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# Medical Device-related Pressure Injuries Associated with Electroencephalogram Leads in a Tertiary Care Children's Hospital: A Retrospective Chart Review

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## ABSTRACT

**BACKGROUND:** Medical device-related pressure injuries (MDRPIs) present a substantial safety risk for children who are hospitalized. **PURPOSE:** This study aimed to describe patient and clinical characteristics of children who

develop MDRPIs related to electroencephalogram (EEG) leads, determine risk factors associated with their development, and determine if there are common risk factors that can lead to actionable strategies to reduce MDRPIs related to EEG leads. **METHODS:** A retrospective review was completed of the electronic health records of all 3136 children who had EEG lead placements between January 1, 2014, and April 16, 2018, at a large tertiary care children's hospital. Data abstracted included demographic variables, patient and pressure injury characteristics, as well as length of stay. **RESULTS:** Twenty-four (24) of the 3136 children (0.8%) developed an MDRPI. Most were stage 2 pressure injuries. Patients who developed a pressure injury were significantly younger than patients who did not (median age, 0.9 and 5.2 years, respectively;  $P = .005$ ). Fifty percent (50%) of all patients who developed pressure injuries were younger than 1 year of age compared with 27% of patients who did not develop pressure injuries. The median length of stay for patients in whom MDRPI developed was 84.5 days (interquartile range, 45–137) versus 3.0 days (interquartile range, 2–8) for those who did not develop an MDRPI ( $P < .001$ ). The mortality rate during the hospital stay was 21% ( $n = 5$ ) for those who developed MDRPIs versus 4% ( $n = 19$ ) for those who did not ( $P = .002$ ). All patients received standard preventive strategies. **CONCLUSION:** The incidence of MDRPIs in this patient population was significantly higher in younger and longer-stay patients, and their mortality rate was significantly higher. This suggests that the patients who developed an MDRPI were more critically ill than those who did not. Vigilant assessment and more research are needed to determine if there are appropriate strategies to reduce MDRPIs related to EEG lead placement.

## INTRODUCTION

Skin is the largest organ of the body and provides a protective barrier against bacteria, chemicals, and physical action while maintaining homeostasis in the internal environment.<sup>1</sup> Hospital-acquired pressure injuries (HAPIs) present a substantial safety risk for children, with the incidence of HAPIs reported to be as high as 10.2% to 27% in children.<sup>2-4</sup> When there is local tissue destruction and necrosis, children experience injury-related pain and are at profound risk of developing systemic infection as well as secondary scarring or alopecia at the site of the injury.<sup>5</sup> The National Pressure Injury Advisory Panel (NPIAP) defines pressure injuries as localized damage to the skin and/or underlying soft tissue usually over a bony prominence or related to a medical or other device.<sup>6</sup> Numerous patient risk factors for HAPI development in children have been identified, including length of stay, edema, weight gain, weight loss, medical device in place, and decreased mobility.<sup>2-4,7</sup> The traditional paradigm around pressure injuries held that they were related to immobility; however, there has recently been an important distinction between immobility-related pressure injuries and medical device-related pressure injuries (MDRPI).<sup>6,8,9</sup>

Medical device-related pressure injuries result from the use of devices designed and applied for diagnostic or therapeutic purposes.<sup>6</sup> Medical devices are often secured tightly to the skin to achieve a proper seal and to prevent the patient from accidentally or purposely removing the device.<sup>10</sup> For hospitalized children, especially those who are critically ill and receiving sedating medications, there may be limited sensation and the inability to communicate the need to have the medical device removed or repositioned due to discomfort. The NPIAP reports that MDRPIs are the leading cause of pressure injuries in children.<sup>6</sup> In the United States, the estimated cost of managing a single full-thickness pressure injury in pediatric patients was reported to be as high as \$19,740 in 2015.<sup>11</sup> Since October 1, 2008, the federal Centers for Medicare and Medicaid Services no longer provide reimbursement for HAPIs that are deemed preventable.<sup>12</sup>

Medical devices, especially those in place for prolonged periods and those that cannot be moved or removed, can cause increased pressure on the skin or mucosal membranes. During the past decade, a skin and wound clinical nurse specialist has led a pressure injury prevention team at our large tertiary care children's hospital. This team has systematically worked to decrease the incidence of pressure injuries. Although the overall incidence and severity of pressure injuries has improved within the study facility, the team noted that there was

an increase in MDRPIs. In 2016, 92 patients developed a pressure injury, and 88% (n = 81) of those were related to a medical device. There were 24 distinct devices that caused pressure injuries, with electroencephalogram (EEG) leads disproportionately accounting for 26% (n = 21) of the total device-related injuries ([Figure](#)).

