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Reducing Pressure Injuries in a Pediatric Cardiac Care Unit

A Quality Improvement Project

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ABSTRACT

The purpose of this quality improvement project was to develop an evidence-based protocol designed for pressure injury prevention for neonates and children in a pediatric cardiac care unit located in the Midwestern United States. The ultimate goal of the project was dissemination across all pediatric critical care and acute care inpatient arenas, but the focus of this initial iteration was neonates and children requiring cardiac surgery, extracorporeal support in the form of extracorporeal membranous oxygenation and ventricular assist devices in the cardiac care unit, or cardiac transplantation. A protocol based upon the National Pressure Ulcer Advisory Panel guidelines was developed and implemented in the pediatric cardiac care unit. Pediatric patients were monitored for pressure injury development for 6 months following protocol implementation. During the 40-month preintervention period, 60 hospital-acquired pressure injuries (HAPIs) were observed, 13 of which higher than stage 3. In the 6-month postintervention period, we observed zero HAPI greater than stage 2. We found that development and use of a standardized pressure injury prevention protocol reduced the incidence, prevalence, and severity of HAPIs among patients in our pediatric cardiac care unit.

KEY WORDS: Pediatric, Pressure injury, Pressure ulcer, Prevention, Quality improvement project.

INTRODUCTION

Critically ill infants and children are at high risk for hospital-acquired pressure injuries (HAPIs) in the pediatric cardiac care unit (CCU). Most surgical patients in our CCU (Regenstein Cardiac Care Unit) undergo complex cardiac procedures that require extended periods of immobility, inotropic support, sedation medications, and chemical paralytics to aid in the healing process. These therapies, in conjunction with the physiologic consequences of the child's cardiac lesion, can lead to decreased oxygenation and perfusion, increasing the patient's risk for injury to additional organ systems, including the skin.[1,2] Bry and colleagues[1] observed that patients with multiple comorbid conditions are at high risk for developing HAPIs, and less likely to respond to typical risk prevention strategies. Figure 1 summarizes HAPI risk factors observed among patients in our CCU. Bry and colleagues further noted that failure of the heart, lungs, and kidneys increases the likelihood of "skin failure" and the likelihood of pressure injury (PI) or ulceration.[1]

Razmus[2] identified risk factors for HAPI in the pediatric population in almost 40,000 children cared for in 271 hospitals and found that patients from pediatric critical care areas had a 3.36 times higher odds of a HAPI, and if the patient was deemed at risk for a HAPI on their last assessment, the patient was 7.71 times more likely to develop a HAPI.[2] These findings are consistent with Curley and colleagues,[3] who noted that patients determined to be at risk for developing pressure injuries via the Braden Q instrument developed more pressure injuries than those found to be at lower risk.[3]

In 2016, the National Pressure Advisory Panel (NPUAP) updated terminology to more accurately describe pressure-related injuries to both intact and ulcerated skin.[4] The updated system defines pressure injuries by stage and range from lesser to more severe, beginning with stage 1, extending to stage 4. The taxonomy includes 2 additional categories, unstageable and deep tissue pressure injuries; deep tissue pressure injuries are characterized by discolored tissue with or intact or nonintact skin with deeply discolored, nonblanchable skin and the unstageable PI has a wound bed covered with necrotic tissue so that depth cannot be accurately determined.

The NPAUP in collaboration with the European Pressure Ulcer Advisory Panel, Pan Pacific Pressure Injury Alliance identify early risk identification as a primary means of HAPI prevention and recommend 2 scales for risk assessment in neonates and children: the Neonatal Skin Risk Assessment Scale (NSRAS) and the Modified Braden Q.[5,6] The NSRAS is used for risk assessment of the neonatal patient 26 to 40 weeks' gestation, and the Modified Braden Q is a valid and reliable risk assessment tool developed for PI risk identification in pediatric

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patients 21 days to 8 years of age. The Modified Braden Q Scale is considered to be the best predictor of patient risk for PI in those requiring medical devices in the acute and critical care settings.[7] Based on the 6 subscales of the Braden Scale for Pressure Sore Prevention, the Braden Q Scale includes a seventh subscale assessing tissue oxygenation and perfusion. This assessment is especially important for evaluating PI risk among infants and children with cardiovascular anomalies and disease. In addition, all subscales of the Braden Q were modified to accommodate differences in developmental functioning and variability of the pediatric population.

