BACKGROUND AND OBJECTIVES: Adherence to the American Academy of Pediatrics safe sleep practice (SSP) recommendations among hospitalized infants is unknown, but is assumed to be low. This quality improvement study aimed to increase adherence to SSPs for infants admitted to a children’s hospital general care unit between October 2013 and December 2014.

METHODS: After development of a hospital policy and redesign of room setup processes, a multidisciplinary team developed intervention strategies based on root cause analysis and implemented changes using iterative Plan–Do–Study–Act cycles. Nurse knowledge was assessed before and after education. SSPs were measured continuously with room audits during sleeping episodes. Statistical process control and run charts identified improvements and sustainability in hospital SSPs. Caregiver home practices after discharge were assessed via structured questionnaires before and after intervention.

RESULTS: Nursing knowledge of SSPs increased significantly for each item ($P \leq .001$) except avoidance of bed sharing. Audits were completed for 316 sleep episodes. Simultaneous adherence to all SSP recommendations improved significantly from 0% to 26.9% after intervention. Significant improvements were noted in individual practices, including maintaining a flat, empty crib, with an appropriately bundled infant. The largest gains were noted in the proportion of empty cribs (from 3.4% to 60.3% after intervention, $P < .001$). Improvements in caregiver home practices after discharge were not statistically significant.

CONCLUSIONS: Sustained improvements in hospital SSPs were achieved through this quality improvement initiative, with opportunity for continued improvement. Nurse knowledge increased during the intervention. It is uncertain whether these findings translate to changes in caregiver home practices after discharge.
and role modeling to families and providers. Studies have demonstrated that supine position and bed sharing at home are both positively and negatively influenced by SSP modeled in the newborn nursery and sleep advice provided by health care professionals. Given this influence of SSP modeling from the newborn nursery, we were concerned about potentially negative influence of unsafe sleep practices modeled in inpatient settings. Parents of hospitalized infants encounter unsafe practices, such as leaving personal care items in the crib, elevating the head of the bed (HOB), or using towel rolls to position the child. Despite the risk of SIDS associated with such practices our experience suggests they commonly occur in inpatient settings. This practice counters a professional responsibility to follow established guidelines intended to reduce preventable sleep-related deaths regardless of the setting.

Previous quality improvement work in other settings demonstrated the value of various approaches to improving SSP: providing nursing education, using visual cues for families and providers, auditing cribs, and surveying parent-reported practices. Such strategies were therefore anticipated to provide a framework on which additional improvement activities might be added.

To address concerns about nonadherence and poor modeling of SSP at our children’s hospital, we used quality improvement methods to enhance knowledge, attitudes, and practices related to the SSP recommendations issued by the AAP. Our specific aim was to increase the number of infants sleeping in complete adherence to the AAP SSP guidelines to 90% within 12 months. We hypothesized that workflow redesign, nurse education, and reinforcement through infant room audits during sleep episodes with just-in-time feedback would result in improved adherence to recommended SSP. We also hypothesized that caregivers would report increased knowledge and adherence to the AAP sleep recommendations at home after discharge.

METHODS

Context

The American Family Children’s Hospital is a medium-sized, urban, academic children’s hospital where the majority of infants are admitted to 1 of 3 mixed medical and surgical units. There is no birthing service at the hospital. Hospital medicine, subspecialty, and surgical attending physicians staff these units, supervise pediatric and surgical residents, and collaborate with nursing colleagues.

Planning the Intervention

We chose SSP as an area for improvement after the release of the 2011 AAP infant sleep environment recommendations. This work paralleled our community hospital advocacy task force initiative to improve the safety of home sleep practices. Figure 1 provides an overview of the hospital quality improvement project.

A multidisciplinary stakeholder team of nurses, attending and resident physicians, a surgical advanced practitioner, and a hospital quality and patient safety officer gathered before the intervention. This group defined the ideal hospital SSP based on AAP guidelines for the home sleeping environment adapted to the inpatient setting by using local expert opinion and best practice sleep policies from 3 other institutions.

A baseline assessment of hospital SSP was conducted via a Web-based audit tool on the intervention unit and included rooms of all hospitalized infants <12 months of age, regardless of underlying medical condition, length of stay, or acuity of illness. Rooms were excluded if they were located outside the primary intervention unit.

Improvement Activities

After the baseline assessment, a fishbone diagram (Supplemental Figure 3) was constructed to identify important candidate causes of nonadherence with SSP in the hospital; improvement activities were then designed to address these causes. We developed a hospital policy statement for SSP, a process map of standard infant room setup on admission, followed by a redesign to eliminate both placement of extraneous items in the crib and provision of excessive linens for bundling. Our final activity at the start of the project was development of a computer-based education module outlining SSP. Hospital staff nurses and nursing assistants from all units completed this education module during their annual education review in 2014.

