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Decubitus Ulcer Development in Individuals with Spinal Cord Injury

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Abstract

Decubitus ulcers are a serious health care concern for patients who experience mobility-related limitations. They are a costly secondary complication affecting more than 2.5 million people in the United States each year. If left untreated, decubitus ulcers can become life-threatening over a short period of time for persons with spinal cord injury. These generally preventable complications should be considered when developing a life care plan. This article reviews causes, prevalence, costs, and management practices of decubitus ulcer development in individuals with spinal cord injuries.

Decubitus Ulcer Development in Individuals with Spinal Cord Injury

Life care planners are often sought to educate interested parties about the potential complications that accompany specific disabilities and address the costs of these complications. One costly and sometimes deadly complication of disabilities, which result in movement limitations, is decubitus ulcers (Redelings, Lee, & Sorvillo, 2005). Decubitus ulcers, also known as pressure ulcers or pressure sores, are defined as "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"(Black, Baharestani, Cuddigan, Dorner, Edsberg, & Langemo, 2007, p.269). Pressure ulcers have long plagued the medical community, with the first documentation of these ulcers by Hippocrates as early as 400 B.C. (Black et al., 2007). In 2013, decubitus ulcer prevention, diagnosis, management, and care continue to receive significant attention from the healthcare community.

Decubitus ulcers are a common complication for individuals receiving medical care in various healthcare settings including hospitals, nursing homes, and in the community. They occur most commonly in older adults (those over age 75), those with limited mobility and are wheelchair dependent, and those who reside in nursing homes or hospital settings (Redelings, Lee & Sorvillo, 2005). Exactly how common decubitus ulcers are depends upon patient-specific factors, healthcare setting factors, and equally as important, data collection factors. It is estimated that over 2.5 million people in the United States develop decubitus ulcers each year (Cuddigan, Ayello, & Sussman, 2001; Lyder, 2003). These ulcers can be fatal, with approximately 60,000 people per year dying from the complications of pressure ulcers (Byrne & Salzberg, 1996; Cuddigan et al., 2001; Redelings et al., 2005).

Decubitus ulcers have become such a chronic health problem in the United States that as of October of 2008, Centers for Medicare and Medicaid Services (CMS) no longer pay for the care delivered to patients for inpatient hospital care for acquired Stage III or Stage IV pressure

ulcers. Centers for Medicare and Medicaid Services now consider decubitus ulcers as one of the eight preventable conditions. Therefore, hospitals can no longer receive reimbursement from CMS for the treatment of patients with this condition. Following CMS' determination, many private insurers also adopted this non-reimbursement policy (Lyder, 2011; Mattie & Webster, 2008). Healthcare communities have paid increasing attention to detecting, documenting, and treating ulcers because ulcer care is not reimbursable and also because decubitus ulcers are associated with poor quality patient care.

With an increasing aging population and as individuals successfully survive traumas as a result of improved medical care, patients who live with limited mobility impairments are increasingly common and have witnessed an increased life expectancy. The movement to better understand decubitus ulcers is a result of all these factors. An additional influence was the Omnibus Reconciliation Act (OBRA) of 1987, which set the stage for quality and accountability in patient care (Cuddigan et al., 2001). Healthcare litigation also increased providing patients an avenue to recover damages incurred in the course of their medical treatment. In the quest to understand how, why, and prevalence, the anatomy and physiology of decubitus ulcers must first be understood.

Anatomy and Physiology of Pressure Ulcers

Pressure ulcers are an area of localized damage to the skin and underlying tissues generally caused as a result of unrelieved pressure (Baustian, Usatine, & Haq, 2007; Hagisawa, Shimada, Arao, & Asada, 2004). When pressure is unevenly applied, damage can occur with pressure conducted through the skin to the underlying tissues particularly near the bone. When a person is sitting or lying, pressure is transferred from the external surface through the layers of the skin toward the underlying bone. Skin, blood vessels, subcutaneous fat, and muscle are compressed between the bone and the external surface; this compression results in a cone, or pyramid-shaped, pressure gradient. This is referred to as the McClemont cone effect (Baustian et al., 2007). The top of the cone equates to the bony surface where tissue interface pressure is the highest. This leads to the intensity of pressure being up to three to five times greater on deep tissues than that of the epidermis (Collier and Moore, 2006; Victorian Government Health Information, 2013).

Pressure ulcers develop when persistent pressure obstructs healthy capillary flow, leading to tissue necrosis (Lyder, 2003). Deep tissue necrosis often occurs first at the bony interface as a result of this pressure (VGHI, 2013). Pressure exerted at the bony interface then emerges at a point in the surface of the skin. A small, inflamed area over a bony prominence may indicate tissue breakdown that is much deeper and wider than indicated at the surface of the skin (Pressure Sores, 2012).