Research suggests that patients cared for in higher acuity settings such as pediatric and neonatal intensive care units are at greater risk for HAPI development as compared to general pediatric units.[8,9] Reported incidences of pressure injuries in pediatric critical care units ranges from 0.8% to 27%.[10] Razmus and Berquist-Berigner[8] published a secondary data analysis of 2012 National Database for Nursing Quality Indicators (NDNQI) of approximately 40,000 infants and children for pressure injuries among pediatric patients. They reported that HAPIs were highest among patients in the pediatric critical care unit (3.7%); most were stage 1 or 2, and 24% were unstageable. Considered collectively, findings from these studies highlight the need for nursing education regarding HAPI prevention, especially for nurses working in the pediatric critical care unit. Further, having a unit-based skin champion serving as a staff role model and mentor proved effective in reducing HAPIs for 1 children's hospital.[9]

Loudet and colleagues[11] reported that the risk for adults in an intensive care unit (ICU) setting to develop a PI is high, especially for those requiring prolonged mechanical ventilation, immobility due to shock, presence of multiple traumas, and traumatic brain injury. Findings from this study suggest a similarly increased risk for pressure injuries among pediatric patients requiring similar treatments.

Evidence suggests that the sacrum and heels are the common locations of PI in adults and older teenagers.[3,5] In contrast, the occiput is the most common site of pressure injuries in neonates due its comparatively large bony surface.[3,5] Regardless of location, patients who suffer from pressure injuries are at risk for pain and discomfort and psychosocial distress related to scarring and changes in body image. For example, occipital pressure injuries may cause permanent alopecia, embarrassment, and body image disturbances.[12]

In addition to adverse patient outcomes, the Centers for Medicare & Medicaid Services[13] identified certain hospital-acquired conditions for which facilities would no longer be reimbursed, including stage 3 and stage 4 HAPIs. The Agency for Healthcare Research and Quality estimated the cost of care for a single full-thickness PI to be $20,900 to $151,700.[14]

A standard process of identifying patient injury risk and effectively communicating this risk between providers has been proven to prevent HAPIs in the adult inpatient setting.[15] The PI prevention strategies applied in the adult population can be adapted for use in the pediatric population and more specifically to high-risk critically ill children. For example, 5-layered silicone foam dressings have been used for prevention of pressure injuries in adult ICU patients.[16] Additionally, a longitudinal study of 399 patients in an adult ICU found a significant and sustainable decrease in the development of stage 2 to stage 4 pressure injuries following the transfer of high-risk, immobile patients onto pressure redistribution mattresses.[17] Gavin and Curley[18] found that use of surface pressure redistribution was the most successful intervention for decreasing the incidence of pressure injuries in pediatric cardiovascular surgery patients.

Singh and colleagues[19] evaluated the impact of a preventive care bundle on PI rates in 99 hospitals who participated in the Solutions of Patient Safety initiative. The bundle included preventive care of patients with medical devices, excess cutaneous moisture nutrition deficits, tissue oxygenation impairment, immobility, loss of skin integrity, and researchers evaluated whether one of these risk factors had a greater effect on the occurrence of a PI.[19] Although 44% of participating hospitals reported only partial implementation of nursing interventions to reduce pressure injuries in the pediatric population, study findings indicated that active participation in the dedicated implementation of a bundle reduced the occurrences of pressure injuries over time.[19] Given our baseline data and the evidence available in the literature, we designed and implement a PI prevention protocol to reduce HAPI incidence, prevalence, and severity in children cared for in our pediatric critical care unit.

METHODS

The setting for this quality improvement (QI) project was Regenstein Cardiac Care Unit, a 36-bed CCU within a 288-bed free-standing tertiary care children's hospital. This unit allows for patients to be cared for from admission to discharge in private, technologically equipped intensive care rooms. The hospital is located in an urban area of the Midwestern United States that serves as a level 1 pediatric trauma center for a diverse population of patients from all 50 states and over 45 countries. Located near a large regional birthing center, the CCU offers immediate care to newborns in need of urgent cardiac care, along with those toddlers, children, and young adults requiring cardiac monitoring and intervention.[20]

Prior to implementation of the PI prevention protocol, skin care practices in the CCU varied according to provider, nurse, and patient/patient family knowledge, experience, and preferences. Formal HAPI prevention training was limited to nurses who served voluntarily on the unit's skin care committee. While internal nursing practice guidelines were available for a limited number of specific aspects of skin care (ie, frequency of skin assessments, patient turning requirements), a comprehensive skin care protocol derived from current evidence did not exist.

