10-28-2010

Pressure ulcers and nutritional deficits in elderly long-term care patients : effects of a comprehensive nutritional program on pressure ulcer healing, length of hospital stay and charges to patients

Beverlin Allen
Florida International University

DOI: 10.25148/etd.FI13101586

FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

PRESSURE ULCERS AND NUTRITIONAL DEFICITS IN ELDERLY LONG-TERM CARE PATIENTS: EFFECTS OF A COMPREHENSIVE NUTRITIONAL PROGRAM ON PRESSURE ULCER HEALING, LENGTH OF HOSPITAL STAY AND CHARGES TO PATIENTS

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

NURSING

by

Beverlin Allen

2010

To: Interim Dean Sharon Pontius
College of Nursing and Health Sciences

This dissertation, written by Beverlin Allen, and entitled Pressure Ulcers and Nutritional Deficits in Elderly Long-term Care Patients: Effects of a Comprehensive Nutritional Program on Pressure Ulcer Healing, Length of Hospital Stay and Charges to Patients, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

JoAnne M. Youngblut

Marcia Magnus

Ellen Brown

Dorothy Brooten, Major Professor

Date of Defense: October 28, 2010

The dissertation of Beverlin Allen is approved.

Interim Dean Sharon Pontius
College of Nursing and Health Sciences

Interim Dean Kevin O'Shea
University Graduate School

Florida International University, 2010

DEDICATION

In loving memory of my mother, Miriam Bialy, who was a great source of inspiration to me in my quest for knowledge and excellence. I dedicate this dissertation to my husband Walcott Allen, whose support and unparalleled understanding have made it possible for me to complete this great educational journey. This dissertation is also dedicated to my three daughters Georgette, Tenecia, and Farah, as well as my son-in-law Dennis Mondesire. Thank you for all your love and support.

ACKNOWLEDGMENTS

I wish to thank the esteemed members of my committee whose support, direction, and patience have made this momentous occasion possible. To Dr. Marcia Magnus and Dr Ellen Brown I express gratitude for their moral support and guidance. Dr. JoAnne Youngblut has been a guiding force to me when it was most needed. I will always be grateful for her patience and diligence in steering me through the challenges of Statistics. Dr Dorothy Brooten my major professor, I am honored for the opportunity to be her student. I am humbled by the trust that she has placed in me. I extend my sincere gratitude to her for her mentorship and for her contributions to excellence in the nursing profession. My challenge is to emulate her by inspiring others as she has inspired me.

I would also like to thank my many colleagues at Sister Emmanuel Hospital who have assisted me and supported me through this challenging process. A special thanks to Joanne Harris who has encouraged and supported me consistently. To Jean Garrision Librarian for her willingness and ready assistance I am deeply appreciative. To Miguel Vasquez and Carmen Aceves I extend heartfelt gratitude for their support and encouragement. Finally, I would like to thank the Florida Nurses Foundation for their generous support in funding this dissertation research.

ABSTRACT OF THE DISSERTATION

PRESSURE ULCERS AND NUTRITIONAL DEFICITS IN ELDERLY LONG-TERM CARE PATIENTS: EFFECTS OF A COMPREHENSIVE NUTRITIONAL PROGRAM ON PRESSURE ULCER HEALING, LENGTH OF HOSPITAL STAY AND CHARGES TO PATIENTS

by

Beverlin Allen

Florida International University, 2010

Miami, Florida

Professor Dorothy Brooten, Major Professor

The elderly are at the highest risk of developing pressure ulcers that result in prolonged hospitalization, high health care costs, increased mortality, and decreased quality of life. The burden of pressure ulcers will intensify because of a rapidly increasing elderly population in the United States (US). Poor nutrition is a major predictor of pressure ulcer formation. The purpose of this study was to examine the effects of a comprehensive, interdisciplinary nutritional protocol on: 1) pressure ulcer wound healing 2) length of hospital stays, and 3) charges for pressure ulcer management. Using a pre-intervention/post intervention quasi-experimental design the study sample was composed of 100 patients 60 years or older, admitted with or acquiring a pressure ulcer. A pre-intervention group (n= 50) received routine pressure ulcer care (standard diet, dressing changes, and equipment). A post-intervention group received routine care plus an interdisciplinary nutrition intervention (physical therapy, speech therapy, occupational therapy, added protein and calories to the diet). Research questions were

analyzed using descriptive statistics, frequencies, Chi-Square Tests, and T-tests. Findings indicated that the comprehensive, interdisciplinary nutritional protocol had a significant effect on the rate of wound healing in Week3 and Week4, total hospital length of stay (pre-intervention M= 43.2 days, SD=31.70 versus M=31.77, SD=12.02 post-intervention), and pressure ulcer length of stay (pre-intervention 25.28 days, SD5.60 versus 18.40 days, SD 5.27 post-intervention). Although there was no significant difference in total charges for the pre-intervention group ($727,245.00) compared to the post-intervention group ($702,065.00), charges for speech (m=$5885.12, SD=$332.55), pre albumin (m=$808.52,SD= $332.55), and albumin($278 .88, SD=55.00) were higher in the pre-intervention group and charges for PT ($5721.26, SD$3655.24) and OT($2544 .64, SD=1712.863) were higher in the post-intervention group. Study findings indicate that this comprehensive nutritional intervention was effective in improving pressure ulcer wound healing, decreasing both hospital length of stay for treatment of pressure ulcer and total hospital length of stay while showing no significant additional charges for treatment of pressure ulcers.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

CHAPTER I.

INTRODUCTION

The social, physical, psychological, and financial burden of pressure ulcers are considerable and are expected to intensify due to the rapidly increasing elderly population in the United States. Estimates suggest that by the year 2030, there will be nearly 36 million in the 65- to 74-year-old age group (National Institute on Aging, 2009). Between 1993 and 2006, the number of hospitalizations related to pressure ulcers increased by nearly 80% with over one million patients developing pressure ulcers annually (American Medical Directors Association (AMDA), 2004). In hospitals, the pressure ulcer rate remains at 16% (Whittington, Briones, 2004).

Adequate nutrition is an important factor in the prevention and management of pressure ulcers. Under-nutrition and protein-energy malnutrition are prevalent in the elderly and occur in 23% to 85% of the population (Harris and Fraser, 2004; Kagansky et al., 2005). Among hospital stays that were primarily for pressure ulcers, nutritional deficiencies were 23.4% of the concomitant conditions for 2006. In addition, adult hospital stays noting diagnoses of pressure ulcers totaled $11 billion (Russo, Steiner, and Spector, 2008). Current practices to manage pressure ulcers in elderly institutionalized patients have become a central issue for government and health care institutions.

Significance

Pressure ulcers are associated with prolonged wound healing, increased length of hospital stay and increased cost of care for many elderly patients in institutions. Studies have shown that pressure ulcers are also associated with increased mortality (Kirkman and Molnar, 2008). While prevention of pressure ulcers is an important gold standard,

increasing numbers of elderly patients with chronic co-morbidities are admitted to long-term care facilities. The statistics show that 70% of pressure ulcers occur in individuals over the age of 70 years old (Gray and Harding, 2006). The past decade has seen a rapid increase in the number of patients admitted with concurrent diagnoses of pressure ulcer. In 2006, there were 503,300 total hospital stays with pressure ulcers noted as a diagnoses, an increase of nearly 80% from 1993 (Russo, Steiner, and Spector, 2008).

Wound Healing

Wound healing is a complex process, involving a biological cascade of cell division and the migration of macrophages, fibroblasts and epithelial cells into the surrounding tissue (Room, 2008). According to Mathus-Vliegen (2004) wound healing is a tightly regulated process, consisting of three distinct phases. Each stage places a high demand on patients' energy, requiring macronutrients for effective recovery (Mathus-Vliegen, 2004). Several studies have shown that certain components of the diet such as amino acid, zinc, arginine, the vitamins A, B, and C, could help to prevent pressure ulcers. Still, uncertainties exist about the benefits of the diet in pressure ulcer management.

The healing process is enhanced by increased blood flow as nutrients, new blood vessels, and epithelial cells from surrounding tissue are brought to the affected area (Harris, and Fraser, 2004). Researchers contend that the metabolic demands of wound healing are significant, and that healing may be delayed without assertive nutritional interventions to meet this increased demand (Thomas, 1997). Like several other diseases affecting older adults, malnutrition affects the skin, mucous membrane, and immune

system. When combined with other risk factors for pressure ulcer development, malnutrition increases the risk by up to 74% (Harris and Fraser, 2004).

Although interventions to promote wound healing vary from institution to institution, the treatment of pressure ulcers can be broken down into four categories: local treatment of the wound, pressure relief modalities, treatment of concurrent conditions, and the use of adjunct therapies (The Royal College of Nursing, 2005). While these modalities have shown some effects in managing pressure ulcer, increasing prevalence and incidence in institutions continue to retard patients' progression toward timely discharge.

Length of Stay

The average length of stay for all diagnoses in 2003 was 4.6 days, down from 5.7 days in 1993 (Russo and Elixhauser, 2006). However, the length-of stay related to pressure ulcers are on the increase as noted by Russo, Steiner, and Spector (2008). These researchers argued that in 2006 there 503,300 hospital stays during which pressure ulcers were noted. Since there were about 281,300 hospital stays related to pressure ulcers in 1993, this marked a 78.9% increase, while the number of hospitalizations for all other admissions increased by only 15 percent. Length of stay for patients with secondary diagnoses of pressure ulcers increased by 86.4%, however, those primarily for pressure ulcers increased by 27.2%. Moreover, stays principally for pressure ulcers were slightly longer than those with a secondary pressure ulcer diagnoses (14.1 days versus 12.7 days). Remarkably, 72.3% of patients with pressure ulcers were 65 years of age or older.

In a study comprising two thousand randomly selected participants, Graves, Birrell, and Whitby (2005) found that having a pressure ulcer resulted in a median excess

length of stay of 4.31 days. These data highlight the growing concerns of pressure ulcers and the impact on hospitals' capacity, measured in bed-days lost to this diagnoses.

Review of the literature shows that recent studies relating to length of stay due to pressure ulcers are scarce, especially in long-term care facilities. However, when compared to length of stays for all other conditions, pressure ulcers accounted for more than three times the rate of hospitalizations for all other conditions (16.2 percent). Additionally, patients with hospitalization related to pressure ulcers were more likely to be discharged to a long-term care facility (e.g. a skilled nursing facility, an intermediate care facility, or a nursing home), as compared to hospitalizations for all other conditions. In fact, over half of principal pressure ulcer stays (53.4 percent) and secondary pressure ulcer stays (54.5 percent) were discharged to long-term care (Russo, Steiner, and Spector, 2008).

Charges

Despite the government's attempt to control cost, health care spending is projected to reach 18.4% of the Gross Domestic Product, by 2013 (Heffler, Smith, Keehan, Clemens, Zezza, et al. 2004). Government payers bear the greatest burden of hospitalizations related to pressure ulcers. According to Russo and Elixhauser (2006), in 2003, 65.9 % of the stays related to pressure ulcers were covered by Medicare, and 23.4% were covered by Medicaid. Conversely, one percent of patients were uninsured.

Although several researchers have attempted to measure the cost of pressure ulcers (Frantz, Gardener, Harvey, Specht, 1991) current studies are limited. Recent studies have shown that the cost of prevention and management is considerably less as compared to the cost of litigation. According to Knox (2004), pressure ulcers are the

second most common claim after wrongful death and are greater than falls or emotional distress. Individual settlements range from under $50,000 to as much as $300,000 for a single event, even if the case never goes to trial.

Knox (2004) also noted that even though most states mandate caps, many attorneys now include pressure ulcers as part of elderly abuse complaints, which have no caps on damages in criminal cases. Additionally, lawsuit claims per occupied bed have increased at an annual rate of 14%, while the average court settlement has risen by 250,000 dollars (AMDA, 2004). Although, quantifying cost remains problematic and controversial, Rijswijk and Lyder (2003) found that the initial cost of intervention varies and is dependent on several factors. These include expenses in areas such as supplies (dressings), specialty beds, nutritional support, laboratory blood test (Complete blood Count (CBC), blood chemistry including albumin and pre-albumin levels), and extra staff time required as the severity of the ulcer increases.

Frantz, Gardener, Harvey, Specht (1991) who used a retrospective research design to describe the cost incurred to treat 240-pressure ulcers over a five-year period, in an 830-bed long-term care facility, noted similar findings. Results suggested that when compared to acute care, the cost of treating pressure ulcers was lower in long-term care facilities. This study attempted to analyze only variable cost that was associated with pressure ulcer treatment rather than the total cost of pressure ulcers management. However, other studies demonstrated that when consideration was given to the cost of time for various activities necessary for the care of pressure ulcers (such as preparation of supplies, treatment, removal of supplies, and the time spent by support staff, such as nursing assistants), cost was more varied (Rijswijk, and Lyder (2003). Pressure ulcer

treatment has been estimated to cost 2.5 times the cost of preventing its occurrence. Additionally, treatment of pressure ulcers increases nursing time up to 50% and is among the most costly in time and resources (American Medical Directors Association, 2004; Rijswijk and Lyder, 2003).

In a quasi-experimental study using retrospective and prospective study data to evaluate the effect of implementing a protocol of care (nutrition consult, support surface, and reposition every two hours) to address the incidence of pressure ulcers, Lyder, Shannon, Empleo-Frazier, McGehee, and White, (2002) evaluated cost and outcomes. The two-phase study was conducted in two long-term care facilities with a total bed capacity of 260. The only inclusion criterion for the study was that residents were identified as at risk for pressure ulcers due to the presence of at least one pressure ulcer risk factor. Among the 203 patients identified as being at risk for pressure ulcers, 32% arrived at the long-term facilities with pressure ulcers. The mean age of patients was 82 years, the majority of residents were female (72%), and White (97%). The findings suggest that the use of a protocol could result in a significant decrease in the incidence of pressure ulcers (87% decrease in pressure ulcer incidence in Facility A, and a 76% decrease in Facility B.) and cost. The average monthly cost of prevention for a high-risk resident was $519.73, in addition to a one-time cost of $277 for mattress and chair overlays. More than half of the monthly costs were related to labor. The most expensive cost was the support surfaces.

These findings were not supported by Xakellis, Frantz, Lewis, and Harvey (2001) who argued that even though there was marked reduction in the cost of treating pressure ulcers with a protocol, a corresponding increase in cost of prevention was noted. While

Rijswijk, and Lyder (2003) point out that even with the initial increase in cost over time, this was more likely to be offset by substantial cost savings after the recommendations were implemented. When the cost of prevention of pressure ulcers is compared to the cost of litigation, a significant increase is noted in the latter. Additional and more comprehensive clinical trials are necessary to provide the strong evidence for clinicians to make cost effective and sound clinical decisions.

Mortality

Concerns relating to pressure ulcers have grown in importance. Recent studies have suggested that of hospitalizations relating to pressure ulcers as a primary diagnoses, about 1 in 25 admissions end in death. Moreover, a death rate of 1 in 8 was evident when pressure ulcers were included as a secondary diagnosis. Compared to baseline information that included known risk factors for increased mortality in-hospitals, pressure ulcers were associated with a greater risk of death than other risk factors (Connelly, 2009). The burden of pressure ulcer-associated mortality in the United States as well as the racial/ ethnic differences and associated co morbidities was examined by Redelings, Lee and Sorvillo (2005) in a descriptive study with matched odds ratio comparisons. Analysis of national multiple cause-coded death records from 1990 to 2001 indicated that pressure ulcers were reported as a cause of death for 114, 380 people (age-adjusted mortality rate 3.79 per 100,000 populations). Mortality rates as high as 18.7% were reported in some studies. Almost 80% of these pressure ulcer associated deaths occurred in elderly people 75 years of age and older. Additionally, results suggest that age adjusted pressure ulcer-associated mortality rates were four times higher in Blacks than in other racial or ethnic groups (Redelings, Lee, and Sorvillo, 2005).

Cognizant of the impact that pressure ulcers could have on the mortality of elderly patients and the economic effect on the nation, current government programs and research are focusing on prevention of pressure ulcers. Examples of these initiatives include the 2005 US Center for Medicare/ Medicaid services (CMS) issued updated surveyors regarding F Tag 314/ Pressure, and The Wound Ostomy and Continence Nurses Society Clinical Practice Guidelines Series. Governmental and other regulatory bodies are now closely scrutinizing hospital acquired pressure ulcers. Since October 2008, hospitals can be penalized for pressure ulcers that occur in their institutions. Moreover, facility-acquired pressure ulcers will no longer receive a higher payment under Medicare Inpatient Prospective Payment System (Center for Medicare and Medicaid Services, 2007). Pressure ulcer reduction is part of the national health promotion and disease prevention initiative Healthy People 2010 program.

Summary

As the American population ages, estimates indicate that hospital stays noting a diagnoses of pressure ulcers totaled $11 billion (Russo, Steiner, and Spector, 2008). Pressure ulcers are associated with prolonged wound healing, increased length of hospital stay and increased cost of care for many elderly patients in institutions (Baumgarten et al. 2004; Frantz, Gardener, Harvey, Specht, 1991). Moreover, mortality rates of 18.7% have been reported in some studies (Redelings, Lee, and Sorvillo, 2005). Adequate nutrition is suggested as a major factor in the prevention and management of pressure ulcers (Lee et al., 2006; Ek, Unosson, Larsson, Von Schenck, and Bjurulf, 1991). Despite the, social, psychological and physiological impact of pressure ulcers interventional studies related to the management of pressure ulcers remain limited. Current studies that address wound

healing, length of hospital stay and charges for care are urgently needed to assist providers, patients and families in coping with this devastating condition.

Study Purpose

Research Questions

In two groups of 50 patients over 60 years old with pressure ulcers, the purpose of this pre/post intervention study was to compare the effects of a comprehensive, interdisciplinary, nutritional protocol on pressure ulcer wound healing, length of hospital stay, and charges for pressure ulcer management. The study was designed to address the following research questions:

1. Comparing the pre-intervention and post-intervention groups were there differences in pressure ulcer wound healing (number of patients with >75% healing in length, width, and depth of wounds)?
2. Comparing the pre-intervention and post-intervention groups were there differences in length of hospital stay (hospital days directly due to the pressure ulcer?
3. Comparing the pre-intervention and post-intervention groups were there differences in charges for pressure ulcer management (direct cost of wound care supplies, (nursing, physical therapy, occupational therapy, dietitian and speech therapy) time, and special equipment)?

The study was unique in several ways, it tested an individually tailored comprehensive, interdisciplinary nutritional protocol based on albumin and pre-albumin levels for patients with pressure ulcers. Direct measurement of pressure ulcers were performed by nurses who were certified in wound management. Findings from this study

could enhance understanding of the complexity surrounding the management of patients with pressure ulcers and its effect on the individual and health care system. Research in this area is crucial to the management of pressure ulcers in institutions and to decreasing the social, physical, and financial burden created by pressure ulcers.

Since the metabolic demands of wound healing are significant, healing may be delayed without the immediate and assertive nutritional intervention needed to meet this increased demand (Harris and Fraser, 2004). Enhanced nutritional practice is proposed to improve the quality, appropriateness, and effectiveness of wound care management for elderly hospitalized patients. At a time when pressure ulcer management holds considerable importance for the aging United States population, the proposed research could brings a unique prospective to investigating this important and understudied problem of nutrition and wound healing.

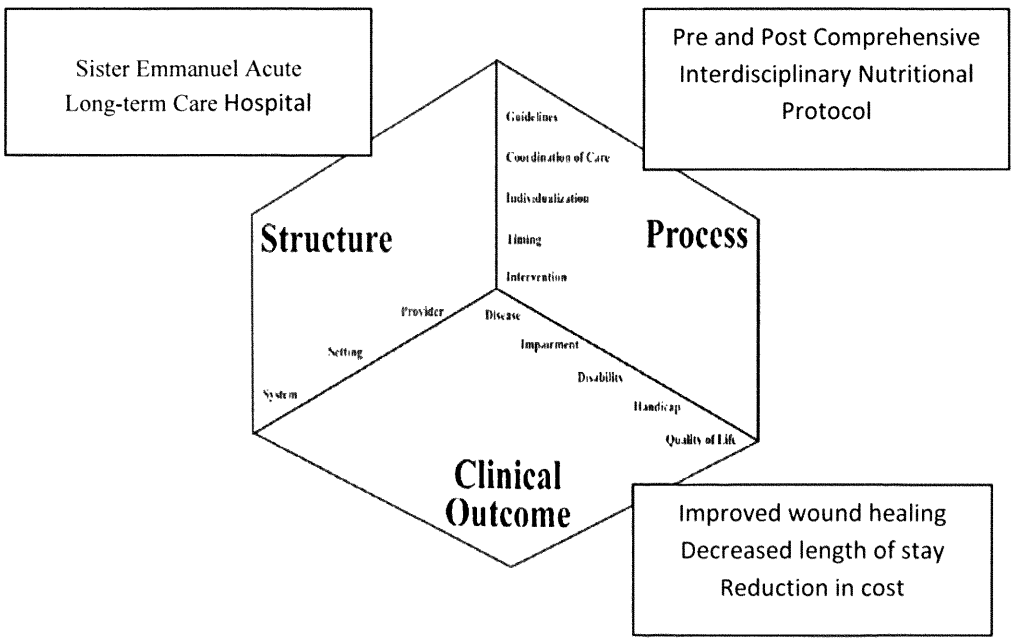
Conceptual Framework

The theoretical framework for this study was based on the work of Donabedian's (1988) health-care triad of structure, process and outcome. Donabedian (1988) asserted that these three categories of quality measures are not independent but are linked in an underlying framework. He further advocates that "good structure promotes good process and good process in turn promote good outcome" (p.1745). Structural measures of quality are defined as the professional and organizational resources associated with the provision of care, such as wound care credentials and facility operating capacities. Donabedian (1988) believed strongly in the importance of health-care structure, seeing it as a driving force for later care processes and ultimately for better health outcomes. Process measures

of quality refer to the activities perform by the staff in the treatment of the patients such as wound care and feeding patients.