One challenge of MDRPI prevention is there are many types of medical devices, and they may require different interventions to ameliorate the risks they pose. The author's pressure injury prevention team identified EEG lead MDRPI as particularly problematic but found few evidence-based strategies in the literature. Current NPIAP recommendations for MDRPI prevention in children include choosing the right size medical device, protecting the skin in high-risk areas, inspecting the skin under and around the device, repositioning devices if feasible, avoiding placement of a device over an area of previous injury, and being aware of edema under the device.<sup>6</sup> In certain cases, the EEG leads may be moved less often if the patient is critically ill and cannot tolerate the procedure. Although the literature shows that it is imperative to examine high-risk areas of skin under medical devices, EEG leads cannot be moved or removed even daily to reassess the skin.<sup>7</sup>

The purpose of this retrospective study was to: 1) describe patient and clinical characteristics of children who develop MDRPI related to EEG leads, 2) determine specific risk factors associated with developing MDRPI (patient or clinical), and 3) determine if there are common risk factors that can lead to actionable strategies to reduce MDRPI related to EEG leads.

## METHODS

### Data collection.

Data were collected through a retrospective chart review of the electronic health records of all children who had EEG lead placement from January 1, 2014, through April 16, 2018, at a large tertiary care children's hospital. Children with EEG lead placement were identified through the electronic health record. The research team developed a list of necessary data that were extracted by nurses working in hospital informatics who were proficient at extracting big data.

Data collected included demographic data, patient characteristics, and clinical characteristics. Demographic data included age, sex, and race/ethnicity. Patient characteristics included primary diagnoses as well as Braden Q score on the day of pressure injury identification and for the 7 days leading up to the injury. The study team audited the chart to assure that all patients received standard pressure injury prevention, which included repositioning every 2 hours and full skin assessment every 12 hours.

In the authors' institution, reusable metal EEG leads were used for all patients during the time frame of this study. The EEG leads on our patients who required long-term EEG monitoring were initially repositioned on day 3, then repositioned again on day 6, and subsequently repositioned every 5 to 6 days until they were removed at the completion of the study. At the time of the study, clinicians did not use a gauze turban to cover leads because the turbans were thought to make skin assessment challenging. All pressure injuries in the hospital and their associated documentation in the electronic health record were validated by the wound and skin care clinical nurse specialist using the NPIAP staging system.<sup>6</sup> All data were collected in collaboration with our Epic data team.

### Study approval.

This study was approved as an exempt non-human subjects' research by the hospital Institutional Review Board.

### Statistical analysis.

Numbers and percentages for characteristics such as sex, race/ethnicity, or mortality were compared between the patients who developed an EEG-related MDRPI and those patients who did not develop an EEG-related

MDRPI using chi-square or Fisher's exact tests. Medians and interquartile ranges were compared for the 2 groups using Mann-Whitney tests. Braden Q risk assessment scores were evaluated over the 7 days prior to the identification of the EEG-related MDRPI, and minimum, maximum, mean, and median scores were evaluated. IBM SPSS Statistics v.20 was used for analysis.

## RESULTS

Between January 1, 2014, and April 16, 2018, there were 3136 patients for whom EEG leads were ordered. In 24 (0.8%) of these patients, a pressure injury on the head, inclusive of the forehead, temporal region, superior aspect of the skull, and the occiput, were noted. The stage of the pressure injury when first noted was as follows: deep tissue injury (2), stage 1 (7), stage 2 (10), stage 3 (1), or unstageable (4). The primary diagnoses of the children who developed an EEG-related MDRPI can be found in [Table 1](#).