Pressure from foreign objects, wrinkles in sheets or cushions, blisters, or abrasions can all lead to a pressure ulcer if a person stays in one position for too long (Hall, 2005). When skin and the underlying tissues are trapped between bone and a surface such as a wheelchair or bed, the pressure may be greater than the pressure of the blood flowing in the tiny vessels that deliver oxygen and other nutrients to tissues (Pressure Sores, 2012). When a change in bodily position does not occur frequently enough and the blood supply gets too low, a sore or pressure ulcer may form. Point-pressure increases tissue injury by increasing capillary permeability (particularly after pressure is released), increasing interstitial edema, blocking lymphatic and venous drainage, occluding vessels causing hypoxia, ischemia and tissue necrosis (Baustian et al., 2007; VGHI, 2013).

Pressure ulcers are more likely to develop in areas that are not well protected by muscle

or fat (such as the buttocks, hips, ankles, or heels) (Mayo, 2011). Common sites of pressures sores for people who use a wheelchair for mobility occur on skin at the following sites: tailbone or buttocks, shoulder blades and spine, and backs of arms and legs (where they rest against the wheelchair) (Pressure Sores, 2012). For people who are confined/restricted to a bed due to their condition, common ulcer sites include the following: back or sides of the head, rim of the ears, shoulders or shoulder blades, hips, lower back or tailbone, heels, ankles, and skin behind the knees (Pressure Sores, 2012).

A wide range of factors affects tissue tolerance. Bradon, Bergstom, and Baggerly (2000) developed a conceptual framework to help the medical community understand the various risk factors leading to ulcer formation. These are generally organized into two major groups: extrinsic and intrinsic (Baustian et al., 2007). Extrinsic factors are physical mechanisms, events, or circumstances that are external to the patient who develops pressure ulcers. These factors are primary or management related factors. The three main extrinsic mechanisms that are known to precipitate pressure ulcers are: moisture, shear, and friction (Australian Wound Management Association, 2001).

Skin that is moist due to sweat, or excessively dry, is more likely to be injured in general and increases the skin's coefficient of friction. An increase in friction intensifies the skin's susceptibility to rubbing and chafing against a number of materials (such as incontinence pads, clothing, and sheets). Moisture can lead to maceration and excoriation, which reduces tissue tolerance (Baustian et al., 2007). This encourages pressure ulcer development. This is also true if the skin is too dry, as it causes skin to break down.

Friction is characterized as resistance to motion (Read, 2001); occurring when two objects are moving relative to each other and rub together. For example, when a person changes position, friction may occur when the skin is dragged across a surface. The resistance to motion may be even greater if the skin is moist. Friction between skin and another surface may make fragile skin more vulnerable to injury (Baustian et al., 2007).

Shear forces are generated as a result of the interplay of friction and pressure (Collier and Moore, 2006). Shear occurs when two surfaces move in the opposite direction (Baustian et al., 2007). For example, when a hospital bed is elevated at the head, a person can slide down in bed. If the skin adheres to the surface support (which is more likely if the skin is moist or wet from environmental factors or intrinsically from incontinence or sweating), the tissues attached to the gradually moving skeletal frame become distorted which, in turn, distort the blood vessels leading to their collapse or rupture (Beldon, 2008; Weir, 2007).

There are four stages of pressure sores, based upon ulcer severity (Baustian et al., 2007). The systems used to describe pressure ulcers usually signify the varying degree of tissue damage numerically, with a lower number being less serious and a higher number indicating more severe tissue damage (Briggs, 2011). The National Pressure Ulcer Advisory Panel, a professional organization that promotes the prevention and treatment of pressure ulcers, has defined each stage as follows (Briggs, 2011; Mayo, 2011):

Stage I: Non-blanchable redness of intact skin

The beginning stage of a pressure sore has the following characteristics: skin is intact, affected skin may feel warm to the touch, and the area may also burn, hurt or itch (Baustian et al., 2007). The skin appears red on people with lighter skin color, and the skin does not briefly lighten (blanch) when touched (Briggs, 2011). The skin may also appear ashen, bluish or purple (Mayo, 2011).

Stage II: Partial thickness skin loss or blister

The affected skin is more damaged in a stage 2 pressure sore. The pressure sore is an open sore that looks like an abrasion or a blister (Pressure Sores, 2012). The skin around the wound may be discolored. The area is very painful. The outer layer of skin (epidermis) and part of the underlying layer of skin (dermis) is damaged or lost (Briggs, 2011; Mayo, 2011).

Stage III: Full thickness skin loss (fat visible)

At this stage, the ulcer is a deep wound (Baustian et al., 2007). These types of pressure sores usually have a crater-like appearance due to increased damage to the tissue below the skin's surface (Pressure Sores, 2012). The loss of skin usually exposes some amount of fat. The bottom of the wound may have some yellowish dead tissue (slough) (Mayo, 2011). The damage may extend beyond the primary wound below layers of healthy skin (Pressure Sores, 2012).

