Prevention of Pressure Ulcers After Pediatric Tracheotomy Using a Mepilex Ag Dressing

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Objectives/Hypothesis: Skin irritation and ulceration beneath the tracheostomy tube or ties secondary to pressure and shearing forces on the skin frequently complicate pediatric tracheotomy in the immediate postoperative period. The aim of this study is to determine the effectiveness of Mepilex Ag dressings in reducing posttracheotomy wound complications.

Study Design: Retrospective study.

Methods: We identified 134 pediatric tracheotomies performed between June 2005 and June 2011 at a tertiary care academic pediatric hospital. Peristomal skin breakdown was documented at the time of the first tracheotomy tube change. Starting in February 2010, the application of Mepilex Ag, a silver-impregnated foam dressing, underneath the tracheotomy tube and twill ties became standard practice. The rates of wound breakdown before and after the introduction of Mepilex Ag were compared. Age, indication for tracheotomy, comorbidities, and severity of wound breakdown were also compared.

Results: Patients undergoing tracheotomies prior to February 2010 had no dressing applied under the tracheotomy at the end of the procedure (n = 93). Beginning in February 2010, Mepilex Ag barrier was applied beneath the tracheotomy tube and ties in all subjects undergoing tracheotomy (n = 41). In the cohort without Mepilex Ag, 11.8% developed skin breakdown by the time of first tracheotomy tube change. When Mepilex Ag was used to pad the tracheotomy site, no peristomal skin breakdown occurred (P = 0.02). No comorbidities were associated with postoperative ulcer formation in either cohort.

Conclusions: The use of Mepilex Ag after pediatric tracheotomy reduces the occurrence of postoperative peristomal pressure ulcers.

Key Words: Pediatric general, tracheotomy, ulcer.

Level of Evidence: 4.

INTRODUCTION

Every year, over 4,800 pediatric tracheotomies are performed in the United States. The risks and hazards of making a surgical incision in the trachea of an infant or child are not insubstantial. Due to the unique anatomical and physiological characteristics of the pediatric airway, tracheotomies performed in the young patient are associated with greater morbidity and mortality than those performed in the adult patient. Postoperative complications of pediatric tracheotomies have been categorized into early (within 7 days) events and late (after 7 days) events. The most frequent early complications include accidental decannulation, the development of interstitial air (subcutaneous emphysema, pneumomediastinum, pneumothorax), hemorrhage, and peristomal wound complications. Late postoperative complications include the development of peristomal granulomas, tracheitis, tracheomalacia, subglottic stenosis, and tracheocutaneous fistula after decannulation.

The hallmark of early tracheotomy wound complications is skin breakdown and ulceration around the tracheotomy tube. In an effort to prevent accidental decannulation, pediatric tracheotomy tubes are secured very tightly around the child’s neck. The pathogenesis of skin erosion and pressure ulcers involves soft tissue damage resulting from prolonged pressure applied from the tracheotomy tube, neck plate, ventilation circuit, and/or twill ties used to secure the tube. Peristomal wounds complicate pediatric tracheotomy at a rate of 8% to 19%, as reported in the literature.

Pressure ulcers are commonplace in the medical field and great efforts are taken to prevent them in dependent areas in immobilized patients. Methods of preventing skin breakdown and pressure ulcers are aimed at relieving the external shearing forces constantly applied to the skin. Pressure-reduction devices have been shown to successfully prevent pressure ulcer formation in other high-risk areas such as the occiput, sacrum, and heel. Examples of such devices include water mattresses, gel pads, air mattresses, and overlays. Mepilex Ag (Mölnlycke Health Care, Norcross, GA) is a soft, absorbent adhesive dressing designed to manage exudative wounds such as pressure ulcers. When
applied to the skin, the foam padding diminishes the effects of stressful forces on the soft tissue while the sustained antimicrobial action of the ionic silver reduces any bacterial burden.\textsuperscript{11,12} The dressing also seals skin margins to keep moisture out. At our institution, the pediatric otolaryngologists currently apply Mepilex Ag under the tracheostomy tube and twill ties at the conclusion of every procedure (Fig. 1). We hypothesized that the application of a Mepilex Ag foam dressing around the tracheotomy site reduces the incidence of postoperative pressure ulcer formation.

