

Practicing What We Preach: An Effort to Improve Safe Sleep of Hospitalized Infants

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Abstract

Introduction: To prevent sudden unexpected infant death, pediatric providers recommend the ABCs of infant sleep: Alone, on the Back, and in an empty Crib. This study's objective was to document sleep practices of infants admitted to a large children's hospital, examine adherence to American Academy of Pediatrics safe sleep guidelines, and develop interventions to improve guideline adherence. **Methods:** We conducted a pre/post quality improvement study at a single quaternary care medical center from 2015 to 2019. Infants 0 to younger than 12 months were observed in their sleeping environment pre- and post-implementation of multiple hospital-wide interventions to improve the sleep safety of hospitalized infants. **Results:** Only 1.3% of 221 infants observed preintervention met all ABCs of safe sleep; 10.6% of 237 infants met the ABCs of safe sleep postintervention. Significant improvements in the post-intervention cohort included sleeping in a crib (94% versus 80% preintervention; $P < 0.001$), avoidance of co-sleeping (3% versus 15% preintervention; $P < 0.001$), absence of supplies in the crib (58% versus 15% preintervention; $P < 0.001$), and presence of an empty crib (13% versus 2% preintervention; $P < 0.001$). **Conclusions:** Most infants hospitalized at our institution do not sleep in a safe environment. However, the implementation of a care bundle led to improvements in the sleep environment in the hospital. Further research is necessary to continue improving in-hospital safe sleep and to assess whether these practices impact the home sleep environment. (*Pediatr Qual Saf* 2022;7:e561; doi: 10.1097/pq9.000000000000561; Published online June 14, 2022.)

INTRODUCTION

Sudden unexpected infant death (SUID) is the leading cause of death from 28 days of age to 1 year of age.^{1,2} SUID is a term used to

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describe infant death from suffocation, strangulation, asphyxia, entrapment, and unknown causes of death, all of which are potentially sleep-related. Sudden infant death syndrome (SIDS) is a subcategory of SUID and describes any infant death that cannot be explained after a thorough case investigation.³ The etiology of SIDS is likely multifactorial, including exogenous triggers, abnormal or premature neurodevelopment, and intrinsic vulnerability of the infant.¹ In 1992, the American Academy of Pediatrics (AAP) recommended that infants be placed supine during sleep to decrease the risk of infant sleep-related death. This recommendation led to a reduction in prone sleeping from greater than 70% of infants to approximately 20% of infants and a greater than 40% reduction in SIDS.⁴ Concordantly, death from SIDS decreased from 120 deaths per 100,000 in 1992 to 56 deaths per 100,000 in 2001. However, since 2001, the overall rate of SIDS has remained constant.²

Subsequent research associated unsafe sleep practices with an increased risk of SUID, and these factors have been targets of quality improvement efforts and educational campaigns. Current recommendations include practicing the ABCs of safe sleep: Alone, on the Back, and in an empty Crib.⁵ The AAP also recommends using a firm sleep surface, breastfeeding, and offering a pacifier; avoiding bed-sharing, soft objects in the bed or under the infant, overheating, and using tobacco, alcohol, and illicit drugs.^{1,2} Recent research suggests that only

two-thirds of infants are placed on their backs to sleep,⁶ and most infants sleep with loose bedding in the sleep space.⁷ Furthermore, in an epidemiologic study of infants experiencing SUID, 75% were found on a sleep surface not intended for an infant, only 25% were found supine, and half of the infants were sharing a bed with an adult.⁸

While sleep safety at home is key to preventing SUID, health care professionals have an important role in reducing SUID risk. This role includes educating parents on the risk of SUID and modeling a safe sleep environment. The 2016 AAP Taskforce update recommends that health-care providers model safe sleep in the hospital, provide employee education on infant safe sleep, and update hospital policies to meet safe sleep standards.⁹ Families are more likely to practice safe sleep techniques following education on a safe sleep environment¹⁰ or after observing modeling of best practices in the newborn nursery or neonatal intensive care unit (NICU).^{11,12} Nursery-based safe sleep programs have reduced average SUID death rates postintervention.¹³ However, recent research suggests that infants are not placed in safe sleep environments when admitted to a hospital, resulting in a new focus on targeting safe sleep within hospital policies.^{14,15} The objectives of this study were to analyze the sleep practices of hospitalized infants, assess adherence to the AAP safe sleep guidelines, and develop interventions to improve adherence to these guidelines at our hospital. The specific aim was to increase the percentage of inpatient infants meeting the ABCs of safe sleep by 20% by December 2018 and sustain change for 6 months.

