictors	Home biliblanket use		Unadjusted OR (95% CI)	Adjusted OR (95% CI)
	Yes n (%)	No n (%)		
Percent weight loss from birth weight	Mean (SD) -7.05 (2.78)	Mean (SD) -7.18 (2.46)	1.02 (0.94-1.10)	1.02 (0.94-1.12)
Sex				
Male (n = 190)	94 (49)	96 (51)	1.57 (1.03-2.39)*	1.56 (1.01-2.41)*
Female (n = 169)	65 (38)	104 (62)	1.00 (Referent)	1.00 (Referent)
Gestational age, wk				
<38 (n = 125)	52 (42)	73 (58)	0.85 (0.55-1.31)	0.85 (0.31-2.37)
≥38 (n = 234)	107 (46)	127 (54)	1.00 (Referent)	1.00 (Referent)
Age at first clinic visit				
3+ days (n = 294)	133 (45)	161 (55)	1.24 (0.72-2.14)	1.20 (0.68-2.13)
2 days (n = 65)	26 (40)	39 (60)	1.00 (Referent)	1.00 (Referent)
Feeding type				
Exclusively breastfed (n = 283)	131 (46)	152 (54)	1.48 (0.88-2.49)	1.61 (0.90-2.90)
Some or all formula-fed (n = 76)	28 (37)	48 (63)	1.00 (Referent)	1.00 (Referent)
Bililtool neurotoxicity risk level				
High (n = 4)	2 (50)	2 (50)	1.19 (0.17-8.63)	1.08 (0.11-10.27)
Medium (n = 140)	59 (42)	81 (58)	0.87 (0.57-1.34)	1.05 (0.39-2.79)
Low (n = 215)	98 (46)	117 (54)	1.00 (Referent)	1.00 (Referent)
Sibling with jaundice				
Yes (n = 71)	28 (39)	43 (61)	0.78 (0.46-1.33)	0.85 (0.49-1.48)
No/Unknown (n = 288)	131 (45)	157 (55)	1.00 (Referent)	1.00 (Referent)
Clinic visit relative to DME department closure				
Before (n = 226)	113 (50)	113 (50)	1.89 (1.22-2.94)*	1.84 (1.17-2.88)*
After (n = 133)	46 (35)	87 (65)	1.0 (Referent)	1.00 (Referent)

Abbreviations: OR, odds ratio; CI, confidence interval; DME, durable medical equipment.

*Significant at P values ≤ 0.05 .

Multivariable Analyses

Newborns treated with a biliblanket (OR = 0.16; 95% CI = 0.06-0.44) and newborns 3 days or older (OR = 0.16; 95% CI = 0.06-0.43) were less likely to be readmitted than newborns not treated with a biliblanket and 2-day-old newborns controlling for sex, GA, Bililtool neurotoxicity risk level, feeding type, family history of jaundice, percent weight loss, timing of clinic visit in relation to DME closure, and difference of TSB from inpatient treatment threshold (Table 3).

Discussion

Our study provides a current look at how newborns with hyperbilirubinemia close to the inpatient treatment threshold are managed by outpatient general pediatricians in 1 academic medical center. In accordance with the 2004 AAP hyperbilirubinemia guideline, pediatricians in our study used home biliblankets to treat hyperbilirubinemia in nearly half of newborns with TSB 0.1 to 3 mg/dL below the inpatient treatment threshold. Our

study found that home biliblanket use was associated with decreased odds of readmission for hyperbilirubinemia in this specific subset of newborns. Although our study did not evaluate the duration or intensity of home biliblanket use as recently described by Chang and Waite,⁹ our study nevertheless suggests a potential benefit of biliblanket use in reducing readmission for hyperbilirubinemia.

We found that 9% of newborns with hyperbilirubinemia in the 0.1 to 3 mg/dL below threshold group were readmitted, similar to another recent study's overall readmission rate.¹³ In addition, when access to biliblankets at our institution was negatively affected by the closure of our DME department, it was associated with an increase in readmission rates. This further suggests the potential utility of home biliblankets in reducing readmission for treatment of neonatal hyperbilirubinemia. A larger randomized study of outpatient biliblanket use is needed to definitively determine whether biliblankets should be recommended for jaundiced newborns being monitored at home.

Table 3. Results From Bivariate and Multivariable Logistic Regression of Factors Associated With Readmission for Treatment of Neonatal Hyperbilirubinemia (N = 359).