Stage IV: Full thickness tissue loss (muscle/bone visible)

This is most serious type of pressure sore (Pressure Sores, 2012). The skin and tissue is severely damaged, causing a large wound. Infection can occur at this stage. A stage IV ulcer exhibits large-scale loss of tissue, which may expose muscle, bones, and tendons (Baustian et al., 2007). The bottom of the wound likely contains slough or dark, crusty, dead tissue (eschar) (Mayo, 2011). The damage often extends beyond the primary wound below layers of healthy skin (Pressure Sores, 2012).

With higher stages, healing time is prolonged. While about 75% of Stage II ulcers heal within eight weeks, only 62% of Stage IV pressure ulcers ever heal completely (Thomas, Diebold, & Eggemeyer, 2005). Complications of pressure ulcers include sepsis, cellulitis, bone and joint infections and cancer (Baustian et al., 2007). Sepsis occurs when bacteria enters the bloodstream through the broken skin and spreads throughout a person's body. Sepsis is a rapidly progressing, life-threatening condition that can cause organ failure. Cellulitis is an acute infection of the skin's connective tissue that causes pain, redness and swelling, all of which can be severe. Cellulitis can also lead to life-threatening complications, including sepsis and meningitis. Bone and joint infections develop when the infection from a pressure sore burrows deep into joints and bones.

Pressure ulcer development continues to be a puzzling and complex process, despite years of research (Regan et al., 2012). Not all pressure ulcers develop progressively through the four stages with time. Unfortunately, even with management, ulcers can continue to progressively worsen given the unfortunate combination of immobility, friction, poor nutrition, etc. While an ulcer can develop in a matter of hours, how long it takes for an ulcer to progress from stage I to stage IV depends upon the individual's risk factors as outlined above.

Pressure Ulcers in America

As recently as the 1980s, the magnitude and severity of pressure ulcer prevalence in the United States could not be characterized. In 1987, an independent non-profit organization, The National Pressure Ulcer Advisory Panel (NPUAP) was developed (Cuddigan et al., 2001). Since then, this group has engaged in the measure of pressure ulcers. They have researched and published data pertaining to pressure ulcers as well as hosting biennial conferences regarding the subject matter. In 1989, this group estimated the prevalence at any given time of pressure ulcers in acute care settings at 3-14% and the incidence within acute care settings at 5-11% annually. Between 1990 and December 2000, there were over 300 studies published on pressure ulcer prevalence and incidence (Cuddigan et al., 2001). The number of cases of pressure ulcers is reported in two ways, prevalence and incidence.

Prevalence is the number of or proportion of individuals who have an ulcer at a specific point in time (Cuddigan et al., 2001). Prevalence measures a person's likelihood of having a pressure ulcer. A prevalence rate is the total number of cases of a disease existing in a population divided by the total population. Prevalence is typically measured either at a specific point in time (point prevalence) or over a certain period of time (period prevalence). Point prevalence is calculated as follows:

$$\frac{\text{Number of persons with an ulcer}}{\text{Number of persons in a population at a particular point in time}} \times 100$$

Period prevalence is calculated as follows:

$$\frac{\text{Number of persons with an ulcer}}{\text{Number of persons in a population during a particular period in time}} \times 100$$

(Cuddigan et al., 2001).

Pressure ulcer prevalence has been measured in various settings and within various populations. The prevalence rate in long term care facilities in the United States has been estimated at 15-25%; and the prevalence of pressure ulcers in home care settings was estimated at 7-12% (Cuddigan et al., 2001). Redelings et al., (2005) report prevalence of pressure ulcers in acute care settings in the United States ranging from 14%-17%. In a review of 51,842 cases in the Medicare Patient Safety Monitoring System (MPSMS) in 2006-2007, pressure ulcer prevalence (on admission) was found to be 5.8% (Lyder, Wang, Metersky, Curry, Kliman, Verzier & Hunt, 2012).

Incidence, in contrast, is the proportion of patients who are at risk for developing ulcers (population) who develop ulcers over a specific period of time or those who were ulcer-free who developed ulcers during a particular time period (Cuddigan et al., 2001). Incidence reflects a person's probability or likelihood of being diagnosed with a disease during a given period of time.

Incidence is calculated as follows:

$$\frac{\text{Number of new cases of a disease}}{\text{Number of persons at risk for the disease}}$$

(Cuddigan et al., 2001).

The National Pressure Ulcer Advisory Panel (NPUAP) has reported incidence rates from .4% to 38% in hospitals, 2.2%-23.9% in skilled nursing facilities and from 0-17% for home health agencies (Lyder, 2011). In a 2006-2007 study of 51,842 cases in the Medicare Patient Safety Monitoring System (MPSMS) hospital acquired pressure ulcer incidence was reported to be 4.5%. (Lyder et al., 2012). Lyder (2003) notes that pressure ulcer incidence rates of less than 2% are ideal.