Preintervention Period

We measured PI occurrences between January 2014 and September 2016 and found that stage 2 or higher HAPI rates in the CCU were higher than the national mean for comparable units, as defined by National Database for Nursing Quality Data Indicators' (NDNQI) quarterly aggregate data reports from 2014 to 2016. We also assessed potential barriers to effective PI preventive care and found inconsistencies in bedside provider knowledge of age-appropriate skin assessment and injury prevention methods, use of outdated pressure redistribution practices and supplies, and limitations in health care team communication. In response to these findings, we designed a protocol for PI prevention in our CCU based on critical appraisal of available evidence. The protocol was reviewed by an interprofessional team of physicians, advanced practice registered nurses (APRNs), RNs from the unit's skin care committee, and ECMO (extracorporeal membrane oxygenation) specialists.

Protocol

The protocol was designed to enable first-line nurses to identify patients at risk for HAPI development via use of age-appropriate risk scales (Modified Braden Q or NSRAS[3]) in conjunction with assessment of risk factors prevalent in patients care for in a pediatric CCU (Figure 1).[12] Once patients were identified at moderate or high risk for skin breakdown, the main interventions included (1) use of specific products outlined in the protocol to redistribute pressure and protect bony prominences where HAPIs are most prevalent and (2) repositioning patients to offload pressure from boney prominences every 2 hours.

At the time of protocol implementation, products recommended by the Association of Perioperative Nurses,[13,18] and approved by the institution's hospital-wide skin care committee, had been purchased for use in the CCU. Products included adhesive options, such as sacral border foam dressings applied when anticipating a prolonged time of immobility such as during cardiac transplant surgery, thin or thick foam-like products applied to boney prominences to offload pressure and wick away moisture, and colloid dressings placed over additional boney prominences (heels of school-aged children and adults; occiput of neonates). Products were selected based on size and location; gel pillows, and fluidized patient positioners were selected based on patient weight and age. A therapeutic mattress overlay was brought in to replace an egg crate mattress, and a variety of specialty bed options for pressure redistribution. Physicians and APRNs prescribed specialty beds within the electronic medical record in accordance with the protocol. Bedside nurses and ECMO specialists requested the additional products from the institution's Central Supply (Figure 2).

Procedures

We used the plan-do-study-act (PDSA) cycle design to guide implementation of the QI project. The PDSA cycles are a critical component of the Model for Improvement framework and allow for iterative tests of change informed by the new knowledge gained in each cycle.[21] Successful improvement usually requires multiple cycles and dedication to studying the results of each test prior to designing the next.

During the 3-month period immediately prior to protocol implementation, nurses from our skin care committee used existing unit-based communication forums to build awareness of the new protocol and garner staff buy-in. They also conducted training sessions for general CCU nursing staff to promote consistency in assessment of PI risk. In order to study the impact of protocol promotion and related training, skin care committee nurses conducted unit rounds and observed each nurse's ability to complete a skin assessment. Skin care committee nurses also used this opportunity to provide in-the-moment guidance and reinforcement of the new protocol as needed.

Based on nursing staff readiness, nursing staff communicated skin assessment results and preventive interventions to patients, families, and relevant health team members during daily bedside patient rounds. All CCU staff were given an opportunity to provide feedback on the new process during staff huddles and via a well-advertised skin care committee group e-mail address. Staff feedback revealed barriers and challenges that allowed for in-depth study and drove planning of subsequent PDSA cycles.

From October 2016 to March 2017, patient census and HAPI prevalence and severity data were collected via electronic medical record review. Components of the review included (1) completion of an age-specific risk scale (NSRAS or Modified Braden Q) and skin assessment by bedside RN every 24 hours, (2) documentation of medical devices in use, (3) evaluation of each patient's nutrition status (eg, nothing by mouth, total parental nutrition, and goal feeding regimen for age), and (4) repositioning at least every 2 hours. At least 15 patient chart audits were conducted monthly; audits included at least 8 patients at risk for PI. Additional data collection included tracking of product use during pre- and postprotocol implementation periods. Aggregate adherence data were shared via a dashboard in the nursing staff break room. Individual adherence data were shared with nursing staff quarterly in a private conversation with a nurse manager.

