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Implementation of a Prone Position Pressure Injury Prevention Bundle in the PICU

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Abstract

Pronation is a low cost, high value intervention used in treating children and adults with Acute respiratory distress syndrome (ARDS). Hospital-acquired pressure injury is the most common complication of pronation. While the presence of PI bundles and protocols have been shown to reduce incidence of PI in the prone position there is no standard bundle or protocol found in the literature, and no bundle or protocol specific to pediatric patients. The purpose of this quality improvement project is to create and implement a prone position pressure injury prevention bundle, called “Prone Pack”. This QI project setting was a 40 bed PICU at a midsized children’s hospital in the Midwest region of the United States. A convenience sample of patients admitted to the PICU at the hospital during a two-month period was utilized. Pre and Post implementation data was obtained via retrospective medical record. Rates of new pressure injury (PI) development, location of PI, and bundle compliance for children in the prone position were analyzed. Potential for clinically significant reduction of PI in prone patients was noted. Creating a standardized pediatric PI bundle has the potential to reduce PI caused by pronation, which can improve patient outcomes and reduce healthcare costs.

Implementation of a Prone Position Pressure Injury Prevention Bundle in the PICU

Hospital-acquired pressure injuries (HAPI) incur a costly burden on hospital systems and increase patient length of stay (Bargos-Munárriz, et al., 2020). The cost of pressure injuries in the United States is estimated to be $11 billion (Patton, et al., 2022). Furthermore, in children ages one through four, the average cost per stage three or four pressure injury is reported to be $85,853 (Delmore, et al., 2019). Hospitals have implemented various methodologies to decrease the risk of hospital-acquired pressure injuries. One such method which has been shown to decrease this adverse event is the use of a PI prevention bundle for patients in the prone position in certain patient populations.

Prone positioning is a positioning method when the patient is placed with their face down and their head in a neutral position. It is commonly used during a variety of surgeries and to aid in treating patients with acute respiratory distress syndrome (ARDS) and COVID-19 (Barakat-Johnson, et al., 2020). Placing patients in the prone position improves alveolar recruitment, improved gas exchange, and in patients with moderate-severe ARDS, prone positioning can improve chance of survival (Ryan, et al., 2021). Patients should remain in the prone position for at least 12 hours for effectiveness and to help decrease mortality (Johnson, et al., 2022).

Infants and children present different risks than adults in regard to pressure injury and skin breakdown due to the biological development of their skin and growth-related changes (Bargos-Munárriz, et al., 2020). Further, admission to a pediatric intensive care unit (PICU) alone increases the risk for pressure injury (PI) (Delmore, et al., 2019). Not only are pressure injuries harmful to patients, but they are also costly (Patton, et al., 2022). Reducing the incidence of pressure injuries occurring from prone positioning will

also reduce healthcare costs. Strategies which have been used to decrease PI include interventions such as thorough skin assessments before and after pronation, utilization of a pronation team consisting of at least five members of the healthcare team, use of pressure redistribution devices, placement of prophylactic foam dressings on high-risk areas, and frequent repositioning of the head and extremities (Moore, et al., 2020; Ryan, et al., 2021).

Implementation of pressure injury bundles and protocols for patients in the prone position have also been shown to reduce the incidence of pressure injury (Patton, et al., 2022). Bundles and protocols aid in standardization of the procedure and education of how to safely place patients in the prone position. Step by step instructions and visual aids in prone bundles are other strategies to aid in the prevention of PI (Johnson, et al., 2022). Combining evidenced based strategies such as prophylactic foam dressings into an easily accessible Prone Pack to prevent PI is a feasible goal. While the presence of PI bundles and protocols have been shown to reduce incidence of PI in the prone position there is no standard bundle or protocol found in the literature, and no bundle or protocol specific to pediatric patients.

The purpose of this quality improvement project is to create and implement a prone position pressure injury prevention bundle, called “Prone Pack”, in an inpatient PICU setting. The aim is to decrease newly acquired pressure injuries by 10% over the course of two months following implementation of the Prone Pack during positioning. The primary outcome measure will be the rate of new pressure injuries developed while in the prone position. The secondary outcome measures will be the location of pressure

injuries developed while in the prone position and the rate of bundle compliance and utilization.