Predictors	Readmitted for treatment of hyperbilirubinemia		Unadjusted OR (95% CI)	Adjusted OR (95% CI)
	Yes n (%)	No n (%)		
Percent weight loss from birth weight	Mean (SD) -7.61 (2.14)	Mean (SD) -7.07 (2.64)	0.92 (0.80-1.06)	0.96 (0.79-1.16)
Difference of TSB from inpatient treatment threshold	Mean (SD) 1.03 (0.71)	Mean (SD) 1.84 (0.82)	0.29 (0.17-0.48)*	0.25 (0.14-0.45)*
Biliblanket use				
Yes (n = 159)	6 (4)	153 (96)	0.26 (0.11-0.65)*	0.16 (0.06-0.44)*
No (n = 200)	26 (13)	174 (87)	1.00 (Referent)	1.00 (Referent)
Sex				
Male (n = 190)	14 (7)	176 (93)	0.67 (0.32-1.39)	1.22 (0.50-2.98)
Female (n = 169)	18 (11)	151 (89)	1.00 (Referent)	1.00 (Referent)
Gestational age, wk				
<38 (n = 125)	11 (9)	114 (91)	0.98 (0.46-2.10)	0.93 (0.17-5.05)
≥ 38 (n = 234)	21 (9)	213 (91)	1.00 (Referent)	1.00 (Referent)
Age at first clinic visit				
3+ days (n = 294)	17 (6)	277 (94)	0.20 (0.10-0.44)*	0.16 (0.06-0.43)*
2 days (n = 65)	15 (23)	50 (77)	1.00 (Referent)	1.00 (Referent)
Feeding type				
Exclusively breastfed (n = 283)	28 (10)	255 (90)	1.98 (0.67-5.82)	1.87 (0.51-6.87)
Some or all formula-fed (n = 76)	4 (5)	72 (95)	1.00 (Referent)	1.00 (Referent)
Bilitool neurotoxicity risk level				
High (n = 4)	1 (25)	3 (75)	3.65 (0.36-36.9)	1.15 (0.03-38.21)
Medium (n = 140)	13 (9)	127 (91)	1.12 (0.53-2.37)	1.44 (0.27-7.70)
Low (n = 215)	18 (8)	197 (92)	1.00 (Referent)	1.00 (Referent)
Sibling with jaundice				
Yes (n = 71)	8 (11)	63 (89)	1.40 (0.60-3.26)	1.41 (0.48-4.16)
No/Unknown (n = 288)	24 (8)	264 (92)	1.00 (Referent)	1.00 (Referent)
Clinic visit relative to DME department closure				
Before (n = 226)	12 (5)	214 (95)	0.32 (0.15-0.67)*	0.46 (0.19-1.10)
After (n = 133)	20 (15)	113 (85)	1.00 (Referent)	1.00 (Referent)

Abbreviations: OR, odds ratio; CI, confidence interval; TSB, total serum bilirubin; DME, durable medical equipment.

*Significant at P values $\leq .05$.

Moreover, we found that newborns treated with home biliblankets resulted in repeat bilirubin levels that trended down in a majority of cases (68%) compared with less than half (45%) of newborns not treated with biliblankets. The potential for biliblankets to decrease bilirubin levels, in addition to the AAP guideline's suggestion for considering their use, may explain why some pediatricians choose to use home biliblankets. Conversely, some pediatricians may not use biliblankets because bilirubin levels are also likely to decrease without intervention. Given that biliblankets were not used for half of the newborns within 0.1 to 3 mg/dL below the treatment threshold in our study, further

investigation is needed to evaluate physician beliefs and attitudes about home biliblanket use for neonatal hyperbilirubinemia to optimize care.

Finally, for newborns who had repeat bilirubin levels drawn, a small number crossed the inpatient treatment threshold that necessitated readmission, in both the biliblanket and no-biliblanket groups. Although biliblankets may have some utility in treating hyperbilirubinemia in the outpatient setting, they are not infallible. This emphasizes the need to remain clinically vigilant about monitoring newborns with hyperbilirubinemia close to the inpatient treatment threshold. Recent work by Kuzniewicz et al¹⁴ offers recommendations to help predict those

newborns who are more likely to have rapidly increasing bilirubin levels that might require readmission.

Limitations

First, our study sample was small in size and limited to newborns born at a single academic center and subsequently evaluated at its affiliated pediatric clinics; this has potential implications for the generalizability of our results. Second, while we confirmed home biliblanket use by chart review, the duration or intensity of home biliblanket use was not well-documented, is user-dependent, and could have varied.

Conclusion

Home biliblanket use was associated with lower odds of readmission for treatment of newborn jaundice in this small study. Our results suggest that home phototherapy might be an effective option to reduce readmissions for jaundiced newborns within 0.1 to 3 mg/dL below the inpatient treatment threshold. Further study is needed to clarify indications for home biliblanket use versus watchful waiting versus inpatient phototherapy for treatment of newborn hyperbilirubinemia. Opportunities to safely reduce readmission could have important impacts on newborn health, breastfeeding rates, and cost reductions that warrant further randomized prospective study.

Appendix

ICD-10 codes for hyperbilirubinemia: P59.9, E80.6, P58.9, P58.5, P58.2, P58.3, P58.0, P58.1, P58.42, P58.41, P59.0, P59.20, P59.29, 774.6, 277.4, 782.4, 774.2, 774.3.

Author Contributions

KO: Contributed to conception and design; contributed to acquisition, analysis, and interpretation; drafted manuscript; critically revised manuscript.

SK: Contributed to conception and design; contributed to acquisition, analysis, and interpretation; drafted manuscript; critically revised manuscript.

KS: Contributed to design; contributed to analysis and interpretation; drafted manuscript; critically revised manuscript.

ES: Contributed to design; contributed to analysis and interpretation; drafted manuscript; revised manuscript.

AG: Contributed to design, analysis, and interpretation; revised manuscript.

MS: Contributed to conception and design; contributed to acquisition, analysis, and interpretation; drafted manuscript; revised manuscript.

EY: Contributed to conception and design; contributed to acquisition, analysis, and interpretation; drafted manuscript; revised manuscript.

Declaration of Conflicting Interests

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