Data from Web-based room audits were reviewed by a smaller unit-based workgroup every 2 weeks. Additional improvement activities targeted adherence to SSP by using iterative Plan–Do–Study–Act cycles. A summary of activities included the following:

1. Recruitment of nurse and nursing assistant safe sleep champions
2. Auditing of infant rooms weekly by champions with the development of scripts for champions to provide feedback to colleagues after room audits
3. Distribution of commercial sleep sacks to intervention unit and families
4. Incorporation of a visual cue in infant rooms based on the US Department of Health and Human Services Safe to Sleep educational campaign material
5. Designation of space for the infant’s personal care items

6. Delivery of grand rounds to physician and nursing providers by a national expert

Results of key measurements and targets for improvement were added to the unit’s publicly posted quality scorecard.

**Study of the Improvement**

**Nurse Knowledge**

Nurses’ knowledge of AAP SSP was assessed immediately before and after the module via a Web-based questionnaire designed for this project. Key hospital SSPs queried included maintaining a flat HOB, absence of items in the crib, appropriate bundling (sleeper alone, single blanket or sleep sack), and supine sleep position in the crib. Self-reported comprehension of the AAP sleep recommendations was also assessed.

**Hospital SSPs**

SSP room audits were conducted via a structured Web-based audit tool designed for this study. The tool included items that assessed infant sleep location (crib or other), infant sleep position (supine, side, or prone), HOB position (elevated or flat), number of items per crib, and appropriate bundling (sleep sack, single blanket, sleeper alone). Complete adherence to SSP was defined as presence of all recommendations simultaneously (sleeping in a crib, supine, appropriately bundled with a flat HOB and no items in the crib).

Nurses from the safe sleep workgroup collected baseline data by using the Web-based audit tool between October 2013 and November 2013, from a convenience sample of rooms of sleeping infants, with a goal of 10 room observations per week. Safe sleep champions collected ongoing data during the intervention period, typically overnight from infant sleep episodes on the intervention unit through December 2014. Champions continuously reviewed the audit tool with the supervising nurse manager.

**Caregiver-Reported Practices at Home**

The home sleep practices of discharged infants <6 months of age were assessed via a structured data collection tool during the preintervention phase, October 2013 through January 2014, and in the postintervention period, February through April 2014. Discharges from the intervention unit in the previous month were obtained weekly from administrative data, and a research...
nurse attempted phone contact ≤2 times. Caregivers were excluded if they did not speak English, they were inaccessible by phone, or the child was in foster care.

As in the room audit tool, measures of SSP included infant sleep location, sleep position, HOB position, and appropriate bundling. In addition, we inquired about bed sharing, and caregivers were queried for recollection of sleep education by hospital staff. We did not inquire about the number of items in the crib, because we thought this would be an unreliable question to recall. The definition of complete adherence to SSP otherwise paralleled that for inpatient SSP. Clinical characteristics we hypothesized to influence SSP at home were also assessed: history of reflux, apnea or cardiorespiratory monitor use, assisted respiration, and tube feeding.

Analysis

Differences in nurse knowledge, hospital practices, and caregiver practices at home before and after the improvement interventions were assessed with χ² tests for categorical variables and t tests for continuous variables. A P value <.05 was considered significant. Statistical process control (SPC) p-charts and run charts were used to monitor changes in hospital SSPs using established rules for identifying special cause variation.17, 18 We considered 8 consecutive points above or below the centerline and any points outside the control limits to represent special cause variation and prompt a change in the centerline.19, 20 Such observations happen <0.4% of the time by chance and are therefore conventionally accepted as suggesting statistically significant changes.21

Human Subjects Protection

This quality improvement initiative was considered exempt by the University of Wisconsin School of Medicine and Public Health’s Institutional Review Board.

RESULTS

Nurse Knowledge

Nursing staff completed 289 preeducation knowledge assessments and 315 posteducation assessments. Staff were primarily full-time registered nurses with >5 years of experience, nearly half of whom had children of their own (Table 1). Preeducation and posteducation results of SSP knowledge are presented in Table 1. Staff demonstrated increased knowledge of appropriate sleep position, crib items, HOB position and bundling, and self-rated comprehension of the AAP SSP recommendations (P ≤ .001).