While prevalence and incidence data provide general guidelines about how common pressure ulcers are, there are problems inherent with pressure ulcer prevalence and incidence data. A review of literature about pressure ulcers reveals varying incidence and prevalence. First, it is noted that the majority of pressure ulcer data focused on elderly patients residing in

nursing homes (Byrne & Salzberg, 1996). Second, there are variations in data due to the use of various pressure ulcer classification systems. Third, incidence data is sometimes substituted for prevalence data. Fourth, healthcare facilities may underreport the existence of ulcers as it is considered an indicator of poor quality care. This results in facilities not documenting or reporting the condition at the time of patient transfer between facilities. Finally, various types of studies and data collection have been used. Some studies use direct examination of patients, while others use surveys or patients' medical records (Kaltenthaler, Whitfield, Walters, Akehurst, & Paisley, 2001).

Costs Associated with Pressure Ulcers

The National Pressure Ulcer Advisory Panel reports that pressure ulcers cost between 9.1 and 11.6 billion dollars annually in the United States, with the cost of care for each pressure ulcer ranging from $20,900 to $151,700. The cost of a pressure ulcer varies significantly based upon the severity of the wound. Lyder (2011) reports that pressure ulcers are the second most common cause of hospital re-admission with treatment costs ranging from $20,000 to $70,000 per wound. A 2006 study by the Center for Medicare and Medicaid Services (CMS) revealed that the average charge per stay for a patient with a Stage III or Stage IV pressure ulcer was $43,180 (Lyder, 2011). In 2009, the total CMS payout to hospital totaled over $11 billion for 257,412 beneficiaries who were admitted to hospitals who developed Stage III and Stage IV pressure ulcers (Lyder, 2011). It is possible, however, that this is an underestimation of the problem, as physicians may not include pressure ulcers in the patients' discharge diagnosis, causing the condition to be overlooked by coders when billing for the patient's hospitalization. In addition to national data, some states report on data pertaining to pressure ulcer care. In 2008, California reported 1,668 pressure ulcer cases at a cost of $28,272 per case while Maryland reported 1,009 cases at a cost of $17,495 per case (Lyder, 2011).

Another cost associated with pressure ulcers is pressure ulcer litigation. Pressure ulcer litigation is now the second most common claim (after wrongful death) in the United States. Each year, more than 17,000 lawsuits related to pressure ulcers are filed (NPUAP advisory panel). A review of pressure ulcer jury awards reveals financial awards ranging from $5,000 to $82,000,000 with a median award of approximately $250,000 (Lyder, 2011).

Decubitus Ulcers in Patients with Spinal Cord Injury

Pressure ulcers are widely recognized as a serious complication for individuals with spinal cord injury (SCI) (Garber, Rintala, Hart & Fuhrer, 2000). As individuals with a complete SCI usually have no sensation below the level of injury, they are unable to feel pressure as it develops on their skin. Compounded with the person's inability to sense pressure is their inability to move their extremities to independently shift weight/pressure, particularly so for those with cervical injuries or tetraplegia (Falvo, 2009). Because of these factors, the pressure forces described go undetected or are detected later by the person with the SCI, increasing the risk that the pressure ulcer will worsen prior to detection/ treatment. As a result, it is estimated that individuals with SCI will experience at least one decubitus ulcer in their lifetime (Weed & Berens, 2010).

Pressure ulcers are currently the most frequent and significant complication among persons with spinal cord injury with an estimated 21-60% of individuals with SCI developing a pressure ulcer during the acute stage of treatment (Gelis et al., 2009; Salzberg et al., 1998; New, Rawicki, & Bailey, 2004; Weaver, 2012). Pressure ulcers are the second cause of re-hospitalization for this population (Chen, DeVivo, & Jackson, 2005; Gelis et al., 2009).

Thousands of deaths each year in the United States are a result of pressure ulcers accompanied with fatal septic infections (Redelings et al., 2005).

Pressure ulcer prevalence in chronic SCI varies from 15%-30% (Gelis et al., 2009). Byrne and Salzberg (1996) reported that up to 85% of individuals with SCI will develop a pressure sore at some point during their lifetime. By 2012, it is estimated that more than 50% of individuals with SCI will develop a pressure ulcer during their lifetime (Weaver, 2012). Medicare data indicates that the incidence rate of pressure ulcers in individuals with SCI ranges considerably by setting, from 0-17% in a home care setting to .4-38% in acute care (Weaver, 2012). Unfortunately, there has been little change in prevalence or incidence of pressure ulcers for individuals with SCI over time (Weaver, 2012).

Studies of pressure ulcer prevalence among individuals with spinal cord injuries in the United States have revealed rates ranging from 27%-62%. In a study of 800 veterans paralyzed during military service, 62.4% had experienced at least one pressure ulcer following paralysis with 17% having a pressure ulcer at the time of the study (Salzberget al., 1998). Chen et al., (2005) conducted a review of 3,361 patients in the Model Spinal Cord Injury System, finding that 27% of patients had one or more stage II or higher pressure sores, which accounted for 1,565 visits. Garber et al. (2000) studied 118 men with spinal cord injury and found that 31% reported having a pressure ulcer. Smith, Guihan, LaVela, & Garber (2008) found that 36% of 2,574 adults with SCI reported having a pressure ulcer during the previous year.