METHODS

Study Design

This project was a pre/post quality improvement study performed at a single quaternary care medical center. Our institution is a 300-bed freestanding children's hospital without a dedicated birthing unit. In the pre- and postintervention groups, we included a convenience sample of infants (ages 0 to younger than 12 months) admitted to a medical-surgical floor or intensive care unit. Exclusion criteria included neurosurgical or airway comorbidities that required a nonsupine sleeping position, invasive mechanical ventilation, or if infants were awake at the time of observation. The study was approved with a waiver of consent by our hospital institutional review board. This report follows the SQUIRE 2.0 guidelines.¹⁶

Data Collection

Study participants were observed surreptitiously by a single observer while in their sleeping environment, and a single observer documented the following aspects of the sleeping environment: location of the sleeping infant; the position of the sleeping infant; parent presence in the room; the presence of co-sleeping; objects noted in the crib; the presence of pacifier; and temperature of the room. The research team collected additional variables via chart

review, including the infant's age, gestational age at birth, exposure to breast milk, admission diagnosis, and active medical problems. The team collected baseline data from June 2015 to November 2015 and postintervention data from December 2017 to August 2019. From December 2015 through November 2017, limited data were collected for monitoring purposes. However, the focus during this time was on the development of interventions. Therefore, audit frequency was limited. Postintervention data collection spanned a greater period relative to baseline data collection to assess the sustainability of changes and monitor later improvement measures.

Intervention

Following baseline data collection, a multidisciplinary group performed a Failure Modes and Effects Analysis (FMEA). This systematic, quality improvement methodology identifies failure modes, their causes, and their effects by reviewing as many components of a process as possible. The group included representatives from bedside nursing on medical-surgical floors and intensive care units, nursing leaders, physicians, a patient safety consultant, physical and occupational therapists, child life specialists, and environmental services representatives. After an in-depth review, the FMEA identified our top failure modes: (1) hospital staff did not educate families about a safe crib nor the risks of bed-sharing/co-sleeping; (2) hospital staff did not enforce safe sleep practices; (3) all members of the care team placed unsafe items in the crib; and (4) confusion existed regarding the appropriate level of the head of the bed. The team then created a key driver diagram (Fig. 1).

Subsequently, the multidisciplinary team developed and implemented a care bundle from May 2017 to December 2017 (Fig. 1). (**Supplementary Table 1**, <http://links.lww.com/PQ9/A375>). This bundle included implementing a new safe sleep hospital policy; developing required online-learning modules for all hospital staff who interact with infants; presenting educational updates to physicians; creating an educational handout for volunteers; including infant safe sleep education in the nursing admission and/or discharge education for infants; documenting infant safe sleep education in the electronic health record; and providing various forms of education for families/caregivers (**Supplementary Figure 1**, <http://links.lww.com/PQ9/A375>). Crib cards and educational materials for families were available in English and Spanish. Following the implementation of the above initiatives, the research team collected postintervention data by observation of infants in their sleeping environments as previously described, with demographic and additional variables collected via chart review. Implementation of additional improvements, including introducing a safe sleep "crib cards" pilot (**Supplementary Figure 2**, <http://links.lww.com/PQ9/A375>), occurred following the initial care bundle (**Supplementary Table 2**, <http://links.lww.com/PQ9/A375>). However, reinforcement of items