**MATERIALS AND METHODS**

Approval for a retrospective case study review was obtained from the Vanderbilt University Institutional Review Board. A search was performed to identify all pediatric patients who underwent a tracheotomy between June 2005 and June 2011 at the Monroe Carell Jr. Children’s Hospital at Vanderbilt. The search revealed 134 patients. All tracheotomies were performed by one of the four pediatric otolaryngology specialists at Vanderbilt University, with a horizontal skin incision followed by a vertical tracheal incision.\textsuperscript{13,14} Medical records, including hospital admissions, operative notes, daily progress notes, discharge summaries, and clinic notes for all 134 patients were collected and reviewed. Specific data were recorded in an Excel 2010 spreadsheet (Microsoft Corp., Redmond, WA) and analyzed using SAS software.

Each chart was reviewed for skin breakdown or pressure ulcer formation around the time of first change of the tracheostomy tube (within 7 days of tracheotomy). Demographic information collected included age, gender, and medical comorbidities. Indication for tracheotomy, date of tracheotomy, type of tracheostomy tube, date of postoperative wound development, and length of hospital stay were also reviewed. Wound assessments were completed either by the pediatric otolaryngology health care providers, the pediatric intensive care unit (ICU) health care providers, the bedside nurse, or the hospital’s wound care nurse, if consulted.

At our institution, no standard grading scale for skin breakdown was routinely utilized. It has been observed that the lack of reporting of tracheotomy wound complications is due to a lack of a standardized staging system.\textsuperscript{7} Wounds in other locations are traditionally rated based on criteria developed by the National Pressure Ulcer Advisory Panel (NPUAP); however, this system is not routinely applied to tracheotomy wounds. In patients noted to have skin complications, the wound care nurses at our institution documented the location, size, drainage, and surrounding skin status of the wound. Healthcare providers who were not experts in wound care used terms such as “erythema,” “skin erosion,” “fissures,” and “chafing” to assess the wound area.

In this study, we rated ulcers as mild, moderate, or severe based on the descriptions documented in the chart. “Mild” wounds included fragile skin that was erythematous or had a small amount of breakdown (<1 cm in diameter). Wounds with evident skin erosion or breakdown associated with drainage and/or pain were classified as “moderate.” “Severe” wounds were felt to be similar to the NPUAP stage II ulcers, noted in our most severe patients as “a partial-thickness loss of dermis presenting as a shallow open ulcer with a red-pink wound bed.”\textsuperscript{15}

Beginning in February 2010, the application of Mepilex Ag around the tracheostomy tube and under the tracheostomy twill ties became routine standard practice among all pediatric otolaryngologists after discussion with our wound nurse in an attempt to reduce peristomal complications. The application of Mepilex Ag under the tracheostomy ties was performed to achieve an en bloc dressing beneath the tracheostomy tube and tube, which could be replaced if the dressing became saturated with secretions. The main outcome measure was the rate of wound breakdown before and after the introduction of Mepilex Ag. Patients were separated into two groups based on the absence (N = 93) or presence (N = 41) of Mepilex Ag. Data analysis was performed using Fisher’s exact test. P values less than 0.05 were considered statistically significant.

**RESULTS**

Of the 134 patients reviewed, 39% were female and 61% were male. The average age at tracheotomy was 3.5 years (range, 2 weeks to 16 years). About two-thirds (N = 93) underwent tracheotomy prior to February 2010, with no dressing applied at the end of the procedure. The remaining one-third (N = 41) receiving tracheotomies from February 2010 through June 2011 had Mepilex Ag applied under the newly placed tracheostomy tube and ties in the operating room. In each of the cohorts, the mean ages were 3.3 and 3.9 years, respectively. A Bivona TTS cuffed tracheostomy tube (Smiths Medical, Dublin, Ohio) was used in all cases (Table I).

The most common indications for tracheotomy were prolonged intubation with failure to extubate and upper airway obstruction in both cohorts. Etiologies of upper airway obstruction included laryngomalacia, obstructive sleep apnea, vocal cord paralysis, and subglottic stenosis. Several patients also suffered from one or more comorbid conditions such as prematurity, congenital heart disease, developmental delay, craniofacial abnormalities, and obstructive sleep apnea (Table I).