Hospital Safe Sleep Practices

Changes in SSP by audits (n = 316) are shown in Table 2 and the Fig 2 SPC charts. Baseline data demonstrated that >96% of cribs contained ≥1 item (mean 4.4 items per crib), 40% had an overbundled infant, and almost 20% were not flat. Significant implementation improvements were observed in the number of crib items and the proportions of cribs with no items, flat HOB, and appropriate bundling (P < .001). Initially, no sleep episodes were completely adherent to recommendations, although this number increased to 26.9% after implementation (P < .001). Supine

### TABLE 1 Nurse Knowledge Before and After Safe Sleep Education Intervention

<table>
<thead>
<tr>
<th>Preeducation, n = 289</th>
<th>Posteducation, n = 315</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>% Correct</td>
<td>n</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Sleep position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supine</td>
<td>275</td>
<td>95.8</td>
</tr>
<tr>
<td>HOB position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>220</td>
<td>76.1</td>
</tr>
<tr>
<td>Appropriate bundling</td>
<td>242</td>
<td>83.7</td>
</tr>
<tr>
<td>Items in crib</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>210</td>
<td>72.7</td>
</tr>
<tr>
<td>AAP bed-sharing policy</td>
<td>283</td>
<td>100</td>
</tr>
<tr>
<td>Reflux and sleep position knowledge</td>
<td>80</td>
<td>30.3</td>
</tr>
<tr>
<td>Self-rated comprehension (4-point Likert scale)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest category</td>
<td>66</td>
<td>23.2</td>
</tr>
<tr>
<td>Years of nursing experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–2</td>
<td>79</td>
<td>27.4</td>
</tr>
<tr>
<td>3–5</td>
<td>53</td>
<td>18.4</td>
</tr>
<tr>
<td>6–10</td>
<td>59</td>
<td>20.5</td>
</tr>
<tr>
<td>&gt;10</td>
<td>97</td>
<td>33.7</td>
</tr>
<tr>
<td>Have their own children</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>139</td>
<td>48.4</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Registered nurse</td>
<td>252</td>
<td>87.5</td>
</tr>
<tr>
<td>Nursing assistant</td>
<td>24</td>
<td>8.3</td>
</tr>
<tr>
<td>Work effort &lt; 50%</td>
<td>36</td>
<td>12.6</td>
</tr>
</tbody>
</table>
Sleep position of an infant in a crib (location) had high baseline performance (>75% adherent) without significant increases after implementation.

Similarly, under established run chart rules, SPC charts demonstrated statistically significant improvement, that is, special cause variation as defined in the Methods section, shortly after the implementation began and was sustained for all measures except supine sleep position and crib sleep location (Supplemental Figure 4). Special cause improvement in crib sleep location was briefly noted after the educational intervention, although this improvement was sustained for only ~2 months before returning to baseline levels.

**Caregiver-Reported Practices at Home**

Table 3 highlights the characteristics of infants included in the caregiver surveys. A total of 56 caregivers before nurse SSP education and 48 caregivers after the education were surveyed (46% response rate). There were no differences in age or clinical characteristics between infants of caregivers surveyed before and during implementation.

The reported increase in SSP education received by caregivers during implementation was not statistically significant. None of the measures we included demonstrated an increase in the implementation compared with preimplementation periods. However, caregivers did report a high rate of crib sleeping both before and during implementation (85.7% and 93.8%, respectively) and absence of bed sharing (>94% in both cases). They simultaneously reported a high use of alternative sleep locations at least once per day in both before- and during-implementation periods (62.5% and 66.7%, respectively).

**DISCUSSION**

We conducted a multifaceted quality improvement project incorporating workflow redesign, nurse education, and audit and feedback, which increased nurse knowledge of SSP and improved adherence to individual components of SSP, including maintaining a flat, empty crib with an appropriately bundled infant. Adherence to SSP by caregivers at home was unchanged. Although we did not reach our aim of 90% adherence within 12 months, we did achieve significant improvement in complete adherence to SSP recommendations. Whereas previous improvement studies have focused on infant SSP in newborn nurseries and NICUs, this is the first study to our knowledge in a general inpatient setting.

Our work in this setting complements and extends previous research describing the influence of modeling SSP in the newborn on home sleep environments. Previous quality improvement efforts have demonstrated improvement in adherence to individual SSP components or a more limited assessment of complete adherence to SSP guidelines (eg, sleeping alone, supine, and in a crib). We sought to investigate a more comprehensive assessment of adherence to all SSP recommended by the AAP.