Outcome measures are the desired states resulting from care processes, which may include reduction in morbidity and mortality, and improvement in the quality of life (Glickman, Baggett, Krubert, Peterson and Schulman, 2008). In this study, structure was the long-term care hospital setting where patients 60 years and older were admitted with pressure ulcers and the staff who provided the pressure ulcer care. Processes, in this study were of two types: the usual wound care and the intervention of a comprehensive nutritional protocol. Outcomes were wound healing, length of stay, and cost of pressure ulcer management. This framework outlined in Figure 1:1 depicts linkage between process and outcomes as evidenced by improved wound healing, reduction in the length of hospitalization, and affordable cost of care.

Figure: 1 Donabedian's Framework



CHAPTER II.

LITERATURE REVIEW

Introduction

In order to examine the effects of a comprehensive interdisciplinary protocol on patients' outcomes; (a) rate of wound healing (b) length of stay and (c) cost of pressure ulcer management, an understanding of the dynamics which govern the causes, risk factors, the role of nutrition, and intervention is necessary. The chapter provides a review of the literature in the following general areas:

1. Literature related to pressure ulcers (pressure ulcer stages, pressure ulcer and turgo, pressure ulcers and skin color, metabolic demand of pressure ulcers).
2. Literature to the causes and risk factors for pressure ulcers (intrinsic and extrinsic causes):
    a. Intrinsic Risk Factors (physical, psychosocial, age, and nutrition
    b. Extrinsic Risk Factors (pressure, immobility, moisture, friction and shear).
3. Literature related to the measurement used in the management of pressure ulcers in older adults.
4. Literature related to interventions used to manage pressure ulcers in elderly institutionalized patients.

Pressure Ulcers

Pressure ulcers are defined as wounds that are caused by persistent pressure or frequent friction that damages the skin and its underlying architecture (Cannon, and Cannon, 2004). While the majority of pressure ulcers are commonly found over bony

prominences, such as the back of the head, sacrum, and heels, these ulcers can develop at any site where tissue has been compressed causing tissue ischemia and hypoxia.

Pressure ulcers are commonly classified using the National Pressure Ulcer Advisory Panel (NPUAP) staging system. This classification was updated in February 2007. The definition of pressure ulcers and the stages of pressure ulcers still include the original four stages, besides deep tissue injury, and un-stageable pressure ulcers categories (National Pressure Ulcer Advisory panel, 2007).

Pressure Ulcer Stages

According to the National Pressure Ulcer Advisory Panel (2007), the stage of pressure ulcers is described as:

Suspected Deep Tissue Injury: This is characterized by a purple or maroon localized area of discolored intact skin. This area may also be a blood-filled blister due to damage of underlying soft tissue from pressure and or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to the adjacent tissue. Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with optimal treatment.

Stage I: Intact skin with non-blanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area. The area may be painful, firm, soft, warmer or cooler as compared to the adjacent tissue. Most clinicians agree that Stage I pressure ulcers are the most challenging to identify and assess (Bethell, 2005).

Stage II: Partial thickness loss of dermis presents as a shallow open ulcer with a red pink wound bed, without slough. This may also appear as an intact or open/ruptured serum-filled blister or as a shiny or dry shallow ulcer without slough or bruising.

Stage III: Full thickness tissue loss: Subcutaneous fat may be visible, but bone, tendon, or muscles are not exposed. Slough may be present but does not obscure the depth of tissue loss. This may include undermining and tunneling. The depth of a Stage III pressure ulcer varies by anatomical location. The bridge of the nose, ear, occipital and malleolus do not have subcutaneous tissue and Stage III ulcers can be shallow. In contrast, areas of significant adiposity can develop extremely deep Stage III pressure ulcers.

Stage IV: Comprises of full thickness tissue loss and exposed bone, tendon or muscle. Slough or Eschar may be present on some parts of the wound bed. This often includes undermining and tunneling. The depth of a Stage IV pressure ulcer varies by anatomical location. The bridge of the nose, ear, occipital and malleolus do not have subcutaneous tissue and these ulcers can be shallow. Stage IV ulcers can extend into muscle and or supporting structures (e.g., fascia, tendon or joint capsule) making osteomyelitis possible. Exposed bone/tendon is visible or directly palpable.

Unstageable: Full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green or) and or eschar (tan, or black) in the wound bed. Until enough slough and or eschar is removed to expose the base of the wound, the true depth, and therefore, stage, cannot be determined. Stable (dry, adherent, intact without erythematic or fluctuance) eschar on the heels serves as "the body's natural (biological) cover" and may not be removed (National Pressure Ulcer Advisory Panel, 2007).

Pressure Ulcers and Turgor

Skin turgor is the skin's degree of resistance to deformation. When the skin is assessed and palpated, it should quickly return to its original state. A slow return may indicate dehydration or the effects of aging. Soft tissue may indicate an underlying infection. Tense skin may indicate lymphedema and cellulites. Palpation is useful to assess skin temperature, edema, and turgor of suspected damaged areas (Bethell, 2005). Poor skin turgor can increase a patient's vulnerability to pressure ulcer development.

Pressure Ulcers and Skin Color

Stage I pressure ulcers occur the most frequently, accounting for 47% of all pressure ulcers (Kelley and Mobily, 1991). Professionals and care givers, who lack training and experience, demonstrate difficulty in identifying Stage I pressure ulcers when present in patients with darkly pigmented skin. Differences in skin color may affect the accurate and speedy detection of pressure ulcers. Inflammatory processes produce erythemia, changes in normal skin color, and increases in temperature (Hart, 2002). Erythematous changes in skin color are caused by a variety of factors including the dilation of capillaries near the skin's surface as well as the activity of polymorphnuclear leukocytes, monocytes and macrophages (Bethel, 2005). The changes that result from inflammation are difficult to detect in people of color. According to Lyder (1991) color is a proven indicator of a physiological response to injury and is a good indicator of Stage I pressure ulcer. Yet, this often goes unnoticed by clinicians, especially in patients with darker skin.

Rosen et al. (2006) traces the emergence of all pressure ulcers in nursing home residents during a 12-week baseline and intervention period. Findings revealed that Black

residents demonstrated a higher rate of Stage II-IV pressure ulcer development. Additionally, Black residents with pressure ulcer were more likely to have multiple Stage II pressure ulcers when compared to White residents. During the baseline period, only 31.8% of the pressure ulcers detected in White residents were Stage I, whereas pressure ulcers beyond Stage I were detected in Black residents because of failure to diagnose early signs of pressure ulcer.

Similarly, in a prospective cohort study comprised of 1,938 residents (301 Blacks, 1,637 Whites) age 65 years and older, Baumgarten et al. (2004) reported comparable findings. The focus of the study was to compare Black and White long-term care residents with respect to the incident of institution acquired pressure ulcers. Additionally, resident's and facility characteristics were examined in order to explain differences between the racial groups. The outcome variable was based on the first occurrence of a Stage 1, 11, 111 or IV pressure ulcer. Although, there were1, 366 females and 572 males in this study, the rate of occurrence of pressure ulcers per person, per- year was 0.37 for females and 0.44 for males. Multivariate analysis was used to analyze data collected from medical records, documentation of wound progress, and from interviewing residents. The research found that the median length of stay was 235 days for Blacks and 107 days for Whites ($p < 0.001$). Although, the overall incidence of pressure ulcers was 0.38 per person per year in the long-term care facility, the rate for Blacks was significantly higher than the rate for Whites (0.56 vs. 0.35, respectively).

Bergstrom and Braden (1992) reported significantly higher incidents of pressure ulcers in Whites (75%) compared to Nonwhites (40%). However, there were only 10 Nonwhites residents in that study. Additionally, the findings were limited to residents

with high risk for pressure ulcers (as defined by a Braden Scale of < 17), thereby reducing the ability to generalize the findings to the entire long-term care population.

Later studies were conducted by Bergstrom, Braden, Kemp, and Champagne (1996) to determine if characteristics (age, gender, and race) and primary diagnosis influenced the incidents of pressure ulcers in varied populations, considering the level of risks for developing ulcers. Of the 843 randomly selected patients (63% male, 79% White) the mean age was 63 years. Observations were made every 48 to 72 hours for a minimum of 1 week to a maximum of 11 weeks. Logistic regression demonstrated that lower Braden Scale scores, older age and White race predicted pressure ulcers. The incident of pressure ulcers was much higher in Whites than in Blacks in long-term care (26% vs. 9%). Limited information is available in the literature on the role of skin color in diagnosing pressure. In many studies race and skin color are not reported.

Metabolic Demands of Pressure Ulcers

Once the pressure ulcer has developed, the metabolic demands of the body increase, as a result of heightened cellular activity in the region (Harris and Fraser, 2004) Wound healing is a complex process, involving a biological cascade of cell division and the migration of macrophages, fibroblasts and epithial cells into the surrounding tissue. This process is enhanced by increased blood flow as nutrients, new blood vessels, and epithelial cells from surrounding tissue are brought to the affected area (Casey, 1998). Nutrients are essential for the immune system which mediates the immune processes such as antibody response, leukocyte migration to the wound, and disposal of waste products produced by leukocytes (Harris, and Fraser, 2004).

The metabolic demands of wound healing are significant. In fact, healing may be delayed without the immediate and assertive nutritional intervention to provide the necessary nutrients (Harris and Fraser, 2004). Based on the premise that nutrition plays an important role in the prevention and treatment of pressure ulcers, the intent of this study is to examine the effects of a comprehensive nutritional protocol on patients' length of stay, wound healing, and cost of pressure ulcer management.

Causes of Pressure Ulcers

Studies have shown that there are several risk factors that are associated with the development of pressure ulcers (Margolis, Knauss, Bilker, and Baumgarten, 2003). While there is still some lack of clarity relating to the cause and risk factors for pressure ulcers development, most researchers concur that the origin of this problem relates to two categories; intrinsic risk factors and extrinsic risk factors (Cannon and Cannon, 2004; and Magalhães et al. 2007).

Intrinsic Risk Factors for Pressure Ulcers

Several conditions have been suggested in the literature as potential cause or risk for pressure ulcer development. Fisher, Wells, and Harrison (2004) conducted a cross-sectional prevalence study with 1992 subjects to identify and describe the relationship of factors associated with pressure ulcers in adults within acute care hospitals, using logistic regression analysis. The mean age of the sample (N = 2573) was 62.5 years with more than 50% of the subjects between 70 and 80 years old. Among the demographic and clinical information captured were age, gender, length of stay and type of clinical services. Race was not included. Findings indicated that age, male gender, sensory perception, moisture, mobility, nutrition, friction and shear were associated with pressure

ulcer formation in hospitalized adult patients. Although intrinsic risk factors for pressure ulcers are varied and still lacks scientific evidence in many cases, the literature overwhelmingly supports physical and psychosocial factors, age and nutritional status as the most frequently encountered intrinsic risk factors for pressure ulcers formation.

Physical Factors

Conditions that have been implicated by multivariate analysis as causes or risk factors for pressure ulcer development include, hypotension, peripheral vascular disease, cerebo-vascular disease, heart failure, diabetes, obstructive pulmonary disease, and stroke (Allman, Goode, Patrick, Burst, and Bartolucci, 1995; Bergstrom and Braden, 1992; Ducker, 2002; Garcia and Thomas, 2006; Margolis, Knauss, Bilker, and Baumgarten, 2003). In a cohort study to evaluate the risk of pressure ulcer development in the presence of certain medical conditions in older ambulatory patients, Margolis, Knauss, Bilker, and Baumgarten (2003) studied 75,168 older individuals from an outpatient record database in the United Kingdom. Results indicate that from the 1,211 individuals who developed pressure ulcer, Alzheimer's disease, congestive heart failure, chronic obstructive pulmonary disease, cerebral vascular accident, diabetes, deep venous thrombosis, hip fracture, hip surgery, angina, hypertension, and pneumonia were inversely associated with the development of a pressure ulcer.

Psychosocial Risk Factors

Psychosocial risk factors indirectly contribute to the development of pressure ulcers in the elderly. These factors are associated with social isolation from family, friends, and memory loss, which in turn influence nutritional intake (Harris and Fraser, 2004). Furthermore, alteration in thought processes in elderly patients may result in an

inability to recognize the need to eat, difficulty in swallowing, and increased risk of pressure ulcer development (Kagansky, Berner, Koren-Mogag, Perelman, Knobler, and Levy, 2005). Structures and procedures within institutions such as not enough assistance with feeding or the method of food preparation may indirectly contribute to patients developing malnutrition and pressure ulcers (Burger, Kayser-Jones, and Bell, 2001).

In a prospective cohort study of 414 patients age 75 years and over in a geriatric hospital, researchers found that dementia, low serum albumin and phosphorus concentrations are significant risk factors for malnutrition. Females were preponderant (65.7%). Bed or chair bound patients comprised about one half of participants (52.4%). Moderate to severe cognitive decline, diabetes, congestive heart failure, and cardiovascular disease were the most prevalent co-morbidities. The race of the participants was not reported (Kagansky, Berner, Koren-Mogag, Perelman, Knobler, and Levy, 2005).

Age

Although the predisposition for pressure ulcer development is not isolated to one group, the elderly population is most at risk for the development of this disease. Skin changes associated with aging include gradual epidermal turnover, increase fragility, decreased vascularity, subcutaneous adiposity as well as decreased collagen and elastic content of the skin (Kelly and Mobily, 1991; Rousseau, 1988). Additionally, normal aging is associated with morphologic and epidermal skin changes which increase the risk for blister formation, tear type injury, deep tissue injuries and infection. The aged skin is slow to heal due to diminished elasticity and attenuated microvasculature (Orlando, 1998). Although, aging increases risk in part because of reduced subcutaneous fat and

decreased capillary blood flow, the risk is further increased by immobility and co-morbidities (Garcia and Thomas, 2006; Magalhães et al., 2007).

Russo, Steiner, and Spector (2008) found that when compared to stays for all other conditions, adult patients hospitalized with pressure ulcers are older. In hospitals, patients with pressure ulcers had a mean age of 65.3 years. This was nearly four years older than the mean age for patients hospitalized for all other conditions (61.5 years). Additionally, patients 65 and older accounted for 56.5% of adult patients with a principal diagnosis of pressures ulcers. Nearly three out of four adult stays with a secondary diagnosis of pressure ulcer occurred among patients older than 65 years old, resulting in a mean age (71.9 years) that was more than 10 years older than patients hospitalized with no diagnoses of pressure ulcers. Secondary pressure ulcer stays had the highest concentration of patients aged 85 years and older (23.0 percent). Moreover, nearly half (49.0 percent) of stays with a secondary pressure ulcer diagnoses occurred among patients aged 65 to 84 years, while this age group accounted for 37.1% all non-pressure ulcer stays.

In a cross-sectional survey of 2,373 patients, conducted by Fisher, Wells, and Harrison, (2004), findings suggest that among the strongest risk factors for pressure ulcers development was the patient's age. Moreover, pressure ulcers were frequent complications of bed-rest, which is common in the elderly hospitalized patients. The mean age of the subjects was 66 years with more than 50% of the subject's ages between 70 and 80 years old. Findings also suggested that male subjects had a higher prevalence of pressure ulcers (14.5%) when compared to females (10.3%). Pressure ulcers were frequent complications of bed-rest. Participants' race was not reported.

Nutrition

Both the Centers for Medicare & Medicaid Services (CMS, formerly HCFA) and Agency for Health care Research and Quality (AHRQ) specifically identify nutritional status as one of the more influential factors associated with pressure ulcer prevention, development, and treatment. Elderly patients in institutions are especially prone to both malnutrition and pressure ulcers for a variety of reasons, including incontinence, increased age, medical conditions such as diabetes, stroke, limited mobility and or poor nutrition (Mayo Clinic, 2009).

Many researchers contend that elderly people experience nutritional problems including malnutrition as a result of a variety of causes. These include inability to self feed, inactivity, anorexia, weight loss and frequent acute illnesses with gastrointestinal losses among others. Moreover, medications including diuretics and laxatives may decrease appetite and increase nutrient losses, thereby contributing to malnutrition and subsequently pressure ulcers. Still others contend that malnutrition and pressure ulcers are associated with poor dentition and the inability to chew food properly, conditions often present in a significant number of elderly institutionalized patients (Burger, Kayser, and Bell, 2001; Harris and Fraser, 2004),). In addition, anorexia of aging is often present in institutionalized elders (Morley and Silver, 1998). This condition is linked with reduced physical activity and decreased metabolic rate as precursor to decreased appetite, decrease nutritional intake, weight loss, and poor health (Morley and Silver, 1998). When anorexia of aging is present in elderly institutionalized patients the chances of developing pressure ulcers is increased.

Malnutrition is as a serious and often subtle problem. It results from a single or combination of factors, including insufficient or inadequate intake and assimilation of food (Burger, Kayser-Jones, Bell, and Prince, 2001). The Agency for Health care Policy and Research (AHPR) defines clinically significant malnutrition as serum albumin less than 3.5 g/dL. Like several other diseases affecting the elderly, malnutrition affects the skin, mucous membrane, and immune system. Research suggests that even in developed countries protein-energy malnutrition is prevalent in the elderly population and ranges from 62% of elderly hospitalized patients up to 85% of residents in nursing homes (Kagansky et al., 2005).

Thomas, Verdery, Gardener, Kent, and Lindsay (1991) reported that malnutrition was present in 54% of subjects on admission to one long-term care facility. Patients who were malnourished at admission were prescribed 2240 ± 620 calories compared with 2000 ± 500 calories in the non-protein energy malnutrition group. By week 8 the diet for patients with protein-calories malnutrition was increased to 2790 ± 760 calories versus 2460 ± 810 calories for non-protein energy malnourished patients. Biochemical and anthropomorphic malnutrition indicators were measured prospectively over a 2- month period. Subjects were observed for a mean of 76 ± 18 days after admission. Factors which might affect nutritional status including method of feeding, energy prescribed, use of supplemental feedings, assistance in eating, and amount of diet consumed were recorded. Confounding variables including illness, mental status, functional status, or prescription drugs were evaluated for their impact. On the basis of an empiric nutrition score, 54% of newly admitted residents were malnourished. Improvement in nutritional score occurred in 63% of malnourished patients remaining in the facility whereas 37%

remained malnourished. Two related factors, percentage of diet consumed and degree of assistance required in eating, were important differences in the outcome of patients remaining malnourished.

Thomas, Zdrowski, Wilson, Conright, Lewis, Tariq, and Morley (2002) in a study comprising of 837 patients, examined the prevalence of under-nutrition in a sub acute-care facility. The patients who had a mean age of 76 years were predominantly women (61%). Race was not reported. The patients' mean serum albumin concentration was low at 32 ± 6.2 g/L. Cholesterol was <4.14 mmol/L in 54.8% of subjects and ≥ 4.14 mmol/L in 45.2% of subjects. The average length of stay was 22.4 ± 15.3 days. Eighteen percent of the subjects had a body mass index (in kg/m^2) <19. Nutritional status was assessed by anthropometric measurements, biochemical markers, and a Mini Nutritional Assessment (MNA) score. With the use of 35 g/L as a cutoff, 53% of the subjects had hypo-albuminemia. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. A Mini Nutritional Assessment (MNA) score was obtained at the time of admission in patients admitted over 2 nonconsecutive, 1 month periods during the study (n=104). Simple descriptive statistics were used for demographic analysis. Other analysis was completed using Student's *t,* chi-square and ANOVA. Laboratory data (albumin, cholesterol, sodium, serum urea, nitrogen, and createnine) were collected on admission and within 10 days. Results suggest that only 8% of the subjects were classified as being well nourished according to the MNA. Almost one-third (29%) of the subjects were malnourished and almost two-thirds (63%) were at risk of malnutrition. Thus, >91% of subjects admitted to sub-acute care were either malnourished or at risk of malnutrition. Length of stay differed by 11 days between the

malnourished group and the nutritionally at-risk group ($P = 0.007$). Whether these results reflects nutritional neglect in acute-care hospitals or are the result of profound illness is unclear. Nevertheless, strict attention to nutritional status is mandatory in sub-acute-care settings. The subgroup did not differ significantly from the whole population in age, sex, BMI, albumin concentration, cholesterol concentration, or length of stay, suggesting that these results can be generalized to the whole population.

In a long-term care geriatric hospital, Larsson, et al. (1990) conducted studies designed to evaluate the effect of dietary supplements on clinical outcomes and nutritional status of geriatric patients (n = 501). The patients were randomized into an experimental group which received nutritional supplementation (400 kcal) containing 4g protein, 4g fat, and 11.8g carbohydrate per 100 mls twice per day, in addition to a standard hospital diet (2200 kcal). The control group received hospital diet alone (2200 kcal). The patients nutritional state was measured on admission, after 8 weeks and at 26 weeks by anthropometry, serum protein analysis (albumin< 36 g/l pre albumin, women < 0.2 g/l and men <0.26measured by electroimmuno assay) and a delayed hypersensitivity skin test (< 10 mm). Protein energy malnutrition was defined as the presence of three or more abnormal parameters. Among the patients investigated, there were 311 women and 190 men with a mean age of 81.3 years and 77.9 years respectively. The race of the patients was not reported. Findings suggest that 28.5% of patients showed evidence of malnutrition on admission. There was some difference between women and men as 32.1% of the women and 22.5% of the men were malnourished ($p<0.001$). The highest frequency of malnutrition was seen among women older than 79 years ($p<0.001$). Hospitalization itself resulted in a gradual deterioration in nutritional status although

nutritional supplementation generally improved nutritional state. Among those patients who were well nourished on admission, and subsequently receiving dietary supplementation, 8.3% met malnutrition criteria after 26 weeks, while 21.1% were considered malnourished in the control group ($p < 0.05$). In the initially well nourished group of more than 300 patients, the mortality rate was 8.6% in those given nutritional support compared to 18.6% in the control group ($p < 0.02$).

