Worldviews on Evidence-Based Nursing

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An Evidence-Based Safe Sleep Program Is Associated With Less Infant Sleep-Related Deaths

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ABSTRACT

Background: Sudden unexpected infant death (SUID) is a leading cause of infant mortality in the United States. Hospitals have implemented infant safe sleep programs with varying measures and degrees of success, but few have demonstrated improvements in hospital-based and home safe sleep practices with nurse subject matter experts (SMEs) and community SUID prevention campaigns.

Aims: This project evaluated the impact of a state-wide, evidence-based infant safe sleep program for birthing hospitals using nurse SMEs and a community awareness campaign on nurse knowledge, safe sleep environments, and trends in infant sleep-related deaths.

Methods: Between 2016 and 2021, a pre- and post-test quality improvement intervention-based design was used to enroll hospitals and train and embed SMEs to educate peers, conduct practice surveillance and audits, and address practice deviations. A website housed comprehensive resources, and a large-scale community-based social and print media campaign on safe sleep practices occurred. Nurse and practice data from 12 hospitals that fully implemented the program were compared pre- and post-implementation. State-wide survey data for key safe sleep indicators reported by parents were compared from our 12 birthing hospitals to other facilities.

Results: Of trained nurses ($N = 902$), 83.4% reported making substantial or exceptional progress in being proactive in surveillance of safe sleep environments. Pre- and post-implementation environmental audits showed a significantly higher proportion of infants in safe sleep positions post-implementation (94.3%) than pre-implementation (89.6%) ($p = 0.001$). Statewide survey data from birth parents discharged from our program hospitals significantly outperformed those discharged from other state facilities. Multi-media campaigns resulted in over 1.4 million impressions on our website. Sleep-related deaths for infants born at four program hospitals dropped 16.1% from 31 in 2018 to 26 in 2021.

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Linking Evidence to Action: A safe sleep program improved hospital-based nurses' knowledge and practice and birth parent's knowledge and behaviors, and it was associated with a decrease in infant sleep-related deaths.

1 | Introduction

Sudden unexpected infant death (SUID) ranks as a leading cause of infant mortality in the United States and globally (Center for Disease Control and Prevention [CDC] 2022; Park et al. 2022). SUID is a broad category encompassing infants whose deaths are attributed to infection, abuse or neglect, congenital anomalies, and so forth. SUID cases classified as sleep-related deaths (SRDs) involve deaths from sudden infant death syndrome, accidental suffocation and strangulation in bed, and undetermined causes due to unsafe sleep environments. The United States elevated this public health issue to a national priority in Healthy People 2030 with objective MICH-14 (i.e., Maternal, Infant, Child Health) that sets an increase from 81.4% in 2021 to 88.9% by 2030 for the proportion of infants who are put to sleep on their backs (Office of Disease Prevention and Health Promotion 2023).

The CDC (2022) estimates that approximately 3500 infants die annually due to SUID attributed to unsafe sleep environments. In 1994, the National Institute of Child Health and Human Development initiated the Back to Sleep campaign (now Safe to Sleep campaign): infants sleep alone, on their back, and in a crib (firm surface). The American Academy of Pediatrics published evidence-based guidelines with several recommendations to promote infant safe sleep environments (Moon et al. 2016a, 2022a, 2022b). SUID rates declined significantly from 158.58 deaths per 100,000 live births in 1990 to 92.9 deaths per 100,000 live births in 2020 (CDC 2023). Although Wolf et al. (2025) reported an increase in SUID between 2020 and 2022.