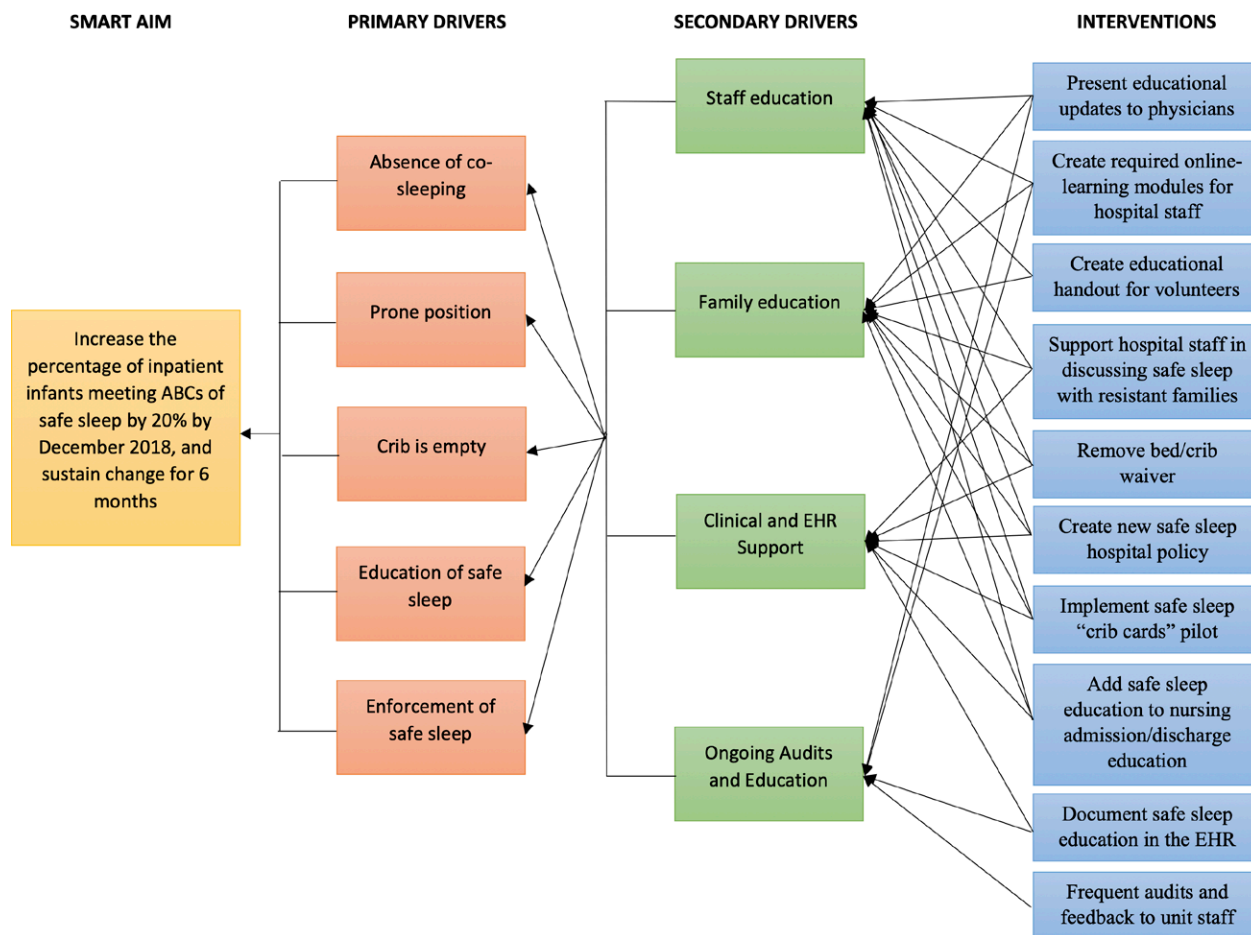


Fig. 1. Key Driver Diagram based on FMEA.

included in the original care bundle, such as repeated online learning modules and brief educational reminders on staff elevators, occurred distant from the initial care bundle implementation (Supplementary Table 2, <http://links.lww.com/PQ9/A375>). The Safe Sleep Task Force members have continued sustainability audits using a similar tool (July–November 2021).