Similar to other studies, we found high levels of nurse knowledge about SSP, particularly regarding supine position. The significant improvement we observed in knowledge of recommendations for flat HOB, empty cribs, and appropriate bundling after education was also consistent with previous work. These gains in knowledge were encouraging because our baseline audits demonstrated poor adherence to these specific practices. Despite these gains, however, half of the nurses did not rate their own comprehension of SSP recommendations at the highest level. This might suggest a need to expand the scope of educational content or to build nurse confidence in their knowledge. Although the training module delivered fundamental information, time constraints, and its “just-in-time” nature limited an in-depth discussion of the rationale behind the SSP recommendations.

Preimplementation measurement confirmed our assumption that adherence to SSP recommendations was generally low. Most notably, no cribs had complete adherence to SSP. As in other studies, implementing room audits demonstrated overall improvements, with larger gains in a subset of practices. Complete adherence remains challenging, probably because of the need for unique solutions for different components of a safe sleep environment. Certain SSPs are probably more responsive than others to our intervention strategies. In particular, we observed no improvements in rates of appropriate

**TABLE 2 Audits of Hospital Practices Among Sleeping Infants**

<table>
<thead>
<tr>
<th>Sleep location (crib)</th>
<th>Preimplementation (n = 59), %</th>
<th>Implementation (n = 257), %</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep position (supine)</td>
<td>48 (81.0)</td>
<td>215 (83.7)</td>
<td>.30</td>
</tr>
<tr>
<td>HOB (flat)</td>
<td>47 (81.0)</td>
<td>215 (83.4)</td>
<td>.54</td>
</tr>
<tr>
<td>Appropriate bundling</td>
<td>26 (44.1)</td>
<td>187 (73.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Items in crib, mean (SD)</td>
<td>24 (40.7)</td>
<td>141 (56.0)</td>
<td>.03</td>
</tr>
<tr>
<td>Cribs with 0 items</td>
<td>4.4 (3.3)</td>
<td>0.9 (1.5)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Complete adherencea</td>
<td>2 (3.4)</td>
<td>155 (60.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age in months, mean (SD)</td>
<td>4.7 (2.9)</td>
<td>5.1 (3.5)</td>
<td>.48</td>
</tr>
</tbody>
</table>

* Complete adherence indicates following all recommendations simultaneously (sleeping in a crib, supine, appropriately bundled, with a flat HOB and no items in the crib).
Inconsistencies between improvements in nurse knowledge of a recommendation and changes in practice for that recommendation were observed. Improvement in knowledge of SSPs through Web-based education has been shown to be achievable; however, increased knowledge does not necessarily translate into practice. Some of this apparent discrepancy may be explained by a gap between knowledge and firmly established beliefs. For example, despite knowing correct sleep position, nurses may maintain the view that supine position increases the risk for aspiration.

In FIGURE 2, SSP adherence. Rooms with infant (A) sleeping flat, (B) appropriately bundled, (C) with no items in crib, (D) with average number of items per crib, and (E) completely adherent.
about safe sleep. Families may hold similar beliefs about SSP, creating a secondary barrier to adherence in the hospital. Parental preference has also been demonstrated to be a barrier to perfect practice of sleep recommendations and may contribute to the lack of improvement in some measures. For example, our observed rates of supine sleep positioning mirror national rates of supine sleep positioning in the home, suggesting to us that future Plan–Do–Study–Act cycles will need to incorporate consideration of current caregiver practices into the development of improvement activities.

Clinical situations may also influence practices, even in the presence of correct information. For example, despite the lack of evidence, elevating the HOB is often used as a strategy for improving respiratory function in infants admitted with respiratory illness. Even if nurses know flat HOB is the “correct answer,” they may be inclined to elevate the HOB of infants admitted with respiratory problems. Similarly, although evidence for elevating the HOB in infants needing nasogastric feeds or continuous gastrostomy tube feeds is lacking, there is confusion or disagreement about positioning the HOB in these infants.

Lastly, a lack of nurse empowerment may explain gaps between knowledge and practice. The education module did not train nurses to have skills to address parent beliefs or practices that conflicted with recommendations. At times, nurses may not have known how to mediate a nonadherent environment when pressured by parents. Furthermore, because staff were not continually present in the room, families may intentionally or unintentionally have deviated from desired SSP.

To address these potential gaps in knowledge and practice, future efforts to improve SSP may need to include training staff to collaboratively resolve differences with parents. Although informal caregiver education occurred at the bedside, future efforts should be enhanced. Examples of potentially effective strategies include structured programs that combine modeling with caregiver education videos and SSP-specific discharge instructions mirroring efforts from newborn nurseries and ICUs.