Fisher, Wells, and Harrison (2004) conducted a cross-sectional prevalence study of factors associated with pressure ulcer development in acute care hospitals. Subjects were divided almost evenly by gender. The mean age of the subjects was 62.5 years, with a mean of 27.8 days of hospitalization. This study was comprised of 1992 subjects who served as the derivation sample and 581 subjects who served as the validation sample. The focus of the study was to identify and describe the relationship of factors associated with pressure ulcers in adults within acute care hospitals. Using logistic regression analysis to derive a model that fit the data and performed well at identifying factors associated with pressure ulcers, findings indicated that age, male gender, sensory perception, moisture, mobility, nutrition, and friction/shear were associated with pressure ulcer in hospitalized adult patients. A significant relationship between male gender and pressure ulcers was found when nutrition was a deficit. The odds of having a pressure ulcer were more than double for male subjects with inadequate to poor nutritional status compared with female subjects.

Examination of the nutritional status of 120 newly admitted hospitalized patients with Stage III and Stage IV pressure ulcers was conducted by Gunter et al. (2000) using a descriptive survey. Medical records and computerized charts were reviewed to extract

the site and stage of the pressure ulcer. Data were collected prospectively from 52 subjects and retrospectively from chart reviews of 68 subjects. A majority of the subjects were elderly (58%) and female (53%). Race was not reported in this study. Measurements included weight, pre-albumin, and albumin levels, nutritional intake, type of diet, and demographics such as age and gender. Using parametric and descriptive statistics, results suggested that a significant relationship exists between serum albumin and pre-albumin levels. Serum pre-albumin and albumin levels were below normal in the majority of subjects (88% and 92% respectively). Seventy five percent of the subjects had a moderately low or severely low serum pre-albumin level (mean = 11.30± 6 mg/dL) and more than 59% of all the subjects had a moderately low or severely low serum albumin (mean = 2.65± 0.5gm/dL). The majority of patients with severe pressure ulcers were elderly and were also malnourished as defined by pre albumin and or albumin levels < 11 mg/dL and <2.5 g/dL respectively.

Earlier study by Pinchcofsky-Devin and Kaminski, (1986), to determine if a correlation exists between deteriorating nutritional status and the development of pressure ulcers used biochemical and anthropometric measurements. The study was comprised of 232 nursing home patients (128 women and 104 men) with a mean age of 72.9 years. Race was not reported. All pressure sores were photographed. Student's t tests were used to determine the level of significance for differences between parameters. Overall, the incidence of some degree of malnutrition (mild <3.5gm/dL – 3.0gm/dL), moderate <3.0gm/dL- 2.5gm/dL, severe <2.5gm/dL) was 59%. Seventeen of the patients were found to have pressure ulcers and all were malnourished. When classified as mild, moderate, or severe malnutrition, the patients with pressure ulcers were in the severe

group. There was a significant difference ($P < 0.001$) between the nutritional status of pressure ulcer patients and the malnourished patients. In this study none of the well-nourished or mildly to moderately malnourished patients developed pressure sores. Pressure sores developed however when patient's condition degenerated to a severe state of malnutrition (<2.5gm/dL).

Subsequent study conducted by Williams, Stotts, and Nelson (2000) described the characteristics of patients with pressure ulcers present on admission to the hospital, predictors of pressure ulcers, and the severity of presented pressure ulcers. This study using a prospective cohort design was comprised of 267 adults. The mean age of the patients was 65.7 years, and most (79.4%) were males. The majority of the patients with ulcers on admission were White (58.8%), and Asian (35.3%). Blacks and others were 2.9% each. The mean albumin level was 2.9gm/dL. They found that 34 of 267 subjects (12.8%) had pressure ulcers. Analysis of variance showed that subjects with pressure ulcers had a significantly lower albumin level (< 2.5), total lymphocyte count, hematocrit level, and hemoglobin level. These subjects were significantly older and had a longer hospital length of stay. Regression analysis showed that albumin level, oxygen saturation, and length of stay ($P < .01$) accounted for 11.3% of the variance of pressure ulcer presence and that albumin level and length of stay ($P < 0.001$) accounted for 11.2% of the variance in ulcer severity.

Kagansky et al. (2005) also used a prospective cohort study to focus on the identification of risk factors for the development of malnutrition (Mini Nutritional Assessment (MNA) < 17) in elderly hospitalized patients. The evaluation of the total Mini Nutritional Assessment (MNA) score, and MNA sub- scores were used as

predictors of in-hospital and long-term mortality. The MNA is a questionnaire in which nutritional status is classified on the following 30-point scale: 24-30, well nourished, 17-23.5 at risk of malnutrition, and < 17 malnourished. The study sample from a geriatric hospital was comprised of mainly females (65.7%) with a mean age of 84.8 years. The Assessment included demographic (excluding race), clinical, laboratory data, cognitive, functional, and nutritional status. The median duration of hospitalization for the whole group was 47.3± 62.1 days Of the 414 patients studied, only 73 (17.6%) were well-nourished (MNA 24-30). Low serum albumin (<2.5gm/dL) and phosphorus concentrations, dementia, and cerebrovascular accident (CVA) were significant risk factors for malnutrition. Moreover, survival was significantly lower in malnourished patients and patients at risk of malnutrition than in well-nourished patients ($P < 0.0001$). Multivariate analysis showed that low MNA-3 sub-scores were significantly correlated with laboratory indexes of malnutrition. Additionally, these scores and were significantly lower in patients with infections, malignancy, pressure ulcers, dementia, recent orthopedic surgery, and CVA.

The relationship between nutritional state and the development of pressure ulcers was evaluated using serum protein analysis, anthropometry, and delayed hypersensitivity skin testing by Ek, Unosson, Larsson, Von Schenck, and Bjurulf, (1991). The aim of the study was to investigate the relationship between nutritional state and the development of pressure ulcers, to test the hypothesis that supplementary nutritional support might prevent pressure ulcer development, and improve healing. The sample of 495 newly admitted long-term care participants (307 women, 188 men) had a mean age of 80 years and were hospitalized for more than 3 weeks. Race was not reported. Participants were

randomized into two groups. The experimental group received 200 kcal of liquid supplements (containing 4g protein, 4g fat, 11.8g carbohydrates, 419kJ, and minerals and vitamins) in addition to the standard hospital diet (2200kcal/day). The control group received the standard hospital diet (2200kcal/day). Nutritional state was evaluated using serum protein analysis, anthropometry, and delayed hypersensitivity testing. The patient's condition was judged using a modified Norton scale within a week after admission and was monitored for a maximum of 26 weeks in the hospital. Serum was analyzed on admission to the study and after 2, 4, 8, and 26 weeks. Findings suggest that a significant number of patients with protein-energy malnutrition (abnormal serum protein, anthropometry, and energy) had, or developed, pressure ulcers. Patients who received extra nutritional support had a tendency to develop fewer pressure ulcers. Additionally, existing pressure ulcers healed much faster than the control group.

To assess the effect of nutritional supplementation on dietary intake and on pressure ulcer development in critically ill older patients, Bourdel-Marchasson et al. (2000) conducted a multi-center, randomized trial involving 672 patients older than 65 years. There were 295 patients in the nutritional intervention group versus 377 in the control group. The patients were similar for age, sex ratio, and C-reactive protein. Race was not reported. During the trial, energy and protein intakes were higher in the nutritional intervention group (day 2: 1081 ± 595 kcal versus 957 ± 530 kcal, $P = 0.006$; 45.9 ± 27.8 g protein versus 38.3 ± 23.8 g protein in the control group, $P < 0.001$). The nutritional intervention group received the standard diet of 1800 kcal/d in 3 meals in addition to daily distribution of two oral supplements. Each supplement contained 200 kcal. Patients in the control group received the standard diet of 1800 kcal/d in 3 meals.

The study was conducted for 15 days. Pressure ulcer incidence was prospectively recorded for grades I (erythematic), II (superficial broken skin), and III (subcutaneous lesion) for 15 days. The risk for pressure ulcer development was assessed using the Norton Scale. Multivariate analysis shows that at 15 days, the cumulative incidence of pressure ulcers was 40.6% in the nutritional intervention group versus 47.2% in the control group. The researchers concluded that it was possible to increase the dietary intake of critically ill elderly patients by systematic use of oral supplements. This intervention was associated with a decreased risk of pressure ulcer incidence. Although a strong relationship between high protein (>3.5gm/dL) in the diets and decreased incidence of pressure ulcers have been frequently discussed in the literature, the role of lipids, vitamins, and antioxidants remain unclear (Theilla, Singer, Cohen, Dekeyser, 2007).

Summary

The literature overwhelmingly supports age, psychosocial factors and nutritional status as the most important intrinsic risk factors for pressure ulcers formation. According to Mathus-Vliegen (2004) wound healing is a complex, tightly regulated process, consisting of three distinct phases. Each stage places a high demand on patients' energy, requiring macronutrients for effective recovery (Mathus-Vliegen, 2004). Several studies have shown that certain components of the diet such as amino acid, zinc, arginine, the vitamins A, B, and C, could help to prevent pressure ulcers. Still, uncertainties exist about the benefits of the diet in pressure ulcer management.

Review of the literature demonstrates that nutrition profoundly influences pressure ulcer formation and healing, both negatively and positively. Inadequate nutrition

(abnormal serum protein, anthropometry, and energy) is a significant risk factor for the development of pressure ulcers; especially in the elderly (Meijers et al., 2008). While the majority of the studies supported the linkage of nutrition to pressure ulcer development, opposing views were expressed by others. Covinsky (2002) argued that given the conglomerate of causes for poor outcomes in hospitalized patients, more evidence is needed to determine if malnutrition causes bad outcomes.

Meeting the nutritional requirements of elderly institutionalized patients remains a daunting challenge. Despite compelling evidence that adequate nutrition promotes the healing of pressure ulcers in humans, patient care practices have not been standardized. Many studies are small and demographics relating to race are missing in the majority of studies. While prior studies have focused on various aspects of nutrition in wound healing, the importance of albumin and pre albumin is still controversial. More research is needed to further explore the role albumin and pre albumin in pressure ulcers management especially in this at-risk population.

Extrinsic Risk Factors for Pressure Ulcers

Extrinsic risk factors for pressure ulcers are described as external entities that irritate or injure the skin. Among the listed causes of pressure ulcers, pressure, immobility, moisture, friction, and shear are the strongest risk factors for pressure ulcer development (Magalhães et al., 2007).

Pressure

One of the most important factors in the development of pressure ulcers is prolonged immobility and unrelieved pressure (Kosiak, 1959; Kosiak, 1991). Pressure ulcers arise from prolonged tissue ischemia which exceeds the tissue capillary pressure.

Ischemia and hypoxia deprive tissues of oxygen and essential nutrients thereby resulting in necrosis and ulceration (Kosiak, 1991; Salcido, Carney, Fisher, 1993; Salcido, 1995). Normally, pressure on the body is reduced by dozens of unconscious body shifts on a daily basis. However, many elderly patients in institutions are unable to accomplish such a minimal task due to a number of reasons. These including spinal cord injuries with subsequent loss of sensory and motor functions, loss of vasomotor control and tone, changes and abnormalities in morphology of bone and soft tissue (Ferguson-Pell, 1990; Rodriguez and Garber, 1994). In many of these patients, unrelieved pressure on tissues is the primary risk factor for pressure ulcer development (Dharmarajan and Ahmed, 2003).

Exton-Smith and Sherwin (1961) studied the spontaneous restless movements made by a group of 50 elderly patients newly admitted to the geriatric unit. Patients' ages ranged from 65 to 93, the average age being 80½ years. Race and gender were not reported. A movement made by the patient operates an inertia switch via a ratchet strip which is attached to the mattress. A small movement of the trunk operates the switch once or twice, but a larger movement sufficient to cause a complete change of bodily position may operate the switch as many as 12 times. The total motility score is recorded on a counter which is kept in the nurses' station. Each study extended over seven hours from 11 p.m. to 6 a.m. Records were made on each patient on 3-10 consecutive nights, and the pressure areas were inspected daily for evidence of developing pressure sores. In general those patients who showed a falling score were studied longer. Of the 50 patients, 10 had average nightly scores of less than 20, and in 9 of these pressure sores developed. Only 1 other patient had a pressure sore; although her average nightly score was 23, erythematic of the pressure areas was noticed after the night when the score fell to 15,

and two nights later, when the score was 7, a frank sacral pressure sore had appeared.

Bennett, Kavner, Lee, Trainor, and Lewis (1981) studied the measurements of blood flow in the ischial area as a function of that load, pressure, and shear experienced in the act of sitting. The experimental group comprised of 14 male geriatric hospitalized patients who were at least 67 years old and 9 healthy young men whose average age was less than half that of the geriatric test subjects. Race was not reported. Each member of the control group had no clinical signs or symptoms of disease. A hard seat was equipped with devices sensing arteriolar pulsatile blood flow volume rate, externally developed pressure, and shear features. All measurements were taken in lateral proximity to the ischial tuberosities of sitting subjects. In addition to the conventional (horizontal) seat attitude, tests were conducted with the seat tipped through a 20° angle to determine the extent of load relief obtainable through body tilt. The study found that no young healthy man demonstrated blood flow occlusion at pressure values less than 120mmHg. Of the geriatric hospitalized subjects, two patients occluded at less than 20mmHg. Average shear values developed by the geriatric hospitalized group were 3 times that of the young healthy group. Average pressure values demonstrated by the geriatric hospitalized subjects were roughly equal to those of the younger subjects (roughly 70mmHg). Additionally, tipping the seat backwards through 20 degrees produced major benefits to the hospitalized geriatric group in terms of increased blood flow, lessened pressure, and lower shear. The young, healthy group experienced some increase in blood flow with no significant change in sitting reactions when tested in a tipped attitude.

Pressure ulcers develop when capillaries supplying the skin and subcutaneous tissues are compressed enough to impede perfusion, leading ultimately to tissue

necrosis. The normal capillary pressure ranges from 20 to 40 mm Hg, with an average of 32 mm Hg (Lyder, 2003). This theory goes back as early as 1930, when Landis used a microinjection method to consulate the arteriolar limb of capillaries in human fingernail beds. This was done to study capillary blood pressure. He reported an average pressure of 32 mm Hg in the arteriolar limb, 22 mm Hg in the mid-capillary bed, and 12 mm Hg on the venous side. These findings recently have been reproduced by using Laser Doppler methods in an animal model in which the mean capillary pressure was 45 mm Hg, approximating human capillary pressure (Salcido and Popescu, 2006).

In a prospective cohort study comprised of 3,233 patients 65 years old or older, Baumgarten et al. (2006) found that pressure ulcers can develop after only a few hours (2-6 hours) of immobility. Of the 201 patients with one or more possibly or definitely hospital-acquired pressure ulcers, the cumulative incidence was 6.2%. Most of the pressure ulcers were Stage II and were found on the sacral area, the heels, or other pressure points. More than 50% of the participants were female, almost 70% were African American, and 18.2% were 85 years old or older. These findings were supported by other researchers. Salcido, et al., (1994) found that if pressure is allowed to continue for a long period (more than 2 hours) it decreases capillary blood flow occludes blood and lymphatic vessels and subsequently may result in tissue death. Moreover, factors such as location and disease process may influence pressure ulcer development (Lyder, 2003). While muscle and subcutaneous tissue have a greater demand for oxygen than skin, ischemic episodes are less tolerated (Grey, Harding, and Enoch, 2006).

Schubert and Heraud (1994) examined the effects of external pressure and shear on the skin microcirculation over the sacral area of 30 elderly high-risk patients'(median

age of 78 years). The skin blood cell flux (SBF) was measured using the laser Doppler technique, with the patient first at rest in the lateral position, then lying for 30 minutes in supine or semi-recumbent 45 degrees position, and finally in lateral position. Thirty elderly patients (median age of 80 years) without pressure sores participated in the study. Gender and race were not included in the study. The patients were first assessed according to the Norton score as being |not at risk' (score > 14), at low risk' (score 14-12), or at high risk' (score < 12) for development of pressure sores. The score includes five main variables such as physical and mental condition, mobility, activity, and continence. According to their scores the patients were divided into two groups. The risk for skin ischemic damage over the sacral area of elderly risk patients was found to be evident in both positions, especially with the patients lying in supine position. Discomfort from compressive and shear forces initiate changes in posture, even in elderly patients prone to tissue breakdown.

The importance of pressure cannot be over emphasized according to Guidelines developed by the Agency for Health Care Policy and Research (AHCPR) Pressure Ulcer Panel. By reducing the effect of pressure, friction, shear forces (positioning devices to raise a pressure ulcer off the support surface, avoid using donut-type devices, use a pressure-reducing surface), and the promotion of adequate tissue perfusion, pressure ulcers could be prevented in the elderly. These views are supported by Bensal, Scott, Stewart, and Cockerell (2005) who argue that since minimal pressure is required to result in skin breakdown in susceptible people, reducing pressure on the body is the cornerstone of management.

Immobility

While immobility predisposes elderly patients to increased risk for pressure ulcers, any neuromuscular or paralyzing agent, including braces and splints that create immobility may potentate the development of pressure ulcers (Bansal, Scott, Stewart, and Cockerall, 2005). Even though people living with paralysis are especially at risk for developing pressure ulcers, studies have shown that any individual who is unable to change position without assistance, bedridden, uses a wheelchair, or has decreased sensation due to medication, is at increased risk for pressure ulcers (Sharp and McLaws, (2005).

Impaired sensation due to anesthesia use, augmented by lying for varying periods of time on an operating table has been implicated as a potential cause of ulcer development in many studies (Schoonhoven, Defloor, and Grypdonck, 2002; Sharp and McLaws, 2005). Although not extensively studied, other high-risk conditions that affect the blood supply, such as diabetes and peripheral vascular disease, may increase the patient's risk for pressure ulcer development when immobility is added (Ducker, 2002).

Geyer, Brienza, Karg, Trefler, and Kelsey (2001) examined the use of pressure-reducing wheelchair cushions compared with the use of convoluted foam cushions over a 12-month period in elderly wheelchair users who were at high risk for developing sitting-acquired pressure ulcers. The randomized control trial comprised of 32 male and female at-risk nursing home residents who were wheelchair users > or = 65 years of age. Race was not reported. Participants had Braden Scale scores < or = 18, Braden Activity and Mobility subscale scores < or = 5, no sitting surface pressure ulcers, and a daily wheelchair sitting tolerance of more than 6 hours. Patients were assigned to either a

foam (n=17) or pressure-reducing cushion (n=15) group. Weekly assessments of skin and pressure ulcer risk were made. Results suggest that at a 95% confidence interval, a 2-tailed analysis showed no differences between the FOAM and pressure-reducing cushion groups for pressure ulcer incidence, total days to pressure ulcer, or initial peak interface pressure. Pressure-reducing cushions were more effective in preventing sitting-acquired (ischial) pressure ulcers (P<.005). Higher interface pressures were associated with a higher incidence of pressure ulcers (P<.001). While no study has been found that directly links immobility or turning schedules of every two hours to curing or preventing pressure ulcers (Bansal, Scott, Stewart, and Cockerall, 2005), the practice of turning patients every two hours to prevent sustained pressure on one area of the body for long periods has been accepted by nurses for many years.

Moisture

The skin of older adults is particularly susceptible to moisture-related damage. Elderly patients in institutions may experience increased skin moisture from perspiration, incontinence, or wound drainage, which could affect the skin integrity and result in pressure ulcers (Institute for Health care Improvement, 2007). Incontinence is the inability to control bladder or bowel function. Bladder changes in the elderly are not be considered a normal part of the aging process, although the bladder empties less effectively and becomes less elastic with age (International Functional Stimulation Society, 2002). Women have a higher rate of incontinence than men due to weakened pelvic floors from child bearing (Burgio, 1991). Urinary incontinence is one of the major reasons for institutionalization of the elderly, and it affects an estimated 50% of nursing home residents (Agency for Health care Policies and Research, 1996). Among people

over the age of 65, women more often experience bowel incontinence. Thirteen out of every 1,000 women report a loss of bowel control (Medline Plus, 2008).

Pressure ulcers related to increased moisture are heightened when combined with age-related and physiological changes in bladder function, skin, mobility and multiple co-morbidities. When an individual experiences both fecal and urinary incontinence, the skin is more susceptible to bacterial growth. The combination of urine and stool allows the high concentration of bacteria to convert urea to ammonia, raising the skin pH and proving an ideal environment for bacterial growth. Ammonia also reactivates digestive enzymes found in stool and can further erode the skin surface (Farage, Miller, Berardesca, and Maibach, 2007). Increased moisture resulting from fecal and urinary incontinence has been cited as a risk factor for pressure ulcers by many authors (Allman, Goode, Patrick, Burst, and Bartolucci, 1995; Merck Manual of Health & Aging, 2004).

In a prospective cohort study comprised of patients with activity limitations, Allman, Goode, Patrick, Burst, and Bartolucci (1995) found that fecal incontinence, diarrhea, 75 years or more, dry skin, previous pressure ulcer history, and immobility, were among the significant findings for the development of Stage II or greater pressure ulcers. The total cumulative incidence of pressure ulcers was 12.9% (n=37) after a median time of 9 days from admission to final skin examination. Of the 286 patients included in the study, the mean age was 73.7 years, females comprised 60.8%, and Blacks comprised 41.3% of the study sample. Results of the study suggest that the total cumulative incidence of pressure ulcers was 12.9% (n=37) after a median time of 9 days from admission to final skin examination. Additionally, the age of 75 years or more, dry

skin, non-bleachable erythematic (a stage 1 pressure ulcer), previous pressure ulcer history, immobility, and fecal incontinence (which increases moisture to the skin) were among the significant indicators for pressure ulcers development.

Since pressure ulcer and skin excoriation due to moisture are closely related, differentiation needs to be made between the two. Despite the cause of increased moisture in the elderly, the management of increased moisture is crucial to minimizing skin exposure. Prompt cleansing of the skin with a mild moisturizing cleanser after soiling is necessary to prevent skin breakdown and the development of pressure ulcer. Additionally, determining the cause of incontinence, treating diarrhea, with attention to the use of barrier ointments, absorbent pads, condoms or external catheters, are important to preventing pressure ulcer formation in the elderly patient (Agency for Healthcare Policies and Research (1992).