Similar studies have been conducted outside of the United States. A study of pressure ulcer incidence among individuals with SCI in Britain revealed a total of 56% of patients experienced a pressure ulcer between injury and discharge from the spinal injuries unit (SIU) (Ash, 2002). Fifty-four percent of individuals with SCI in Brazil were found to have pressure ulcers (Salzberg et al., 1998). In Iceland, 58% of individuals who used a wheelchair developed a pressure ulcer (Salzberg et al, 1998).

Pressure ulcers in the SCI population are most commonly seen in the sacrum and coccyx, however, there have been recent increases in the number of heel ulcers (Cuddigan et al., 2001). Hammond, Bozzacco, Stiens, Buhrer, and Lyman (1994) reported that 40% of the pressure ulcers were located in the pelvis area (ischial and sacral sites); 22% were located in the perineal area (penis, scrotum, groin and gluteal sites); and 16% were located on the leg or trochanter. Other ulcers were located between the feet 15%, back 5%, arm 2% and head 1%. Ash (2002) in a study of individuals with SCI in the United Kingdom found that the most common areas of pressure sores in acute SUI unit were the sacrum (46%) and heels (30%). In a study of 134 patients with SCI in Australia, the most frequent region of pressure ulcer development was the pelvis (60%), with occurrence of 31% of pressure ulcers present on the foot (New et al., 2004).

Costs of Pressure Ulcers in Population with SCI

Annual cost of pressure ulcer treatment for individuals with SCI in the United States is estimated at $1.2-$1.4 billion (Gelis et al., 2009; Regan et al., 2012). Pressure ulcers alone account for one-fourth of the total cost associated with SCI patient care (Byrne & Salzberg, 1996; Regan et al., 2012). As the length of time to heal a pressure ulcer is 41.7 (mean) to 42 (median) days, the development of a pressure sore can lengthen the stay in the hospital for those with SCI (New et al., 2004). For patients who develop pressure ulcers during rehabilitation, a difference of 36 days in length of stay can be anticipated (New et al., 2004). SCI Model Systems data estimate that patients with SCI who have pressure sores incur hospital charges of three to four times more than other patients with SCI, averaging at least an additional $15,000 per year in health care costs. This figure can increase to more than $30,000

for grade 4 sore requiring months of skilled care (Blackwell, Krause, Winkler & Stiens (2001). Model SCI data indicates that the cost of treatment for pressure ulcers that required hospitalization was $14,000-$23,000 with more complicated cases at a Model SCI Center exceeding $100,000 (Weed & Berens, 2010). Annual healthcare costs within the VA system for individuals with SCI and pressure ulcers is $87,639 higher than annual costs for veterans with SCI without pressure ulcers ($25,940) (Weaver, 2012). However, these costs do not include resulting costs of disrupted employment, decreased contact with family or friends, or other losses.

Decubitus Ulcer Risk factors for Individuals with SCI

To better understand why some patients with SCI develop pressure sores, while other patients with SCI do not develop ulcers, numerous studies have been conducted in an attempt to identify possible risk factors. While not are all specific to SCI, more than 200 pressure ulcer risk factors have been identified (Byrne & Salzberg, 1996; Lyder, 2003). The likelihood of developing pressure ulcers increases significantly when a patient has multiple risk factors. Smith et al., (2008) found that the odds of an individual who was 58 years old, had a SCI for more than 30 years, uses multiple healthcare systems, is unemployed, has come college and does not smoke had a 40% probability of acquiring at least one pressure ulcer. If that same patient had diabetes instead of depression, the probability would increase to 54%. Having both depression and diabetes increased the patient's probability to 70% likelihood of acquiring a pressure ulcer over his lifetime.

Intrinsic risk factors are secondary or patient-condition related factors. Intrinsic factors are those that influence the skin's supporting structures and/or the lymphatic system; and hence reduce the tissue's tolerance to pressure (Baustian et al., 2007). Intrinsic patient-specific factors are unique to the individual, and include, but are not limited to: nutrition, demographics, oxygen delivery, skin temperature, and chronic illness. Intrinsic factors are the unique patient characteristics that affect the ability of skin and soft tissue to withstand unrelieved pressure, friction, and shear forces.

Blackwell et al., (2001) outlined major risk factors for developing pressure sores in people with SCI within three categories: (1) Severity of SCI: Decreased activity, immobility, completeness of SCI, urine incontinence/ moisture, severe spasticity/ autonomic dysreflexia; (2) Pre-existing Conditions: Advanced age, tobacco use, pulmonary disease, cardiac disease, diabetes, renal disease, impaired cognitive function, residing in a nursing home/ hospital; (3) Malnutrition and anemia: Hypoalbuminemia/ hypoproteinemia, anemia. Risk factors including demographic factors (age, ethnicity, gender, education, and employment), injury-specific factors (level of lesion, cause of SCI, time since injury), and behavioral factors (nutrition, smoking, and activity level) are explored.