In 2016, the Pennsylvania (PA) Department of Health prioritized funding to mitigate infant deaths due to unsafe sleep environments and practices. Between 2018 and 2019, PA reported a decrease in SUIDs from 9.8% (87 of 888) of infant deaths in 2018 to 7.8% (67 of 854) in 2019 (Pennsylvania Department of Health, Bureau of Family Health Division of Bureau Operations 2020). A review of sleep environments for 154 SUID-related deaths in PA from 2018 and 2019 revealed 33.1% were in adult beds known to be unsafe and 46.0% involved infants sleeping on the same surface with another person or animal. In 2018 alone, only 34.5% of SUID deaths occurred with infants placed on their back for sleep, the safest position, warranting more widespread awareness of other risks for SUID. PA's 2020 SUID rate, 87.5 per 100,000 live births, was lower than this national average (CDC 2023).

Several international and United States regional and statewide hospital-based safe sleep programs achieved varying degrees of success in improving health professional and parental knowledge of safe sleep environments (Butler et al. 2024; Cho et al. 2020; Gilmour et al. 2019; Shin et al. 2023; Tipene-Leach and Abel 2019). Parents learn about safe sleep from nurses and other healthcare professionals, underscoring the importance of modeling safe sleep behaviors, especially during birth hospitalizations (Ahlers-Schmidt et al. 2019; Kellams et al. 2017). A recent scoping review, however, cautions that parents tend to form their own sleep practices when at home (Landsem and Cheetham 2022).

Researchers have assessed the impact of hospital- and community-based strategies, interventions, and resources to support safe sleep practices such as nursing policies, clinical practice guidelines, education of nurses, birth parents and caregivers, health record audits, surveillance of infant sleep environments, tool kits, community-based programs and social media (Ahlers-Schmidt et al. 2019; Aitken et al. 2023; Kellams et al. 2017; Kuhlmann et al. 2016; Macklin et al. 2019; Shin et al. 2023). Few researchers, however, focused on SUID prevention by implementing multi-prong safe sleep interventions or reaching multiple sites (Landsem and Cheetham 2022).

Multi-pronged public health strategies to reduce risks for infant SRDs facilitate community engagement of families with safe infant sleep practices after birth discharge. In collaboration with PA's Department of Health and Maternity Care Coalition (a community organization), we designed and implemented the PA Safe Sleep Program, a comprehensive, evidence-based program in birthing hospitals and community settings to promote and evaluate healthy newborn safe sleep practices. Prior studies and guidelines support this work to deliver consistent messaging across multiple levels such as the individual, agency, and community level (Moon et al. 2016b; Ward and Balfour 2016). To our knowledge, no statewide safe sleep programs combine nurse subject matter experts (SMEs), a publicly accessible website, and a multi-media community-based campaign.

1.1 | Conceptual Framework

The Integrated Promoting Action on Research Implementation in Health Services (i.e., i-PARIHS) framework guided the development, implementation, and evaluation of our infant safe sleep program (Harvey and Kitson 2016) (Figure 1). This evidence-based framework posits that successful implementation of any program is a function of the interconnectedness of evidence for the innovation, context, recipients, and facilitation. Evidence for innovation is driven by the American Academy of Pediatrics Task Force on Sudden Infant Death (Moon et al. 2016a, 2022a, 2022b). Context is inclusive of characteristics of the environment that may support or inhibit the intended practice change, our birthing hospitals and childbearing communities. Recipients or intended receivers of the innovation or program included maternal child health providers and childbearing families. Facilitation is the act of assessing, aligning, and integrating the innovation, context, and recipient. Key facilitators, SMEs, expeditiously transform environments and sustain outcomes-driven improvements with infant safe sleep practices. Our previous work documented the benefits of training and embedding frontline clinical nurse SMEs to translate evidence into practice (Stringer et al. 2022).