Friction and Shear

The term friction, which is often used synonymously with shearing, describes the mechanical resistant of a skin surface against another, thereby causing abrasions. Friction which is often caused by pulling or dragging the patient across bed linen, may present as a superficial laceration causing damage to the epidermis and dermis (Salcido, and Popescu, 2006). Due to fragility of the skin, elderly patients are particularly prone to friction resulting from devices such as splints or from simply turning their body from side to side (Mayo Clinic, 2005).

Shear

Shearing is the mechanical stress associated with interaction of both gravity and friction. This occurs when the skin remains stationary and the underlying tissue moves,

stretches, angulates, or tears the underlying capillaries and blood vessel resulting in tissue damage. This perpendicular force on the skin surface can extend into the boney skeleton (Sharp and McLaws, 2005). Although, elderly patients are prone to skin breakdown due to reduced elastin in the skin (Grey, Harding, and Enoch, 2006), several activities centered on the care of immobilized patients may cause shearing. These include activities such as sliding down in a bed, chair, or raising the head of the bed more than 30 degrees. The coccyx or tailbone is especially affected by shearing since the skin in this area is already thin and fragile (Wound Skin (2008). Therefore, sacral pressure ulcers are more easily developed.

Studies conducted by Bennett, Kavner, Lee, Trainor, and Lewis (1981) described the measurements of blood flow in the ischial area as a function of load, pressure, and shear actually experienced in the act of sitting (study described, p. 35). The investigators found that the sitting mechanics of the hospitalized geriatric patient are such that on the average, 3 times the shear is generated, as compared to the young and healthy. While researchers are not able to separate the effect of the shear variable from other variables in these tests, findings suggest that the average shear value in geriatric horizontal sitting ($26.7g/cm^2$) is possibly equivalent to an additional 10mmHg of external pressure in terms of occlusive effect (Bennett, Kavner, Lee, Trainor, and Lewis, 1981).

Although, scientific evidence is lacking, it is reasonable to conclude that the angular and vertical forces that occur downward when patients are in the semi-upright position in bed, tend to distort the tissues and blood vessels near the sacrum, placing this region at risk for tissue breakdown (Salcido and Popescu, 2006). In research focused on assessing the pressure-reducing effects of operating-table mattresses, Defloor and

Schuijmer, 2000) used a quasi-experimental design to assess the interface pressure-reducing effects of four intra-operative postures on five types of operating-table mattress, foam mattress, a gel mattress, a visco-elastic polyether foam mattress, and a visco- elastic polyurethane mattress. Interface pressure measurements were taken for 36 healthy volunteers. Twenty four men and 12 women ages 23 to56 years were included in the study. Race was not reported. Four intraoperative postures were evaluated (supine, lateral, fossa, and the Miles-Pauchet position). The foam mattress and the gel mattress seem to have little or no pressure-reducing effect; the polyurethane mattress and the polyether mattress reduce interface pressure significantly better ($p < .001$); but none of the mattresses reduce pressure sufficiently to prevent the occurrence of pressure ulcers. The researchers concluded that a 30° elevation of the top end of the operating table might cause high pressure and a shearing force on the sacrum during head and neck surgery. The synergy of shear and pressure results in the formation of pressure ulcers.

The coccyx is especially affected by shearing due to the characteristic thinness and fragility of the overlying skin (WoundSkin-ce, 2008). A good example of shearing is that of sacral wounds that have undermining. Care must be taken to avoid skin injury due to friction and shearing forces. Interventions to reduce skin injury include proper turning techniques, positioning, transferring and the use of skin lubricants (The Agency for Health care Research, 1992).

Summary

Of the many suggested intrinsic risk factors for pressure ulcers development, age, psychological states, and nutrition state are considered the most important, while pressure, immobility, moisture, friction and shear are described as the most important

extrinsic risk factors (Allman, Goode, Patrick, Burst, and Bartolucci, 1995; Bergstrom and Braden, 1992; Ducker, 2002; Garcia and Thomas, 2006; Margolis, Knauss, Bilker, and Baumgarten, 2003). Despite the many suggested risk factors, no study has demonstrated a direct cause of pressure ulcer. When compared to hospital stays for all other conditions, adult patients with pressure ulcers are nearly four years older than patients hospitalized for all other conditions (Russo, Steiner, and Spector,2008; Fisher, Wells, and Harrison; 2004).

Despite compelling evidence that adequate nutrition promotes the healing of pressure ulcers in humans, patient care practices have not been standardized. More research is needed to further explore nutritional risk factors for pressure ulcers and more important, to describe standard management practices which might prevent pressure ulcers in this at-risk population.

Measurement Used in the Management of Pressure Ulcers

Introduction

The early identification of patients' nutritional risk is essential in the design of a successful wound care program. The use of systematic assessment with a validated risk assessment tool is recommended for individuals at risk for pressure ulcer. They enable health professionals to systematically evaluate individual risk factors using quantitative measures (Foltz, Schiller and Ryan, 1993).

Several measures are currently being employed to screen and assess the nutritional status of patients. These measures include: a) Body Mass Index (BMI) such as height, weight, and nutritional intake, b). Biochemical measures, including serum albumin, hemoglobin, potassium, and c). Nutritional screening tools such as the Mini

Nutritional Assessment (MNA) (Clark, 2003). Pressure ulcer risk assessment tools commonly used include the Braden Scale (Bergstrom, Braden, Kemp, Champagne, and Ruby, E. 1998), Norton Scale, and the Waterlow Score (Anthony, Reynolds and Russell, 2000). These tools are vital in the prompt identification of patient at risk for developing pressure ulcers. Tools such as the Pressure Ulcer Scale for Healing (PUSH) and the Pressure Sore Status Tool (PSST) are used to capture wound healing over time.

According to Thomas (1997), no single biologic parameter will satisfactorily diagnose patients at risk of becoming nutritionally compromised. For this reason, a combination of several biochemical and anthropometric parameters are employed to obtain a far more reliable index. To determine the frequency of nutritional screening and assessment practices in hospitals Foltz, Schiller and Ryan (1993) surveyed 388 patients. Results suggest that although assessment practices varied widely among the hospitals in which surveys were conducted, 68.7% had dietitians who were involved in individual or group screening of patients.

Using data from a cross-sectional retrospective study conducted in a long-term veteran's center, Langkamp-Hanken, Hudgens, Stechmiller, and Herrlinger-Garcia (2005), contended that the Mini Nutritional Assessment (MNA) Screening Form provided advantages over using visceral protein when determining the nutritional status of elderly patients. Visvanathan, Penhall, and Chapman (2004) carried out a prospective study comprising of 65 (21 males) patients older than 65 years in a sub-acute care facility. With the use of screening methods such the Mini Nutritional Assessment, standard nutritional assessment, 'rapid screen and discharge outcome, results suggest that the prevalence of under-nutrition ranged from 35.4% to 43.1%, depending on the

screening method used. Of the methods tested, the more sensitive Mini Nutritional Assessment was suggested as best choice for institutions, if there were adequate resources.

Williams et al. (2000) investigated predictors and severity of pressure ulcer admission in an acute care environment. In a prospective study of 267 subjects, of which 12.8% had a pressure ulcer present on admission, participants' Braden Scale, biochemical markers, such as albumin, and hematocrit levels as well as Body Mass Index, were examined. Analysis of variance showed that subjects with pressure ulcers were significantly older, had longer Length of Stay (LOS) and poorer nutritional status.

Serum Albumin and Pre-albumin

Serum albumin and pre-albumin levels are frequently used to measure the nutritional status of patients. However, opinions vary in regard to the role of low serum albumin and wound healing. Collins (2001) points out that albumin which is manufactured in the liver accounts for more than 50% of total serum proteins and is one of the most abundant proteins found in the blood. Due to long half-life and a very large serum pool, albumin is a late indicator of malnutrition. Furthermore, albumin, pre-albumin, another protein status indicator has a half life of approximately two days. As pre-albumin binds and transports protein, this is a far more sensitive and timely indicator of protein status than albumin (Collins, 2001).

In a longitudinal prospective cohort study involving 2,771 subjects from 47 Veterans Affairs hospitals, Reed et al. (2003) investigated the significance of low serum albumin (< 2.5), fecal incontinence and confusion (impaired mental status) as significant risk factors for pressure ulcer development. The study design was a longitudinal cohort

study using data collected as a component of a multi-site controlled clinical trial. The data were collected at 47 Veterans Affairs Hospitals where 2,771 subjects that required high levels of nursing care were identified to have mobility impairment. The mean age of the subjects was approximately 70.7 years with 2.1% of the group being women. Although race was recorded among the risk factors, this was not reported in the analysis of findings. Multivariate analysis indicated that of 3 potential risk factors, low albumin Odds Ratio (OS), 1.40 and confusion OR 1.45 were both statistically significant risk factors for Stage II pressure ulcer development, while fecal incontinence was not. Four hundred and six patients (14.7%) subsequently developed at least one Stage II or greater pressure ulcer over a 2- week period. The study indicates that low protein status, was a significant risk factor for pressure ulcer development. Similar findings were also reported by (Kagansky, Berner, Koren-Mogag, Perelman, Knobler, and Levy, 2005).

Anthony, Reynolds and Russell (2000), conducted a retrospective study including 773 elderly participants who were hospitalized for at least 1 week. This observational study of patients at risk of developing pressure ulcer used the hospital information support system data to determine ascertain the relevance of serum albumin, and serum sodium, as predictors of pressure ulcers, in addition to the Waterlow Score. Results suggest that the Waterlow Score and serum albumin were significant predictors of pressure ulcers.

Knowledge of albumin and pre-albumin values, as good predictors of malnutrition, can facilitate proactive intervention when necessary. Horn et al., (2004), suggest a possible link between low serum albumin (<2.5), improved quality of life for patients and a decrease in the number of malpractice suits against institutions.

Pressure Ulcer Related Assessments

Due to the variety of risk factors associated with pressure ulcer development, many facilities perform two pressure ulcer related assessments on every patient admitted to the institution. Assessments employed in most institutions are :(1) risk assessment for the development of pressure ulcers, such as the Braden and Norton Scale and (2) pressure ulcer evaluation tools, such as the Pressure Ulcer Scale for Healing (PUSH) and the Pressure Sore Status Tool (PSST).

Pressure Ulcer Risk Assessment Tool

In the United States, the most popular instruments for predicting pressure ulcers are the Braden and Norton Scales. Their popularity is based on the presence of clinical research supporting their reliability and validity (Pang and Wong, 1998). The Waterlow instrument was designed for both medical and surgical patients and is well known in the United Kingdom, but less so in the United States (Sharp and McLaws, 2006). The Pressure Ulcer Scale for Healing (PUSH) and the Pressure Sore Status Tool (PSST) are the most widely used tools in the United States for the measurement and overall assessment of wound status (Gardner, Frantz, Barquist, and Shin, 2005; Stotts et al., 2001).

Although, there are several instruments used to predict the development of pressure ulcers in vulnerable populations, the predictive value or accuracy of these tools show inconsistency (Schoonhoven, et al., 2002). According to Rycroft-Malone (2001), some studies were of poor quality in respect to methodological rigor, sample size, population, and outcome measurement, while others were regarded as being susceptible to bias. In order to evaluate the efficacy of using risk assessment scales to identify

patients likely to get pressure ulcers, Schoonhoven et al. (2002) conducted a prospective cohort study in two large hospitals in the Netherlands. Of the 1229 patients admitted to the hospital, 135 patients developed Stage II or worse pressure ulcers within four weeks of admission. Using the recommended cut-off points (Norton < 14, Braden < 14, Waterlow score <25), the positive predictive value was 7.0% for the Norton Scale, 7.8% for the Braden Scale, and 5.3% for the Waterlow Scale indicating good predictive value.

Braden Scale

Developed in 1983, the Braden scale is internationally known and is probably the most widely used tool for identifying elderly patients who are at risk for developing pressure ulcers (Bergstrom, Braden, Kemp, Champagne, and Ruby, 1998). The Braden Scale is composed of six sub-scales: sensory perception, moisture, activity, mobility, nutrition, and friction/shear. Included in this tool is intensity, duration of pressure, and tissue tolerance for pressure. Five of the subscales: sensory perception, mobility, activity, moisture, and nutrition have scores that range from 1 to 4, with 1 representing the lowest score and 4 representing the highest score. Friction or shear ranges from1 to 3. The scores on the Braden Scale range from 6 to 23. Patients with scores below 18 are considered at risk for pressure ulcer development. Lower scoring patients have the highest risk for developing a pressure ulcer (Braden and Maklebust, 2005).

Inter-rater reliability of between 0.83 and 0.99 has been established for this tool. Moreover, the tool has been shown to be equally reliable with Black and White patients (Ayello, 2007). Sensitivity ranges from 83% to 100% and specificity from 64% to 90%, depending on the cut-off score used for predicting pressure ulcer risk. A cut-off score of

18 should be used for identifying both Black and White patients at risk for pressure ulcers (Ayello, 2007).

The Braden Scale has been used in numerous studies both internationally and in the United States (Bergstrom, Braden, Kemp, Champagne, and Ruby, 1998; Tompson, Langeemo, Anderson, Hanson, and Hunter, 2005; Lyder, 1998). Bergstrom, Braden, Kemp, Champagne, and Ruby (1996) examined the effects of demographic characteristics such as race, age, and gender as risk factors for pressure ulcer development. This retrospective cohort study with convenience sampling was conducted in 95 long-term care facilities throughout the United States and comprised of 843 randomly selected participants. The majority of the participants were White (70%). The results suggest that 12.8% of the subjects developed pressure ulcers. Using logistic regression, the researchers found that lower Braden Score results, older age, and White race were significant predictors of pressure ulcer development.

The high predictive value of the Braden Scale was noted by Rosen et al. (2006). Researchers reported that patients who were classified as high risk – scoring less than 18 on the Braden Scale, had a 22.3% to 31.7% chance of developing pressure ulcers during the baseline and intervention periods. Unlike other scales, the predictive validity of the Braden Scale has been tested in several ethnic groups and has been found to be effective in predicting pressure ulcer development in these groups.

Lyder et al. (1998) used a prospective design comprised of 36 patients 60 years and older to determine which variables specifically predicted pressure ulcer risk in Black and Latino/Hispanic elders. Researchers found that at a cut-off score of 16 the Braden Scale under predicted Black and Latino/Hispanic patients at risk for developing pressure

ulcers. Moreover, with a Braden Score of ≤ 16, the sensitivity was only 35% but specificity was 100%. These results suggest that the Braden scale may be too conservative for predicting those Black and Latino/Hispanic elders at risk for pressure ulcers.

A subsequent study conducted by Lyder et al., (1999) in a 650-bed urban hospital with 74 patients age 60 years or older and a larger number (30%) of Blacks and Latino/Hispanic elders, found opposing results. Results from this prospective study suggest that 32% of participants developed either a Stage I or Stage II pressure ulcer. Black elders had a higher incidence rate (21%) than Latino/Hispanic elders (11%). The sensitivity was 81% and the specificity was 100%. A 2- tailed Fisher exact test revealed that the Braden scale with a cut-off score of 18 was highly associated with predicting the risk for pressure ulcer in Black elders aged 75 years and older. This was a change from other studies that suggested 16 as high risk for pressure ulcer development. The cut-off score for the Braden Scale varies in different studies but is more consistent with 18 in the varied populations (Bergstrom and Braden, 2002; Lyder, et al., 1998).

Norton Scale

The Norton Scale is a popular tool for measuring patients' risk for the development of pressure ulcers. This tool has been in existence since 1962 and was developed specifically for geriatric patients. The assigned categories are: physical condition, mental condition, activity, mobility, and incontinence. Each category is rated as "good" 3, "fair" 2, "poor," and " very bad" 1 (Garcia and Thomas, 2006). The maximum score on the scale is 20. A cut-off score of <14 (Norton et al. 1979) or <16 (Norton, 1987) has been used to predict patients at risk of developing pressure ulcers.

The predictive validity of the scale has been examined in different settings. A sensitivity ranging from 63% to 100%, and a specificity from 26% to 89% have been reported in different studies (Fisher, Wells, and Harrison, 2004; Pang and Wong, 1998; Mei-che and Kwok-shing, 1998).

The Modified Norton Scale

A modified version of the Norton scale was introduced for the first time in Sweden in 1987. Factors consisting of body temperature and social activity incorporated into the original Norton Scale were later removed as they did not appear to be specific risk factors for pressure ulcer. Particular focus was placed on food and fluid intake, which are both significant risk factors for pressure ulcer development. Patients with a score of less than 21 were considered to be at high risk for the development of pressure ulcers. The maximum score for the modified version was 28 (Ek and Bjurulf, 1987; Ek et al. 1991). The predictive validity of this version, when measured by sensitivity and specificity, was 52% and 65%, respectively (Ek, 1987).

Ek, Unosson, and Bjurulf (1989) in a study of 110 patients examined the inter-rater variability of the Norton scale. The subjects were evaluated by 22 registered nurses and 22 practical nurses. Findings suggest that the percentage of agreement between registered nurses ranged from 55% for incontinence to 86% for activity. The corresponding figures for practical nurses ranged from 51% for general physical condition to 87% for food intake. Based on these findings, it was suggested that the analysis be performed by registered nurses as there was less discrepancy between the evaluations of these groups.

These views were not supported however, by Bååth, Hall-Lord, Ewa-Idvall, Wiberg-Hedman (2008) who used a cross-sectional design study to examine the interrater reliability between and among registered (N=50, 49 women and 1 man) and enrolled nurses (N= 61, 58 women and 3 men), using the Modified Norton Scale, Pressure Ulcer Card, and Short Form-Mini Nutritional Assessment. Registered nurses and enrolled nurses made 228 assessments of patients' skin, risk for pressure ulcer and malnutrition, in patients with hip fracture and patients who had suffered a stroke. Assessments were made on day3 or 4 after admission to the ward. Patients' ages were 65years and older. Race was not reported. The findings suggest that the interrater reliability of the Modified Norton Score total score was very good among registered nurses, good among enrolled nurses and between both groups. Additionally, there was good, moderate and fair agreement on the subscales. Interrater reliability of Short Form Mini-Nutritional Assessment screening score was very good between both groups, good among registered nurses and moderate among enrolled nurses. There was good and moderate agreement on the items. There was good, moderate and fair agreement between and among registered nurses and enrolled nurses when using the Pressure Ulcer Card.

The Norton Scale has been criticized for over prediction and under prediction of patients at risk. Lewko et al. (2005) used the Norton scale to examine the risk for the development of pressure ulcers in 199 hospitalized patients considered to be at risk of developing pressure ulcers. The greatest proportion of patients (91%) was in the age range 65-89 years old, race was not reported. Among the patients examined in this study, an increased risk for the development of ulcers was found in 107 cases (59 women and 48

men) which represented 53.8% of the sample. However, pressure ulcers developed in only 17.6% of the patients, with women being at a significantly greater risk (56.2%).

Gunningberg, Lindholm, Carlsson, and Sjoden (1999) used a prospective, controlled design study to examine the predictive validity of the re-modified Norton scale among 124 patients with hip fracture. The study comprised of 73.4% women and 26.6% men with a mean age of 82 years, race was not reported. Finding suggests a sensitivity of 71% and specificity at 44%. Studies conducted by Perneger, Gaspoz, Raë, Borst, and Héliot (1998) assessed the specific contribution to overall scale performance of each of the five items that constitute the Norton Pressure Ulcer Prediction Scale in 2,373 hospitalized patients.

Norton scale items measuring activity, mobility, physical condition, mental condition, and incontinence on a 4- point scale were examined as predictors of Stage I or greater pressure ulcers. A total of 245 new pressure ulcers occurred between admission and patient observation. Patients' assessments were made at a median of 9 days after admission for 515 men and 41% women. The median age of the patients was 63 years. Race was not reported. The study used a comparison of statistical models based on cross-sectional surveys of hospitalized patients. Findings suggest that activity and mobility items of the Norton scale were sufficient to express the risk of pressure ulcers in the hospitalized patients examined.

The Norton Scale is used mainly in the United Kingdom. Review of the literature finds that current studies addressing race or skin color are extremely rare, since race is often not included in these studies. Despite this deficiency, the Norton and Braden Scales

are supported by the Agency for Health care Policy and Research (AHCPR) due to their high validity and reliability (AHPR, 1992).

Despite the increased focus on risk assessment tools, controversy exists regarding their predictive effectiveness when compared to arbitrary skin inspection (Sharp and McLaws, 2006). Nevertheless, researchers agree that the use of scales increase the intensity and effectiveness of prevention interventions (Pancorbo-Hidalgo, Garcia-Fernandez, Lopez-Medina, and Alvarez-Nieto, 2006; Sharp and McLaws, 2006).

Waterlow Scale

The Waterlow Scale was developed in 1985 in the United Kingdom. The tool is based on the Norton Scale but is considered to be more comprehensive. The scale consists of eight items: build, weight for height, visual assessment of the skin in the area at risk, gender and age, continence, mobility, appetite, medications and special factors (Pang, Wong, and Thomas, 1998). Weststrate et al. (1998) found that most categories in the Waterlow scale were confirmed to have an influence on the development of pressure ulcers. Moreover, the combination of category items selected and their individual weighting were based on a study of the relevant literature and discussions with other health care professionals.

Weststrate, Hop, Aalbers, Vreeling, and Bruining (1998) conducted a prospective study to investigate the prognostic significance of the Waterlow Pressure Sore Risk (PSR) Scale for intensive care patients. The study group included 389 men and 205 women, with a mean age of 58.8 years, who had been admitted to intensive care units (ICU). Findings from the total sample of 594 patients studied suggest that patients with Waterlow scores > 25 on admission, were at greater risk of developing pressure ulcers

compared to patients with a Waterlow score <25. After admission, Waterlow PSR scores obtained on a daily basis continued to be significantly associated with the risk of developing a pressure ulcer. For each additional point on the Waterlow PSR Scale, patient risk increased by 23%.

