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Pressure ulcers in maturing skin – A clinical perspective

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ABSTRACT

While the problem of Pressure Ulcers (PU) in adults has received a great deal of attention, far less is known about PUs in neonates and children. The overall health status of children is generally better and multi-morbidity is limited to a small percentage of patients, like very low term neonates (born before 32 weeks of gestation age), newborns with congenital abnormalities, genetic disorders, perinatal distress syndrome or children with a limited immunity. Survival rates of both critically and chronically ill neonates, infants and children have improved dramatically in recent years, introducing new challenges for medical and nursing care. Children's skin undergoes several changes throughout the first 18 years of life. The most important function of the skin is to protect against water loss, absorptions of noxious substances, intrusions of microorganisms and physical trauma. Effective PU prevention includes device related under-padding and careful positioning and fixation of such devices. At least regular head-to-toe-skin assessment of neonates and infants at risk of PUs should be performed.

1. Introduction

Pressure ulcers (PUs) are a common and highly relevant professional care issue in hospitals. They are associated with psychological and physical suffering, increased morbidity and mortality rate and higher costs for health care worldwide [1–3]. PU development can be attributed to multiple factors that are fairly well-studied in adults and elderly people [1,4–6]. Through large-scale, nationwide epidemiological studies, the prevalence of PUs in medical care institutions for adults is now known and well documented.

While the problem of PUs in adults has received a great deal of attention, far less is known about PUs in neonates and children [7]. Recent studies have indicated that PUs are also common in the pediatric population, and in the last ten years greater attention has been paid to this problem. There is greater awareness that pediatric patients in certain health care settings are also at high risk of developing PUs [8,9]. Prevalence rates for PUs in hospitalized pediatric patients range from 3% to 35% [8,10]. An overview of pediatric pressure ulcer rates is given by Kottner et al. [8].

2. The pediatric patient and its challenges

"The United Nations Convention on the Rights of the Child defines a child as "a human being below the age of 18 years". Within this time period one distinguishes between neonate, infants, toddlers, preschool child, school child and adolescent [11]. A neonate is defined as a child from birth up until its first 30 days of life. This includes preterm neonates, which means neonates born before 38 weeks of gestational age. Children born after 37 weeks of gestational age are categorized as term-born neonates. A newborn is a neonate within his first hours of life. An infant is a child in the time period from the age of 4 weeks up to its first birthday, followed by toddlers, which are children from the age of 1 up to their third birthday. A preschool child is between 3 and 5 years old, a school child between 6 and 12 years of age; adolescence covers the time from 12 up to the 18th birthday [12,13]. It becomes clear that there is not one pediatric patient-it is a small (both in numbers and sizes) and very heterogenic population.

It should be kept in mind that pediatric patients, in comparison to adults, are in widely differing health conditions. The overall health status of children is generally better and multi-morbidity is limited to a small percentage of patients, like very low term neonates (born before 32 weeks of gestation age), newborns with congenital abnormalities, genetic disorders, perinatal distress syndrome or children with a limited immunity. Survival rates of both critically and chronically ill neonates, infants and children

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have improved dramatically in recent years, introducing new challenges for medical and nursing care. Furthermore, new devices, Extra-Corporal-Membran-Oxygenation (ECMO), long lasting surgical procedures (LLSP) and advanced therapies in critical areas of admittance requires much more attention in order to prevent pressure-related ulcers [10,13].

3. The skin in pediatrics: from fetus to newborn

Children's skin undergoes several changes throughout the first 18 years of life [14]. The most important function of the skin is to protect against water loss, absorptions of noxious substances, intrusions of microorganisms and physical trauma [14]. The skin of children is morphologically and functionally different from adult skin [14–16]. Within the first days of life neonates undergo various adaptation processes needed to accommodate the transition from the wet intrauterine environment to the dry outside environment [14]. During the first months and years the skin continues to develop and evolve its structure and functions (Table 1).

The unique physiological needs of children with regard to skin first require some explanation. Physiologically, fluid and electrolyte disturbances occur more frequently and develop more rapidly in infants and young children than in older children and adults. The higher proportion of water content and greater relative surface area of young bodies increases the risk of dehydration under the metabolic demands associated with fever. Skin cells that are not well perfused may be hypoxic and are at risk of breaking down even with minimal trauma [17].