In pediatric patients ages 0-18 admitted to a midwestern, suburban hospital PICU, following implementation of the Prone Pack during prone positioning:

1. What is the rate of newly acquired pressure injuries?
2. What are the physical locations of pressure injuries acquired?
3. What is the rate of bundle compliance and utilization?

Review of Literature

Databases CINHAL, MEDLINE, and PubMed were used to conduct the initial literature search. The key search terms used for this literature search include *prone position, pressure injury, pediatric, prevention, prone, pressure, skin, bundle, protocol, breakdown, foam dressing, prophylactic dressing, silicone dressing,* and *Mepilex*. The Boolean operators AND and OR were used to create search phrases. The initial number of publications returned for all key search term combinations was 415,980. Studies included in the refined search were publications published within the last five years, peer reviewed, and those published in academic journals. Publications that were excluded from the refined search were publications published before 2018, publications in languages other than English, and publications conducted in the surgical setting or operating room. After applying inclusion and exclusion criteria, the refined search generated a total of 36,762 publications for all key search term combinations. 35,312 publications were generated from the phrase, Prone AND Pressure OR Skin AND Bundle OR Protocol. Finally, 11 publications were selected for this literature review.

During the COVID-19 pandemic, a resurgence of prone positioning was seen in intensive care units (ICU) around the world (Ibarra et al., 2020). Increased use may have been related to the low-cost and effectiveness of this maneuver, and the large influx of patients requiring mechanical ventilation in ICUs for the treatment of ARDS specifically caused by COVID-19 (Ibarra et al., 2020). In certain adult ICU settings 28% of patients with a confirmed COVID-19 diagnosis were placed in the prone position (Moore, et al., 2020). The rapid utilization of prone positioning also introduced the need for current practice recommendations on how to reduce the risk of injury to patients, and healthcare workers placing patients in this position (Morata et al., 2023). COVID-19 impacted adults significantly more than children, in both number of cases and severity of illness. Therefore, all studies found in the literature search discussing COVID-19 and prone positioning consisted of adult subjects only. The lack of pediatric subjects reduces the ability to translate results to the pediatric population.

Prone positioning in combination with mechanical ventilation is a low cost, high yield postural intervention used in the treatment of adult and pediatric patients with ARDS, to reduce respiratory distress and improves oxygenation (Bhandari, et al., 2022). Placing patients with ARDS in the prone position can improve the ratio of lung ventilation and perfusion, re-recruit dependent lung tissue, and improve drainage of pulmonary secretions (Lucchini, et al., 2020). In children, the prone position is shown to improve oxygen use when compared to supine positioning (Bhandari et al., 2022). However, due to the nature of randomized control trials (RCTs) and the vulnerability of the pediatric population, the certainty of this evidence it low, due to the small number of trials and small sample sizes (Bhandari et al., 2022). In adults with ARDS early

implementation of prone positioning showed a 26% decrease in mortality (Lucchini, et al., 2020).

Prone positioning is one of the many risk factors for development of skin breakdown and pressure injury (PI) (Lucchini, et al., 2020). In a quasi-experimental study with a sample size of 110 pediatric patients, it was found that children in the intervention group who were placed in the prone position had a twentyfold increase in risk of PI [95% CI 3.49 to 1115.97] compared to children not placed in the prone position (Bargos-Munarriz, et al., 2020). Other risk factors for PI identified in this study were prolonged hospitalization, PICU admission, fasting/NPO status, invasive mechanical ventilation, and non-invasive mechanical ventilation. Prone positioning and mechanical ventilation were the highest risk factors for PI (Bargos-Munarriz, et al., 2020). In addition, a retrospective analysis of 170 adult patients with ARDS who were mechanically ventilated and placed in the prone position found the length of prone positioning sessions, total number prone positioning sessions, and the total time spent in the prone position to be statistically significant risks for PI (Lucchini, et al., 2020).

Utilizing evidenced based methods to prevent pressure injuries in proned patients is a multi-faceted approach to reduce harm to patients who are placed in the prone position. A common method for decreasing prone related PI and negative outcomes is the use of a minimum of five members of the healthcare team to manually pronate a patient (Ryan, et al., 2021). A minimum of four team members were assigned to perform the turn, and a fifth person coordinated/lead the turn via verbal cues and manage the airway for intubated patients (Ryan, et al., 2021; Morata, et al., 2023). By requiring a

minimum number of team members for manual pronation both the patient and the individuals performing the maneuver are better protected from harm.