Summary

Several studies support the view that existing risk assessment tools can provide medical and nursing personnel with early information that reliably identifies patients who are at risk of developing pressure ulcers. The major limitation of these studies appears when examining their application to elderly patients of color. Only studies related to the Braden Scale reported inclusions of persons of color in the study population (Lyder et al., 1998). In all cases the number of patients included account for a very small percentage of the total group. Moreover, data from the ethnic minority subset are rarely analyzed separately. In fact, the small percentage of minorities in a study population may be considered a deterrent to drawing statistically sound conclusions (Bergstrom and Braden, 2002).

Instrument to Assess Pressure Ulcer Healing

Pressure Ulcer Assessment Tools

Despite the availability of many instruments for the overall assessment of pressure ulcers, few instruments exist to accurately track some of the subtle changes related to pressure ulcer healing. As a plethora of reliable and valid measuring tools are approved which enhance communication among clinicians and lay the foundation for solid care plans for patients, systematic means for determining which instrument to use become even more important. To evaluate which instruments best capture pressure ulcer

progression, two commonly used scales will be compared. These are, the Pressure Ulcer Scale for Healing (PUSH) and the Pressure Sore Status Tool (PSST).

Pressure Ulcer Scale for Healing (PUSH)

The PUSH tool, developed by a task force for the National Pressure Ulcer Advisory Panel (NPUAP), is a data collection instrument used to track healing in pressure ulcers over time (Gardner, Frantz, Bergquist, and Shin, 2005). Parameters are commonly used to monitor pressure ulcer healing, and statistical analyses are done of existing research data based on pressure ulcer monitoring (NPUAP, 2006).

According to Ratliff, and Rodeheaver (2005), the PUSH tool consists of three parameters: length by width, exudates amount, and tissue type. The first parameter, length x width, measures the greatest length and the greatest width using a centimeter ruler. By multiplying these two measurements, an estimate of surface area in square centimeter is achieved. The second parameter, exudates amount, estimates the drainage as none (0), light (1), moderate (2), or heavy (3).

The third parameter, tissue type, refers to the type of tissue found in the wound bed and is described as 4 for necrotic tissue 3, for slough 2 for granulation tissue 1, for epithelial tissue, and 0 if the wound is closed. Each parameter is individually scored, and the wound status is determined by the sum of the three parameters. Scores range is from 0- 17, with a low score indicating wound healing and a high score indicating degeneration of the wound. Recommendations for the use of the tool include measurement of wounds at least weekly (NPUAP, 2006). The PUSH tool takes less than a minute to complete.

Pressure Ulcer Scale for Healing (PUSH) Version 3

Center for Medicare & Medicaid Services (CMS) conducted a clinical test of the PUSH Version 3 tool to determine its usability in long term-care facilities and made recommendations for changes. Version 3.0 of the tool is based on this pilot study and a second retrospective study (Scotts et al., (2005). The results of these studies indicated that the original five categories of wound size did not accurately reflect the extent of pressure ulcers routinely encountered. Additionally, the scoring of necrotic tissue was not sufficiently defined for clinical purposes. The tool was subsequently modified to include 10 categories. High scores were given for the presence of necrotic tissue and a simplified scoring system was devised to reduce the potential of error in the calculation of scores (Stotts et al., 2001).

Several researchers have found the PUSH tool to be a valid and reliable instrument for measuring wound healing over time. Gardner, Frantz, Bergquist, and Shin (2005) using a prospective research design, studied a convenience sample of 32 nursing home residents with pressure ulcers. The purpose of the study was to assess the validity of PUSH (version 3.0) when used to assess pressure ulcers in clinical practice. The mean age of participants was 79.5 years. Twelve of the 32 participants (52%) were male and 20 (87%) were White. The patients' pressure ulcers were assessed each week with the PUSH and the Pressure Sore Status Tool. Surface area measurements derived from wound tracings were also obtained. Weekly assessments continued until the ulcer healed, the resident died, the resident transferred from the nursing home, or 6 months of assessments were complete. The findings suggest that of the total pressure ulcers assessed in the study, 21 (66%) healed during the 6- month study period and 11 (34%) did not heal. The

PUSH scores decreased over time in proportion to the healing rate of healed ulcers. Conversely no decrease of scores was noted for patients with unhealed ulcers.

Similarly, Thomas et al. (1997) found that the PUSH tool meets the requirements of simplicity, validity, and sensitivity to change. In this study, a research database of 37 subjects was used to test hypothetical models of healing. Subjects had a mean age of 74 years old and 22% were women. The race of the patients was not mentioned in the study. Stage III pressure ulcers made up 46% of the cases, while 35% reported Stage IV ulcers.

Stotts et al., (2001) conducted a study aimed at establishing the validity of PUSH as a tool for monitoring the healing of Stage II-IV pressure ulcers. The study was comprised of 273 subjects from 10 cities in eight states, using information collected from patients' records. About half of the sample was female, and the mean age of the group was 74.6 years old, 81% of the subjects were White, 17% were Black, and 2% other. Multiple regression techniques indicated that three variables (surface area, exudates amount, and surface area) provided the best model of healing. Additionally, the model explained 39% of the variance in healing in the first six weeks. After securing validation in study one, the PUSH tool was pilot tested in a long-term care facility.

Based on this study, several modifications were made to the tool and a second study was conducted to validate the modified PUSH tool. The subsequent study included 2,490 nursing home residents and participants in the National Pressure Ulcer Long-term Care Study (NPULS). The mean age of the sample was 80 years old. There were 1,746 (70%) women and 744 (30%) men. Race was not reported. Analysis was performed using revisions to the original tool such as the increased size of categories and a refined scoring for tissue type. Multiple regression analysis, used to measure the sensitivity of the

model to total healing, showed PUSH accounted for 39% of the variance in 6 weeks and 31% of the variance over 12 weeks ($p < 0.001$). Inter-rater reliability reported 95% agreement among personnel, although there was no clarification as to regarding whether this was for specific items or total score (Stotts et al., 2001). While the PUSH model provides a simple clinical way to measure progress towards healing, this does not intended to eliminate clinical judgment.

Pressure Sore Status Tool (PSST)

The Pressure Sore Status Tool (PSST) is a data collection form developed by Barbara M. Bates-Jensen to illustrate the status of pressure ulcers over time for clinical and research purposes (Bates -Jensen, Vredevoe and Brecht, 1992). The assessment items on the PSST were developed through the use of experts participating in a modified Delphi panel. The established PSST content validity began with a panel of 20 experts. However, items were refined by a nine-member expert judge panel. The mean overall content validity index was 0.91 ($p = 0.05$) (Bates –Jensen, 1997). Reliability of the tool was established by two enterostomal nurses (ET) with more than two years experience in a 400 bed acute care facility.

These nurses had previously been involved in PSST projects. A total of 10 patients, ages ranging from 32 to 83 years old, and 29 pressure ulcers were rated and compared in this study. Of the participants, 40% were women, 30% Black, and 10% were Hispanic. The patients presented with a number of co morbidities, including chronic obstructive pulmonary disease and diabetes. After nurses attended a 30 minutes educational training, ratings for pressure ulcer were tabulated for each rater and between rates for different occasions. Inter-rater reliability mean was established at $r = 0.91$ and

r = 0.92 for second observation. Intra-rater reliability yielded a mean of r = 0.96 (Bates-Jensen, Vredevoe, and Brechi, 1992),

Reliability of the PSST was also addressed with regular health care practitioners in long-term care facilities. Inter-rater reliability was established within groups, between practitioners, and between practitioners and experts. Inter-rater reliability for the practitioners yielded a mean of 0.78. Reliability estimates for the practitioners versus the ET experts yielded a mean of 0.82. The inter-rater reliability for the practitioner versus the ET experts averaged 0.89 (Bates-Jensen, 1997). The 13 items on the scale describe the ulcer by focusing on the wound size, depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudates type, exudates amount, skin color surrounding wound, peripheral tissue edema, peripheral tissue indurations, granulation tissue, and epithelialization. Item number nine (skin color surrounding wound) on the PSST specifically addresses people of color. According to Bates-Jensen, (1992), skin color surrounding the wound assesses tissue within 4 cm of the wound edge. In the case of dark skinned persons the colors bright red, dark red, a purple hue, or a general deepening of normal ethnic skin color are identifiable. As healing occurs in dark- skinned persons, the new skin is pink and may never darken (Bates-Jensen, 1990).

Although there are 15 items are in this tool, only 13 are scored. Two items, location and shape, are non-scored items. The remaining 13 items are scored on a Likert response format ranging from one to five, with one being the best score and five being the worst. The total scores are derived at by adding subgroups. This ranges from 13-65, and reflects wound health as a low score and deterioration as a high score (Bates-Jensen, Vredevoe, and Brecht, 1992). The PSST total scores are plotted on a wound status

continuum form by putting an X on a line and the date beneath the line. By multiplying scores with the date beneath the line, one can see at a glance the regeneration or degeneration of the wound. The tool is administered on a weekly basis ending with complete resolution of the wound.

To evaluate the relationship between PSST and the National Pressure Ulcer Advisory Panel staging system the researcher examined 496 pressure ulcers of varying severity. Pressure Sore Status Tool ratings were compared with staged score for the same wound. There was a total of 15 practitioners (mean ratings/ staff person = 33.0) from 12 institutions. The population was representative of every geographic region in the United States. The results indicate that PSST total scores discriminate between partial and full thickness wounds, thus establishing concurrent reliability (Bates-Jensen, 1997). Although this tool takes longer than some tools to complete, and requires training to obtain reliable measures, data collection was made easy through the automated Wound Intelligent System. Clinically, the tool contains a great deal of information that gives the appearance of being relatively long. However, the headings all seem to be integrally related to a complete assessment of pressure ulcers. Additionally, the instructions for completing the tool are clear with explicit definitions of terms.

Inspection

The prediction of pressure ulcer is an essential but highly complex endeavor, which cannot be accurately accomplished by simple risk-assessment tools (Goodridge, et al. (1998). Traditionally nurses were taught that Stage I pressure ulcers could be detected by examining the skin for signs of redness or erythematic. However, in people of color, this may not be so obvious. The detection and early identification of Stage I pressure

ulcers are difficult with the standard method of visual skin assessment. This method is unreliable and often fails to detect skin color changes in darkly pigmented skin (Bates-Jensen, McCreath, Kono, Aples, and Alessi, 2007).

Several studies heightened the difficulties encountered in being able to establish early interventions and preventative measures for pressure ulcers in people with dark skin (Alung, Miller, and Bosley, 2001; Bates-Jensen, McCreath, Kono, Aples, and Alessi, 2007). Meehan (1994) conducted a prevalence survey comprised of 177 participating hospitals and 3,487 patients. This report suggests that Stage I ulcers affected 46.95% of patients, while Stage II ulcers affected 32.66% of the patients studied. These were the most frequently reported ulcers. Additionally, the data showed that although Blacks comprised 17% of the total patients reported with ulcers, 41% of their ulcers were Stage II and 16% were Stage IV. Blacks had the least number of Stage I pressure ulcers (18%) and a greater number of advanced ulcers when compared to all other reported racial groups (Bergstrom and Braden, 1992; Bergstrom, Braden, Kemp, Champagne, and Ruby, 1996).

Health care professionals are watchful for signs such as persistent erythematic, non-blanching erythematic, blisters, discoloration, localized heat, localized edema, and localized indurations. These signs are particularly indicative of early pressure ulcer development and so are very useful indicators for identifying predicting Stage I pressure ulcers in persons of color. In those patients with darkly pigmented skin, changes may also include purple/bluish discoloration, and localized heat. In cases where tissue damage is present, heat may be replaced by coolness, localized edema, and localized indurations (Rycrof-Malone, 2001). Skin assessment is therefore, vital to the early identification of

pressure ulcer warning signs and a subsequent plan for individualized care (Scanlon, and Stubbs, 2004).

The limited number of Stage 1 and increased number of Stage II-IV pressure ulcers in people with darkly pigmented skin speaks to concerns about the ability of practitioners to identify early pressure ulcer in people of color (Hendison, et al., 1997). Valid and reliable tools (such as the Braden Scale) that specifically address people of color are limited in the literature reviewed and are needed urgently for this population. One of the primary goals of institutions is to use tools that assist health care practitioners to identify patients with a potential for pressure ulcers and initiate the appropriate preventive measures. Their intent is to reduce both the prevalence and incidence of pressure ulcers. The concept of providing valid tools for pressure ulcer management has taken on greater focus since the Healthy People 2010 Initiative has included pressure ulcers reduction as an objective for health care providers (US Department of Health and Human Services, 2000).

To determine at-risk patients, nurse researchers and others have used tools based on key physiologic indexes associated with pressure ulcer development (such as weight, nutritional assessment, Mini Nutritional Assessment (MNA), laboratory markers such as albumin and pre-albumin levels, Functional Independent Measures (FIM)). Many believe that these modalities can identify persons at risk for the development of pressure ulcers, thereby facilitating preventive measures and early intervention (Lyder, 1996). Despite the presence of various indices and scales, the accurate prediction of pressure ulcers among elderly institutionalized patients remains a daunting challenge (Bergtrom and Braden, 1992).

Intervention Used to Manage Pressure Ulcers

Introduction

Currently, much controversy exists about the best method of managing pressure ulcers. The review of the literature shows that interventions vary from institution to institution and are sometimes used in combination, or as a single modality (Mukamel, William, and Spector, 2000). Interventions include education, protocols, nutritional management (oral feeding, enteral feeding, calories, protein, hydration, vitamins, and zinc), dressings, pressure relief modalities (beds/cushions), and adjunct therapy (electrotherapy, ultraviolet, and vacuum assisted closure) (Gibbons, Shanks, Kleinhelter and Jones, 2006; WONC Society, 2003).

Protocols

Protocol is defined as a detailed plan for a scientific experiment, medical trial, or other piece of research (Wound Care Protocol, 2001). The use of protocols in wound management is not a new phenomenon in nursing. As early as 1993, it was suggested by Granick, McGowan, and Long (2001) that standardized wound management and a multidisciplinary wound care team were extremely important in reducing cost and forging good patient outcomes. Although protocols may vary in there composition, certain components (such as nutrition and wound care) remain vital to the regiment (Horn et al., 2004).

Using a retrospective cohort study with convenience sampling, 95 long-term care facilities participated in the National Pressure Ulcer Long-Term Care Study (Horn et al., 2004). A total of 1,524 residents aged 18 and older, with length of stay of 14 days or longer were involved. These participants did not have an existing pressure ulcer but were

at risk of developing pressure ulcer, as defined by a Braden Scale for Predicting Pressure Sore Risk score of 17 or less. Interventions examined in the different institutions included nutritional treatment (Oral standard medical nutritionals (1kcal/ml.), oral high-calorie/protein medical nutritionals (> 1.5 kcal/ml. or high protein), oral-disease specific medical nutritionals (design for specific disease states e.g. diabetes mellitus), fluid orders (oral or intravenous), use of MedPass program (facilities used a high-calorie/protein medical/nutritional supplement with which to take medications rather than water), medications, pressure ulcer management (turning every 2 hours, devices used to relieve pressure e.g. beds and cushions), and staffing patterns necessary to prevent pressure ulcers in long-term care residents. Of the study population, 71% of the subjects (n = 1,081) did not develop a pressure ulcer during the 12-week study period, the remaining 29% of residents (n = 443) developed a new pressure ulcer. The findings suggest that a broad range of factors including nutritional interventions, fluid orders, medications, and staffing patterns, are associated with the prevention of pressure ulcers in at risk long-term care institutionalized patients. Based on the study results, experienced clinicians and researchers in the field of pressure ulcers can develop protocols that include these factors and target interventions for reducing pressure ulcers.

Thompson, Langeemo, Anderson, Hanson, and Hunter (2005) evaluated the effect on pressure ulcer prevalence, incidence, and healing time of incorporating use of a specific body wash and a skin protectant into skin care protocols that are based on guidelines from the Agency for Health Care Policy and Research. This quasi-experimental intervention study was based on data collected in two skilled long-term care facilities located in north central United States. The sample consisted of 136 patients with

ages ranging from 79.9 to 81.7 years. Females comprised approximately 70% and males approximately 30% of the sample. Race was not included. A 3-month pre-intervention observation period (baseline) was followed by a staff in-service session, in which the use of a body wash and a skin protectant was introduced into skin care protocols, and a 3-month post-intervention observation period. The skin care protocols included skin assessment techniques, prevention and treatment strategies for Stage I and Stage II pressure ulcers, and management of incontinence. Results suggest that Stage I and Stage II pressure ulcers significantly decreased from 35 pre-intervention to 14 post-intervention ($t = 19.48$, $df = 47$, $P = .05$). The prevalence of pressure ulcers pre-intervention was 11.3%, compared with 4.8% post-intervention ($t = 2.47$, $df = 1.0$, $P = .24$). The change in the incidence of pressure ulcers was significant ($t = 8.48$, $df = -2.0$, $P = .01$), with 32.7% pre-intervention and 8.9% post-intervention. Healing time for pressure ulcers ranged from 4 to 70 days pre-intervention (mean = 22.72 +/- 18.25) to 6 to 49 days post-intervention (M = 16.0 +/- 12.93). The decrease in pressure ulcer healing time (rapid, medium, and long) pre-intervention to post-intervention was statistically significant (chi 2= 14.9, P = .001). The presence of fecal and urinary incontinence was significantly associated with the development of Stage I and Stage II pressure ulcers (chi 2= 44.8, P = .000). The use of a wound care protocol in the management of pressure ulcer is suggested to improve quality of life for patients and possibly decrease litigation for institutions (Horn et al., 2004). Frantz, Gardener, Specht, and McIntire (2001) found that when protocols were used in the treatment of pressure ulcers, care was less expensive and resulted in complete healing in the majority of the wounds.

Nutritional Management

The management of malnutrition in the elderly is an interdisciplinary and collaborative venture. In developing an interventional plan to correct pressure ulcer nutritional deficits in the elderly, consideration is given to all aspects of nutrition (Clark, 2003). The provision of an individualized well balanced diet becomes the corner stone of treatment (Thomas, 1997). The nutrition in long-term care is provided mainly by the oral or enteral route (tube feeding) and places emphasis on: (a) *Calories* (b) *Protein* (c) Hydration (d) Vitamins and (e) Zinc (Salva, Coll-Planas, Bruce, De Groot, Andrieu, and Abellan, et al., 2009). The approach to each of these components will be reviewed in view of their nutritional management.

Oral Feedings

The effects of oral nutrition were evaluated by Faras, Soriano, Large Vasquez, Maristany, and Xandri (2004) who conducted an interventional study to investigate the effects of oral nutritional supplements (rich in protein and enriched with arginine, vitamin C and Zinc) on the healing of pressure ulcers. The study which included 39 patients with Stage 3 or Stage 4 pressures ulcers took place in 10 hospitals in Spain. Males and females over 18 years were included in the study. Racial composition of participants was not reported. Oral intake (scored at breakfast, lunch, and dinner) were scored at week 1, 2, and 3 as all, half or nothing by the investigator. Using this information, the total energy requirements were recorded as < 50% (50-75%) or > 100% (75-100%) of the required energy intake. Based on energy requirements, the amount of energy covered by oral intake, baseline serum albumin and the stage of the wound, patients received 1 to 3 packets of oral supplements daily for 3 weeks. The number of required packages of

nutritional supplements was assessed weekly. Each package (200 mls.) contained energy 250 kcal, protein 20 gram, carbohydrates 24.8 grams in addition to vitamin C 250mgs, zinc 9.0gms. Wound characteristics, length, and with were documented weekly. Statistical analysis were performed using Standard Deviation (±SD), Wilcoxon's signed rank test ($p< 0.05$), and McNemer test ($p< 0.05$). The results suggest that after 3 weeks of supplementation, median wound area reduced significantly ($p < 0.001$) from 23.6 cm to 19 cm a reduction of 29%. Median healing of wounds area was 0.34cm per day. Within 3 weeks, the amount of exudates in infected ulcers ($p=0.012$) and the incidence of necrotic tissue ($p=0.001$) reduced significantly. The researchers concluded that nutritional intervention in the form of a specific oral nutritional supplement resulted in a significant reduction in wound area and improvement in wound condition in patients with Stage III and IV pressure ulcers within three weeks.

Raffoul, Far, Cayeux, and Berger, (2006) used an observational cohort study to investigate the nutritional status and wound-healing related micronutrients and to identify the nutritional risk factors of delayed wound healing. The trial which lasted 15-16 days was comprised of 9 patients, age 55-90 years. The intervention consisted of encouraging oral food intake, and of providing the patients 1- 4 units of oral supplements per day, 300 kcal/unit, and 11.2 g proteins (others liquid supplements: 300 kcal/unit) during the investigation period from day 5 before surgery and until day 10 after surgery. Standardized meals were provided with the aim of attaining 300 kcal at breakfast, 700 kcal at lunch, and 700 kcal at dinner. All patients were supplemented with one multivitamin tablet per day (500mg). Laboratory testing included: blood count, plasma proteins, antioxidant status, vitamins, Fe, Se, and Zn. Baseline blood samples showed

anemia and strong inflammation in 4 patients: albumin, retinol, and selenium were low; iron and zinc were very low. Food intake was largely variable and covered only about 76% (31-95%) of energy requirements. Breakfast provided 225+/-110, lunch 570+/-215, and dinner 405+/-150 kcal. Supplements were willingly consumed covering 35+/-12% of energy target. While vitamin supply was adequate, selenium and zinc requirements were not met. The researchers concluded that most patients with chronic skin ulcers suffered micronutrient status alterations, and borderline malnutrition. Meals did not cover energy requirements, although oral supplements covered basic micronutrient requirements and compensated for insufficient oral energy and protein intakes, justifying their use in hospitalized elderly patients. The study was limited by its small sample and lack of a control group. Nevertheless, malnutrition and micronutrient status alterations were clearly demonstrated. The study lasted only 2 weeks which was too short to achieve changes with a nutritional intervention.

