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Review Article

Assistive Technology and Pressure Ulcers in Children: Preventive and Interventional Options

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Abstract

Objective: This study did a thorough review of the literature and examined the safety, the efficacy and applicability of the different preventive and interventional options/techniques/technologies for the management of Pressure Ulcers (PUs) and skin breakdown in pediatric population in comparison to those found in adult's literature.

Method: A research has been made in the following databases: Ovid (MEDLINE, PsychINFO, and Global Health), and CINAHL.

Method: PUs in the pediatric population have been poorly documented and have not received as much attention in the literature as those in the adult population. The chronically ill children and the pediatric patient population with neurological and sensory motor impairments such as cerebral palsy, spina bifida and SCI, are at significant risk for the development of PUs. Early assessment and detection are essential because early stage PUs is far easier and less costly to treat.

Conclusion: Most of the current techniques/technologies/options for prevention and management of pediatric PUs are limited and largely modifications of adult practice guidelines. Healthcare professionals should keep in mind that pediatric patients are not just small adults but deserve unique consideration in their medical and surgical care. Therefore, further future research studies and well-designed randomized clinical trials (RCTs) are needed to examine the efficacy, the applicability, and safety of the available prevention and treatment technologies/options for the management of PUs and skin breakdown in pediatric population.

Keywords: Pediatric; Pressure Ulcers; Skin Integrity; Risk Factors; Physical Disabilities; Assistive Technology; Adaptive Seating Interventions; Prevention

A Pressure Ulcer (PU) is defined as a ''localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear and/or friction'' [1]. PUs represents a significant healthcare problem and play a critical role in the patients' quality of life and their treatments affect the patients' lives emotionally, mentally, physically and socially [2]. PUs in the pediatric population have not received as much attention in the literature as those in the adult population. PUs occurs less frequently in the pediatric population than adult patients. PUs is often considered significant complications in pediatric patients with severe illnesses or with neurological and sensory motor impairments such as cerebral palsy, spina bifida, and traumatic and acquired Spinal Cord Injuries (SCI). Unfortunately, most of the current evidence-based guidelines and information available for identification of risk factors and prevention and management of pediatric PUs have been relatively limited and are largely modifications of adult practice guidelines. Due to the anatomical and physiological differences between pediatric and adult populations, PU management protocols retrieved from adults may not be optimal for children. Specific differences include a disproportionately large head in comparison to the rest of the developing body and immature integumentary and immunologic systems in children. In addition, medical and surgical advances have led to an increase in the survival rates of infants and children in acute intensive care settings and as a secondary consequence may be contributing to the increased incidence and prevalence of PUs in the pediatric patient population [3]. Limited information exists regarding the identification of risk factors associated with skin break-

down in the pediatric patient in comparison to those found in the adult literature. However, there are a variety of extrinsic and intrinsic risk factors that contribute to the initiation and progression of PUs in pediatric patients. Most of those factors were identified and derived from adult's population and include: prolonged pressure over bony prominences, friction and shear forces, any externally imposed condition that limits mobility (prolonged diagnostic and surgical procedures, sedation, intubation, traction devices, casts, and splints) [4-6], physical conditions and characteristics that cause limitation in mobility (terminal illness, sepsis, hypotension, edema, trauma, neurological or neurocognitive impairments; SCI, decreased sensation, impaired cognition, or reduced consciousness level from Traumatic Brain Injury (TBI) or pediatric stroke, spina bifida, and cerebral palsy, obesity, large head circumference, demographic variables such as age and race, and abnormalities such as edema and incontinence), abnormal physiological conditions (decreased oxygenation or perfusion, infection, anemia, and hypovolemia) [7,8], and the misconception that children are not at risk for PUs becomes a major risk factor in itself because their skin may not be thoroughly assessed and appropriate preventive measures may not be instituted. Pediatric PUs is often related to the use of equipment and devices. Potential locations for skin breakdown are points of contact with objects such as wheelchairs, orthotics, prosthetics, traction boots, casts, identification bands, blood pressure cuffs, continuous positive airway pressure (CPAP) equipment, nasogastric and orogastric tubes, and tracheostomy plates [9].