Applying prophylactic multilayer silicone foam protective dressings over areas at risk for pressure injury has also been shown to reduce the risk of soft tissue damage and PI in supine and prone positioned patients (Morata, et al., 2023). Certain areas of the body are more susceptible to PIs when in the prone position. The face, thorax, chest, knees, toes, and iliac crest are some of the most common areas for PI to develop (Moore, et al., 2020). A consistent finding was that the head/neck region, including the chin and cheekbones, were found to have the largest incidence of PI development (Johnson, et al., 2022; Lucchini, et al.,2020; McFee, 2023; Patton, et al., 2022). In a study conducted by McFee (2023), foam dressings were utilized to protect skin from injury caused by medical devices such as endotracheal tubes, nasogastric tubes, IV tubing, monitor cables etc. In addition, soft multilayer foam dressings aid in reducing shearing during pronation and repositioning of limbs (Johnson, et al., 2022). Furthermore, using PI prevention methods in conjunction with each other in prone bundles or protocols further reduces the risk of PI for patients in the prone position (Johnson, et al., 2022). While there is data lacking in which specific type of foam dressing off loads pressure best in the prone position, prophylactic foam dressings should be included in prone positioning bundles.

Implementing a bundle or protocol for manually placing patients in the prone position can reduce the incidence of PI (Ryan, et al., 2021). Bundles should include the personnel, supplies, and resources needed for the procedure and PI prevention guidelines. Annual education should also be done to ensure faculty and staff are proficient in safely pronating patients (Morata, et al., 2023). Bundle adherence is crucial to the reduction of

PI. A QI project implementing a dressing pack consisting of single use foam dressings with instruction on where to place them on the body prior to being placed in the prone position showed a 76.7% reduction in pressure injuries when compared to PI rates prior to utilizing the dressing packs (McFee, 2023). A multicenter observational cohort study created and implemented a prone protocol made up of multidisciplinary team members. The study found after adjusting for variables, the intervention group which used the prone protocol had a 97% lower adjusted odds ratio (AOR) of PI (AOR, 0.03 [95% CI, 0.01-0.14]; $P < .001$) (Johnson, et al., 2022). No published literature was found on the use of a prone protocol or bundle for the pediatric patient. This is a significant gap in the literature that was identified through this literature search.

The evidenced base practice (EBP) framework used to guide this QI project is the IHI Model of Improvement- Plan- Do-Study- Act (PDSA) Cycle. This model was chosen for its purpose of accelerating change (IHI, 2023). The Model of Improvement has two steps; First, three fundamental questions are asked with the goal of setting aims, establishing measures, and selecting changes. Next, the PDSA cycle is used to test the change (IHI, 2023). The steps of PDSA are a continuous cycle allowing for revisions and improvements to be made after each cycle. The successful implementation of a sustainable prone positioning bundle in a pediatric intensive care unit requires collaboration and continual revision based on results and team feedback, making the IHI Model of Improvement-PDSA Cycle the ideal framework for this project.

In summary, evidence confirms placing adult and pediatric patients with ARDS in the prone position is a high value intervention, as it improves oxygenation and gas exchange (Ryan, et al., 2021). Pressure injury is the greatest risk to patients in the prone

position (Lucchini, et al., 2020). The literature shows the incidence of PI in patients in the prone position is a significant safety issue. High-quality effectiveness trials that test interventions to reduce the risk of PI in the prone position are needed to guide future practice (Pattton, et al., 2022). Limitations of this study are small sample sizes, lack of randomization, lack of pediatric studies, and the rapidly evolving hospital settings during the COIVD-19 pandemic when many of the studies were conducted. A significant gap in the literature is the lack of studies conducted with pediatric patients. Infants and children have different anatomy, development, and risk for pressure injury related to the prone position than adults, which is why more studies on pediatric patients in the prone position are needed to develop effective evidenced based pressure injury prevention strategies.

Methods

Design

This quality improvement project used a descriptive, observational design. A retrospective chart review was used to assess the rate of pressure injury rate and location of pressure injuries sustained while in the prone position during the implementation period of February to April 2024.

Setting

The setting was a 40 bed Pediatric Intensive Care Unit (PICU) in a midsized children's hospital in the Midwest region of the United States. This hospital unit saw 2,851 patients in 2022 and the unit has had 46 mucosal, stage I and II PI and 2 stage III, IV, or unstageable PI.

