A Hospital-Based Initiative to Reduce Postdischarge Sudden Unexpected Infant Deaths

Scott D. Krugman, MD, MS,¹ Carolyn J. Cumpsty-Fowler, PhD, MPH²

ABSTRACT

BACKGROUND AND OBJECTIVES: Sudden unexpected infant deaths (SUID) most often occur because infants are placed in unsafe sleep environments. Although authors of previous literature have demonstrated that parents who receive comprehensive safe sleep education increase knowledge and intention to place children in safe sleep environments, no studies have demonstrated improved outcomes. We describe the development of a hospital-based newborn SUID risk reduction quality improvement project and its effectiveness in reducing subsequent SUIDs in a community using linked outcome data from local Child Fatality Review Teams.

METHODS: Qualitative and quantitative evaluation of a long-term iterative performance improvement intervention for a nursery-based comprehensive safe sleep program in a community teaching hospital. Key themes and exemplary comments were noted. The rate of infant deaths per 1000 births was the primary quantitative outcome. The rate is calculated quarterly and monitored with control charts by using Child Fatality Review data about infant sleep deaths.

RESULTS: The average death rate fell from 1.08 infants per 1000 births preintervention to 0.48 infants per 1000 births after complete intervention, and the average number of deaths between deliveries increased from 1 in every 584 deliveries (upper control limit: 3371) to 1 in every 1420 deliveries (upper control limit: 8198). Qualitative observation of nursery providers revealed 3 themes, including routine inclusion of sleep safety information, dissemination of safety information by all staff, and personal commitment to success.

CONCLUSIONS: A comprehensive sleep safety culture change can be effectively integrated into a nursery setting over time by using feedback from Child Fatality Review and performance improvement methodology. Repeated messaging and education by the entire nursery staff has the potential to play a role in reducing sleep-related deaths in infants born at their hospital.
Sudden unexpected infant death (SUID) encompasses sudden infant death syndrome, sudden undetermined death of infancy, and accidental sleep and suffocation in bed and causes the majority of postneonatal infant death. Nationally, ∼3500 infants died of SUID in 2015, making it the leading cause of postneonatal death in infants in the first year of life. Despite the drop in sudden infant death syndrome rates in the 1990s, the overall SUID mortality rate stagnated in recent years, primarily from an increase in infants dying in unsafe sleep environments. As Moon et al recently highlighted, achieving reductions in SUID deaths through parental behavior changes and evaluating safe sleep interventions continue to be challenging because of the variability of interventions, heterogeneity of outcomes, and the low frequency of SUIDs. In previous studies, it has been demonstrated that hospital safe sleep education using quality improvement (QI) methodology may improve the modeling of safe sleep practices in hospitals but fails to impact postdischarge outcomes. It is not surprising that a generic single-dose educational strategy such as discharge counseling would not impact outcomes given that authors of previous health and safety-related behavior change research demonstrate little impact on postdischarge practices of adults with diverse backgrounds, lifestyles, and parenting experience. Additionally, there is evidence that parents recall little of the anticipatory guidance delivered in the newborn nursery.

Feedback of outcomes is a primary driver that helps a unit own an outcome and change a culture. The actual outcome of rates of sleep-related SUID has not been in the focus of any previous hospital SUID reduction study. We hypothesized that a focus on the outcome of the actual infant death rate from SUID from infants born in our hospital would provide significant motivation for the nursery staff to invest in major culture change. Our specific aim in this article is to describe the development and evaluation-informed enhancement of a hospital-based newborn SUID risk reduction program by using hospital-specific SUID death rates as our measure of success as provided through a link to the local Child Fatality Review Team (CFRT).

METHODS

Context
MedStar Franklin Square Medical Center is a 352-bed community teaching hospital with a busy obstetrical service. In 2015, 3000 infants were born, mostly from Baltimore County, but 20% were from neighboring Baltimore City and Harford County. Compared with the rest of the county, the community surrounding the hospital has significantly higher rates of teen-aged pregnancy (10.8% vs 7.5% of all births), low birth weight infants (9.5% vs 8.9% of all births), and other adverse social outcomes. The need for an intervention to reduce SUID cases became apparent between 2003 and 2005 when each year, 6 infants presented dead on arrival to the emergency department after dying in an unsafe sleep environment. Institutional review board approval was granted for the evaluation of the intervention.