Management of PUs begins with prevention. The principles of wound management include controlling or eliminating causative factors and providing support of systemic conditions promoting wound healing and maintaining a physiological wound environment. Causative factors for PU development include pressure, shear, friction, moisture, circulatory impairment, and neuropathy. Systemic conditions promoting wound healing include appropriate nutrition and fluid support and edema management. Maintenance of the physiological wound environment helps prevent and manage infection, cleanse the wound, remove nonviable tissue via debridement, maintain an appropriate level of moisture, eliminate dead space, control odor, and eliminate or minimize pain [3]. In 1999 the Canadian Association of Wound Care (CAWC) developed 12 recommendations of PU management forming best clinical practices in patient care which include a completion of patient's medical history and determination of risk factors that may delay healing, modifications of situations where pressure may be increased (e.g. when seated or lying down), maximization of nutritional status, activity and mobility, reducing or eliminating friction and shear [10], development of a patient-centered plan and interdisciplinary team with flexibility to meet the patient's needs, staging and treating the wound to provide an optimal wound environment (debridement, infection and incontinence control, moisture balance), considering surgical intervention for deep nonhealing ulcers (Stage III and IV), and educating patient, caregiver, and healthcare professional on the prevention and treatment of pressure ulcers [2,11]. A variety of techniques and technologies could be performed to prevent and/or treat PUs in children. The child should be assessed directly to determine if he or she is comfortable with the bed, chair, devices, and/or equipment he or she is using. In addition, any object or equipment that can press or rub on the skin should be removed or padded and monitored carefully. In neonates, respiratory devices, which are in contact with sensitive facial skin, must be closely monitored to prevent development of PUs. Also, Preterm neonates should be repositioned at least twice in an 8-hour shift if clinically feasible [4]. Children with SCIs are at a particularly high risk of developing ulcers on their buttocks and sacrum because of diminished sensation, so frequent change of position, such as leaning forward and backward, can relieve pressure and prevent prolonged ischemia. The use of specialized support surfaces (such as mattresses, beds, and cushions) reduce or relieve the pressure that the patient's body weight exerts on skin and subcutaneous tissues as it presses against the surface of a bed or chair [12]. An alternating pressure mattress with small cells and a rapid deflation mode was developed and proven to be effective in small children [13]. In 2001, a study showed that the use of pressure-reducing wheelchair cushions for elderly nursing home resident wheelchair users who are at high risk for developing sitting-acquired pressure ulcers resulted in a lower incidence rate of pressure ulcers, a greater number of days until ulceration, and lower peak interface pressures compared with the use of regular foam cushions over a 12-month period [14]. A ROHO cushion for wheelchair seating along with supervised and learned push-up exercises can further decrease the risk of PU formation [15]. Prescribing seating for individuals who use wheelchairs primarily for mobility often entails considering posture, comfort, function, and pressure management. Power wheelchairs with self-actuated seating functions, such as tilt-in-space, backrest recline, and seat elevation, are usually prescribed by clinicians to facilitate posture change and/or assist activities of daily living (ADL) for persons with a high-level SCI who have impaired sensation and are unable to adjust postures independently or for those with neuromotor impairments who are unable to use a standard wheelchair seat. The appropriate use of seat functions leads to PU prevention. Researchers found that tilt-in-space significantly reduced static seating pressure, a key component in PU development, and that combining tilt-in-space with backrest recline reduced pressure more than tilt-in-space alone. In addition, many previous studies suggested that persons use large tilt-in space and recline angles to effectively manage pressure to

reduce the risk of skin breakdown [16]. A study concluded that the biggest reduction in maximum pressure at the ischial tuberosities was found at 45° of tilt-in space and 120° of backrest recline and that an effective weight shift could be achieved only when tilt-in-space is >15° [17].

Children with severe types of cerebral palsy use adaptive seating systems to encourage function and assist in delaying the development of deformity. However, there has been no unifying policy or theoretical basis on which these systems are provided, and research evidence is lacking, with studies tending to be small and non-controlled. The application of a lotion containing hexachlorophene, squalene, and allantoin was found to be superior when compared to a simple moisturizing lotion which proposed that hexachlorophene could act as a bactericidal agent and that allantoin might stimulate cell proliferation and tissue growth [12]. A retrospective study suggested that Negative Pressure Therapy (NPT) which has been accepted as a valuable adjunct for wound closure in adults can be effectively used to treat a variety of wounds in children. In NPT negative suction pressure is applied to the wound base through a porous sponge that is sealed to the wound by an adherent drape. The system has been shown to stimulate the rapid proliferation of granulation tissue, accelerate wound contraction, decrease wound and tissue edema, lower wound bacterial load, increase local microcirculation, and provide a closed, moist healing environment. Further prospective studies are needed to determine appropriate modifications that could be applicable to the child to harness the benefits of this technology in this unique and vulnerable population [18]. Topical management of PUs is an essential aspect of wound care. Choosing the appropriate wound dressing is an integral step in maintaining a healing wound environment. When making a selection, clinicians should consider the molecular regulation of growth factors, adhesion molecules, cytokines, and proteases in acute wound healing and how their molecular regulations are disrupted in chronic wounds [3]. There is a variety of available types of dressings that have been used to promote PU healing in pediatric patients and are intended to add moisture to a wound bed, such as hydro gels, transparent films, hydrocolloids, hydro cellular foam, composite border dressings, and silver antimicrobial dressings. The International Classification of Functioning, Disability and Health (ICF) address the area of adaptive seating for children with cerebral palsy and their families. The ICF is an important and exciting development because of its holistic framework and concentration on function and health, rather than disease-based models of disability, and places the individual at the core of the health care process. The ICF model not only gives a basis for therapists to evaluate their own activity, but also encourages a powerful dialogue with funders and managers and provides a means of communication with children and their families [19].

In conclusion, PUs in the pediatric population have been poorly documented and have not received as much attention in the literature as those in the adult population. The risk factors for PU development such as immobility, neurologic impairment, impaired perfusion, and decreased oxygenation are primarily defined in the adult research. It can be assumed that these risk factors also apply to the pediatric population. The chronically ill children and the pediatric patient population with neurological and sensory motor impairments such as cerebral palsy, spina bifida and SCI, are at significant risk for the development of PUs. Early assessment and detection are essential because early stage PUs is far easier and less costly to treat. Most of the current evidence-based preventive and interventional options of pediatric PUs such as seating interventions, support surfaces, cushions, power wheelchairs seating functions, Negative Pressure Therapy (NPT), and wound dressings, have been relatively limited and are largely modifications of adult practice guidelines. Healthcare professionals should keep in mind that pediatric patients are not just small adults but deserve unique consideration in their medical and surgical care. Therefore, theoretical guidelines and evidence from future clinical studies for prevention and treatment of PUs specifically targeting pediatric population are required.

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