Several studies suggest a correlation between improvements in pressure ulcers and the management of patient nutrition. Donini, Defelice, Tagliaccica, Debernardini, and Cannella (2005), evaluated the effects of nutritional supplementation on dietary intake and on pressure ulcer development in critically ill older patients. A 15 day multi-center trial, involving 672 subjects older than 65 years was conducted. Women comprised 69.6% of the participants and men 30.4%. Race was not reported. Participants, were unequally distributed into a nutritional intervention group receiving two 200 Kcal oral supplement and a control group receiving standard nutrition (2200kcal diet). Prospective evaluation of Grades I, Grade II and Grade III pressure ulcers were performed using multivariate analysis. The researchers found that the cumulative incidence of pressure

ulcers was 40.6% in the nutritional intervention group versus 47.2% in the control group. The authors concluded that nutritional interventions were associated with a decreased risk of pressure ulcer incidence.

In a randomized, prospective, controlled, multi-center trial at 23 long-term care facilities in 4 states, Lee et al., (2006) compared Pressure Ulcer Scale for Healing (PUSH) scores of patients who were given standard care (patient appropriate topical and pressure ulcer relief treatment as well as enhanced foods, commercial supplements, and supplements formulated for wound healing) plus 15 grams of concentrated, fortified, collagen protein hydrolysate supplement in a 45 unit dose, to a control group comprised of residents who were given standard care plus placebo. A total of 89 residents with Stage II, III, or IV pressure ulcers were entered into the trial. However, only 71 residents completed the study. Demographic findings such as age, sex, and race were not reported. Residents were randomized to receive standard care plus a concentrated, fortified, collagen protein hydrolysate supplement (n = 56) or standard care plus placebo (n =33) 3 times daily for 8 weeks. Wound healing was assessed biweekly using the PUSH tool, version 3.0. This tool categorizes pressure ulcers by surface area, exudates, and type of wound tissue. The findings suggest that after 8 weeks of treatment, residents who received standard of care plus the concentrated, fortified, collagen protein hydrolysate supplement had significantly better PUSH tool scores as compared with those who received standard care plus placebo (3.55 ± 4.66 vs. 3.22 ± 4.II, respectively; $P < .05$). By week 8, PUSH tool score measures showed approximately twice the rate of pressure ulcer healing in the treatment group compared with the control group.

Several studies have demonstrated an association between impaired dietary intake, particularly an inadequate intake of calories and protein, and pressure ulcer risk and development (Bergstrom & Braden, 1992; Berlowitz & Wilking, 1989; Ek et al., 1991; Maklebust & Sieggreen, 1996). In a retrospective study Donini, Defelice, Tagliaccica, Debernardini, and Cannella (2005), evaluated the effects of nutritional supplementation on pressure ulcer healing in a long-term care hospital. The charts of 125 patients (69.6% women aged approximately 80.1 years and 30.4% men aged approximately 60-91 years) were studied. The researchers found that in 46.4% of patients there was overall healing of the ulcer, 31.2% of the patients showed slight improvement in the pressure ulcers, and 22.4% of the patients showed worsening of the pressure ulcer. The researchers concluded that nutritional interventions were associated with a decreased risk of pressure ulcer incidence.

Bergstrom and Braden (1992) conducted studies to determine if dietary intake, nutritional status, and other physical markers were risk factors for the development of pressure ulcers in the elderly. The cohort study was conducted in a 250-bed skilled nursing facility with 90 extended care beds in which the average length of stay was 28 days. The study comprised of two hundred newly admitted patients (70% female, 95% Caucasian) who were over age 65 years. Patients were estimated to stay greater than 10 days and were at risk for pressure sore development (Braden Scale score ≤ 17). The study lasted for 12 weeks or until discharge. Measures including skin assessment, Braden Scale score, blood pressure, body temperature, anthropometrics, and dietary intake were studied weekly. Complete Blood Count (CBC), serum albumin, serum total protein, serum iron, iron binding capacity, serum zinc and copper, and serum vitamin C were studied weekly

for 4 weeks and biweekly for 8 weeks. Results suggests that Stage I pressure sores developed in 70 (35%) and Stage II or worse in 77 (38.5%) of patients. Subjects who developed pressure sores were older (P less than 0.001) and had lower systolic and diastolic blood pressure ($p< 0.001$) and higher body temperature ($p< 0.001$) than those without pressure sores. Dietary intake of all nutrients was lower among subjects who developed pressure sores. Using logistic regression, the best predictors or pressure sore development were the Braden Scale score, diastolic blood pressure, temperature, dietary protein intake, and age. While a substantial body of knowledge exists in the support of oral nutrition, studies relating to race are still not reported in most studies

Enteral Feeding

A substantial body of data suggest that the route of nutrient administration influences the body's response to injury (Bourdel-Marchasson, Dumas, Pinganaud, Emeriau, and Decamps (1997; Pompeo, 2009). Patients with pressure ulcers and other complex problems are particularly prone to nutritional deficits (Salva, Coll-Planas, Bruce, De Groot, Andrieu, and Abellan, et al., 2009). Study data indicate that the challenge to achieve an optimal nutritional status in these patients is significant (Pompeo, 2009). In the presence of a functioning gastrointestinal tract, patients who are unable to meet their nutritional needs orally may require enteral tube feeding. Access to the gastrointestinal system is via naso-gastric, naso-intestinal, percutaneous gastrostomy or jejunostomy. Percutaneous Gastrostomy (PEG) is the preferred method when long-term feeding is needed (Fergunson, Cook, Rimmasch, Bender, and Voss, 2000).

Few studies have been found in the literature relating to the effects of enteral feedings on pressure ulcers. Bourdel-Marchasson, Dumas, Pinganaud, Emeriau, and

Decamps (1997) used a retrospective design to examine the effects of early and late tolerance of enteral feedings in older frail patients. The study was conducted in a 240 bed long-term setting with 58 patients. There were 12 patients who were under 65 years (48±10.6), and 46 over 65 (80.7± 93) years. There was no report of race or gender of patients involved in the study. Pressure ulcers were present before insertion in 34 patients in the PEG group and in 7 of the control group ($p<0.001$). The follow-up period for patients was 5- 210 weeks (71.6±61.8) in the PEG group and 3- 230 weeks (48.0±70.5) in the control group. Results suggested that early mortality (4 weeks) was 13.8% in the PEG group versus 10% in the control; mid-term mortality rate (between 4 and 8 weeks) was 12.1% in the PEG group versus 14% in the control group, and late mortality was 19.0% versus 42.0% in the control group. Pressures sores were healing in 20 out of 34 patients in the PEG group verse 2 out of 7 in the control group and new ulcers appeared in 6 out of 24 patients in the PEG group verses 8 out of 43 in the controls.

Kudsk et al. (1992) examined the effects of early enteral versus early parenteral (intravenous) feedings of trauma patients in the first 15 days of hospitalization. The randomized prospective study was comprised of 98 acute care trauma patients who had required laparotomy, all with surgically placed jejunostomy feeding tubes. Patients were randomized to receive either Total Parential Nutrition (TPN) (nutrition by vein) or enteral (tube) feeding. The pharmacy provided a parenteral formula with similar concentration of protein to the enteral feed. Instructions for full-strength formulas progressed towards the goal rate of 1.5 to 2.0 Kcal/kg/day of protein and 30 -35 Kcal/kg/day of non-protein calories. Twenty four hour urine collection was done on days 1, 4, 7, and 10 from the first 25 patients admitted to the trauma intensive care unit. Nitrogen balance was calculated

on days 1, 4, 7, and 10. Patients remained in the study until they were able to tolerate one full meal. Patients included in the study were above 18 years old. The study report did not include race or gender. Although no significant differences in nitrogen balance were found between the groups, enterally fed patients developed significantly fewer infections ($p<0.05$). The authors postulated that enteral feeding improves gut architecture and micro flora and helps the mucosa withstand challenges.

Pompeo (2009) using a prospective, descriptive study evaluated the hypothesis that many wound patients require higher levels of protein than is commonly recommended and that wound size and severity affect protein requirement. Because many tube-fed patients have wounds and estimates of actual intake are easier to obtain in this patient population, tube-fed patients with and without wounds participated in the study. Wound patients and non-wound patients were started at 1.25 g/Kg/day protein and 1.0 g/Kg/day protein, respectively. The standard protocol recommended by the dietitian for both groups emphasized weekly pre-albumin level checks and rapid escalation of protein provision if the pre-albumin was not normal (18 - 45 mg/dl) Changes were made weekly based on weight and pre-albumin trends until patients were discharged. The 150 patients enrolled in the study included 93 wound patients (37 men, 56 women; mean age 72.5 years) and 57 non-wound patients (26 men, 31 women; mean age 70.3 years). Women comprised the majority of patients in both groups (60% of the wound group, 54% of the non-wound group). Race was not reported. Wound information, including wound size (measured in cm with a disposable paper ruler) and the PUSH score obtained on admission. For patients with more than one wound, individual wound PUSH scores (range 0 for healed wounds to 17 for most severe wounds) were summed to obtain a total

PUSH score per patient as an indicator for patient wound burden as previously described. Although average length of stay (LOS) was longer for wound patients (36.9 versus 29.7 days), this difference was not statistically significant. Pre-albumin normalization or an increase by 8 units or more was achieved in 42% and 46% of wound and non-wound patients, respectively. Protein requirements suggested by total admission PUSH scores demonstrated a higher correlation/statistical significance (0.463, P = .003).

Opposing views were noted by Hartgrink, Wille, Kcnig, Herman, and Breslau (1998) who conducted studies to determine the effect of supplemental feeding on the nutritional status, the development and severity of pressure sores. The randomized study was comprised of 129 patients (62 tube +, and 67 tube -). Protein and energy intake, hemoglobin, serum albumin, total serum protein and pressure-sore grade were measured at admission and after 1 and 2 weeks. Of the 62 patients randomized for tube feeding (tube +), only 25 tolerated their tube for more than 1 week and 16 for 2 weeks. All patients received the standard hospital diet (2200 kcal). Tube feeding patients received 1 liter (1500kcal/1 energy, 60 gm protein Nutricia (A high protein drink). Results suggest that, energy and protein intake were significantly higher in the tube +group (P< 0.001). This, however, did not significantly influence total serum protein, serum albumin, development and severity of pressure sores after 1 and 2 weeks. This study was limited in that the nasogastric tube for supplemental feeding was not well tolerated in this patient group.

Theilla, Singer, Cohen, Dekeyser (2007) in a prospective randomized study, evaluated the preventive and healing effects of an enteral diet (enriched in eicosapentanoic acid (EPA), gamma-linolenic acid (GLA), and vitamins A, C and E) on

pressure ulcers. The control group received a ready to feed, high fat, low carbohydrate, enteral formula (Pulmocare, Ross Laboratories containing 16.7 gm protein, 28.1% carbohydrate, and 55.25 lipids). The study group received a formula with the same macronutrient composition but with additions of EPA, GLA and vitamins A, C, and E. Pre-albumin and albumin levels were measured every 3 days. The occurrence and the state of the pressure ulcers were checked daily and graded according to the National Pressure Ulcer Advisory Panel guidelines (Stage 1, Stage 2, Stage 3, and Stage 4). The randomized, prospective, non-blinded study sample was 100 patients, males and females with a mean age of 62.3 years. Males were predominant (57.1%) in the study, and race was not reported. Results suggest that after 14 days the occurrence of new pressure ulcers in the experimental group was significantly less ($p < 0.05$). No difference was observed in the healing of existing pressure ulcers in the experimental group as compared to the control group.

Calories

Adequate calories are needed to prevent malnutrition, the breakdown of protein and to meet energy needs. Malnutrition is prevalent in elderly populations and recommended methods of nutritional screening are often too complicated and time-consuming for routine application in frail, very old, hospitalized patients.

To identify risk factors for development of malnutrition in very old hospitalized patients and to evaluate the total Mini Nutritional Assessment (MNA) score and MNA sub-scores as predictors of in-hospital and long-term mortality, Kagansky, Berner, Koren-Mogag, Perelman, Knobler, and Levy (2005) conducted a prospective cohort study of patients aged ≥75 years.. Assessment included demographic, clinical, and laboratory data

and cognitive, functional, and nutritional status. Follow-up was conducted for ≤2.7 years. Females were predominant (63.7%) and most of the patients (69.3%) reported moderate to severe loss of appetite. Race was not reported. Of the 414 patients studied, only 73 (17.6%) were well-nourished. Low serum albumin and phosphorus concentrations, dementia, and cerebrovascular accident (CVA) were significant risk factors for malnutrition. Survival was significantly lower in malnourished patients and patients at risk of malnutrition than in well-nourished patients ($p < 0.0001$). Low MNA-3 sub-scores (dietary habits) were significantly correlated with laboratory indexes of malnutrition and were significantly lower in patients with infections, malignancy, pressure ulcers, dementia, recent orthopedic surgery, and CVA. Multivariate analysis showed that a low MNA-3 score was an independent predictor of mortality; scores <7.5 increased the risk of death 2.05-fold.

The Agency for Health Care Policy and Research Guidelines (AHCPR) recommends providing 30 to 35 calories per kilogram of body weight daily for individuals with a pressure ulcer who are malnourished. These recommendations include patients at risk of pressure ulcer development although the calorie needs vary for each patient. A carbohydrate intake of 55% to 60% is required for the provision of the energy necessary to support metabolism and prevent the development of pressure ulcers (Fergunson, Cook, Rimmasch, Bender, and Voss, 2000).

Protein

Several studies have been conducted demonstrating that low protein status is a significant risk factor for pressure ulcer development (Kagansky, Berner, Koren-Mogag, Perelman, Knobler, and Levy, 2005; Reed, Hepburn, Adelson, Center, and McKnightld,

2003). To determine the effect of dietary protein on healing of pressure ulcers in malnourished patients Breslow, Hallfrisch, Guy, Cawley, Andrew, and Golberg (1993), conducted a nutritional intervention trial with the non-randomized assignment of patients by pressure ulcer stage and bed type. The study comprising of 28 male and female patients (age = 72 +/- 18 years) with a total of 33 pressure ulcers, took place in a long term care facility. The race of the patients was not reported. Patients received liquid nutritional formulas as tube feedings or meal supplements containing either 24% protein (61 g protein/L; n = 15) or 14% protein (37 g protein/L; n = 13) for 8 weeks. The result demonstrated that there was a significant decrease in pressure ulcer surface area of the 15 patients in the 24% protein group (-4.2 +/- 7.1 cm2, $P < 0.02$), but not in the 13 patients in the 14% protein group (-2.1 +/- 11.5 cm2, P = NS). The change in total ulcer area correlated with both dietary protein intake per kg body weight ($rs = -0.50$, $P < 0.01$) and caloric intake per kg body weight ($rs = -0.41$, $P < 0.03$). The decrease in stage IV ulcer area in eight patients in the 24% protein group (-7.6 +/- 5.8 cm2, $P < 0.02$) was significantly greater ($P < 0.05$) than in eight patients in the 14% protein group (-3.2 +/- 16.4, P = NS). In these 16 patients, the decrease in ulcer size also correlated with dietary protein intake per kg body weight ($p < 0.01$). Although the ability to generalize the study findings due to it size is limited, the results suggested that a trend towards the healing of pressure ulcer with a 24% protein diet.

Desneves, Todorovic, Cassar, and Crowe (2005) studied the effects of a standard hospital diet (2,200 kcal/day), a standard diet plus two high-protein energy supplements, or a standard diet plus two high-protein energy supplements containing additional arginine (9g), vitamin C (500mg) and zinc (30mg). The 16 patients with Stage II, Stage

III or Stage IV pressure ulcer were randomized to receive daily nutritional status measurements. Nutritional status measurements (dietary, anthropometric and biochemical) and pressure ulcer size and severity (by PUSH tool; Pressure Ulcer Scale for Healing; 0= completely healed, 17=greatest severity) were measured weekly for 3 weeks. Patients' age and BMI ranges were 37-92 years and 16.4-28.1 k g/m2 respectively. Race of patients was not reported. Baseline PUSH scores were similar between groups (8.7+/-0.5). Results suggested that only patients receiving additional arginine, vitamin C and zinc demonstrated a clinically significant improvement in pressure ulcer healing (9.4±1.2 vs. 2.6±0.6 at baseline and after week 3, respectively, $P<0.01$). In this small set of patients, supplementary arginine, vitamin C and zinc significantly improved the rate of pressure ulcer healing. The results need to be confirmed in a larger study.

Decreased protein has been associated with pressure ulcers in cross-sectional studies (Bergstrom and Braden, 1992; Berlowitz and Wilking, 1989). Protein depletion impairs wound healing by inhibiting fibroblast proliferation and collagen synthesis. In the presence of a wound, exudates could be as much as 100g per day (Russell, 2001). Earlier approaches to address protein malnutrition involve daily intake of 1.5 to 1.8 g/Kg of protein daily without wound size considerations (Gersovitz, Motil, Munro, Scrimshaw, and Young (1982). Current guidelines by the Agency for Health care Policy and Research (AHCPR) recommend 1.25 to 1.5g/kg/day for patients with pressure ulcers who are malnourished (Bergstrom et al., 1994). However, some studies recommend even higher levels.

According to Harris and Fraser, (2004), protein intake may need to be increased by as much as 2.5 times to accommodate the loss of lean body mass. Still other

researchers argue that increasing protein intake beyond 1.5 g/kg/day may not increase protein synthesis and may cause dehydration (Ayello, Thomas, and Litchford, 1999; Long, Nelson, Akin, Geiger, Merrick, and Blakemore, 1990; Rudman and Feller, 1989). Still other researchers argued that to improve pre-albumin levels, patients with wound require higher levels of protein than is commonly recommended. Pompeo (2009 found that the average maximum amount of protein provided to patients whose pre-albumin improved was significantly higher in the wound than in the non-wound group (1.85 g/Kg/day compared to 1.47 g/Kg/day).

Hydration

The age-related decrease in total-body water (relative and absolute) makes elderly persons markedly susceptible to stresses in water balance (Kugler and Husted, 2000). Fluid is an essential nutrient for the normal functioning of cells and is especially important for older adults because of their increased risk for dehydration. Dehydration is common in patients who are malnourished and indirectly puts patients at greater risk of developing ulcers (Fergunson, Cook, Rimmasch, Bender, and Voss, 2000). Dehydration reduces the amount of oxygen, nutrients and cell-building substances to the wound because of its effect on blood volume and circulation, (Campbell and Hall, 1997). Average healthy 30- to 40-year-old persons have a total-body water content of 55 to 60 percent. By age 75 to 80 years, the total-body water content has declined to 50 percent, with even more of a decline in elderly women (Kugler and Husted, 2000).

Chidester and Spangler (1997) studied actual fluid intake in 40 institutionalized elderly residents who were free from acute illness and or were not receiving enteral feedings, compared with three established standards to determine adequacy of fluid

intake. Consecutive 3- day food and fluid intake was observed directly and analyzed by computer for water content. Number and frequency of medications and Minimum Data Set (MDS) information about cognitive skills, physical locomotion, and ability to understand were obtained from medical records. Recommended fluid intake was determined using three established standards for two age groups: 65 through 85 years and 86 through 100 years. The standards were 30 mL/kg body weight (standard 1); 1 mL/kcal energy consumed (standard 2); and 100 mL/kg for first 10 kg, 50 mL/kg for next 10 kg, and 15 mL for remaining kg (standard 3). A two-tailed t test was used to compare actual fluid intake with recommended fluid intake. Interaction effect of age on fluid intake was analyzed using multiple analyses of variance. Correlations were used to evaluate relationships among fluid intake, number and frequency of medications, age, and weight. Findings suggest that this population received adequate or more than adequate fluid according to the standards of 30 ml/kg body weight or 1 ml/kcal energy consumed, but inadequate fluid according to standard 3, which adjusted for extremes of underweight or overweight. When the standard of 30 ml/kg body weight is used, underweight residents have unrealistically low fluid recommendations. Standard 3, which adjusts for extremes in body weight, is more reasonable for patients whether they are of normal weight, underweight, or overweight. This standard more closely supports other recommendations of 1,500 to 2,000 ml fluid intake per day.

In a study (previously described, p. 27) comprised of 837 patients, Thomas, Zdrowski, Wilson, Conright, Lewis, Tariq, and Morley (2002) found that there was a high correlation between poor hydration and MNA score. Subjects with an MNA score <17 were 6 times more likely to be dehydrated than were subjects who had an MNA

score of 17-23.5. The researcher suggested that it is likely that subjects who are malnourished are not meeting their hydration needs because of poor intake. A number of factors increase the risk of dehydration in the elderly. These include inadequate intake, poor appetite, compounded by chronic illnesses such as diabetes, hormonal changes associated with menopause, and the use of certain medications (Mayo Clinic, 2009). Most noticeable are decreased sensitivity to thirst and increased personal concerns about incontinence (Schmidt, 2002). Excessive fluid loss such as wound drainage can lead to dehydration and electrolyte imbalance. Optimal hydration is attained when fluid intake equals fluid output. According to the AHCPR guidelines, unless medically contraindicated; the minimum daily fluid intake includes 30-33ml per kilogram body weight for patients with pressure ulcer. Additional fluids of 10-15 ml/kg may be requires for wound drainage, air-fluidized bed and other losses (Bergstrom et al., 1994; Campbell and Hall, 1997).