DATA ANALYSIS

In accordance with the QI approach, statistical process control (SPC) charts were used to analyze and interpret nursing staff adherence with the care processes outlined in the protocol. Plotting these process metrics within SPC charts

Congenital cardiac anomalies (surgically repaired/unrepaired)	Immobility
Critical illness before and/or after cardiac surgery or arrest	Inotropic support
Compromised circulation and/or oxygenation	Mechanical ventilation
Continuous infusions of necessary sedation/paralyzing agents in an effort to reduce metabolic demand	Heart failure
Need for extracorporeal support: Extracorporeal Membrane Oxygenation (ECMO) Ventricular Assist Device (VAD)	

Figure 1. HAPI risk factors observed in pediatric CCU. CCU indicates cardiac care unit; HAPI, hospital-acquired pressure injury. Data from McCord and colleagues.[12]

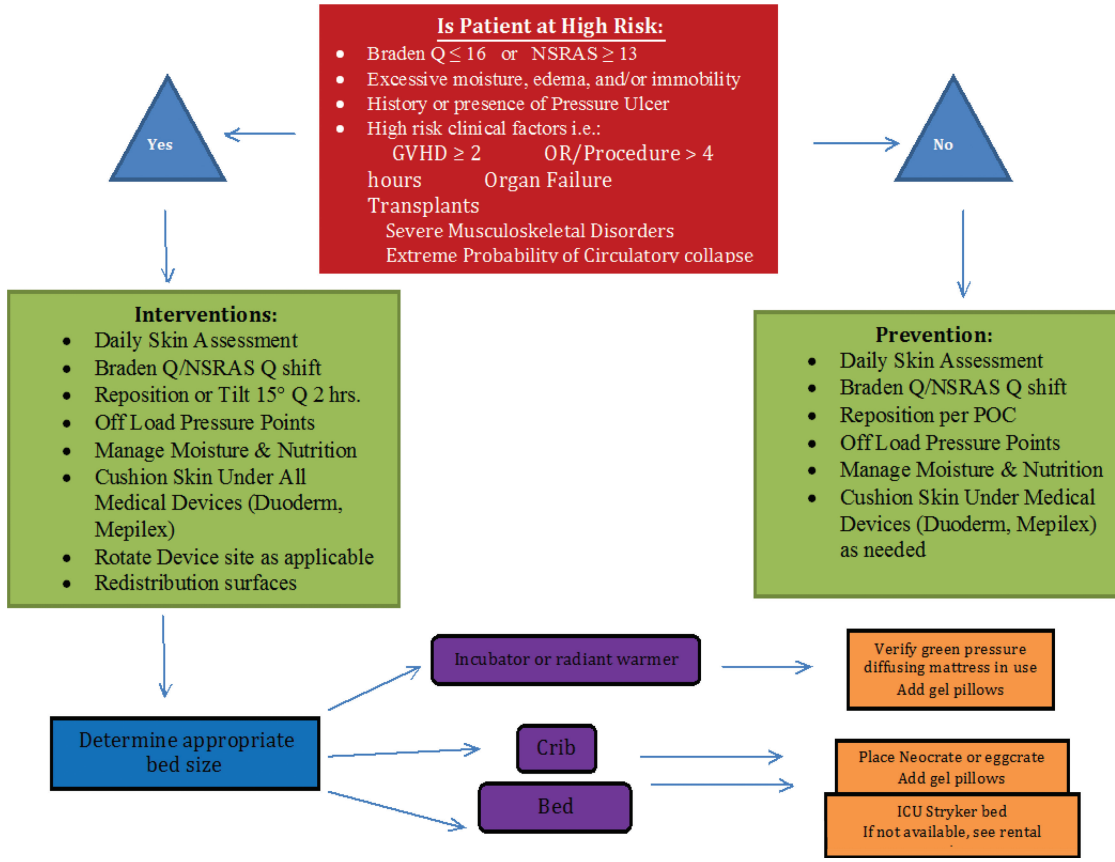


Figure 2. Skin care algorithm. Duoderm (ConvaTec Global, Oklahoma City, Oklahoma). Mepilex (Molnlycke Health Care, Norcross, Georgia).

allowed us to assess adherence over time. Descriptive statistics were used to summarize outcome data and focused on HAPI prevalence (number of HAPI) and severity (stage of HAPI) (Figure 3).