Outcomes

The primary outcome was meeting the ABCs of safe sleep, where the researcher observed the infant: Alone in the sleep environment, on their Back on a firm sleep surface, and in an empty Crib. We assessed the primary outcome pre- and postintervention. Covariates included infant age, gestational age, admission service within the hospital, and admission diagnosis. Secondary outcomes included specific safe sleep guidelines such as location and position of the infant during sleep, presence of co-sleeping, the position of the crib head-of-bed, presence of supplies in the crib, and whether or not the crib was empty. Supplies were categorized as “medical supplies,” which included medical equipment (eg, loose stethoscope, syringes, suctioning equipment), and “home supplies,” which included items that one could commonly find in a crib at home (eg,

loose blankets, loose clothes, diapers, wipes, bottles, or diaper cream).

Statistical Analysis

We created run charts to demonstrate associations between the interventions and outcomes. We used descriptive statistics to examine the frequencies and percentages for categorical variables, including meeting the ABCs of safe sleep and median and interquartile range for age. Pearson chi-square test or Fisher exact test (expected cell count < 5) examined differences in safe sleep measures preintervention and postintervention and tested the association of characteristics with meeting the ABCs of safe sleep. We considered 2-sided P-values < 0.05 to indicate statistical significance. Data were analyzed using R (version 4.0.3) within RStudio (version 1.2.463; R Foundation for Statistical Computing, Vienna, Austria).¹⁷ Audits by the Safe Sleep Task Force members were analyzed outside of the pre/postintervention data.

RESULTS

We included 458 infants in this study, 221 infants in the preintervention group (observed in 2015), and 237 in the

postintervention group (observed in 2017–2019). Table 1 displays the demographics and clinical characteristics. The median age in both pre- and postintervention groups was 2.0 months. There was a relatively balanced male-to-female ratio (46% female preintervention, 47% female postintervention). Preintervention, we observed 81% of infants (n = 180) in an acute care setting, with 18% of infants (n = 41) admitted to an ICU. Postintervention, we observed 40% of infants (n = 95) in an acute care setting, with 59% of infants (n = 142) admitted to an ICU, primarily the NICU (n = 101). Most infants in both the pre- and postintervention groups were admitted to a medical service (83% and 93%, respectively) rather than a surgical service.

Primary Outcome

Three infants (1.4%) met the ABCs of safe sleep during the preintervention period, and 25 infants (10.5%) met ABC criteria in the postintervention period (P < 0.001, Table 2). In addition, we examined demographic and clinical characteristics related to safe sleep adherence (n = 28) compared with those

not meeting safe sleep guidelines (n = 430; Table 2). Younger infants were more likely to meet the ABCs of safe sleep; 9.3% of infants younger than 3 months met the ABCs of safe sleep compared with 0% of 7 to <12-month infants (P = 0.001). Similarly, we found increased adherence to safe sleep environments for preterm infants compared with term infants (9.9% preterm versus 4.2% term; P = 0.022). Infants admitted to an ICU had a higher proportion of meeting the ABCs of safe sleep compared with infants on an acute care service (12.0% in ICU versus 2.2% in acute care; P < 0.001); however, there was not a statistically significant difference between patients on a medical versus surgical team (P = 0.060).

Figure 2 demonstrates run charts for several key outcomes (2A: meeting the ABCs; 2B: co-sleeping; and 2C: empty crib) and displays pre- and postintervention audits over time. We implemented most interventions in December 2017 (following FMEA kickoff in March 2016), with several bundle revisions and ongoing educational pieces occurring throughout the postintervention period.