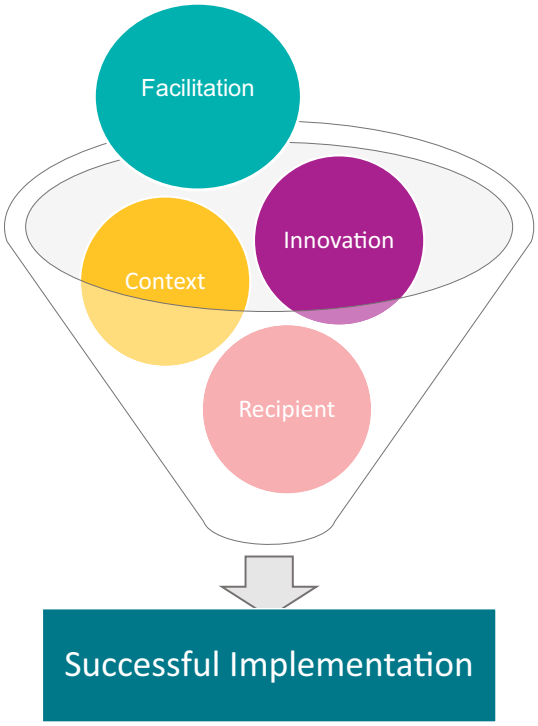

FIGURE 1 | Integrated promoting action on research implementation in health services (i-PARIHS) Adapted from Harvey and Kitson (2016).

1.2 | Aim

This project evaluated the impact of a statewide, evidence-based infant safe sleep program for birthing hospitals using nurse SMEs and a community awareness campaign on nurse knowledge, safe sleep environments, and trends in infant SRDs. Specific aims were to (1) provide infant safe sleep education to inpatient clinical nurses and measure changes in their practice, (2) assess nurses' confidence in infant safe sleep messaging to co-workers and parents, (3) design and assess the reach of a multi-media messaging campaign to the community, and (4) compare differences in self-reported at-home infant safe sleep behaviors between birth parents discharged from our program hospitals to those discharged from other PA facilities.

2 | Methods

2.1 | Design

This statewide project used a non-equivalent group quasi-experimental, pre- and post-test program evaluation design implemented with a quality improvement methodology to examine the impact of hospital- and community-based infant safe sleep education, interventions, and resources on nurses' knowledge and practice, birth parents' knowledge and behaviors, social media access, and local community infant SRDs. Survey data from birth parents discharged from 12 participating hospitals were compared to those discharged from other statewide facilities. This project aligned with the Squire 2.0 guidelines for transparency in reporting quality improvement work (Ogrinc et al. 2016).

2.2 | Program Components and Interventions

2.2.1 | Stakeholder Engagement, Resources and Social Media Campaign

In 2016, our health system was awarded funding from the PA Department of Health to embark on a statewide infant safe sleep program. An interdisciplinary project team was formed with nurse leaders, nurse scientists, clinical nurses, professional development specialists, neonatologists, community members, and a community partner, Maternity Care Coalition. Based on the American Academy of Pediatrics (AAP) guidelines (Moon et al. 2016a) during project year 1, educational resources developed for health professionals included (1) two 1-h basic training online infant safe sleep practice modules; (2) six brief instructional videos with simulation scenarios and actors depicting risks for SRDs, safe and unsafe sleep practices, and corrective active strategies; (3) a hospital-based safe sleep policy template; (4) published evidence-based guidelines and scientific web-based resources; and (5) electronic print materials and images (e.g., signage, posters, pamphlets, palm cards) with free access and permission for use. Launched in 2017, a PA Safe Sleep website (pasafesleep.org) housed all program materials containing educational resources for nurses and consumer education pamphlets available in over 20 languages. A city-wide multi-media campaign occurred with safe sleep pictures, messaging, and a link to our website advertised on Southeastern Pennsylvania Transportation Authority trains and buses and in transportation shelters. Public service announcements and other media outlets (e.g., Facebook, Instagram, Twitter) messaged the ABCs (i.e., alone, back, crib) of safe sleep and directed viewers to our website. Other resources were developed and posted during the project implementation, for example practice audit forms, updated educational slide sets, huddle forms.

2.2.2 | Recruitment of Hospitals

From 2016 to 2021, 21 birthing hospitals across the state were recruited, but only 12 fully implemented all requirements for the PA Safe Sleep Program for greater than 1 year. We report multiple outcomes from these 12 hospitals.