In the cohort that did not receive Mepilex Ag, 11 patients developed some degree of skin breakdown around the tracheotomy site. The average age of patients with wound complication was 2.5 years (range, 2 weeks to 12.5 years). The average time to observed skin complication was 5 days after the operation (range, postoperative day 3 to 8). Mild skin breakdown was most commonly observed, followed by moderate and severe cases of skin ulceration (Tables II and III).
In eight of the 11 subjects developing peritracheal wounds, the age of the patient was under 12 months and breakthrough was observed among all subjects undergoing tracheotomy without Mepilex Ag and younger than 1 year, eight of 54 (15%) developed skin breakdown. Among those older than 1 year, only three of 42 (7%) developed a wound complication.

In comparison, of the 41 patients who received Mepilex Ag applied under the tracheostomy tube and twill tie, no subjects developed wound complications, which was a statistically significant difference ($P = 0.02$). The estimated difference in risk between the two cohorts was 11.8% (Exact 95% CI, 6% to 20%). Age less than 1 year was notably associated with an increased rate of wound complications; however, this was not statistically significant. There were no significant associations between skin breakdown and indication for tracheotomy or associated comorbidities (Table III). There were no occurrences of subcutaneous emphysema or unrecognized decannulation associated with use of Mepilex Ag.

In nine of the 11 cases of skin breakdown or pressure ulcer development, a member from the wound, ostomy, and continence nurses (WOCN) team was consulted and provided an assessment and treatment plan for the wound. Interventions included the application of a barrier such as Mepilex Ag, DuoDERM (ConvaTec USA, Skillman, NJ), Clearsite (Cardinal Health, Dublin, OH), or nystatin powder when breakdown was first noticed. Our wound nurses felt that Mepilex Ag provided superior wound protection, and this was used thereafter. Complete resolution of the wound was documented when these interventions were utilized.

Among subjects who developed postoperative wound complications, two prematurely born infants died from respiratory failure within 2 months of undergoing tracheotomy unrelated to the skin breakdown. The remaining nine patients had complete resolution of their ulceration prior to discharge. The average length of hospital stay among subjects with wound complications was 21 days, and the group with Mepilex Ag use was 22 days.

**DISCUSSION**

Hospital-acquired peritracheal wound breakdowns represent an under-recognized postoperative complication in the pediatric patient. Jaryszak et al. emphasized the importance of early recognition and treatment of tracheotomy-related complications. In order to implement appropriate prevention guidelines, identifying predictors of skin breakdown and pressure ulcers is essential.

Suggested risk factors have been categorized as intrinsic or extrinsic. Intrinsic risk factors include the friction, shear, and prolonged pressure from medical devices. Extrinsic factors contributing to pressure ulcer formation include sepsis, malnutrition, infection, anemia, immobility, and critical illness. Children with tracheotomies have a significantly longer hospital length of stay and duration of mechanical ventilation as compared to children without tracheotomies. Acutely ill children and infants also have poorer nutritional status, are more prone to infections, are kept immobile due to sedation, and often cannot express discomfort or pain. In this study we found that many of the patients requiring treatment...
tracheotomy did have comorbidities but none of these were statistically related to peristomal breakdown. Combining these extrinsic factors with the friction of the tracheotomy device and the moisture from tracheal secretions puts critically ill children at a higher risk for peristomal skin breakdown. Data on nutritional status, immobility time, and infections were not available to include in this study.

Pressure ulcers are associated with prolonged hospital stay and increased risk of secondary infection. The financial burden associated with hospital-acquired pressure ulcers is also not insignificant, with an estimated treatment cost of $11 billion every year. In 2008 the Centers for Medicare & Medicaid Services (CMS) suggested that hospital-acquired pressure ulcers should be minimized, which may also affect Medicare and Medicaid reimbursement. Hospitals currently bear the cost of these preventable complications. Consequently, emphasis on wound care and pressure ulcer prevention has become an important component of clinical care.

Pressure-reducing devices that redistribute weight over a larger surface area have been shown to reduce the development of wounds and pressure ulcers. Prior studies have shown the effectiveness of applying a foam overlay, egg crate, sheepskin, or gel pillow in high risk areas to reduce the incidence of pressure ulcers in the sacral and heel areas. Mepilex Ag is another example of a viable device surgeons can use to reduce postoperative wound complications.

In our retrospective study, our rate of skin breakdown or pressure ulcer formation after tracheotomy was 11.8% without the use of Mepilex Ag, which is similar to other studies. These studies have also shown that skin breakdown more often occurs in infants. The increased rate of peristomal breakdown may be attributed to the inability of infants to verbally express pain and to the underdeveloped, more fragile skin integrity seen among premature infants. With the use of Mepilex Ag, we noted a significant decrease in breakdown after tracheotomy from 11.8% to 0%.