Table 1. Baseline Demographics

	Overall (n = 458)	Preintervention (n = 221)	Postintervention (n = 237)	P*
Age				0.11
Median (IQR)	2.0 (1.0, 5.0)	2.0 (1.2, 6.0)	2.0 (0.8, 4.0)	
Gender				0.813
Female	214 (46.7%)	102 (46.2%)	112 (47.3%)	
Male	244 (53.3%)	119 (53.8%)	125 (52.7%)	
Ethnicity				0.007
Not Hispanic/Latino	332 (72.5%)	147 (66.5%)	185 (78.1%)	
Hispanic/Latino	121 (26.4%)	71 (32.1%)	50 (21.1%)	
Unknown	5 (1.1%)	3 (1.4%)	2 (0.8%)	
Acuity				<0.001
Acute care	275 (60.0%)	180 (81.4%)	95 (40.1%)	
ICU	183 (40.0%)	41 (18.6%)	142 (59.9%)	
Service				<0.001
NICU	126 (27.5%)	25 (11.3%)	101 (42.6%)	
PICU	8 (1.7%)	1 (0.5%)	7 (3.0%)	
Medical subspecialty†	82 (17.9%)	56 (25.3%)	26 (11.0%)	
General pediatrics	137 (29.9%)	92 (41.6%)	45 (19.0%)	
Cardiology/CICU	63 (13.8%)	19 (8.6%)	44 (18.6%)	
Surgery	42 (9.2%)	28 (12.7%)	14 (5.9%)	
Medical versus surgical primary team				<0.001
Medical	405 (88.4%)	184 (83.3%)	221 (93.3%)	
Surgical	53 (11.6%)	37 (16.7%)	16 (6.8%)	
Admission diagnosis				
Respiratory	76 (16.6%)	42 (19.0%)	34 (14.3%)	
Cardiovascular	68 (14.8%)	15 (6.8%)	53 (22.4%)	
FEN/GI/liver	45 (9.8%)	28 (12.7%)	17 (7.2%)	
Infectious/sepsis	92 (20.1%)	67 (30.3%)	25 (10.5%)	
Heme/oncologic	7 (1.5%)	0 (0.0%)	7 (3.0%)	
Surgical	63 (13.8%)	39 (17.7%)	24 (10.1%)	
Neurosurgical	12 (2.6%)	4 (1.8%)	8 (3.4%)	
Prematurity	47 (10.3%)	10 (4.5%)	37 (15.6%)	
Other	47 (10.3%)	16 (7.2%)	31 (13.1%)	
(NA)	1 (0.2%)	0 (0.0%)	1 (0.4%)	
Preterm				<0.001
No	307 (67.0%)	173 (78.3%)	134 (56.5%)	
Yes	151 (33.0%)	48 (21.7%)	103 (43.5%)	
Diet				0.019
No breastmilk	212 (46.3%)	115 (52.0%)	97 (40.9%)	
Breastmilk	245 (53.5%)	106 (48.0%)	139 (58.6%)	
(NA)	1 (0.2%)	0 (0.0%)	1 (0.4%)	

P < 0.05 considered significant in bold.

*Wilcoxon rank sum test; Pearson chi-squared test.

†Medical subspecialty includes: hematology/oncology, neurology, gastroenterology, infectious disease, urology, nephrology, pulmonology, genetics, orthopedic surgery, and neurosurgery.

NICU, neonatal intensive care unit.

Table 2. Clinical and Demographic Variables Associated with Meeting the ABCs of Safe Sleep

	Meets ABCs of Safe Sleep*		P‡
	No (n = 430)†	Yes (n = 28)†	
Intervention status			<0.001
Preintervention	218 (98.6%)	3 (1.4%)	
Postintervention	212 (89.5%)	25 (10.5%)	
Age group (mo)			0.001
0 to younger than 3 months	233 (90.7%)	24 (9.3%)	
3 to younger than 7 months	106 (96.4%)	4 (3.6%)	
7 to younger than 12 months	91 (100.0%)	0 (0.0%)	
Preterm			0.022
No	294 (95.8%)	13 (4.2%)	
Yes	136 (90.1%)	15 (9.9%)	
Service			
NICU	106 (84.1%)	20 (15.9%)	
PICU	8 (100.0%)	0 (0.0%)	
Medical subspecialty§	82 (100.0%)	0 (0.0%)	
General pediatrics	132 (96.4%)	5 (3.6%)	
Cardiology/CICU	60 (95.2%)	3 (4.8%)	
Surgery	42 (100.0%)	0 (0.0%)	
Acuity			<0.001
Acute care	269 (97.8%)	6 (2.2%)	
ICU	161 (88.0%)	22 (12.0%)	
Medical versus surgical primary team			0.060
Medical	377 (93.1%)	28 (6.9%)	
Surgical	53 (100.0%)	0 (0.0%)	

*ABCs of safe sleep is defined as found alone (without other people or objects), on their back, in a crib.