2.2.3 | Safe Sleep Education

At recruitment, nurse leaders from participating hospitals identified potential SMEs to complete all safe sleep education and participate in a 4-h virtual intensive training session. Content included local, state, and national SUID statistics by race and ethnicity, infant SRD terminology, SUID risks and risk reduction, evidence-based guidelines, AAP recommendations, and navigating the PA Safe Sleep website. Training prepared SMEs to implement peer education, ensure access and utilization of the PA Safe Sleep Program web-based resources, conduct

practice environment audits, perform frequent practice rounds of infant sleep environments and SUID risks, and take corrective actions to address deviations from evidence-based and best practices. Twenty-two SME training sessions were held between 2017 and 2021.

The first cohort of SMEs, once trained, conducted pre-implementation audits of infant sleep environments over at least 1 month using the *PA Safe Sleep Environmental Audit Tool*. Knowing that a high percentage of infants were already receiving safe sleep practices prior to any intervention, we estimated needing at least 1200 pre- and post-implementation audits across hospitals to detect differences (power > 80%, small effect size $w = 0.1$) in the portion of infant safe sleep positions pre- to post-implementation. Based on hospital birth rates, this translated to a minimum of about 3% of annual births at each site.

Two months post-implementation, SMEs again conducted environmental audits over 1–2 months. Each hospital was expected to send a SME representative to monthly sessions with our program team to be accountable for updates on evidence and resources.

Next, SMEs from all participating hospitals rolled out safe sleep education for all clinical nurses (registered nurses-RNs) caring for postpartum dyads (birthing parent and infant) and an updated infant safe sleep policy. Each nurse first completed a baseline practice analysis survey and then two online modules preparing them to understand the scientific basis for the AAP safe sleep guidelines, incorporate all recommendations into practice, and implement nurse and patient teaching strategies. Learners also viewed our website resources, for example, instructional videos illustrating unsafe sleep environments and situations, and ways to change nurses' and parent's behaviors. Nurses educated patients, distributed pamphlets, posted signage and posters in patient rooms and common areas, and demonstrated safe sleep behaviors with patients. Learners completed a self-assessment of their progress made in advancing safe sleep practice and environments 2 months after completing the modules.

2.3 | Data Collection and Measures

2.3.1 | Nurse-Level

All data collected from individual nurses were anonymous and coded by hospital only. Data were entered by nurses via Qualtrics (Provo, UT) to standardize data collection across facilities. Prior to completing safe sleep education, nurses completed the PA Safe Sleep Practice Analysis Survey, created for this program, that assessed demographic information (e.g., years in nursing, age category) and knowledge of safe sleep practices using a 5-point Likert scale (1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *often*, 5 = *always*). The survey required that respondents estimated the frequency of practices (e.g., positioning, tummy time, swaddling) for themselves, peers, and birth parents. Five safe sleep experts (neonatologist, nurse researcher, clinical nurse leader, and two experienced clinical nurses) provided content validation by reaching consensus regarding the relevancy of all items (Content Validity Index [CVI] = 1.0). Nurse end users trialed the form and offered feedback prior to using the survey for the program. Baseline data prior to our educational interventions documented opportunities for all sites to improve infant safe sleep practices and teach nurses about evidence-based guidelines.

Two months after completing all safe sleep education components, nurses self-reported their progress made in several areas of infant safe sleep practice via the Progress You Made Survey, which was adapted from a well-established survey used for measuring the impact of the curriculum. Eight questions, scored on a 5-point Likert scale (1 = *none*, 2 = *slight*, 3 = *moderate*, 4 = *substantial*, 5 = *exceptional*), focused on nurses' knowledge, confidence, and capabilities with infant safe sleep practices and environments. Content validation was also established using feedback from end users. Reliability and validity testing are reported in the results section.