FINDINGS

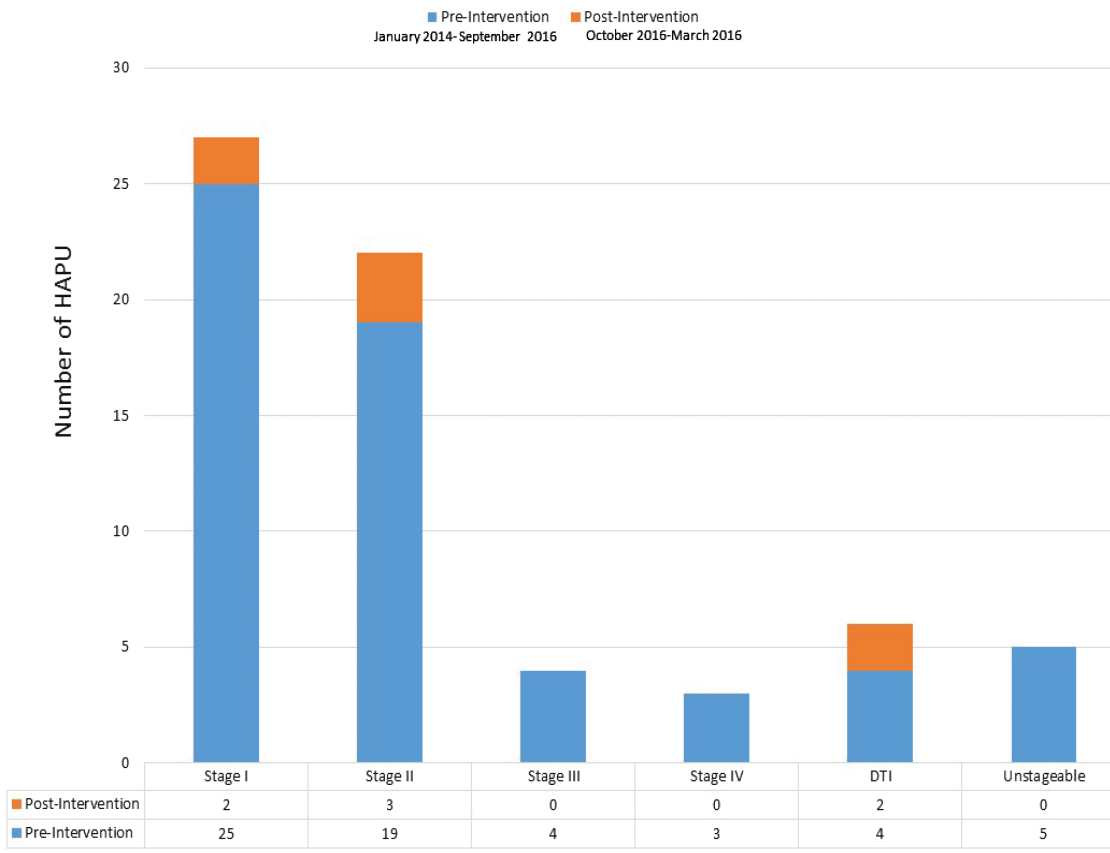
In the 33-month preintervention period, 2186 patients (an average of 66 patients per month) were admitted to the CCU. In the 6-month postintervention period, 359 patients (an average of 59 patients per month) were admitted to the CCU. Patients admitted during both the preintervention (January 2014 to September 2016) and post-intervention (October 2016 to March 2017) time periods ranged in age from less than 1 month to 34 years; the majority were either less than 3 months or between 3 and 18 years of age.

	2014	2015	Jan 2016-Sept 2016	Total
Stage 1	8	9	8	25
Stage 2	9	4	6	19
Stage 3	4	0	0	4
Stage 4	3	0	0	3
DTI	1	1	2	4
Unstageable	5	0	0	5

Figure 3. Pediatric CCU HAPI incidence from January 2014 to September 2016. CCU indicates cardiac care unit; HAPI, hospital-acquired pressure injury.

In the preintervention period, the CCU cared for 36 patients (an average of 1 patient per month) of ages less than 1 month to 18 years who required ECMO support. In the postintervention period, the CCU cared for 7 patients (an average of 1 patient per month) of ages less than 1 month to 26 years who required ECMO support. Procedures for this QI project were reviewed and approved as exempt, by 2 separate internal review boards: one at the project institution (LC), and a second at a supporting institution, Rush University. Both deemed the developed protocol suitable for implementation in this patient population for QI.