†Population includes patients from both pre- and postintervention groups.

‡Fisher exact test. $P < 0.05$ considered significant in bold.

§Medical subspecialty includes: hematology/oncology, neurology, gastroenterology, infectious disease, urology, nephrology, pulmonology, genetics, orthopedic surgery, and neurosurgery.

NICU, neonatal intensive care unit.

Secondary Outcomes

Sleep location improved significantly among postintervention infants; we observed 94.1% in a crib postintervention versus 80.1% preintervention ($P < 0.001$, **Supplementary Table 3**, <http://links.lww.com/PQ9/A375>). Similarly, the postintervention group had a significantly lower prevalence of co-sleeping (15.4% pre versus 3.8% post; $P < 0.001$), fewer inappropriate head-of-bed elevations ($P = 0.001$), and a more remarkable absence of home supplies in the crib ($P < 0.001$). Although the vast majority of infants in both preintervention (98.2%) and postintervention (86.9%) groups were not sleeping in an empty crib, there was a statistically significant association between intervention status (pre- versus postintervention) and an empty crib ($P < 0.001$). No association was found between the position of the infant (prone versus supine) or the presence of medical supplies in the crib when comparing the pre- and postintervention groups.

Supplementary Table 4, <http://links.lww.com/PQ9/A375> displays additional details of the sleep environments in the pre- and postintervention groups. Most infants in both cohorts had unsafe items present in the sleep space. Still, postintervention, there were significant improvements for several of them: blankets ($P < 0.001$), pillows ($P = 0.024$), and bottles ($P = 0.034$). There were also postintervention improvements in room temperature ($P < 0.001$) and the presence of pacifiers ($P = 0.032$). After the intervention, toys and mobiles in the sleep space did not significantly change.

Sustainability Audits

Seventy-three patients were analyzed in recent sustainability audits. These audits demonstrate sustained and improved adherence to safe sleep guidelines for nearly all metrics (**Supplementary Table 5**, <http://links.lww.com/PQ9/A375>).

DISCUSSION

Like other hospitals, our hospital staff infrequently adhere to infant safe sleep guidelines. However, this quality improvement study confirmed that targeted interventions and education could improve many aspects of safe sleep in the hospital environment, consistent with findings from other institutions.^{5,15,18–21} The main areas of improvement at our institution included more infants sleeping in the crib, reduction in co-sleeping, head-of-bed position more often not elevated, reduction in the presence of home supplies in the crib (specifically blankets, pillows, and bottles), and an empty crib. We did not find significant improvements in infant sleep position (supine versus prone) or the presence of medical supplies in the crib. Although our study demonstrated a significant increase in the proportion of infants meeting all AAP safe sleep recommendations (from 1.4% to 10.6%), much work remains before even a simple majority of our inpatient babies sleep in a safe environment.

Several prior studies have examined outcomes associated with implementing safe sleep initiatives in children's hospitals.^{5,18–21} A consistent area of statistically significant change among these studies, as with ours, is the reduction