2.3.2 | Practice-Level

The PA Safe Sleep Environmental Audit Tool, designed for this program, required documentation of multiple-choice practice questions, which for content validity were aligned with AAP infant safe sleep guidelines and recommendations (Moon et al. 2016b). This audit tool was developed and reviewed by infant safe sleep experts and field tested to ensure that criteria identified deviations from safe sleep practices. Questions captured the birthing parent's location (e.g., bed or chair), activity with the infant, state of wakefulness along with the infant's location, position, and state of swaddling. SMEs were trained in the accuracy, consistency, and integrity of conducting environmental audits and given assurance of anonymity for their hospital findings in reporting program outcomes.

2.3.3 | Program Level

A Program Dashboard tracked and maintained each hospital's progress in implementing the safe sleep program components to ensure consistency, accurate records of clinical nurse engagement (percentage of eligible staff completing a Practice Analysis Survey, self-learning modules, Progress You Made Survey, and pre- and post-implementation environmental audits). In addition, a Statewide Newborn Reach Dashboard tracked quarterly data on the number of births per hospital whose newborn birthing parent had received education and materials from the PA Safe Sleep program along with hospital and statewide annual births. Dashboard data were obtained from participating hospital contacts who verified birth data through their data repositories.

2.3.4 | City Level

A Philadelphia-Specific Dashboard incorporated SRD counts by year provided by Philadelphia County's Medical Examiner—the only county with accessible SRD data during

our program evaluation period. Infant death data for infants discharged from the 12 program hospitals were only available up to 2022.

2.3.5 | State Level

The Pregnancy Risk Assessment Monitoring System (PRAMS) identified and monitored birth parent experiences and behaviors occurring before, during, and after birth from a statewide sample. This surveillance system is a population-based, representative survey that underwent rigorous design and methodology development and testing and is fielded statewide by the CDC to inform policy and program development to reduce maternal and infant morbidity and mortality (Shulman et al. 2018). The PRAMS survey captures birthing experiences, such as attitudes and feelings about their most recent pregnancy, content of prenatal care, and infant health care. Studies demonstrate validity for PRAMS self-reported items (Dietz et al. 2014; Hirai et al. 2019).

Survey respondents were randomly selected from the state's Birth Certificate Registry to receive a survey by mail within 2–6 months post-live birth, with most responding 3–4 months post-partum (Pennsylvania Pregnancy Risk Assessment Monitoring System 2020). The PA Safe Sleep Program leadership requested aggregated response data on 5 survey questions related to infant safe sleep. Data were stratified by respondents discharged from 12 PA Safe Sleep Program birthing hospitals and compared to respondents from the remaining 100 PA facilities (including 9 recruited hospitals in various stages of program implementation).

2.3.6 | Social Media Level

A Social Media Dashboard was created to track the reach for Facebook, Instagram, and Twitter impressions and website link clicks. We also counted the number of public service announcements and PA Safe Sleep Program postings in bus shelters, bus interiors, and subway interiors, along with their run times.

2.4 | Data Analysis

Sample characteristics and responses on all nurse surveys, environmental audits, PRAMS data, and website traffic were summarized using descriptive statistics (e.g., frequencies, means, medians, interquartile ranges). Chi-square tests compared changes in safe sleep practices reported in the PA Safe Sleep Environmental Audit tool prior to and after implementation. Linear regressions compared changes in the average percent of birth parent respondents with positive survey responses discharged from the 12 PA Safe Sleep Program participating hospitals compared to other state birthing facilities over time. All analyses were conducted in R (R Foundation, Vienna). Cronbach's alpha and the Mann Whitney *U* test were used for reliability and validity testing for the Progress You Made Survey.

2.5 | Ethical Considerations

All procedures and data collection were deemed exempt from research oversight by the health system's Institutional Review Board (IRB) under the application mechanism for quality improvement. The IRB application assured procedures for anonymity for all participating hospitals.