Despite significant improvements in nurse knowledge and many hospital practices, reported adherence of caregivers to SSP recommendations at home did not demonstrate significant changes after our implementation of SSP. Several potential explanations exist for this finding. First, posteducation surveys were conducted shortly after the nursing education intervention, corresponding to a time in which our hospital-based adherence to...
SSP was at its lowest. Repeated evaluation of caregiver practices during a period of more robust adherence might provide better assessment of their influence on caregiver practice. Second, small sample sizes limited our power to detect changes in parent-reported behaviors. Finally, most education was done informally at the bedside, which may have been less influential in changing home sleep practice and resulted in fewer caregivers who recalled SSP education. Nurses were instructed to provide SSP education when they found the crib to be in a state of nonadherence, although this was at the discretion of the nurse, and our intervention did not allow us to systematically evaluate these interactions. Nurses may have provided in consistent education or failed to fully take advantage of educational tools. Improved implementation of nurse–caregiver education may be necessary to create changes in SSP after discharge.

This work has several limitations. First, we allowed infants to be resampled because our measurement unit of interest was the sleeping episode rather than patient. Though not completely independent, each sleep occurrence represented a new opportunity to adhere to SSP recommendations. We never resampled infants during the same day or same sleep episode. Second, the cross-sectional nature of our nursing assessment makes it unclear how long the increase in adherence might provide better evaluation of caregiver practices. Second, small sample sizes limited our power to detect changes in parent-reported behaviors. Finally, most education was done informally at the bedside, which may have been less influential in changing home sleep practice and resulted in fewer caregivers who recalled SSP education. Nurses were instructed to provide SSP education when they found the crib to be in a state of nonadherence, although this was at the discretion of the nurse, and our intervention did not allow us to systematically evaluate these interactions. Nurses may have provided in consistent education or failed to fully take advantage of educational tools. Improved implementation of nurse–caregiver education may be necessary to create changes in SSP after discharge.

CONCLUSIONS

This project illustrates our institution’s approach to implementing the AAP recommendations for infant SSP in the hospital setting. Although previous improvement interventions have been successful in the NICU and nursery setting, our findings show that interventions may also be successful in a general inpatient setting, where providers may have less expertise and focus on safe sleep practices. Several improvement strategies translated well to this more heterogeneous population, including nurse education and audit and feedback. This work identified elements of SSP that are more challenging to achieve in the hospital setting, particularly eliminating items in the crib, flattening the HOB, avoiding overbundling, and completely adhering to recommendations for SSP. Future research should explore root causes of nonadherence in these areas and continue to examine the potential influence of education regarding SSP from the nonbirth hospital on caregiver practices at home.

ACKNOWLEDGMENTS

We thank Jody Belling, RN, and Andrea Blom, RN, for their assistance with caregiver interviews. We also acknowledge the American Family Children’s Hospital Safe Sleep workgroup for their support in designing the intervention. We thank the safe sleep nurse champions for their enthusiastic involvement in this initiative.

REFERENCES


ABBREVIATIONS

AAP: American Academy of Pediatrics
HOB: head of bed
SIDS: sudden infant death syndrome
SPC: statistical process control
SSP: safe sleep practice


Improving Safe Sleep Practices for Hospitalized Infants
Kristin A. Shadman, Ellen R. Wald, Windy Smith and Ryan J. Coller

Pediatrics originally published online August 1, 2016;

Updated Information & Services
including high resolution figures, can be found at:
http://pediatrics.aappublications.org/content/early/2016/07/28/peds.2015-4441

Supplementary Material
Supplementary material can be found at:
http://pediatrics.aappublications.org/content/suppl/2016/07/28/peds.2015-4441.DCSupplemental

References
This article cites 22 articles, 7 of which you can access for free at:
http://pediatrics.aappublications.org/content/early/2016/07/28/peds.2015-4441.full#ref-list-1

Subspecialty Collections
This article, along with others on similar topics, appears in the following collection(s):
Administration/Practice Management
http://classic.pediatrics.aappublications.org/cgi/collection/administration/management_sub
Quality Improvement
http://classic.pediatrics.aappublications.org/cgi/collection/quality_improvement_sub
Hospital Medicine
http://classic.pediatrics.aappublications.org/cgi/collection/hospital_medicine_sub

Permissions & Licensing
Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
https://shop.aap.org/licensing-permissions/

Reprints
Information about ordering reprints can be found online:
http://classic.pediatrics.aappublications.org/content/reprints

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2016 by the American Academy of Pediatrics. All rights reserved. Print ISSN: .

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™
Improving Safe Sleep Practices for Hospitalized Infants
Kristin A. Shadman, Ellen R. Wald, Windy Smith and Ryan J. Coller

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/early/2016/07/28/peds.2015-4441