Iterative Intervention and Qualitative Evaluation
From 2005 to 2009, we progressively increased education about infant safe sleep to all parents of newborns. A flowchart of the iterative evaluation-informed development of the program is shown in Fig 1. One author (S.D.K.) assumed responsibility for championing and monitoring the QI process; the other (C.C.F.) served as an independent evaluator. The intervention began simply in 2005 by passing out the Baltimore County Department of Health Injury Prevention Program’s Safe Sleep Alert: Healthy Babies Are Dying (Supplemental Fig 4). This material was developed with input from home visiting public health nurses and parents, tested with parents of varying ages and backgrounds in our community, and is available in Spanish. Recognizing that the distribution of educational material in a single-discharge encounter was necessary but insufficient to influence behavior change, we committed to expanding exposure to safe sleep teaching and modeling in the newborn nursery. In summer 2006, in a baseline observational assessment of the nursery culture by the evaluator (following caregivers into rooms, observing their behaviors and counseling), it was noted that nursery staff was not consistently modeling safe sleep. The evaluator observed many infants placed on their sides, excess blankets in cribs, and inconsistent messaging by staff. A baseline written awareness and readiness to influence assessment was deployed in fall 2006 to staff in the newborn nursery, NICU, and pediatric emergency department. Thirty-three out of 75 surveys (44%) were completed. In this assessment, it was demonstrated that although most of the staff identified sleep-related deaths as important and felt education was important, there was great variation in the language used to describe the safety problems. Physicians and nurse practitioners reported lower readiness to influence parents. Frontline staff, including ancillary staff, believed their knowledge and role modeling behavior could influence parents’ infant safety–related knowledge. This was used to inform the first program enhancement: provider training to support consistent messaging and practice by all nursery staff. In 2007, we added a mandatory safe sleep education online module for all nursery and pediatric providers and “bed checks” to monitor modeling of safe sleep position, checking infant position and crib accessories every shift on the vital sign flow sheet.

The final iterative step to address ongoing infant deaths was added in 2009 after analyzing the 3 infant sleep deaths in 2008 as “sentinel events.” Each death led to a review of how education was delivered at the hospital. The unsafe home sleep environments contributing to the cause of the SUIDs were shared with nursery staff to inform the education being provided to parents. Nursery leadership reviewed current procedures and implementation of previous interventions. After the 3 deaths, the final intervention was implemented, which included a safe sleep video for parents to watch and required parents to sign a commitment statement saying they will always place their infant to sleep in a safe position (alone, back, crib, the “ABC
Compliance of completion of commitment statement signing increased from 16% initially in 2009 to 75% throughout 2010. In 2011, the commitment statement became part of the electronic record and spot checks of compliance since then consistently demonstrated 100%. Since 2009, all parents of newborns have received the full intervention and safe sleep counseling became the central topic incorporated into every interaction between staff and parents.

In 2010, recognizing the program was both influencing and being influenced by the complex nursery environment, we added an adaptive, qualitative approach to monitoring program dynamics and outcomes. Developmental evaluation data informs program development and adaptation by “getting beyond surface learning to deeper understanding of what’s happening.” To be successful, the evaluator must be viewed by the organization as having a seat at the strategy table; this requires a level of trust between those involved in the evaluated program and the evaluator.