Vitamins

Researchers have identified several nutritional cofactors involved in tissue regeneration, including vitamins A, C, E, and zinc. Deficiencies of these cofactors have been shown to have significant effects on pressure ulcers (Alverez and Gilarteh, 1982; Gode and Burns, 1992). The prevalence of vitamin deficiencies among older Thai people was found to be quite different from that found in Western countries (Assantachai1 Somsong, 2005), reflecting different socioeconomic backgrounds. The researchers found that Vitamin deficiency was not only from poor food intake but also from the dietary habit of monotonous food consumption in older people. In a cross-sectional study of 2336 subjects, Assantachai1 Somsong (2005) examined the prevalence

and risk factors of vitamin deficiencies among older Thai adults. The proportion of males to females was 889:1447 (1:1.63). The mean age of subjects was 68.94 years (range 60–97 years). Anthropometric variables, demographic data, blood glucose and lipid profile, albumin, globulin and blood levels of vitamin A, B-carotene, folic acid, vitamin B12, vitamin C, vitamin E and vitamin B1 were all measured. The prevalence of vitamin deficiencies was 0.6% for vitamin B12, 6.1% for vitamin A, 9.9% for vitamin C, 30.1% for vitamin B1, 38.8% for erythrocyte foliate, 55.5% for vitamin E and 83.0% for b-carotene. Male gender was a common risk factor for at least three vitamin deficiencies, i.e., b-carotene, folate and vitamin E. Being a manual worker was a common risk factor of b-carotene and vitamin B1 deficiency. Poor income was found as a risk factor only in erythrocyte foliate deficiency while increasing age was a significant factor only in vitamin C deficiency.

Similarly, Shara, Yin Chee, and Wan Chik (2002) evaluated the nutrient intake and food preferences of patients in a cross sectional survey of 120 hospitalized geriatric patients. Of the patients who completed the study, 55% were females and 82.5% aged 60 to 74 years. The race composition of the subjects was 50.8% Malay, 37.5% Chinese and 11.7% Indian which was close to the national ratio. The researchers reported that the mean intake of energy and all nutrients, except for vitamin C, and fluid were below the individual requirement for energy, protein, fluid, and the Malaysian Recommendation of Dietary Allowances (RDA) for calcium, iron, vitamin A, thiamin, riboflavin, niacin and acid ascorbic.

The contribution of specific nutritional deficiencies (as indicated by zinc; vitamin A, C, and E; albumin; and hemoglobin concentrations) to the risk of pressure sores has

been extensively studied (Harris and Fraser, 2004; Scholl and Langkamp-Henken, 2001; Gode and Burns, 1992). In an observational cohort study of 21 elderly patients Gode and Burns (1992) examined the effects of Vitamin C depletion and pressure sores in elderly patients with femoral neck fracture. The main outcome measured was full thickness epidermal break over a pressure bearing surface. Age, gender and race of patients were not reported. Findings suggest that 10 patients (48%) developed a pressure ulcer during their hospital stay. Indices of zinc status and concentrations of albumin, hemoglobin, and vitamins A and E were similar in patients who developed pressure ulcers to those who did not. Mean leukocyte vitamin C concentration, however, was 6.3 (SD 2.2) micrograms/10(8) cells in patients who developed a pressure ulcers as compared with 12.8 (4.6) micrograms/10(8) cells in patients who did not. The researchers concluded that low concentrations of leukocyte vitamin C appear to be associated with subsequent development of pressure sores in elderly patients with femoral neck fractures.

Rojas and Phillips (1999) compared nutritional serum indices between patients with chronic leg ulcers and an age-matched control population. The study included 17 patients (male and females), ages 47 to 90 years old with chronic leg ulcers. A panel of vitamins (A, B_1, B_2, B_6, B_{12}, and E), trace elements (zinc, copper, and iron), folate, and carotene levels were screened on fasting blood samples. Study data were compared with data obtained from the nutritional status survey (NSS) in the greater Boston area. The findings have shown that deficiencies of vitamins and minerals exist in patients with pressure ulcers. Significantly lower levels of vitamin A ($p < 0.0001$), zinc ($p < 0.0001$ men, $p = 0.027$ women), and carotenes ($p = 0.0023$ men, $p = 0.0067$ women) were found

in chronic ulcer patients. In addition, significantly lower levels of vitamin E ($p < 0.009$) were observed in the men.

According to Fleishman (2005), vitamin A, if taken in large doses for a long period can become toxic and cause liver abnormalities. Therefore, vitamin A is taken for 10 days and then the wound is reassessed. No evidence has been found for wound healing with vitamin C supplementation in patients who are not vitamin C-deficient. In administering vitamin and zinc supplements, care is taken to avoid toxicity or antagonistic effects on wound healing (Scholl and Langkamp-Henken, 2001).For patients who regularly consume less than 75% of their diet, a daily multivitamin/mineral supplement that provides 100% of the recommended daily intake for most vitamins and minerals is normally provided (Fergunson, Cook, Rimmasch, Bender, and Voss (2000). When specific deficits are diagnosed, vitamin supplements may need to be increased by 10-20 times the normal recommended dose (Russell, 2001). Vitamin C recommendations for treating pressure ulcers are usually 1,000 to 2,000 milligrams per day in divided doses if deficiency is suspected (Fleishman, 2005).

Zinc

Zinc is a common and essential mineral found in almost every cell in the body. In addition to its importance in the inflammatory phase of wound healing, zinc is also associated with the activation of lymphocytes, enzymes, proliferation, and remodeling phase of wound healing (Harris and Fraser, 2004). "Historically, zinc has long been associated with wound healing. Zinc oxide, in the form of calamine, was used by the Egyptians, and since then, zinc compounds have been used in a large variety of lotions, salves (smoothing ointment) and ointments although their usefulness has never been

demonstrated experimentally" (p. 1048). Although, patients with zinc deficiency may experience delay in wound healing (Schmidt, 2002), supplementation is only recommended to replenish depleted stores, as excess supplementation may adversely affect wound healing (Scholl and Langkamp-Henken, 2001).

Agren (1990) examined the effect of topically applied zinc on leg ulcer healing in humans and examine its effect on some mechanisms in wound healing using standardized animal models. Thirty-seven patients with leg ulcer were randomized to zinc oxide or placebo treatment. The study included men and women whose median age was 78 years old. The ulcers area was determine by tracing of the ulcer outline on plastic foil. Zinc oxide was topically applied to the wound daily. After a treatment period of 8 weeks, the wounds were assed independently by 2 physicians. The success rate was significantly higher ($p < 0.05$) after 8 weeks for the zinc treated group (83%) than for the placebo treated group (42%). In addition, 11 of the 18 ulcers treated with the zinc oxide had healed completely after 12 weeks compared to 4 of the 19 placebo treated group.

Pories, Henzel, Rob, & Strain (1967) reported positive outcomes from clinical experiments with orally administered zinc sulfate on wound healing. Using an experimental and control group ten randomly selected controls (mean age 25 years old) were matched against ten who were given the drug (mean age 24.6 years). The wounds were cleansed and dressed daily but otherwise not treated. Wound impressions were made serially with dental alginate hydrocolloid permitting direct measurement of wound volume as a quantitative indicator of healing progression. The end point of healing was total epithelialization of the cavity when no new crust would form. They administered zinc sulfate USP, 220 mg. by mouth in gelatin capsules three times a day to one group of

ten men. Another group of ten with the same wounds served as controls. The results showed that the control group required 80.1 ± S.E. 13.7 days to heal wounds averaging 32.3 ml. in volume whereas the zinc medicated group required only 45.8 ± S.E. 2.6 days to heal wounds more than one and one-half times as large (averaging 54.5 ml. in volume). Opposing views were reported in similar studies however (Barcla, 1970).

Barcla (1970) examined the acceleration of wound healing with zinc sulfate using a randomized control trial. Twenty young and otherwise healthy patients (19 to 35 years) with chronic wounds were numbered consecutively with odd numbered patients assigned to the control group and even numbered patients to the zinc therapy group. Ten control group patients were maintained on their usual diets without restriction during the healing period. The remaining 10 patients received zinc sulfate by mouth in addition to a normal diet. Dosage was one capsule, three times a day, each capsule containing 220mg. of Zinc Sulfate USP ($ZnSO_4 \cdot 7H_2O$) supplying the equivalent of 150mg of elemental zinc per day. At 5 days intervals, wound volume was measured and recorded. All wounds were considered healed when the entire surface was covered with epithelium and no new crust would form. Results of this study demonstrated a lack of acceleration in wound healing. In the control group, wounds healed in 59.6 ± S.E. 3.7 days, and in the zinc-medicated patients wounds healed in 63.7 ± S.E. 6.2 days. Results of this study did not agree with those of other studies (Pories,, Henzel, Rob, & Strain, 1967). The reasons are not apparent, but it is suggested that either zinc sulfate is not a significant factor in the acceleration of wound healing or that neither study could be controlled sufficiently to cover all variations in individual patients. Several possible reasons for a potential failure were postulated. First, variations in the intensity of the chronic inflammatory process

existed among the patients due either to prior operations or repeated infections. Second, the effect on healing of the different bacterial flora in the various wounds could not be determined. Third, the wide differences in body configurations among patients may be a factor both in healing and measurement of the wounds (Barcla, 1970).

Summary

Despite the cause of reduction in food intake, now good evidence exists that inadequate intake will predispose elderly patient to increase risk for pressure ulcer development. Despite compelling evidence that adequate nutrition promotes the healing of pressure ulcers in humans, patient care practices have not been standardized. More research is needed to further explore nutritional risk factors for pressure ulcers and more important, describe standard management practices which might improve nutrition in this at-risk population.

Consideration needs to be given to a variety of factors including patients' individual needs, cultural norms, and the ability to masticate as well as psychological factors such as social isolation which may adversely affect institutionalized elderly patients. Studies relating certain components of the diet (such as vitamins and zinc) in wound healing are varied. Some studies have reported no significance in the development of pressure ulcers (Barcia, 1970); while other studies have demonstrated beneficial effects in patients with slow healing of wounds (Gode and Burns, 1992; Pories, Henzel, Rob, & Strain, 1967). More rigorous studies are needed to further clarify these findings.

Dressings

Introduction

Realizing that prevention of pressure ulcers is less costly than treatment;

most current studies are geared towards pressure ulcer prevention and early identification (Horn, et al. (2004). However, even with the best strategies, not all pressure ulcers can be prevented. Furthermore, once acquired, existing pressure ulcers may become chronic. Although interventions for managing pressure ulcers vary from institution to institution, the treatment of pressure ulcers can be broken down into three categories: local treatment of the wound, pressure relief modalities, and the use of adjunct therapies (The Royal College of Nursing, 2005).

Once a patient develops pressure ulcer, wound management is crucial according to Bansal, Scott, Stewart, and Cockerell (2005). Local treatment of the wound includes wound and peri-wound cleansing (Gray and Jones, 2004: Thompson, Langeemo, Anderson, Hanson, and Hunter, 2005) and the reduction of bacterial load in the wound through dressings (Meaume, Villet, Morere, and Téot, 2005; Chandler, Benfield, Williams, and Lansdown, 2005). With an estimate of more than three hundred different types of dressings currently on the market (Lyder, 2005), choosing the right dressing is not always a simple decision for clinicians. Questions about the efficacy of treatment and the evidence that supports the various interventions are often expressed by clinicians. Current studies relating to wound care are few and are mainly related to the exploration of the theory of moist wound healing (Welbery (2002).

In an 8 week, randomized, single-blind, controlled trial, Graumlich et al., (2003) compared the effects of topical collagen to hydrocolloid on pressure ulcer healing. This study, which included 65 patients, was conducted in 2 nursing homes. Participants had a median age of 83.1 years and were being treated for Stage II or III pressure ulcers. Using multivariate analysis, the study concluded that although collagen was more expensive

than hydrocolloid, there were no significant differences in healing outcomes between the two dressings. Other than cream and lotions, the theory of moist wound healing has been tested using less conventional materials.

In a clinical study that compared polyvinylidine (PVL) food wrap dressing versus conventional ointments and gauze dressings for pressure ulcers, Takahashi, Yokota, Fujisawa, Sasaki, Ishizu, and Okawa (2006) used a prospective open controlled design. Twenty five patients age 60 years and older were treated with the PVL film dressings and 24 with the conventional treatment. The study included both males and females. Race was not reported. The severity of pressure ulcers in both groups was evaluated using the DESIGN system (a wound assessment tool developed in China). DESIGN is an acronym for six of the seven subscales used to classify the wound state (depth, exudates, size, infection, and granulation). Necrosis in the wound is also assed using this tool. The total score range from 0 to 28. The higher the DESIGN scores the greater the severity. Scores were compared at baseline, 4, 8 and 12 weeks. The test group showed greater improvement in DESIGN scores than the control group throughout the observation period, and the difference reached statistical significance at 12 weeks ($p<0.05$). Using multivariate analysis, the incidences of local wound infection in the two groups were not statistically different ($p>0.999$). The research concluded that the PVL film dressing was more effective than conventional treatment in the management of severe pressure ulcers.

To evaluate the effect of a hydrogen wound dressing containing a combination of endopeptidases on pressure ulcers Parnell, Ciufi, and Gokoo (2005) conducted a 12-week prospective study involving 10 nursing home patients with Stage II ($n = 3$) or Stage III ($n = 7$) pressure ulcers that had failed to respond to previous treatments. Seven subjects

(three with Stage II ulcers and four with Stage III ulcers) completed the study. Healing was based on wound closure by re-epithelialization as determined by area measurement and clinical assessment. All three Stage II ulcers and two of the Stage III ulcers healed completely; four Stage III ulcers were categorized as healing (>60% improvement) after 12 weeks of care. No dressing-related adverse events occurred and subject acceptance of the product, including comfort, was high. These results suggest that additional studies designed to define the possible contribution of endopeptidase enzymes in wound healing are warranted. No report of sex, age or race was mentioned in this study.

Xakellis and Chrischilles (1992) examined the cost effectiveness of using hydrocolloid dressings versus non-sterile saline-gauze wet-to-moist dressings for treatment of pressure ulcers in a long-term care setting. During a period of 21 months, 39 females were randomly assigned to two groups. The median age of the subjects was 83.5 years. Race was not reported. The findings suggest that 89% of the hydrocolloid subjects and 86% of the saline-gauze subjects healed. Median healing time was shorter for the hydrocolloid group (9 days) than for the saline-gauze group (11 days), although the difference did not reach statistical significance ($p = .12$). Presence of exudates at baseline was associated with a prolonged time to healing. For the hydrocolloid treatment, the median nursing time was 1/ 8 that of the saline-gauze treatment, but the materials' cost was 3.3 times higher. Using local nursing wages, median total cost for treatment with hydrocolloid dressing was $15.58; for the saline gauze, it was $22.65. Using national nursing wages, these costs were $15.90 and $25.31, respectively. The cost savings of the hydrocolloid treatment using local wages did not reach statistical significance. However, using national wages, the cost of the hydrocolloid treatment was significantly less

expensive. Nursing home treatment of pressure ulcers was inexpensive overall. Consequently, the absolute cost savings of using hydrocolloid dressings instead of non-sterile saline-gauze dressing, although real, was relatively modest.

Pressure Relief Modalities

Introduction

Described as the cornerstone of pressure ulcer management (Bensal, Scott, Stewart, and Cockerell, 2005), pressure relief modalities come in a number of forms. Although evidence exists that these surfaces provide an environment in which ulcers can be prevented or improved, no evidence suggests that one support surface consistently performs better than all others in all circumstances (Nixon et al., 2006). Therefore, patients are actively treated on an individual basis to reduce specific risk factors. Current interventions are geared towards preventing or relieving pressure to the body. These modalities include beds, flotation devices, mattresses, cushions, foam devices, air-filled devices, water-filled devices, gel-filled devices, low air-loss beds, and air-fluidized beds (Cavicchioli and Carella, 2007; Kirk man and Molnar, 2008).

Beds/Cushions

Earlier studies by Allman, Walker, Hart, et al. (1987) compared the effectiveness of air-fluidized beds to conventional therapy for patients with pressure sores. The study was comprised of 65 patients. The experimental group comprised of 31 patients on air-fluidized beds (Clinitron Therapy) was repositioned every 4 hours and were without the use of other anti-pressure devices. The 34 patients in the control group on conventional therapy used an alternating air-mattress covered by a foam pad (Lapidus Air Float System) on a regular hospital bed. The control group patients were repositioned every 2

hours; and had elbow or heel pads as needed. Pressure sores showed a median decrease in total surface area (-1.2 cm2) on air-fluidized beds, but showed a median increase (+ 0.5 cm2) on conventional therapy. Improvement, as assessed from serial color photographs by investigators masked to treatment group, occurred in 71% and 47%, respectively; 95% CI for the difference, 1% to 47% (p = 0.05). For pressure sores 7.8 cm2 or greater, outcome differences between air-fluidized beds and conventional therapy were greater: median total surface area change was -5.3 and +4.0 cm2, respectively; 95% CI for the difference, -42.2 to -3.2 cm2 (p = 0.01). Improvement rates were 62% and 29% respectively; 95% CI for difference, 1% to 65% (p = 0.05). After adjusting for other factors associated with pressure ulcer outcome, the estimated relative odds of showing improvement with air-fluidized beds were 5.6-fold (95% CI, 1.4 to 21.7) greater than with conventional therapy (p = 0.01). No significant increase in adverse effects was seen with air-fluidized beds. The findings suggest that air-fluidized beds are more effective than conventional therapy, particularly for large pressure sores.

Similar findings were reported by Ochs, Horn, and Smout (2005) who compared air-fluidized therapy with other support surfaces used to treat pressure ulcers in long-term care residents. The retrospective observational study included 664 male and female patients. Study data were obtained from the medical records of 2,486 adult residents from 109 long-term care facilities. Three months of data were collected for each resident 18 years of age or older with a length of stay >=14 days. Pressure ulcer data included Braden Scale assessments, number of ulcers per resident, ulcer tissue type, amount of exudates, the site, stage, and surface area of each pressure ulcer. Support surfaces were categorized as: Group 1 (static overlays and replacement mattresses), Group 2 (low-air-loss beds,

alternating pressure, and powered/non-powered overlays/mattresses), and Group 3 (air-fluidized beds). Patients were reevaluated on a weekly basis. Significant differences were found in pressure ulcer healing rates for residents with air-fluidized support surfaces compared with residents on other surfaces ($p<0.007$). Patients with pressure ulcers on air-fluidized surfaces had statistically significant faster healing rates (particularly for stage III and stage IV ulcers) compared with patients on low air-loss and replacement mattresses.

Opinions vary when comparing differences between alternating pressure overlays and alternating pressure mattresses as demonstrated by Nixon et al., (2006). The study which included 1972 males and females, 55 years or older, examined differences between alternating pressure overlays and alternating pressure mattresses in the development of new pressure ulcers, healing of existing pressure ulcers, and patient acceptability. Participants were randomized to an alternating pressure mattress ($n = 982$) or an alternating pressure overlay ($n = 990$). The clinical research nurses assessed skin status twice weekly for 30 days and then once a week up to 60 days. Results based on multivariate analysis found no difference in the proportions of participants developing a new pressure ulcer of Stage2 or worse (10.7% overlay patients, 10.3% mattress patients; difference 0.4%, 95% confidence interval − 2.3% to 3.1%, $P = 0.75$). More overlay patients requested a change owing to dissatisfaction (23.3%) than mattress patients (18.9% $P = 0.02$).

In a 6 month, randomized, prospective cohort study Rosental et al., (2003) compared wound healing between three different support surface modalities (low air loss beds, upgraded bed overlays, and generic therapeutic seat). The study which included 207

men and women (median age75 years) took place in a long-term care facility. Subjects were allocated to low air loss bed, upgraded bed overlay or 4h /day sitting on an experimental generic total contact seat. The seat was designed using prosthetics principles aimed at distributing pressure off bony prominences onto less pressure-sensitive areas. Using multivariate analysis, the results reflect that in study 1, 3 subjects worsened on the bed overlay, none worsened on low air loss or generic total contact seat. At 4 weeks in both studies, pressure ulcer status score was lowest for the generic total contact seat (*P*-.0001), compared with the other surfaces. Subject populations were similar, so to analyze total healing, results from both studies were combined. Total healing of pressure ulcers occurred as early as 4 weeks in some subjects using the generic total contact seat. Even at 8 weeks, total healing was primarily seen with use of that seat, on which interface pressures, function, and seating tolerance were best.

Adjunct Therapy

There a number of adjunct therapies that has been investigated for effectiveness in managing pressure ulcers. These include electro stimulation, ultrasounds, laser therapy, hyperbaric oxygen, and pulsed electromagnetic field energy and vacuum assisted therapy. Emphasis in this study will include the most frequently used methods for managing pressure ulcers (electro therapy, and vacuum assisted therapy (VAC).

Electrotherapy

Electrotherapy is the use of electrical energy as a medical treatment (Dictionary, 2009). In medicine, the term *electrotherapy* can apply to a variety of treatments, including the use of electrical devices to promote wound healing. Electrotherapy devices have been studied in the treatment of chronic wounds and pressure ulcers. Carley, and

Wainapel (1985) investigated the use of electrotherapy for acceleration of wound healing. A small and portable low intensity direct current (LIDC) stimulator was specially constructed and used in a study of the effects of LIDC on wound healing rates. In this randomized controlled trial, 30 male and female patients with a mean age 73.6 years were assigned to the LIDC protocol (low intensity direct current in the range of 200 microA to 800 microA) or to more conventional wound therapy. The patients in each treatment group were matched by age, diagnosis, wound size, and wound etiology. Race was not reported. Comparison revealed 1.5 to 2.5 times faster healing in those receiving LIDC, which was statistically significant. The wounds treated with LIDC required less debridement and the healed scars were more resilient. Additionally, no wound infections occurred and patients reported less discomfort at the wound site. Low intensity direct current appears to be a convenient, reproducible, and effective method for improved healing of chronic open wounds and warrants more widespread use in the clinical setting.