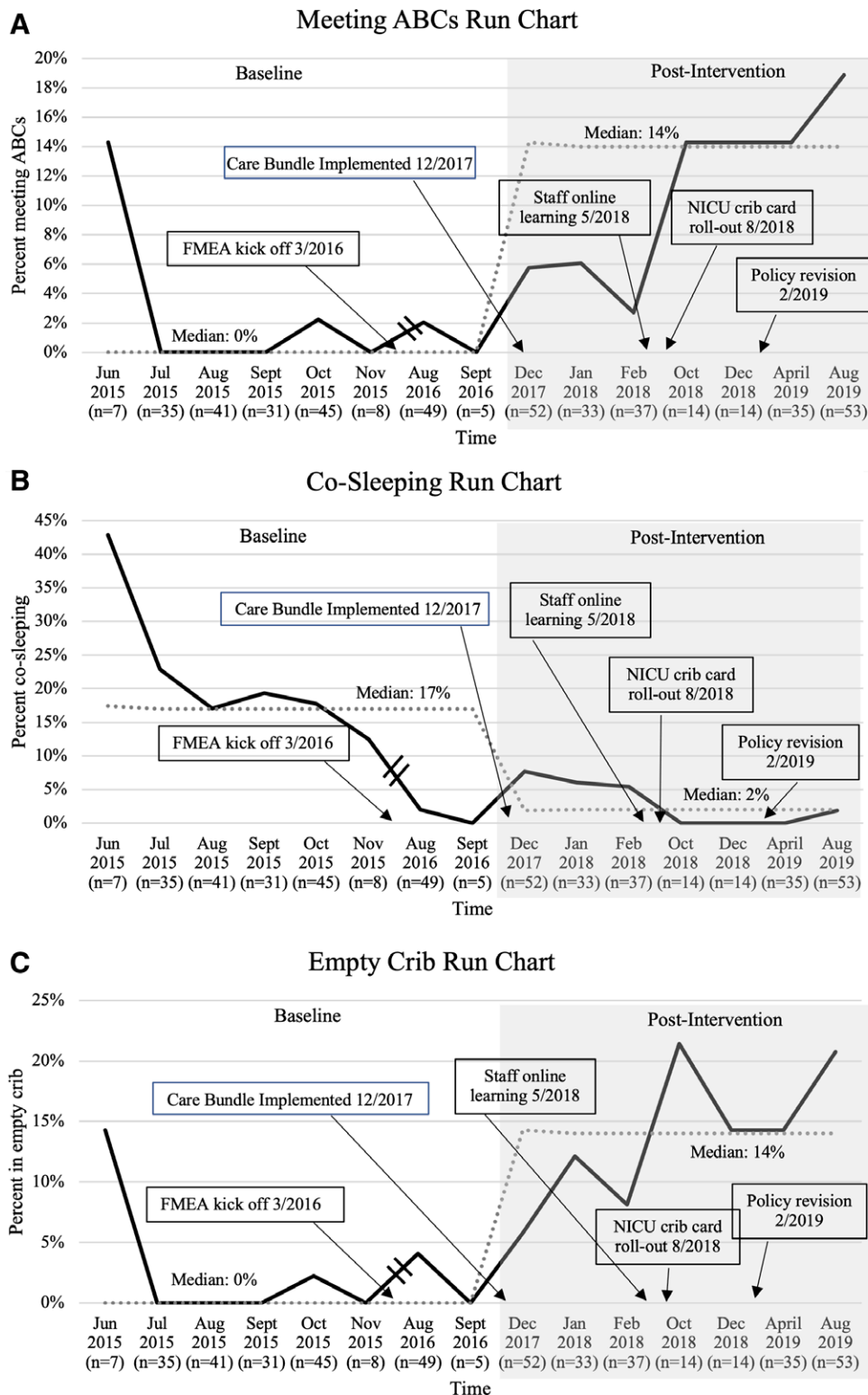


Fig. 2. Run Charts of safe sleep metrics pre- and postintervention. A, Prevalence of meeting ABCs of safe sleep. White background reflects preintervention data, and gray background reflects postintervention data. Break in data collection is denoted by 2 dashes. B, Prevalence of co-sleeping. White background reflects preintervention data, and gray background reflects postintervention data. Break in data collection is denoted by 2 dashes. C, Prevalence of empty cribs. White background reflects preintervention data, and gray background reflects postintervention data. Break in data collection is denoted by 2 dashes.

of nonmedical items in the crib, which is an essential behavior to model for families.^{5,15,18-21} Although infants in our study were frequently asleep in the appropriate

supine position in the preintervention group (86.5%), much like other studies, we failed to show improvement in this metric.^{5,18,19,21} Although prior quality improvement

work demonstrated that hospital staff could remove medical supplies from hospital cribs,⁵ we did not demonstrate improvement in that aspect of the sleep environment. This factor remains a large area for improvement for our institution even though our inpatient rooms include ample counter and storage space for supplies. Finally, our study noted a statistically significant association with the change in location of the sleeping infant, whereas other studies did not demonstrate this improvement.^{18,19}