During the preintervention period, patients cared for in our CCU developed 60 total HAPIs; 13 (22%) were classified as stage 3 or greater (Figure 3). In the 6-month postintervention period, patients in the CCU developed 5 total HAPIs, none of which was greater than stage 2. The 2 deep tissue injury wounds displayed in Figure 4 occurred at an outside hospital prior to patient transfer to the site involved in this study. Postimplementation, the CCU's percentage of patients with stage 2 or greater HAPI ranged below the NDNQI national mean for comparable units. Figure 4 shows the HAPI incidence preintervention versus postintervention.



	Stage I	Stage II	Stage III	Stage IV	DTI	Unstageable
Post-Intervention	2	3	0	0	2	0
Pre-Intervention	25	19	4	3	4	5

Figure 4. Incidence of HAPI in pre- versus postintervention period. The 2 DTIs listed in the postintervention period occurred at an outside hospital prior to the patient transfer to the site involved in this study. DTI indicates deep tissue injury.

DISCUSSION

We found that implementing an evidence-based PI prevention protocol with collaborative assessment of patient skin care needs reduced the number and stage of hospital-acquired PIs in our pediatric CCU. The benefits of standardized care included early risk identification, and improved adherence to evidence-based preventive interventions. Products identified as being influential for PI prevention in our unit included foam overlays that replaced use of egg crate or other mattress cushions. We also found that fluidized positioners beneath the occiput of neonates, infants, and smaller pediatric patients (more specifically those cannulated onto ECMO in the neck) appeared to reduce the rate of medical device-related PIs. We further observed that use of a border foam dressing applied immediately prior to surgical procedures anticipated to last more than 4 hours, in immobile adolescent patients, and immobile younger patients with higher than average BMI for age. In addition, we observed that implementation of the protocol promoted adherence with patient positioning best practices.

Our experiences reinforced the importance of using a feedback mechanism or strategy for continuous QI during protocol implementation. Specifically, use of PDSA cycles allowed for prompt changes to the protocol when indicated. For example, to address gaps in communication among care team providers and the patient/family, the team created and tested a door magnet that acted as a flag for patients at high risk for HAPI development. Staff feedback also led to improved prevention product stocking that made it easier to access pressure redistribution devices when needed. Through additional PDSA cycles, our team initiated and refined a partnership with the ECMO team that enabled incorporation of skin protection measures into ECMO circuit initiation and maintenance workflows.

LIMITATIONS

During the preintervention period, HAPI incidence and severity in the CCU began to decline prior to formal protocol education, training, and implementation. This trend included occurrences of stage 3 and stage 4 HAPI. Our clinical experience shows this is not uncommon in QI work and may be attributed to increased awareness of the problem and attention to preventive strategies. Nevertheless, the team was able to leverage this early success as a means to secure staff buy-in prior to implementation and sustain staff engagement after implementation.

Our preintervention data collection period (January 2014 to September 2016) was longer in duration than the postintervention time period (October 2016 to March 2017). The duration of each time period was selected to account for the preintervention improvement phenomena described earlier. It was important to include the 2014 data to demonstrate the incidence and severity of HAPIs prior to the increased awareness brought forth by the initiation of protocol development.

An inferential statistical comparison may have been helpful; however, we found that use of descriptive statistics allowed for adequate measurement of protocol impact. Future recommendations would include initial project design that would allow for additional measurement of pre- and postinterventions for pediatric cardiac patients.

CONCLUSION

While historically described as an adult and geriatric problem, HAPI incidence and associated injury in the neonatal and pediatric population across all acuity levels require immediate and future attention. Our experiences with this QI project demonstrate how a standardized preventive care protocol reduced HAPI occurrences in a group of high-risk patients receiving care in a pediatric CCU.

KEY POINTS

- Standardization of skin care via implementation of an evidence-based protocol in a pediatric CCU reduced occurrences and severity of HAPIs across all patient demographics (age, diagnosis, and acuity level).
- Successful development and implementation of the protocol was enhanced by use of QI methodologies that ensured elimination of barriers that would otherwise prevent health care staff from executing the evidence-based care outlined in the protocol.

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