3 | Results

Of 21 hospitals recruited by 2021, data are reported for 12 hospitals that fully integrated all nurse (e.g., safe sleep education and SMEs) and patient education for > 1 year and submitted all data requirements (nurse- and practice-level data). Due to the COVID-19 pandemic, not all 21 hospitals completed and integrated the program within 1 year of recruitment. Across the 12 hospitals, over 900 nurses completed online safe sleep education. All 12 hospitals also integrated patient education resources (e.g., signage, pamphlets, website) into their practice and disseminated a hospital-approved nursing policy for safe sleep.

3.1 | Practice Analysis and Safe Sleep Education

By the end of 2021, 906 nurses from the 12 hospitals completed the pre-intervention practice analyses prior to completing the safe sleep online education. Nurses were predominantly female (99.2%), 40 years of age and older (52%), held a Bachelor's degree as the highest degree (68.5%), and were employed in an academic medical center (45.7%). Approximately one-third (34%) of nurses worked in a community hospital (Table S1). Over one-third (34.2%) had over 20 years of experience in labor and delivery and overall experience as a nurse (41.2%). Only 4.9% were lactation consultants. While 91.2% of nurses reported often or always placing infants in the supine position to sleep, 18.5% indicated sometimes or always placing infants in prone positions for sleep. Nearly 1 in 5 nurses observed peers placing infants in prone positions. Additionally, 17.7% of nurses incorrectly identified some medical equipment as safe to leave in the crib while the infant was sleeping. Less than half of all nurses (42.4%) had acknowledged reading the latest AAP safe sleep guidelines (Moon et al. 2016a). The total time for the completion of the evidence-based educational modules was about 1.5 h.

Two months after completing the online safe sleep education, all nurses from the 12 hospitals ($N = 906$) were asked to gauge the progress that they made in safe sleep practices. Overall, 827 (91.2%) completed the Progress You Made Survey. Results indicated knowledge and confidence gained from the education. For example, nurses reported making substantial or exceptional progress in acquiring factual knowledge about SRD in infants (74.4%), understanding environmental risks for SRD (78.1%), taking corrective actions (83.1%), and being more proactive (83.4%) regarding safe sleep practices. Based on our findings, trends were also observed across other domains (Table S2).

Internal consistency reliability (Cronbach's alpha) for the Progress You Made Survey was 0.96. Construct validity using known or contrasted groups approach, a technique

where survey data are compared with groups known to differ significantly on a trait being measured, was supported (Davidson 2024). Participants were grouped based on scoring low (none, slight or moderate progress, $n = 212$) or high (substantial or exceptional progress, $n = 614$) for Item 1 "Acquiring factual knowledge." A group comparison of the mean score for Items 2 to 8 yielded a statistically significant difference ($p < 0.001$).

3.2 | Hospital Environmental Audits

Results for the pre-implementation ($n = 1805$, range 22–289 audits per hospital) and post-implementation ($n = 1410$, 21–302 audits per hospital) audits for the 12 hospitals were compared using Chi-square tests (Table 1). A significantly higher proportion of infants were documented in safe sleep positions, defined as supine on back midline in the crib, in the post-implementation period (94.3%) than during the pre-implementation period (89.6%) ($X^2 = 22.67$, df = 1, $p < 0.001$). A significantly lower proportion of infants were found with unsafe items in their cribs in the post-implementation period (17.8%) compared to the pre-implementation period (29.7%) ($X^2 = 59.9$, df = 1, $p < 0.001$).

3.3 | City and Statewide Findings

In Fiscal Year 2021 (July 1, 2020 - June 30, 20), with approximately 21 hospitals enrolled in the PA Safe Sleep Program, 31% ($n = 40{,}433$) of families of infants born across the state received their safe sleep education at hospitals participating in the program based on a yearly average statewide birth rate of 132,622 (CDC 2023). Statewide data on the impact of SUIDs are not available, but for Philadelphia County, the most populous county in PA, a decrease of 16.1% in the number of SRDs for infants born at hospitals ($n = 4$) implementing our PA Safe Sleep Program was reported from 2018 to 2021 (31 deaths to 26 deaths, respectively). Data from 2022 were not available at the time of our analysis.