Failure to adopt a standardized staging system for wounds associated with tracheotomies has led to underreporting of posttracheotomy wound complications. Only one study by Boesch et al. classified the severity of tracheotomy skin breakdown according to the NPUAP classification system. Their study reported a 14% incidence of tracheotomy-related stage I pressure ulcer, 50% stage II, 36% stage III, and 0% stage IV. Inconsistent reporting of peritracheotomy ulcers makes it challenging to document and assess progression of the wound. We believe that the potential for misclassification could be minimized with the adoption of a standardized grading system for pediatric tracheotomy wound complications. One of the limitations of our study was the failure to use a consistent wound grading scale, as the one proposed here.

In this study we highlight that posttracheotomy wound complications due to pressure from the tracheotomy device are reduced with a foam dressing barrier. Analysis of our patient demographics and comorbidities was similar to that of other studies; and before using Mepilex Ag, our ulceration rate after pediatric tracheotomy was comparable. Our data demonstrate that the use of Mepilex Ag’s soft, absorbent padding prevents pressure and friction due to the tracheostomy plate from irritating the patient’s skin. In this era of cost containment and quality improvement, we suggest that the use of a barrier to reduce pressure ulceration after pediatric tracheotomy is beneficial for patients and medical centers.

**CONCLUSION**

Postoperative wound monitoring and management is an essential part of optimal patient care. Although peristomal pressure ulcer is an infrequent event, the avoidance of peristomal tracheotomy complications is beneficial for both healthcare costs and morbidity. The

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**TABLE III.**

Clinical Characteristics of 11 Subjects With Wound Breakdown or Pressure Ulcer.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Gender</th>
<th>Indication for Tracheotomy</th>
<th>Comorbidities</th>
<th>Degree of wound breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 wks</td>
<td>F</td>
<td>Failure to extubate</td>
<td>Prematurity, craniofacial abnormalities</td>
<td>Mild</td>
</tr>
<tr>
<td>2</td>
<td>2 mos</td>
<td>M</td>
<td>Upper airway obstruction</td>
<td>Prematurity, congenital heart disease</td>
<td>Mild</td>
</tr>
<tr>
<td>3</td>
<td>4 mos</td>
<td>F</td>
<td>Upper airway obstruction</td>
<td>Prematurity, congenital heart disease, developmental delay, chronic lung disease</td>
<td>Mild</td>
</tr>
<tr>
<td>4</td>
<td>5 mos</td>
<td>F</td>
<td>Central apnea</td>
<td>Craniofacial abnormalities</td>
<td>Mild</td>
</tr>
<tr>
<td>5</td>
<td>9 mos</td>
<td>F</td>
<td>Chronic lung disease</td>
<td>Developmental delay</td>
<td>Mild</td>
</tr>
<tr>
<td>6</td>
<td>3 yrs</td>
<td>F</td>
<td>Failure to extubate</td>
<td>Chronic lung disease, developmental delay, pneumonia</td>
<td>Mild</td>
</tr>
<tr>
<td>7</td>
<td>7.5 yrs</td>
<td>F</td>
<td>Upper airway obstruction</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>8</td>
<td>5 mos</td>
<td>F</td>
<td>Upper airway obstruction</td>
<td>Prematurity, chronic lung disease</td>
<td>Moderate</td>
</tr>
<tr>
<td>9</td>
<td>9 mos</td>
<td>F</td>
<td>Upper airway obstruction</td>
<td>Prematurity, GERD</td>
<td>Moderate</td>
</tr>
<tr>
<td>10</td>
<td>6 mos</td>
<td>M</td>
<td>Upper airway obstruction</td>
<td>Craniofacial abnormalities</td>
<td>Severe</td>
</tr>
<tr>
<td>11</td>
<td>12.5 yrs</td>
<td>F</td>
<td>Failure to extubate</td>
<td>Developmental delay, congenital heart disease</td>
<td>Severe</td>
</tr>
</tbody>
</table>

There were no associations between indication for tracheotomy or comorbidities and the development of postoperative wound complications.
use of Mepilex Ag to protect fragile skin successfully prevented ulceration in all of our patients and suggests that applying a barrier after every pediatric tracheotomy should be highly considered.

**BIBLIOGRAPHY**