In spring 2010, the evaluator and a graduate nursing student with newborn nursery experience at another hospital assessed staff messaging and behaviors in the nursery using explicit direct observation by the evaluator, indirect observations by the student using observation guidelines, and conversational interviews by both evaluators with frontline nursery staff. Nursery staff knew the evaluators were observing newborn nursery practice but did not know of the specific focus on safe sleep. Brief, semistructured interviews conducted by the student were used to ask about awareness of the safe sleep program. Observation yielded three insights. First, staff in all professional categories were performing safe sleep checks, modeling safe sleep practices, employing teach-back techniques, and using many opportunities to reinforce the ABC message. Second, when asked to describe the hospital’s safe sleep program, many nurses were unaware that a separate program existed. They explained the observed safe sleep–related activities as standard practice in the nursery. Third, and an opportunity for improvement, physicians seldom described or acknowledged the nursing staff’s role in the safe sleep program. To better understand the dynamic nursery culture and how the culture change had happened, we followed-up with more observational rounding and key informant interviews in 2011, the final qualitative evaluation. Over a period of 3 months, the evaluator spent 45 hours observing staff and holding conversational interviews with frontline staff and physicians. She conducted in-person, semistructured interviews about the culture shift with key nursery staff influencers: 2 physicians, 1 nurse practitioner, the nurse educator, and nurse manager. To determine if culture change was newborn nursery–specific, a graduate student conducted 9 semistructured interviews with key informants in the department of pediatrics who were not active in the newborn nursery (5 pediatricians, 1 physician assistant, 1 nurse practitioner, and 2 registered nurses). The evaluator employed an inductive approach to content analysis, discovering common themes in the observational data and interview-generated narratives.

Quantitative Evaluation of Outcomes

The primary outcome was the rate of infant (<12 months old) deaths in an unsafe sleep environment per 1000 births at the hospital. Unsafe sleep environments included prone position, cobedding, in an adult bed, on a couch, or in another nonrecommended sleep location. Data were obtained in collaboration with both the Baltimore County and Baltimore city CFRTs. The teams reviewed all sudden and unexpected deaths, including SUIDs and identified potentially modifiable risk factors that contributed to a child’s death. The CFRT provided feedback to the birth hospital when an infant died in an unsafe sleep environment. Over the time period of the study, the office of the chief medical examiner maintained a consistent death review protocol, and the CFRTs did not


change their documentation of sleep risk factors.

The hospital-specific death rate was calculated quarterly by using the number of live births and the number of SUIDs who died in an unsafe sleep environment. The data were monitored by using Shewhart control charts (U chart), noting the quarter of the death (even if the birth occurred during a previous quarter). In addition to the quarterly death rate, the number of births between sleep-related infant deaths was also tracked (Shewhart G chart). We considered the adoption of the final intervention in July 2009 and compared rates of infant deaths per 1000 births for the iterative period (2005 through June 2008) and the complete intervention period (July 2009 through December 2016). First, the control limits were calculated for the test period and extended into the future. When special cause signals were observed (8 consecutive quarters below the control limit on the U chart in the third quarter 2016), the limits were recalculated starting at the point of the complete intervention period by using published rules of statistical process controls because no significant changes to the intervention occurred after July 2009.

**RESULTS**

The demographic descriptions of the population from 2005 to 2009 and 2010 to 2016 are shown in Table 1. During the iterative period, 13,395 infants were born, whereas 16,369 were born after the intervention. The population of low-income and minority infants significantly increased in the complete intervention time period as compared with the iterative period.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Race, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>3147 (23)</td>
<td>4391 (28)</td>
</tr>
<tr>
<td>Asian American</td>
<td>279 (2)</td>
<td>96 (1)</td>
</tr>
<tr>
<td>Other, including Hispanic</td>
<td>806 (6)</td>
<td>1589 (10)</td>
</tr>
<tr>
<td>White</td>
<td>9223 (69)</td>
<td>9649 (61)</td>
</tr>
<tr>
<td>Insurance, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private, commercial, or HMO</td>
<td>8376 (47)</td>
<td>4445 (34)</td>
</tr>
<tr>
<td>Medicaid</td>
<td>8888 (51)</td>
<td>8386 (63.5)</td>
</tr>
<tr>
<td>Self-pay</td>
<td>159 (1)</td>
<td>58 (0.5)</td>
</tr>
<tr>
<td>Other</td>
<td>120 (1)</td>
<td>299 (2)</td>
</tr>
<tr>
<td>Maternal age, y, median (IQR)</td>
<td>26 (22–31)</td>
<td>28 (23–32)</td>
</tr>
</tbody>
</table>

HMO, health maintenance organization.