Sample

A convenience sample of patients admitted to the PICU at the hospital during February to April 2024 was obtained. Inclusion criteria were: male and female patients aged 0-18 years admitted to the unit, who are mechanically ventilated and are proned for more than four hours. Exclusion criteria were patients older than age 18, and those who have a previously documented pressure injury prior to implementation, not mechanically ventilated, in the prone position for less than four hours or not proned.

Approvals

The project was approved by hospital's internal review committee. In addition, institutional review board (IRB) approval was obtained from the university. There are no known risks or ethical considerations related to this study.

Data Collection & Analysis

Pre and Post implementation data was collected via retrospective medical record review. Data was collected by the Primary Investigator and the PICU Skin Team monthly. Data was confirmed against PICU skin team audits. Demographic data included age, gender, race, and length of PICU stay. In addition, pressure injury development and documented physical location of PI was collected. Data was stored on a password-protected computer by the principal investigator. All data was de-identified and study participants were coded as A1, A2, A3, etc. Descriptive statistics were used to describe the sample population.

Procedures

Stakeholders buy-in was gained from the hospital unit's leadership team. The primary investigator conducted bedside education with Physicians, Nurse Practitioners (NP), Registered Nurses (RN), Respiratory Therapists (RT), and Patient Care Technicians (PCT) before implementing the Prone Pack protocol. Education included the risk of skin breakdown while in the prone position, the benefit of using foam dressings to reduce PI, an overview of the contents of the Prone Pack, and where to find them on the unit.

The PI prevention bundle involved the use of the "Prone Pack" which included a large and small circle foam pillow, protective foam dressings for the face, body, and knees, EKG leads, 2 chuck pads, and a Tip Sheet on placement of foam dressings, personal needed for pronation, and other tips for protecting skin in the prone position. One Prone Pack was used each time a patient was placed in the prone position. All of the supplies in the Prone Pack are currently stocked and utilized in the PICU. The creation of the Prone Pack placed all the needed supplies and instructions for skin protection in a consolidated convenient location.

Results

The total number of participants included in the study was 11 (n = 11). Of the patients included, five (n = 5) were female and six (n = 6) were male. The average age of participants was 8.49 (SD = 6.02). The majority of patients included were white at 63.6% of the sample (n = 7), followed by Black at 36.4% (n = 4). All patients were mechanically ventilated, and a majority were ventilated via endotracheal tube (ETT) at 81.8% (n = 9). All patients who received the intervention were placed in the prone position an average of 3.45 times (SD = 3.08) amounting to 41.2 (SD= 42.5) total hours

proned during each respective PICU admission. The average PICU length of stay for patients requiring pronation while mechanically ventilated was 23.9 (*SD*= 10.0) days, as described in Appendix A.

The rate of pressure injury (PI) which developed following implementation of the Prone Pack was 27.7% (*n* = 3), described in Appendix A. Of the PI observed, two were categorized as Stage 1 PI (*n* = 2, 18%) and one was categorized as stage 2 PI (*n* = 1, 9%). See Appendix A. One patient developed stage 2 PI on their nose and another patient developed stage 1 PI on their ear and cheek.

Finally, staff compliance with documentation over the course of the project was 46%. Use of the bundle was consistently high, as the 11 patients who received the intervention were placed into prone positions 38 times, with 25 total prone packs used. Overall, Prone pack utilization was unknown (*n*=6, 54.5%), used at least once (*n*=4, 36.4%), or not used (*n*=1, 9%).

Discussion

During the data collection period two PDSA Cycles were conducted. The first cycle was three weeks long and ended due to supply shortages. Prone Pack supply was depleted sooner than anticipated due to the popularity of the Pack and a large number of patients admitted to the PICU with ARDS who required pronation. The second cycle lasted four weeks after additional supply packs were acquired and provided. A significant barrier to this study was an unexpected supply shortage resulting in an inadequate number of Prone Packs and a pause in data collection. Once supply issues were resolved by requesting Material Services to restock all supplies used in the Prone Pack on the unit, PDSA Cycle 2 began. By having all items stocked on the unit, additional Packs are able

to be created when needed. The primary change in Cycle 2 was the addition of sign-out sheets to improve monitoring of Prone Pack utilization. The use of the sign-out sheet improved monitoring, however a decrease in patient census and decrease of patients with ARDS resulted in fewer patients requiring pronation thus a very small sample size (n=3) in the second cycle. Additional limitations of this study included small sample size, decreased compliance monitoring, and inappropriate use of the Prone Pack by staff.