Demographic Variables

Gender has been considered a risk factor in pressure ulcer development in those with SCI. As the majority of those with SCI are male, more males than females tend to develop pressure sores. Ash (2002) found that 60% of males and 38% of females developed pressure ulcers in a study of 144 patients admitted to UK spinal injuries unit. In a review of 14 studies of pressure sores in patients with SCI, gender was accounted for in eight studies. Being male was found to be a risk factor in two high power studies, validating the gender (male) risk factor as being a powerful predictor of pressure ulcer development in a 2005 study of 3,361 individuals with spinal cord injury and in a study reviewing data from the National SCI Statistical Center

for patients with SCI injured between 1973 and 1998 (Gelis et al., 2009).

Ethnicity has also been considered a possible risk factor for pressure ulcer development, though reliable and valid evidentiary support is lacking. Ethnicity is a controversial risk factor in the development of pressure ulcers among individuals with SCI. Only one cohort study in the United States found a link between ethnicity (African-American) and pressure ulcer development (Chen et al., 2005). However, it is cautioned that possibly confounding factors of violence, unemployment and unequal access to healthcare may be responsible for this finding (Gelis et al, 2009). In a study of 2,574 veterans with SCI, Smith et al., (2008) found no statistically significant differences between white and non-white groups in pressure ulcer development, they note that previous research in individuals without SCI report that that detecting skin problems/ pressure ulcers is more difficult in individuals with darker skin.

Several studies have examined age as a risk factor in pressure ulcer development. Chen et al., (2005) found that advanced age increased both frequency and severity of the pressure ulcer development in those with SCI. This may be attributable to: age-related loss of muscle mass, a decrease in the density of adrenergic receptors which decrease blood supply below the level of injury, a decrease in vascularity, and perhaps aging caregivers whose diminished physical capacity impairs their ability to consistently assist in turning or transfers (Chen et al., 2005). New et al., (2004) found age to significantly increase the risk of pressure ulcer development in initial rehabilitation patients. With every year of increase in age, they found the risks of pressure ulcer development increased by 4.2%. Garber et al., (2000) also found that those who acquired a spinal cord injury at a younger age (average age 25.51) were more likely to develop decubitus ulcers. Byrne and Salzberg (1996) conducted a review of research publications associated with the risk factors for pressure ulcer development in patients with SCI. They found that one's risk of pressure ulcer development increases after age 35 and again after age 65, suggesting that in the SCI population, age may have a bimodal curve for pressure ulcer development. Chen, DeVivo and Jackson (2005) also found an increase in pressure ulcer development at 15 years post-SCI, even though pressure ulcer development within the first 10 years post-injury remained steady.

Other studies, however, have concluded that age is not a pressure ulcer risk factor for patients with SCI (Gelis et al., 2009). In a study of 2,574 veterans with SCI, Smith et al. (2008), concluded that age was not a predictor of pressure ulcers. Salzberg et al., (1998) concluded that age at the time of study was not a significant risk factor for pressure ulcers in their sample of 800 veterans with SCI but younger age at SCI onset was a risk factor for pressure ulcer development.

Chen et al., (2005) identified lower levels of education (less than a high school diploma) as a risk factor for pressure ulcers in 3,361 individuals with SCI However, in a study of 2,574 veterans with SCI, Smith et al., (2008) did not find a relationship between education level and pressure ulcer development.

Unemployment has been linked to pressure ulcer prevalence in several cross-sectional studies. Chen et al., (2005) concluded that either being employed or a student was a protective factor against ulcer development. Similarly, Smith et al., (2008) found that employed veterans had a lower risk of pressure ulcers than non-employed veterans.

Physiologic Risk Factors

Numerous health-related factors have been identified as pressure ulcer risk factors. These include (but are not limited to): diabetes mellitus, peripheral vascular disease, cerebrovascular

disease, sepsis, and hypotension. It is believed that these conditions contribute to pressure ulcer development as they impair one's microcirculatory system (Redelings et al., 2005). Other conditions such as cardiac and pulmonary disease have also been identified as risk factors (Byrne & Salzberg, 1996). Smith et al., (2008) found that those who have diabetes and hypertension were more likely to have pressure ulcers than patients without these conditions. Salzberg et al., (1998) found that pulmonary disease, renal disease and autonomic dysreflexia were each associated with pressure ulcers.

Injury Related Factors

Factors including cause of injury, level of SCI lesion, and time since injury have been explored as correlates to pressure ulcer development. In a study of 3,361 patients with SCI, Chen et al., (2005) found that time since injury significantly increased pressure ulcer prevalence in individuals up to age 49. Hammond et al., (1995) also found that pressure ulcer risk increases with time after SCI, with those who were more than 10 years post-traumatic SCI being at increased risk for developing pressure ulcers. Garber et al., (2000) studied pressure ulcer predictors in a group of 118 men with spinal cord injuries and found that those who had longstanding SCI (average 16 years) -were at greater risk for developing pressure ulcers.

In addition to the amount of time that lapsed since the injury, the cause of the SCI has also been identified as a risk factor for pressure ulcer development. Salzberg et al., (1998) found that 71.5% of respondents who developed pressure sores were paralyzed from a traumatic injury or accident (e.g. motor vehicle accident, gunshot wound, fall, etc).