The variability in outcomes between different infant safe sleep studies may be due to inherent differences in the sampled population, variability in the educational materials, or other factors, including institutional barriers to implementation. For example, implementation of our care bundle was a more gradual process and included a longer postintervention time sample to monitor for a sustained change compared with the hospital-acquired conditions model used in a 2021 study from Batra et al. In comparison with the Batra et al study and several others, our study is unique in that it describes variability in safe sleep practices among ages, diagnoses, and prematurity status.^{5,19,21} Additionally, the inconsistent improvement suggests that there could be gaps in healthcare professional education about safe sleep, an unknown workflow barrier, or a parent/nursing practice belief that we do not yet understand. Scott et al demonstrated that a quality improvement collaborative improves screening, counseling, and documentation of anticipatory guidance during newborn nursery and primary care visits.²² A similar approach could improve screening and education for at-risk infants in the hospital setting. Further research is needed to determine if an optimal implementation strategy could be generalized across institutions, perhaps by combining the most successful aspects of several different care bundles.

Macklin et al conducted one of the largest infant safe sleep studies.²⁰ This multicenter quality improvement study comprised several plan-do-study-act cycles, including safe sleep policy updates and practice changes. They demonstrated significantly improved safe sleep practices across institutions, despite the lack of a standardized care bundle—the most significant improvements found to be the prevalence of an empty crib and removal of loose blankets. Another single-center study showed improved compliance with safe sleep environments across multiple hospital settings (inpatient, NICU, ED, and primary care). However, these improvements have not translated to improved outcomes in sleep-related deaths at the population level.¹⁵ Our unique care bundle also demonstrated significant improvements, although with some variability in secondary outcomes. This finding supports the hypothesis that a multi-pronged care bundle can effectively improve safe sleep for hospitalized infants. Future studies should focus on which portions of these care bundles result in meaningful practice improvements and which aspects are generalizable across institutions.

While safe sleep education should occur during prenatal and infant primary care visits, additional education and modeling in the hospital setting may reinforce safe sleep practices at home. The Infant Care Practices Study demonstrated that maternal adherence to a safe sleep environment declines over time, measured at 1 month, 3 months, and 6 months postdelivery,²³ suggesting that postnatal education and modeling could influence the sleep environment. In addition, a safe sleep bundle in the NICU can improve safe sleep environments for hospitalized infants and improve the sleep environment postdischarge.¹¹ Our study adds support to the developing body of evidence showing that care bundles improve safe sleep environments in the hospital; however, further study is needed to determine the effect of hospital practices on safe sleep behaviors at home and the potential impact on SIDS-related deaths.

Limitations

This project was a quality improvement study at a single academic center, limiting generalizability to other institutions. We implemented our interventions simultaneously. Therefore we cannot determine which changes had the most significant impact on safe sleep practices in the hospital. It is possible that with any change in policy or practice, the increased general awareness results in greater adherence to the standard of care. However, we could not measure culture change or separate which factors (policy change, education, greater awareness, etc.) were most impactful on outcomes improvements. There were several significant differences in our pre- and postintervention cohorts, including acuity, service, and prematurity. It is possible that the higher proportion of NICU patients in our postintervention group biased our postintervention results in favor of a more significant improvement. Given our small sample size, we could not control for potential confounding between these 2 groups. We did not assess parental understanding of safe sleep or address provider knowledge of safe sleep guidelines. Our sustainability audits were performed by multiple members of the Safe Sleep Task Force; therefore, we cannot guarantee data integrity for this cohort. Finally, we have no information on patient outcomes, such as the sleep environment at home.

CONCLUSIONS

Hospitals infrequently follow AAP infant safe sleep guidelines. However, implementing a safe sleep quality improvement bundle results in significant improvements sustained over time in many safe sleep practices. In addition, future studies should evaluate which in-hospital interventions are the most effective in improving the sleep environment to develop an optimal implementation strategy. Finally, future investigations should examine the effect of hospital practices on patient outcomes, such as safe sleep practices at home and SIDS-related deaths.

DISCLOSURE

The authors have no conflicts of interest to declare in relation to the content of this article.

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