Between 2016 to 2021, 6509 complete respondent data (independent variables—year and facility) and outcome (PRAMS item response) were provided from the PA PRAMS. Table S3 presents demographic data for respondents. Figure S1 shows trends and details for five key PRAMS items where birthing parents from our 12 participating hospitals reported better outcomes compared to other statewide facilities. The average percent of respondents reporting "Yes" that a doctor, nurse, or other health care worker told them that things should or should not go in the bed with their baby was significantly higher for our program hospital respondents ($p = 0.036$) (Figure S1). Linear regression modeling showed this difference held with no significant gains over time ($p = 0.484$). The proportion of our program respondents (97%) were also significantly higher for indicating "Yes" that a doctor, nurse, or other health care worker told them to place their baby on his/her back to sleep compared to respondents discharged from other hospitals (95%) ($p = 0.019$). Linear regression modeling indicated that PA Safe Sleep Program hospitals had a 2.2% increase ($p = 0.005$) in addition to the 0.1% gain seen across all facilities year over year ($p = 0.001$). A 10% average percent increase was observed for our program hospital respondents (65%) answering "Yes" that a doctor, nurse, or other health care worker told them to place their baby's crib or bed in their (birthing parent's) room compared to other hospital statewide respondents (55%) ($p = 0.013$). While no differences were associated with time, linear regression modeling estimated PA Safe Sleep Program hospitals improved by 9% overall from other statewide facilities ($p = 0.011$). Models indicated that 95% of patients discharged from our safe sleep program hospitals reported answering "No" that in the past 2 weeks, their new baby usually sleeps with toys/cushions or pillows, compared to 92% of patients discharged at other statewide facilities completing PRAMS, which translates to a statistically significant 3% average difference ($p = 0.036$). PA Safe Sleep Program hospitals had an estimated 4.9% increase in the percentage of respondents reporting that they did not have their new baby usually sleep with a blanket in the past 2 weeks compared to comparator hospitals ($p = 0.025$).

TABLE 1 | PA Safe Sleep Environmental Audit Tool ($N = 3215$).

Audit item	Response	Pre-implementation ($n = 1805$)	Post-implementation ($n = 1410$)	p
Hospital (%)	Community Hospitals	157 (8.7)	192 (13.6)	
	Medical Centers	450 (24.9)	568 (40.3)	
	Academic Medical Centers	1198 (66.4)	650 (46.1)	
Infant activity during audit (%)	Awake	287 (16.0)	212 (15.1)	0.825
	Crying	43 (2.4)	32 (2.3)	
	Feeding	293 (16.3)	243 (17.3)	
	Sleeping	1172 (65.3)	917 (65.3)	
Infant observed in safe sleep position (%)	Yes	1617 (89.6)	1330 (94.3)	< 0.001
Crib contains unsafe items (%)	Yes	536 (29.7)	251 (17.8)	< 0.001

3.4 | Social Media Campaign

During year 1 of our ad campaign, traffic to the pasafesleep.org website yielded over 36,000 page views. Messaging on infant safe sleep was accelerated in subsequent years using social media posts. By mid 2020, we reached nearly 2 million people with ads across these platforms and traditional marketing media (e.g., flyers, posters, and subway and bus advertisements). Our geographic reach expanded to all partnering hospital areas, narrowing target audiences to infant caregivers and potential or new parents. The impressions to click ratio resulted in 1.4 million impressions on the PA Safe Sleep Program's website. Once on the site, the Health Professional page was visited the most, followed by the Resources page.

4 | Discussion

The PA Safe Program is distinguished from other infant safe sleep programs based on integral components that include embedding SMEs into practice, launching social media and public awareness campaigns, and tracking available infant SRD data (Stringer et al. 2022). Our statewide, hospital-based safe sleep program demonstrated significant improvements in nurse safe sleep knowledge and practices and post-discharge birthing parent infant safe sleep survey data across 12 participating hospitals. Post-discharge survey data from birthing parents at these hospitals showed significantly better safe sleep knowledge and newborn care when compared to a statewide comparator group discharged from other hospitals. We also experienced a measurable reduction in local reportable infant SRDs among infants discharged after birth from four of our participating hospitals.