**TABLE 1 Demographic Description of Infants Born Between 2005 and 2009 and Between 2010 and 2016**

**Final Qualitative Evaluation**

Themes from the final qualitative key informant interviews and observations are shown in Table 2. In the 2011 observations and interviews, dissemination of sleep safety counseling by all members of nursery staff was revealed. In direct observation, routine inclusion of sleep safety in all encounters was demonstrated. Although some staff knew of the program “innovator,” staff who had worked in the nursery for fewer than 5 years were unaware of the innovator or the QI work. Despite an apparent lack of exposure to the QI work, they had ingrained the tenets of the program, describing it as, “that’s what we do here.” Commitment to infant sleep safety was described not only as a practice protocol but as a component of nursery staff’s identity. This helped explain the level of ownership we observed in staff, from those in support roles to attending physicians. Two influential early adopter change agents in the newborn nursery were identified in interviews: a pediatric nurse practitioner and an attending pediatrician who modeled appreciative inquiry-style education during her interactions with families. Their influence crossed professional groups. Staff who had been in the unit for several years emphasized the importance of staying connected to the overarching purpose or “why” of the work. They described the sentinel case reviews as essential to sustaining and improving the program. Interviews with pediatric providers not working in the nursery revealed awareness of the department’s commitment to sleep safety but little evidence of safe sleep culture change.

**Quantitative Results**

The Shewhart control chart method was used to evaluate these data. In the iterative phase, an average of 1.08 infants per 1000 births died in an unsafe sleep environment (upper control limit (UCL): ∼5.0, depending on the specific number of births). The centerline and upper limit were extended into the intervention phase and were used to test for an important change during the intervention period. These updated limits revealed that the death rate fell to 0.48 infants per 1000 births as shown in Fig 2 (UCL: ∼3.0). Quarterly death rates varied from 0 infants per 1000 births to a maximum of 4.5 infants per 1000 births. The special cause signaled by the 4.5 rate in first quarter 2014 was a result of 2 highly atypical cases of infant deaths: 1 as a result of neglect at 9 months and 1 being cared for by a grandmother on methadone cosleeping with an infant in a chair. Two extended periods of no sleep-related deaths occurred in the complete intervention period from August 2011 to June 2013 (22 months) and July 2014 to November 2016 (28 months).

In Fig 3, we show the G chart in which the number of deliveries between each sleep-related death was noted. During the intervention phase, 1 SUID occurred on average after 584 deliveries (UCL: 3371). After complete intervention, the average number of deliveries between deaths increased to 1420 (UCL: 8198), with 2 large numbers of deliveries between deaths corresponding to the dates above: 4647 deliveries from 2011 to 2013 and 5207 deliveries from 2014 to 2016.

**DISCUSSION**

A comprehensive, longitudinal infant safe sleep program was associated with a sustained improvement in SUID outcomes.
Our study differs from previous QI work in that we engaged in longitudinal audit and feedback about infant deaths in unsafe sleep environments in our community using outcomes from local CFRTs instead of focusing on intermediate outcomes. We believe that our focus on actual local infant deaths is the key piece of our intervention that helped create a culture of infant sleep safety in our nursery. The use of patient safety methods, including striving for 0 adverse events, increasing interventions on the basis of review of sentinel events (deaths), and tracking outcomes through control charts, can help staff own safe sleep education and provide effective modeling and counseling. We believe that to reduce the SUID incidence, a complete culture change embracing safe infant sleep practices must be achieved. Although performance improvement methodology