Urological factors have also been identified as risk factors for those with SCI who develop pressure ulcers. Incontinence and moisture have consistently been associated with pressure ulcer development (Byrne & Salzberg, 1996; Salzberg et al., 1998). In the Salzberg et al. (1998) study of veterans with paralysis, the combination of fecal and urine incontinence posed a greater risk (OR=4.5) than urine incontinence alone (OR=2.1). In addition, use of condom catheters has also identified as a correlate to pressure ulcer development (Hammond et al., 1994).

While inactivity is typically a risk factor for pressure ulcer development, this factor is less discriminatory in the population of patients with SCI because most patients are non-ambulatory. While it was historically believed that pressure ulcer prevalence was higher in SCI patients with cervical lesions, evidence suggests that completeness of lesion may be a better predictor of pressure ulcers than level of lesion (Byrne & Salzberg, 1996; Chen et al., 2005; Salzberg et al., 1998). Maynard et al., (1997) note that patients with complete lesions (ASIA A) were 37% more likely to develop pressure ulcers than those with incomplete lesions. Eighty percent (80%) of patients with SCI who had neurologically complete injuries developed pressure ulcers (Ash, 2002).

The activity level of the individual with SCI may be one of the most important factors measured in pressure ulcer development. Salzberg et al., (1998) reported that level of activity was the most significant factor associated with pressure ulcer development, with only 30.9% of ambulatory respondents reporting pressure ulcers compared to 70.3% of those utilizing wheelchairs for mobility, and 76.9% of those restricted to bed. Garber et al., (2000), in their study of 118 men with SCI found that greater impairment and disability were associated with increased pressure ulcer development.

Risk Behaviors

In addition to physiological risk factors, patient behaviors have also been associated with

pressure ulcer development. Smoking cigarettes has been identified as a pressure ulcer risk factor (Salzberg et al., 1996; Smith et al., 2008), as cigarette smoking impairs the blood flow through the body. The body is then limited in its ability to restore blood flow to a pressure damaged area of the skin. Smith et al., (2008) in a study of 2,574 veterans with SCI who developed pressure ulcers found that current smokers were more likely to develop pressure ulcers than non-smokers. Byrne and Salzberg (1996) concluded that patients with SCI who smoke are at a significantly higher risk for pressure ulcer development and more severe ulcers than non-smokers, citing evidence that heel pressure ulcers were four times more common in smokers than non-smokers.

A patient's nutritional status also contributes significantly to pressure ulcer development. Malnutrition, by means of hypoproteinemia, anemia, or hypoalbuminemia, has been identified as an important risk factor in developing pressure ulcers (Byrne & Salzberg, 1996). Hypoalbuminemia is abnormally low levels of albumin, the body's main serum-binding protein. Hypoalbuminemia typically indicates malnutrition. Anemia results when the body is deficient of red blood cells or of hemoglobin. Hemoglobin normally carries oxygen from the lungs to the capillaries throughout the body. Hypoproteinemia is the result of abnormally low levels of protein in the blood. It is also a measure of inadequate diet.

Hammond et al., (1994) reported that patients with serum albumin below 3.5gm/dl were nearly five times as likely to develop a pressure ulcer. It is noted, however that this cut off was not developed with a SCI population. As anemia is another antecedent of pressure ulcer development, measures of hematocrit and hemoglobin are recommended (Byrne & Salzberg, 1996). Non-SCI patients and SCI patients may have different hematocrit thresholds.

A patient's cognitive or mental health status may also contribute to pressure ulcer acquisition. Hammond et al., (1994) found that in 410 patients with SCI admitted to an inpatient spinal cord unit, 17% of patients who developed pressure ulcers in their study also had a psychiatric impairment. Byrne and Salzberg (1996) reported that patients who are unconscious at time of injury are at a higher risk of developing pressure ulcers than semiconscious patients. Depression has also been studied with mixed results (Bryne & Salzberg, 1996; New et al., 2004; Smith et al., 2008).

Having an existing pressure ulcer or history of decubitus ulcers can also be a predictor of developing future pressure ulcers (Garber et al., 2000). Byrne and Salzberg (1996) estimated that more than 70% of individuals with SCI who have a pressure ulcer have multiple ulcers. Hammond et al., (1994) reported that 66% of the patients with SCI in their study had one or more pressure ulcers upon admission. In a study of 134 patients with SCI in Australia, of the patients with a current pressure ulcer, 40.5% of patients had more than one ulcer (New et al., 2004). If surgical closure is required for a pressure ulcer, the recurrence rate for the ulcer is also high (Lyder, 2003). If an individual with SCI resides in a nursing home, they are also at increased risk for pressure ulcer development (Byrne & Salzberg, 1996).