Median age at admission was much lower for those patients with pressure injuries (0.9 years) than those without (5.2 years) ( $P = .005$ ) ([Table 2](#)). Fifty percent (50%) of all patients who developed pressure injuries were younger than 1 year of age; 27% of patients who did not develop pressure injuries were younger than 1 year of age. Median length of stay for patients in whom MDRPI developed was 84.5 days (interquartile range [IQR], 45–137) versus 3.0 days (IQR, 2–8) for those in whom MDRPI did not develop ( $P < .001$ ). Mortality rate was 21% ( $n = 5$ ) for those who developed MDRPIs versus 4% ( $n = 19$ ) for those who did not ( $P = .002$ ). There were no statistically significant differences in the incidence of pressure injury between patients of different sexes or races/ethnicities.

There were notable trends in the Braden Q scores between and within the 2 groups. In the group that developed pressure injuries, the Braden Q scores were evaluated at 3 time points. The median Braden Q score on the day a pressure injury was first noted was 15 (IQR, 13–20). In the 7 days before pressure injury identification, the median Braden Q score was 16 (IQR, 14–20). In the assessments made prior to these 7 days, the median Braden Q score was 18 (IQR, 15–22), indicating a change in overall risk. In comparison, the median Braden Q score for all days of hospitalization for those patients without pressure injury was 22 (IQR, 18–25).

## DISCUSSION

The findings of the current review suggest that within the pediatric inpatient population there exists a relationship between the incidence of pressure injury and expected patient outcome. There is a paucity of literature related to the incidence of pressure injuries in the pediatric population related to EEG lead use. A descriptive, secondary analysis of 2012 data on pressure injuries among pediatric patients from the National Database for Nursing Quality Indicators found the general rate of HAPIs in the acutely ill pediatric population to be 1.1%.<sup>13</sup> No studies were found by the authors beyond those on the topic of general prevalence of pressure injuries within the inpatient pediatric population of 10.2% to 27% and associated with increased length of stay, edema, weight gain, weight loss, medical device in place, decreased Braden Q score, and decreased mobility.<sup>2–4,14</sup> However, the authors have begun to see a larger focus on research related to MDRPIs in the literature, although not specifically related to EEG leads.<sup>15–17</sup> Further research and exploration are needed to determine best practices concerning risk factors and prevention measures for EEG lead–related pressure injuries in the pediatric population to improve outcomes. Our study does suggest that early identification of patients at risk, including patients younger than 1 year, those with prolonged hospitalization, and those with lower Braden Q scores, may benefit from more frequent assessment and more frequent repositioning of EEG leads or, if possible, breaks from continuous EEG placement.

In the authors' institution, the pressure ulcer prevention team has been successful in mitigating the risks associated with immobility; however, MDRPIs continue to occur in critically ill children. This is consistent with

current literature that demonstrates that pediatric patients, especially those who are critically ill, require multiple medical devices and that these devices can be a primary cause of HAPIs.<sup>9</sup>

## LIMITATIONS

The population represented in this study comes from a single center. Although EEG leads represented the largest subset of MDRPIs in the institution, it was still a small sample, and it may be difficult to extrapolate the findings to other centers. The Braden Q score was used in the study, which the authors recognize is a risk assessment tool for pressure injuries rather than the newly validated Braden QD scale that can assess immobility and MDRPI risk.<sup>9</sup>

This study was also limited in its retrospective design. This was necessary in the attempt to uncover the association between pressure injury and traceable outcomes in the pediatric population. Given this design, the authors were unable to determine the exact timing between placement of EEG leads and development of MDRPIs. Future studies may seek to examine differences in the incidence of pressure injury based on factors that vary among institutions, such as type of glue, use of electrode caps, or difference in type of EEG leads.

## CONCLUSION

This retrospective chart reviewed aimed to describe patient and clinical characteristics of children who develop MDRPIs related to EEG leads, determine risk factors associated with the development of MDRPI, and determine if there are common risk factors that can lead to actionable strategies to reduce MDRPIs related to EEG leads. Findings indicate that the development of pressure injuries in this patient population was higher in younger patients and those who were hospitalized for longer periods. The mortality rate of patients who developed an MDRPI was also higher. Considering their length of hospitalization and mortality rate it appears that patients who developed an MDRPI were more critically ill. These patients need vigilant assessment, and more research is needed to determine if there are appropriate strategies to reduce MDRPI related to EEG leads.

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## AFFILIATIONS

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