In total, our program reached 91,064 birthing families in PA, with the successful program implementation reported for 12 hospitals contributing, in part, to decreasing PA SRDs. The program addressed previously identified organizational- and individual-level barriers to integrating infant safe sleep evidence-based and best practices, notably the lack of formal education and awareness about safe sleep among hospital staff and birth parents (Lowe et al. 2023). SMEs were key to program implementation and engagement of staff (Stringer et al. 2022). Through monthly virtual sessions, our team shares updated scientific evidence and unsafe consumer products and recalls, and best practices. Ongoing support is maintained to implement all PA Safe Sleep Program resources (e.g., signage, ABCs of safe sleep crib cards, and environmental audit forms known to be effective in promoting infant safe sleep environments and practices; Leong et al. 2020).

PRAMS data allowed comparisons of self-reported parental behavioral outcomes between birthing parents discharged from our hospitals compared to other statewide facilities. Previously, PRAMS data gauged state-level prioritization of safe sleep education and program outcomes (Hwang et al. 2023). Recently, PA data are generated specifically for the purposes of our program evaluation. Our 12 participating hospitals had significantly higher average results for positive safe sleep behaviors. These findings advantage our program in demonstrating a longitudinal evaluation of the effectiveness of our interventions. Analyses of 2017 to 2021 PA PRAMS data published by the PA Department of Health comparing 27 of our participating hospitals to comparator statewide hospitals validated that birth parents from our program hospitals reported significantly better safe sleep practices at home (Decker et al. 2025).

4.1 | Limitations

There are limitations to our program and its evaluation. The lack of paired data for demographic and clinical birthing parent data hampered our ability to link this data with individual-level changes in safe sleep knowledge and practices. Nursing shortages, high turnover, and competing priorities of hospitals affected our ability to obtain timely and complete data at the start and ongoing implementation of the program. Despite training SMEs in the integrity of data collection, bias in reporting hospital-level data may have occurred. No data were collected on the simultaneous opioid and COVID-19 crises in regions that may have negatively influenced infant safe sleep implementation by birth parents and staff. Despite the 16.1% decline in SRD observed from 2018 to 2021 in Philadelphia County hospitals implementing our safe sleep program, these numbers are relatively small and do not reflect the statewide burden of infant SRDs. We also acknowledge difficulty in establishing downstream effects of an intervention program and inherent bias with self-reported measures to assess the effectiveness of interventions such as education. Despite these limitations, our multi-pronged approach to infant safe sleep was associated with improvements in nurses' knowledge, hospital safe sleep environments, community awareness of infant safe sleep and birthing parents' safe sleep practices, and a reduction in local SRDs.

5 | Linking Evidence to Action

- An educational training program is associated with nurses' behavior changes to promote safe sleep practices and environments and parent-reported infant safe sleep behaviors.
- Hospital nurses are improving practice and gaining knowledge and confidence to educate patients and families about infant safe sleep.

6 | Conclusion

Between 2016 and 2021, a total of 21 birthing hospitals implemented this evidence-based PA Safe Sleep Program. Those that fully implemented the program for more than 1 year demonstrated significant improvements in nurse practice and birthing parents' outcomes. The PA Safe Sleep Program is the only known program with SMEs implementing the interventions and among a few to launch a multi-media campaign and connect specific interventions to birthing parents. Recently, the PA Safe Sleep Program was officially accepted to the MCH Innovations Database as a Best Practice sponsored by the Association of

Maternal & Child Health Programs. Future longitudinal program evaluation data are warranted to continue to demonstrate the sustained positive impact of safe sleep interventions on infant health.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.