### Table 2: Summary of Final Qualitative Results

<table>
<thead>
<tr>
<th>Theme</th>
<th>Method</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine inclusion of sleep safety in all encounters</td>
<td>Direct observation</td>
<td>Sleep safety content is included in multiple encounters, some of which are informal, such as after helping a new father change a diaper (rather than during “formal” teaching). Teaching styles varied, but several episodes of learner-centered approaches (Q&amp;A, teach back, teaching other family members) were noted.</td>
</tr>
<tr>
<td>Dissemination of safety counseling to all members of nursery staff</td>
<td>Key informant interviews</td>
<td>Unsolicited comments from staff. “It’s so natural; it’s just what we do here; it’s embedded in our culture.” “It’s so automatic. I feel that this awareness has been beaten into me since I started here.”</td>
</tr>
<tr>
<td>Personal investment or commitment to success</td>
<td>Key informant interviews</td>
<td>Comments from staff. “I have to convince them that an ounce of prevention saves a pound of heartbreak.” “If one of mine died, I would think of it as sentinel, an indication of my neglect.” “I never want anyone else here [to] have [a sleep-related death of an infant even though the provider had counseled the parents about safe sleep] happen to them.” “One [sleep death] is one too many, it’s just so unnecessary.”</td>
</tr>
</tbody>
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Q&A, question and answer.

![Figure 2](https://example.com/image2.png)  
**Figure 2** Control chart of the quarterly infant sleep-related death rate (per 1000 births) from 2005 to 2016. LCL, lower control limit; Q1, quarter 1; Q2, quarter 2; Q3, quarter 3; Q4, quarter 4; UCL, upper control limit.
may help achieve intermediary goals, the ultimate goal of reducing the SUID rate to 0 fits better with a patient safety approach (similar to central line infections or ventilator associated pneumonias). In recent publications in the pediatric literature, it has been demonstrated that unit-based pediatric patient safety programs can impact and improve the culture of safety. Although a nursery intervention alone is never going to prevent every death, this intervention is low cost and requires only staff buy-in and the time to track outcomes.

In previous safe sleep research, authors have focused on process and behavioral intention measures. In recent publications, multiple authors have described QI interventions in the nursery that demonstrated improvements in nurse’s knowledge and practice around safe sleep practices. Although improvements were demonstrated in in-hospital process measures, Shadman et al found no change in parent home practices after discharge. In other studies, it has been demonstrated that health care providers are a significant source of education for safe sleep and that information given at the time of delivery translates to improved compliance with safe sleep recommendations. Authors of this study demonstrated that total incorporation of an infant safe sleep culture in the nursery can impact post discharge SUID mortality.

The reason we believe a difference in outcomes was demonstrated in our intervention was a result of the iterative approach we took to achieve culture change that was informed by evaluation of staff knowledge and beliefs, repeated observation of staff behaviors, and reviews of sentinel events. This combined approach of adaptation to both patient outcomes and observational feedback allowed for specific programmatic changes (ie, addition of mandatory training module) as well as noticeable changes to educational practices, like teach back and demonstration. As noted by the Agency for Healthcare Research and Quality, “Safety culture is fundamentally a local problem” influenced by interprofessional relationships and other local circumstances that occur at a microsystem level. We suggest that diffusing incremental safety practice expectations in a way that aligns with current unit culture and workflow is more likely to change providers’ everyday behaviors and commitment to safety than introducing an innovator’s “safety program.”

There are numerous limitations to our QI data. First, we present results from a single institution. Additionally, we cannot assess causation from this intervention because other external factors may have played a role in changing awareness of safe sleep practices. It should be noted that the infant deaths lagged up to 9 months after the intervention, which clearly decreases any potential impact of the intervention. Additionally, we were unable to control for the changing demographics between the intervention and postintervention periods. However, given the population became more at risk for SUID because of increasing poverty and minority status, if any bias occurred, it would skew to less probability of seeing a change. Importantly, the decrease in sleep-related SUIDs in our population decreased at a time when the national rate remained flat.

CONCLUSIONS
A comprehensive sleep safety culture change can be effectively integrated into a nursery setting over time by using feedback from Child Fatality Review and performance improvement methodology. Repeated messaging and education by the entire nursery staff has the potential to
play a role in reducing sleep-related deaths in infants born at the hospital.

Acknowledgments

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