Pediatric NIV Pressure Injury: Honing the Cause and Progress to Solutions

Like adults, pediatric patients are at risk for pressure injury due to reduced perfusion, mobility, neurological response, and increased moisture, with additional risk due to underdeveloped skin in neonates.[1] Institutional health care goals of improving health care outcomes, patient safety and quality, meeting higher certification standards, and reducing costs have prompted focus on the early detection, reduced severity, and prevention of pressure injuries.[2,3] Pressure injuries in pediatric subjects 1–4 y old were associated with increased stay by 14 days and costs by $86,000 compared to age-matched subjects without injury.[4]

The incidence of pediatric pressure injury has been reported to be 1–8% overall and up to 43% in critical care units.[5] Medical devices, including face masks for noninvasive ventilation (NIV), account for 38.5–90% of injuries in neonates and young children.[6,7] Although pressure injuries are acute, injuries from NIV can result in problematic, longer-term deformities.[8] However, NIV is effective for respiratory failure because it reduces the rates of endotracheal intubation and re-intubation.[9]

Rates of pressure injuries from NIV masks have been reported to be as high as 30% in adult patients.[10] In a comparative study, the occurrence of pressure injuries for nasal-oral masks was 20% versus 2% for total face masks among 2 groups of adults age 61 ± 15 y.[11] The times to pressure injury were 28.4 h and 61.4 h for nasal-oral versus total face masks, respectively. Face mask-related pressure injuries can occur at the nasal bridge, cheeks, chin, and forehead. Figure 1 shows an example stage II pressure injuries at the nasal bridge and forehead from a nasal mask in a young patient. Figure 2 shows the results of a 3-dimensional surface-scanning technique to measure mask fit on the same subject.[12] The mean distance from the face to the mask was 7.2 mm; positive values indicate the mask to be pressing into the skin. Distances in red are the highest (at cheeks). The mask was not touching the face at the upper cheek (right side of image) near the bridge of the nose.

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Fig. 1. Example of stage II pressure injuries at the nasal bridge and forehead from a nasal mask in a young patient.

More recently, 3-dimensional surface scanning and 3-dimensional printing have been used to create customized face masks. A randomized crossover trial among healthy adults tested the concept and reported that such masks have the potential to reduce the incidence and severity of pressure injuries and to improve comfort.[13] Advances in monitoring systems have facilitated the determination of mask/skin interface pressures, showing higher pressures at the nose bridge versus the cheeks and higher pressures

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with increasing strap tension.[14] At the time of the highest strap tension, mask interface points contained increasing levels of interleukin 1α, a cytokine biomarker of inflammation, which was measured from sebum collected from the skin surface. Measures of transepidermal water loss in combination with cytokine assessment indicated that humidification with CPAP ventilation compromised the skin integrity relative to no humidification.[15]

Lauderbaugh et al[16] report important, multifactorial research results on the factors associated with pressure injury in pediatric subjects using NIV devices. Their comprehensive examination not only provides new information about the multiple potential contributors to injury but will focus efforts and practices to reduce the incidence and severity. This work also provides an investigative strategy and statistical approach that can serve as a benchmark for future investigations. Fur-

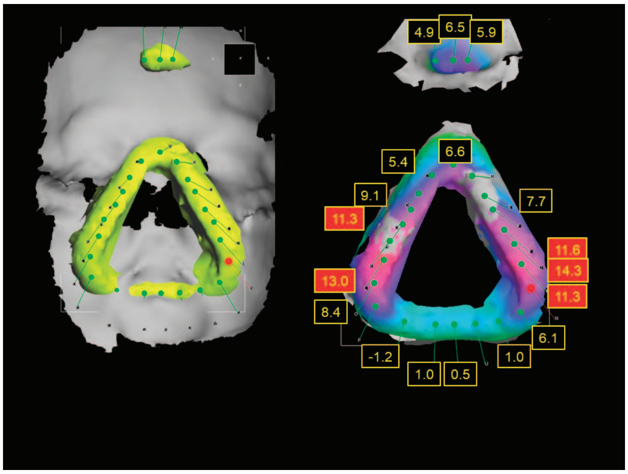

Fig. 2. Results of a 3-dimensional surface-scanning technique to measure mask fit on the same subject.

ther, their information and findings help fill gaps in the available literature regarding pediatric pressure injuries.

Lauderbaugh et al[16] retrospectively evaluated pressure injuries due to NIV in a large sample size (N = 255 subjects, no. = 343 episodes) of pediatric subjects over a wide range of ages (2 months to 35 y). They found an incidence of 7.3% and comprehensively queried causative factors using multivariate logistic statistical methods. They are the first to report that high mask leak was the sole factor that was significantly associated with pressure injury. The nonsignificant factors were maximum inspiratory positive air pressure, log of time on NIV, maximum mask leak, use of more than one mask/mask type, older age, time to skin erythema, and Braden Q score. Sixty-four percent of pressure injuries were stage I. These results reinforce the relatively rapid onset of skin compromise with visible but blanchable redness occurring by 1.8 ± 2.3 d of mask use for half of the subjects and pressure injury by day 3.7 ± 2.7. Consistent with previous reports, the majority of pressure injuries were at the nasal bridge.

The findings of Lauderbaugh et al[16] clearly inform practice. Importantly, future efforts should focus on strategies and interventions, including mask/equipment modifications, to reduce leak. It is recommended that new approaches be studied among complex patients because further reduction in pressure injury among such patients will likely translate across users of NIV.

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