Implications for Life Care Planners

Armed with the body of research currently available, life care planners are in a very good position to recommend plans of care to facilitate pressure ulcer prevention. Prevention of pressure ulcers is estimated to cost less than one-tenth of the amount spent on treatment (Byrne & Salzberg, 1996; Regan et al., 2012). Prevention may include patient education and empowerment, the use of appropriate equipment/ supplies as well as well-trained staff members (in a facility) with the ability to provide pressure relief through turning the patient as recommended. Ash (2002) recommends a holistic approach that manages pressure ulcer risk

and shifts the responsibility of pressure ulcer prevention from healthcare providers to patients. He also suggests that we shift our focus from standalone prevalence and incidence data collection, to a focus on resolution of early pressure damage as a quality indicator.

Salzberg et al., (1998) recommend that individuals with SCI who are at highest risk for pressure ulcer development should be scheduled for more frequent examinations and enrolled in ulcer prevention programs. They may also require specialists to manage pulmonary problems, renal diseases, and incontinence and conduct more frequent blood screenings to assess for malnutrition. Garber et al., (2000) recommended more systematic and frequent physician follow up, including annual checkups to focus on prevention and treatment of pressure ulcers. They also recommend frequent review of pressure ulcer prevention and management behaviors and provision of necessary personal assistance and appropriate equipment. Patient education techniques may include newsletters, videotapes, or telemedicine (i.e. using telephone or email communication between patient and medical professional) to convey information related to pressure ulcer prevention. Garber et al., (2000) described a Texas Institute of Rehabilitation and Research (TIRR) program that emphasized pressure ulcer education resulting in a reduction in incidence of pressure ulcer recurrence from 32% to 11% within a five-year period.

Patient education programs should specifically target smoking cessation to prevent ulcers (Smith et al., 2008). Smoking cessation can serve as a useful intervention strategy, as it reduces the risk of developing pressure ulcers (Byrne & Salzberg, 1996). Smoking cessation programs can often be found at little or no cost at local medical centers if a referral is obtained from a physician.

Life care planners should consider equipment and supplies that are beneficial in maintaining the skin integrity of clients throughout the life care plan development process. Equipment recommended to prevent pressure sores include: specialty mattresses, adequate seating systems or wheelchair cushions, and reclining/ tilt wheelchairs (Blackwell et al., 2001; Falvo, 2009; Weed & Berens, 2010). The recommendation of patients attending seating clinics can assist in teaching people to sit properly in the devices and ensure proper fit. Static devices, (those that do not require electricity) including air, foam, gel and water overlay or mattresses may be suitable for those who are at low risk for pressure ulcer development (Lyder, 2003). For those at moderate to high risk of ulcer development or for those with existing pressure ulcers, dynamic devices (such as those powered by electricity) including alternating low air loss mattresses are recommended (Lyder, 2003). For those at highest risk for pressure ulcer development, air fluidized beds (containing silicone-coated beads that liquefy as air pumps through them) should be considered. These beds should be used for patients with a non-healing, full-thickness pressure ulcer or numerous full-thickness pressure ulcers.

In addition to equipment recommendations, life care planners should consider the multiple supplies available to those at risk for pressure ulcer development. Protecting the skin with regular use of emollients is highly recommended for preventive measures. Other supplies to be considered include, but are not limited to: mirrors, antibiotics, antiseptics, saline solution, gauze and topic enzyme preparations (Blackwell et al., 2001). It is estimated that there are more than 300 different dressings marketed for pressure ulcer care(Lyder, 2003). Life care planners without specialized wound care training may learn about these various products by conferring with local wound care staff.

Nutritional support is beneficial to pressure ulcer prevention and healing (Weed & Berens, 2010). Nutrition that maintains a positive nitrogen balance can increase wound healing (Lyder, 2003). Byrne and Salzberg (1996) recommend objective measurement of nutritional status

through laboratory blood analysis. Nutritional supplements may be used to increase hematocrit and albumin levels to increase pressure ulcer healing (Byrne & Salzberg, 1996).

Visually inspecting the area where pressure is known to occur at least twice daily with a mirror is recommended for pressure ulcer prevention (Blackwell et al., 2001). A two-hour repositioning schedule should also be instituted for any patient at-risk (Lyder, 2003). Of utmost importance is having well trained staff available to provide these services, if the individual with spinal cord injury is hospitalized or in a long-term care facility

Conclusion

Decubitus ulcers have become a chronic health problem in the United States. They are particularly recognized as a serious complication for individuals with a spinal cord injury (SCI) (Garber et al., 2000). Yet, most pressure ulcers can be prevented. Risk factors for developing a pressure ulcer include demographic factors (age, ethnicity, gender, education, and employment), injury specific factors (completeness of lesion, cause of SCI, and time since injury) and behavioral factors (nutrition, smoking, and activity level). Using existing available research regarding decubitus ulcers, life care planners are in a position to recommend plans of care to facilitate pressure ulcer prevention. As the focus shifts away from the study of pressure ulcers within inpatient settings to the study of pressure ulcer development for individuals residing in the community (Weaver, 2012), we will be even better informed about risk-factors for developing pressure ulcers and the practices and goods available to prevent them.

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