Compliance was monitored in Cycle 1 by the completion of a survey accessed via QR code. The QR code was posted at each patient bedspace and staff accessed the survey by scanning the code with their phones. During Cycle 1, eight patients were placed in the prone position a total of 25 times and 19 total packs were created and utilized, resulting in an estimated 76% compliance with the bundle. During Cycle 2 compliance was monitored by sign-out sheets located next to the packs. During Cycle 2, three patients were placed in the prone position a total of 13 times and six prone packs were used. Resulting in a known compliance of 46%.

Despite a small sample size, there exists a potential for clinically significant reduction of PI in prone patients. Prior to implementation there were seven Stage 1, Stage 2, or unstageable PIs in a 3-month period. After implementation the rate of PI development was 27.7%. During the implementation period two patients developed PI for a total of 3 PIs. One patient developed PI on their ear and cheek. One patient developed PI on the bridge of the nose, documented to be from a bi pap mask and not related to pronation.

Strengths of this study include high rates of staff buy-in and implementation of a standardized pronation process. Verbal feedback from nursing staff was positive overall,

and included feedback that they appreciated the standardization, ease of use, time saved and improved workflow. Nursing staff also praised the step-by-step instructions and visual guide for placement of prophylactic foam dressings which improved understanding of safe pronation. Due to positive feedback and positive results, the Prone Pack will continue to be available in the unit. To aid in sustainability, the Patient Care Operations Coordinator will continue to assume responsibility for the assembly of the Prone Pack after the completion of PDSA Cycle 2. To further improve bundle compliance, it is recommended that the Prone Pack be included in annual nurse education days.

Patient size is thought to contribute to decreased bundle compliance, as the Prone Pack included 'one size fits all' supplies that may not be suitable for infants or toddlers. Recommendations for future consideration include continued monitoring of Prone Packs in the pediatric population, with potential for cross-over into other populations. The hospital may consider application of the Prone Pack implementation based on age and size, issuing packs for infant, child, and adult sizing.

Conclusion

Prior to the implementation of the Prone Pack, there was no standardization or education resource on how to safely prone a patient and protect them from prone related PI. Implementation of the Prone Pack provided easy access to the supplies needed and education on preventing PI and safely placing patients in the prone position. During PDSA Cycle 1 and 2, only one patient developed a pressure injury related to pronation. Despite challenges in monitoring compliance, buy in from bedside nursing was high. Findings of this study support the continuing use of the Prone Pack for reduction of PI. Creation of an infant and toddler size pack could improve overall bundle compliance. The

study of pronation in a pediatric setting is limited. Further studies that include a larger sample size and longer period of data collection are recommended.

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Appendix A

Table 1

Patient Demographics

Variable	*n*	*%*
Gender		
Female	5	45.45
Male	6	54.55
Missing	0	0.00
Race		
Caucasian	7	63.64
African American	4	36.36
Missing	0	0.00
Airway		
Trach	2	18.18
ETT	9	81.82
Missing	0	0.00

Note. Due to rounding errors, percentages may not equal 100%.

Table 2

Patient Age

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
Age	8.49	6.02	11	1.81	0.16	15.00	-0.18	-1.67

Note. '-' indicates the statistic is undefined due to constant data or an insufficient sample size.

Table 3

Location of Injury and Bundle Compliance

Variable	*n*	*%*
Location_of_PI		
No Injury	8	72.73
Face	3	27.27
Missing	0	0.00
Prone_Pack_Used		
Unknown	6	54.55
Yes	4	36.36
No	1	9.09
Missing	0	0.00

Note. Due to rounding errors, percentages may not equal 100%.

Table 4

Frequency of Pronation and Development of Pressure Injury

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
Pressure_injury	0.27	0.47	11	0.14	0.00	1.00	1.02	-0.96

Number_of_Prone_Sessions	3.45	3.08	1 1	0.93	1.00	11.00	1.38	1.22
Hours_of_Pronation	41.27	42.57	1 1	12.84	10.00	159.00	2.09	3.54
PICU_length_of_stay	23.91	10.08	1 1	3.04	10.00	37.00	0.01	-1.47

Note. '-' indicates the statistic is undefined due to constant data or an insufficient sample size.