It is known that any skin breakdown (like epidermal stripping and skin tears due to friction or tapes), especially in critically ill neonates and infants, increases the risk of septicemia as well as related severe complications and higher mortality [18]. Pressure ulcers also cause an increase in pain, infection and calorie expenditure in pediatric patients [19–21] and therefore it is of great importance to avoid any damage to the fragile skin of pediatric patients.

According to the guidelines of NPUAP and EPUAP (National and European Pressure Ulcer Advisory Panels), PUs are differentiated into four different categories, with category one being the least severe, and defined as “intact skin with non-blanchable redness of a localized area usually over a bony prominence” and category four the worst, being defined as “full thickness tissue loss with exposed bone, tendon or muscle” [22]. These EPUAP/NPUAP categories are also used frequently in pediatric settings [8,19,23]. With regard to the different aspects affecting pediatric skin development (Tables 1 and 2) the etiology of pediatric pressure ulcers and whether there are any differences in classifying PUs in pediatric patients according to adult categories has not been studied so far and is thus unknown.

The tissue tolerance of a person is an intermediate variable and not a causal factor in the development of PUs. How high the pressure must be and how long it must be maintained to cause skin damage depends on the individual's tissue tolerance and other influencing factors [24]. Immobility, pressure ulcer and skin status, perfusion, metabolic condition, skin moisture, sensory perception and nutrition of the patient, body temperature and co-morbidity are relevant determinants which influence tissue tolerance [24–26]. In pediatric patients skin breakdown is a common topic and it is not the same as a pressure ulcer. Maintaining skin integrity in pediatric patients is difficult because of patients vulnerability, acuity and the highly invasive interventions and therapies they receive.

4. Pediatric specific pressure ulcer risk

Potential risk factors for PUs are well known and described for the adult population. There is some evidence that immobility and decreased skin sensitivity [6,27–31] in pediatric patients increase the risk of pressure ulcer development as well [27,28]. With regard to the pediatric patient, sick children in general, but also due to limited communication skills, neonates, infants and toddlers, disabled and neurologically impaired children, seem to be at particular risk of developing pressure ulcers [18,19,28].

Further, several risk factors with regard to external devices are known for pediatric patients. The consequences of immobility and decreased skin sensitivity and risk factors related to equipment such as tubes, IV catheterization and CPAP have been described [10,19,28]. Especially patients in pediatric intensive care units (PICU) and neonates are at increased risk for skin failure. PICU dependent children have due to their general condition a quick and sudden change in shape and form of body sites (like for ex face). The children's body sites change due to increased fluid intake, edema or several medication. External devices (for.ex CPAP masks) which affect the skin often fail to adapt to these rapid changes adequate. Further the pressure of tubes in oscillation and ECMO as well as the decreased tissue tolerance in these patients due to their critical condition makes these children most vulnerable [10,19,32]. Medical devices on the skin are the predominant risk factor for PU occurrence in pediatric patients [19,28,33]. With regard to neonates and infants, in whom mechanical ventilation support devices have shown to be the major risk factor, this was also reported in the studies of Schindler et al. (2007), Curley et al. (2003) and Boesch et al. (2012), Schlüer, (2013) [10,19,32,34].

The need for additional medical and therapeutic aids, such as wheelchairs, unadjusted ortheses and prostheses [20,21] are known risk factors for pressure ulcer development in children as well [13]. A problem limited to neonates is their immature skin with regard to the friable skin and circulatory system, which leads to extravasation, or skin failure due to strapping or tubing or monitoring sensors.

Younger age can also be considered as major PU risk factor in

Table 1
Skin features in neonatal age [14–16].

Underdevelopment of subcutaneous fat tissue
Less of cohesion between epidermis and dermis
Dermal instability
Alkaline skin surface (skin surface pH > 7.4)
Transition from wet intrauterine to a dry extra uterine environment with increased Trans Epidermal Water Loss (TEWL) in neonatalperiod
Fat, Zincum and metallic deficiencies
Increased risk for skin traumas (shearing and friction forces like epidermal stripping and skin tears, neonatal dermatitis)
Reduced insulation and loss of surface temperature
Reduced secretions and sebum production
Infant corneocytes and granular layer keratinocytes are smaller due to high cell turnover rates
Delayed full functioning of melanocytes*
Intensity of pressure: capillaries collapse at 23 mmHg