Adunsky and Ohry (2005) in a double-blind, randomized, placebo-controlled study involving 11 departments of geriatrics and rehabilitation, examined direct current treatment (DDCT) electro-stimulation treatment of pressure ulcers Stage 3, with respect to rates of ulcer closure and wound area reduction. The study included 63 male and female patients with a mean age of 71.4 years. Race of patients was not reported. The researchers compared a placebo treated group (PG) with an active treatment group (TG). Treatment lasted for 8 consecutive weeks, followed by a 12-week-period of follow-up. At day 57 (end of treatment) and at day 147 (end of follow-up), there was no difference between the groups with regard to rates of complete closure of ulcers ($p = 0.28$ and 0.39, respectively) as well as for the mean time needed to achieve complete wound closure

($p = 0.16$). Absolute ulcer area reduction and speed rate of wound area reduction (reflected by change from baseline ulcer area, percentage) were better in participants allocated in the treatment group only until day 45. Afterwards, there were no differences between the two groups. A logistic regression analysis favored complete healing in TG, compared with PG (odds ratio 1.6, CI 0.4–4.73). Analysis of per protocol patients revealed that time needed for wound closure was 52% longer in PG ($p = 0.03$, compared with TG. The results suggest that DDCT treatment for pressure ulcers Stage 3, in addition to the conservative wound care, may be useful in accelerating the healing process during the first period of care.

Ultraviolet

Ultraviolet light treatment uses a particular band of the non-visible light spectrum to treat a variety of skin diseases including pressure ulcers (Nussbaum, Biemann and Mustard, 1994). Wills, Anderson Beattie, et al. (1983) investigated the use of ultraviolet (UV) light treatment of pressure sores. Eighteen patients residing in a long-term care facility participated in the randomized controlled trial. The patients, suffering from superficial pressure sores of recent onset were assigned to active and placebo treatment groups. Two groups consisting of male and female residents, with a mean age of 87.1 years participated in the study. Both the patients and the hospital staff were blind about individual allocation, because treatment procedures appeared identical in both groups. Sixteen patients completed the study. Mean time to complete healing was 6.3 weeks in the UV treated group, significantly ($p< 02$) less than the mean of 8.4 weeks in the placebo group. This difference persisted unchanged when each patient's age and the initial size of the sore were taken into account by an analysis of covariance. Thus, in spite of growing

skepticism about its effectiveness, it appears that UV light may play a useful role in the treatment of pressure sores, and a systematic evaluation of different treatment protocols seems to be justified.

Vacuum Assisted Therapy

Researchers around the world are focusing on negative pressure therapy otherwise called vacuum assisted closure (VAC) as one of the most innovative wound care interventions in many years (World Union of Wound Healing Societies, 2008). This simple technique comprises of a piece of foam dressing placed in a wound bed which is then covered with a transparent adhesive membrane. The exposed end of the drain tube is connected to a computerized vacuum source that removes fluids from the wound. The application of controlled levels of negative pressure has been shown to accelerate debridement, assist with the removal of interstitial fluid, reduce localize edema, and increase blood flow, thereby promoting expeditious wound healing (Thomas, 2001).

Several studies have been conducted that demonstrate the effect of negative pressure vacuum (VAC) on various types of wounds, including pressure ulcers (Mullner, Mrkonjic, Kwasny, and Vecsel, 1997). However, studies relating to treatment modalities for pressure ulcers over the last five years were deficient in literature review. Thomas (2001) argues that even in the absence of such studies, the effectiveness of the VAC is clear.

Argenta and Morykwas (1997) examined the effect of vacuum-assisted closure (VAC). The study reported the first 300 wounds treated in clinical trial that led to the development of vacuum-assisted wound closure technique and device. The V.A.C. technique entails placing open-cell foam dressing into the wound cavity and applying a

controlled sub-atmospheric pressure (125 mmHg below ambient pressure). Dressings are changed every 4 to 8 hours. The researchers found that 296 wounds responded favorably to sub atmospheric pressure treatment, with an increased rate of granulation tissue formation. Nearly one-third (32%) of pressure ulcers healed completely in 2- 16 weeks. Almost half (46%) closed more than 80%. No pressure ulcers recurred at the original wound site. Wounds were treated until completely closed, were covered with a split-thickness skin graft, or a flap was rotated into the health granulating wound bed. The technique removes chronic edema, leading to increased localized blood flow, and the applied forces result in the enhanced formation of granulation tissue.

To compare the Vacuum-Assisted Closure device (VAC) with the Healthpoint System (HP) of wound gel products in promoting ulcer healing Ford et al. (2002) conducted a randomized controlled trial of 28 patients with one to three Stage IV ulcers. The average patient age was 41.7 years in the VAC group and 54.4 years in the HP group. Enrolled patients had an albumin level more than or equal to 2.0 g per deciliter. Ulcer volume after debridement was between 10 and 150 ml. Dressings were changed Mondays, Wednesdays, and Fridays. A total of 22 patients with 35 Stage IV ulcers completed the 6- week trial of treatment. Patients were evaluated at 3 and 6 weeks for of wound healing. The 3- week evaluation included a photograph of the wound site, a plaster wound impression, and measurement of wound dimensions. The 6- week evaluation included a series of post-treatment tests, consisting of a photograph of the wound site, a soft tissue biopsy, a plaster wound impression, and measurement of wound dimensions. During this time 2 patients (10%) in the VAC group (N = 20) and 2 patients (13%) in the HP group (N =15) healed completely. The mean percent reduction in ulcer

volume was 42.1% with HP and 51.8% with VAC (p= 0.46). The researchers concluded that VAC promotes an increased rate of wound healing and favorable histological changes in soft tissue and bone compared with HP.

Despite the many written articles relating to the positive outcomes of the VAC in the treatment and management of many wounds, the cost of the system is a deterrent to its wide-spread use. Subsequently, some clinicians may be reluctant to use this tool without further studies demonstrating its cost effectiveness in routine use (Thomas, 2001). However, advocates argue that when rates of healing, efficiency of time management, and other positive patient outcomes are taken into consideration, the use of the VAC measures favorably in financial terms as compared to conventional treatment modalities.

Summary

Pressure ulcer is a devastating condition that affects more than one million patients annually (American Medical Directors Association (AMDA), 2004). Although, most researchers agree that the primary cause of this problem is pressure that occludes the capillary blood flow resulting in ischemia (Kosiak, 1961), adequate nutrition is essential in the growth and repair of tissue (Larsson, et al., 1990).The importance of studies in this area is evident as wound healing is a complex, tightly regulated process, that produces high demand on patients' energy, requiring macronutrients for effective recovery (Mathus-Vliegen, 2004).

An extended account of pressure ulcer formation must include not only the intrinsic and extrinsic factors that causes pressure ulcer but also ways of preventing and treating this devastating condition. With the recent increased focus of regulatory agencies

on the management of pressure ulcers, institutions are actively supporting preventative strategies. Although there are many studies that focus on pressure ulcer prevention, the review of the literature for the past five years demonstrates a steady decline in the number of studies that address treatment modalities for pressure ulcers. However, the prevention of pressure ulcers has taken on greater focus since the Healthy People 2010 initiative has included pressure ulcers reduction as an objective for health care providers (United States Department of Health and Human Services, 2009). This topic is at the forefront of local health care practice and is an integral part of the national health care agenda. The new governmental mandate addressing the management of pressure ulcers in health care institutions has placed increased responsibility on health care providers to implement a more cost effective treatment process that would promote effective and timely wound healing.

In determine at-risk patients, nurse researchers and others have developed tools based on key physiologic indexes associated with pressure ulcer development. Many researchers believe that these scales can identify persons at risk for the development of pressure ulcers, thereby facilitating preventive measures and early intervention (Lyder, 1996). Despite the presence of various indexes and scales, the accurate prediction of pressure ulcers among elderly institutionalized patients remains a daunting challenge (Bergtrom and Braden, 1992) which requires further investigations.

Contradictions exist in the literature regarding the clinical efficacy of some interventions used in the management of pressure ulcers. Previous research has not revealed any one pressure relieving devise such as flotation beds, chairs, cushions, over lays that can prevent or cure pressure ulcer(Nixon et al., 2006; Rosental et al., 2003).

Despite many studies that address nutrition and pressure ulcers, there is a lack of clarity about the role, amount, and combination of nutrients necessary to effect changes in the wound bed.

The effectiveness of many studies is complicated by a lack of standardized methodologies and thus limits the strength of evidence provided by past research. Most studies are cross-sectional which limits knowledge relating to treatment modalities over time. In addition, as race is rarely reported in the studies, it is unclear about the effect of these interventions on race. Of the many different treatment modalities for managing pressure ulcers reported in the literature, data on the impact of pressure ulcer on healing, length of hospitalization, and cost is lacking. The proposed study is designed to fill this knowledge gap. The use of retrospective and prospective methods will provide valuable information that will influence the care of patients with pressure ulcers in institutions. Study findings will yield beginning information on the influence of an interdisciplinary nutrition protocol on pressure ulcer outcomes. Additionally, findings from this study will provide a base for staff education to reduce fragmentation of care for patients with pressure ulcers.

CHAPTER III.

METHODOLOGY

Research Design

Using a pre-intervention/post-intervention, quasi-experimental design, the primary aim of this study was to test the effects of a comprehensive interdisciplinary nutritional protocol on patients' outcomes of pressure ulcer wound healing, length of stay, and charges for care as of October 2008 (pre intervention). All patients with pressure ulcer were placed on a pre-approved comprehensive multidisciplinary nutritional protocol in 2009 to monitor its effect post intervention.

The study, conducted at an acute long-term care hospital in South Florida, used a convenience sample (N=100, 50 pre-intervention, 50 post intervention patients) of patients 60 years old and above. Both males and females admitted with pressure ulcers, or who developed pressure ulcers during the intervention period were included. Demographic data collected included body mass index (BMI), co-morbidities and plate waste. Using chart data (inter-rater reliability established by 2 wound care specialists), wound healing was measured by length, depth, and width of the wound using the Pressure Sore Status Tool (PSST). Length of Stay (LOS) was measured in hospital days directly due to the pressure ulcer. Charges for pressure ulcer management included direct charges for wound care supplies, nursing time, and any special equipment. A matched cohort of pre intervention patients' chart data (n=50) was compared to post intervention patients' chart data (n=50). Data analyses were conducted using descriptive statistics and paired *t*-tests.

Setting

Participants for this study were recruited from Sister Emmanuel Hospital for Continued Care, a 29 beds acute long-term care facility located inside of Mercy Hospital, in Miami, Florida. Patients were admitted to Sister Emmanuel Hospital from hospitals, nursing homes, rehabilitation centers, and by direct admission through the emergency room at Mercy Hospital. Sister Emmanuel Hospital had an average daily census of 25 patients with multiple medical problems. Approximately 25% of patients were admitted with a diagnosis of pressure ulcer. The annual number of patients with pressure ulcers was approximately 210.

Pressure ulcer was an accompanying diagnosis in approximately one third of the patients. One of the institution's top goals was to develop the Wound Care Program as an area of service excellence. Such programs were vital to the institution as the majority of the patients were elderly, immobilized, and had multiple complex medical conditions. These multiple risk factors increased the possibility of skin break down and extended the length of stay.

Sample

Inclusion Criteria: The post intervention experimental group consisted of chart data from 50 patients, 60 years old and older identified from the hospital's list of patients with a diagnosis of pressure ulcer from October 1, 2008 to September 30, 2009. The patients included in the study were of any race and gender, admitted with a diagnosis of pressure ulcer, or had developed pressure ulcers during their hospital stay. All patients with Stage I, Stage II or Stage III pressure ulcers (based on the NPUAP Classification system) were included in this study until the sample size was achieved. A pre

intervention comparison group (October 1, 2008 to September 30, 2009) consisted of data from 50 patients' charts matched with post intervention experimental subjects for age (by 5 years block), gender, severity of illness based on the Braden Scale and ulcer stage. Pressure ulcers were considered resolved when they showed at least a 75% reduction in size, no signs of infection, and 100% granulation tissue.

Exclusion Criteria: Patients with Stage IV pressure ulcers were excluded from the study due to the possible need for surgical intervention. Patients who died, who were less than 60 years, or had a medical condition that prohibited them from taking vitamins, zinc, iron, or protein supplements included in the nutrition protocol were excluded from the study. Since the study was based on an institutional approved comprehensive interdisciplinary nutrition protocol for pressure ulcer, all post intervention patients from October, 2009 received the same standard of care.

Power Analysis

Adequacy of the sample size for the planned analyses was assessed with power analysis. There were 50 pre intervention and 50 post intervention patients in the sample. With this number of patients with pressure ulcers and equal cell sizes, the two sample t-tests and 2X2 Chi-square tests provided 80% power at alpha=.05 to detect a small effect for group differences for all outcomes where 2 groups are compared.

Procedure

Patients' enrollment and data collection took place once the study was approved by the Institution Review Board (IRB) for the Protection of Human Subjects at Florida International University and Mercy Hospital, which is the Governing Board for Sister Emmanuel Hospital IRB. Potential post-intervention patients who met the study criteria

were referred to the principal investigator by nursing staff. All the patients with pressure ulcers were placed on the preapproved pressure ulcer protocol which began on October 1, 2009. Patients remained on this protocol until pressure ulcers had shown at least a 75% reduction in size, no signs of infection, and 100% granulation tissue. The pre intervention comparison group charts (10/1/2008–9/31/2009) were selected from the hospital's list of patients with a diagnosis of pressure ulcer following the enrollment of post intervention subjects.

Protocol for Pressure Ulcer Care

Pre-intervention Comparison Group

Pressure ulcer care for patients in the pre intervention group consisted of physician orders for local wound care (daily dressing changes with normal saline wet to dry or other wound care dressings), regular diet (1800 - 2200 kcal/daily, 60-80 grams protein/daily), and specialized beds (Clinitron or other reduced pressure beds) for extensive pressure ulcer management. The care of wounds was left to the discretion of the nurse with little input from other disciplines (physical therapy (PT), occupation therapy (OT), speech therapy (ST) and dietician), and no focus on the nutritional deficits of patients.

Post-intervention Group

The protocol for patients in the post intervention group included the assessment of all patients admitted with pressure ulcers or who developed pressure ulcer in the hospital. The interdisciplinary team assisted and treated patients. Physical and occupational therapists evaluated all patients and developed interdisciplinary goals to assist patients with strengthening exercises, mobility and activities of daily living. Based on the

patients' needs, therapy was done once or twice daily until the patients were discharged. Patients were encouraged to participate in their nutritional care if able to do so. Speech therapists evaluated patients and treated patients when required to avoid aspiration and to increase nutritional intake. Treatment was provided daily until swallowing difficulty was resolved, another route of feeding was determined (example, tube feeding), or the patient was discharged.

Treatment of pressure ulcers included dressing changes (e.g. Vacuum Assisted Closure [VACs], creams, and coverlets) and specialized beds (Clinitrons or Airflow beds), as required for each patient with complex wounds (multiple Stage 3 to Stage 4 wounds). Treatment of wounds varied depending on the complexity of the wound. All participants remained on the interdisciplinary nutrition protocol until resolution of the pressure ulcer as per study criteria or hospital discharge.

Protein and caloric needs were based on the medical condition and the patient's individualized needs. Patients who received oral feedings were given a regular diet (1800 - 2200 kcal/daily, 60-80 grams protein/daily) or disease specific diet (diabetes mellitus 1800 - 2000 kcal ADA). For patients on tube feeding, the rate of the tube feed was adjusted based on the formula (example calories per kilogram of body weight; for Protein the formula is for example 59 kg x 1.8-2.5g/kg so the protein needs would be 106-147 g/kg/day).

All patients with pressure ulcers were placed on the Nutritional Protocol which included (Multivitamins w/Minerals: daily Vitamin C 500mg: bid, Zinc sulfate 220mg: bid, Ferrous sulfate 324mg: daily, and Vitamin A 10,000 units: daily.

Protein Supplementation:

All patient with pressure ulcer received Proteinex protein supplement 30ml *d*aily (18 grams protein and 97 Calories per 30 ml dose). Patients with MODERATE malnutrition (Albumin level 2.1- 2.9g/dl, Pre-albumin 5- 9mg/dl) received an added dose of Proteinex for a total of: Proteinex 30ml twice daily. Patients with SEVERE malnutrition (Albumin level less than 2.1g/dl, Pre-albumin less-than mg/dl) received Proteinex -WC 30ml twice daily (22 grams of protein and 107 Calories in each 30 ml dose). In addition, patients on or*al feedings* received a regular diet (1800 - 2200 kcal/daily, 60-80grams protein/daily) or disease-specific diet (diabetes mellitus 1800 - 2000 kcal ADA). The interdisciplinary team included physical and occupational therapist, speech therapists, and a wound care nurse. Dressing changes and specialized beds were provided as required for each patient with pressure ulcer.

Table 1:1 Lab Values for Albumin and Pre-albumin

Lab Values	Normal Range	Mild Range	Moderate Range	Severe Range
Albumin (g/dl)	3.5 – 5.0	3.0 – 3.4	2.1 – 2.9	< 2.1
Pre-albumin (mg/dl)	18 - 45	10 - 17	5 - 9	< 5

Measures/Instruments

Pressure ulcer wound healing was measured using: (1) Pressure Sore Status Tool (2) Length of Stay (LOS) was measured in hospital days directly due to the pressure ulcer (3) Cost of pressure ulcer management included cost of wound care supplies, nursing time, physical therapy, speech therapy, occupational therapy, and any special equipment.

Pressure Ulcer and Wound Healing

The Pressure Sore Status Tool (PSST), is a 13 item tool that describes an ulcer over time. The Likert response format ranged from one to five; one being the best score and five being the worst. The pressure ulcer was described by focusing on the wound size (measured with paper tape), depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudates type, exudates amount, skin color surrounding wound, peripheral tissue edema, peripheral tissue indurations, granulation tissue, and epithelialization. Although there are15 items in this tool, only 13 were scored. The total scores were derived at by adding subgroups. The PSST ranged from 13 - 65, and reflected wound health as a low score and deterioration as a high score. The mean overall content validity index was 0.91. Inter-rater reliability yielded a mean score of $r = 0.96$ (Bates-Jensen, Vredevoe and Brecht, 1992).

Length of Stay: Since patients may develop pressure ulcers at any time during an admission, the length of stay was counted from the day the patient presented with a pressure ulcer and ended with pressure ulcers showing at least a 75% reduction in size, no signs of infection, and 100% granulation tissue. Continued hospitalization for other medical problems was not counted in length of stay. Length of stay was compared to the International Classification of Disease (ICD) for the primary diagnoses and for patients admitted with a primary diagnosis of pressure ulcers.

Charges: included topical therapy (creams and ointments), dressings (films, hydrocolloids, vacuum assistive devices and gauze), and incontinence and pressure relief devices (beds/cushions). A charge calculation form was based on price of labor for pressure ulcer care only (i.e., nursing time, nursing assistant time, PT, OT, ST, dietitian),

and an added 33% benefit based on the hourly salary of all levels of personnel). The wound care nurse charges were calculated based on quarter hourly incremental logs of wound care activities. Compensation for work done was based on the standard hourly rate for the wound care nurse as reported by the human resource department.

Charges for supplies were based on the facility's supply charges and pharmacy charges. Additionally, the charge for laboratory blood tests (complete blood count, electrolytes, etc.) and x-rays were not calculated as these tests may be ordered for conditions unrelated to the study. Biweekly albumin or pre albumin levels were included as charges related to the study. Physical therapy, occupational therapy, or speech therapy contracts were obtained, and charges for these services were included in the study costing comparison. Charges for the pre intervention group were based on the number and amount of supplies, nursing time, physical therapy, occupational therapy speech therapy, and dietician time consumed. However the dollar amount was based on post intervention charges. Patients' demographic data (included date of admission, age, sex, race, BMI, plate waste, co morbidities, discharge disposition, date of admission, and discharge) were collected by the principal investigator. Consultation from each of the disciplines was used for clarification of data. The investigator kept a daily log of all activities. Iinter-rater reliability of the log was established by two certified wound care nurse.

Data Collection Procedures

The wound care nurse completed daily wound care and documentation on a skin care sheet. Data collection was also the duty of the wound care nurse and another nurse who was trained in the use of the PSST. The principal investigator (PI) trained the data collectors on the use of the PSST, monitored the use of the tool, and recorded on pressure

ulcer every Monday morning. The wound care nurse focused on staff compliance and the monitoring of pressure ulcers. Data on pressure ulcers using the PSST were collected at admission and every Monday thereafter by the wound care nurse. The PI monitored overall use of the tool, inter-rater and intra-rater reliability, and retrained nursing staff if their levels fell below 85% agreement.

Data Management

Data management tasks can be categorized as those that ensure integrity during the collection phases and those that maintain integrity during coding and entry. All form pages were labeled with the patient's pressure ulcer study identification number. Before conducting an assessment, lists of necessary forms were given to the wound care nurse who was then trained in their proper use. She was instructed by the PI to review all forms for completeness before concluding each assessment. The PI also verified the returned forms for completeness.

Data packets had two levels of coding: First level or initial coding by the wound care nurse and a second-level coding by the PI. With the purpose of ensuring consistency, all decisions were made during coding and then recorded in the codebook, and updated frequently. All discrepancies identified at verification were resolved by referring to the raw data.

Data Analysis

Data were analyzed using the Statistical Package for Social Science (SPSS). The steps to database management included setting up a code book, defining each variable, setting up the study database, data dictionary, and testing the data management procedure before the study began. Data cleaning and data entry were done on a continuing basis

throughout the data collection period. Additional steps were taken to minimize error in the database by training data entry personnel and by creating a double data entry system. The PI coordinated the collection of the pre and post data and verified correctness of data entry by the use of SPSS to look for trends and errors in data entry.

RQ1. Comparing the pre-intervention and post-intervention groups were there differences in pressure ulcer wound healing (number of patients with > 75% healing in length, width, and depth of wounds)?

Hypothesis 1. There would be positive differences in healing of wounds with a comprehensive interdisciplinary nutritional wound care protocol. Pressure ulcer healing was measured every Monday using the PSST. The total scores were derived by adding subgroups of the tool. This ranged from 13-65and reflected wound health as a low score and deterioration as a high score. Two-sample *t*-tests were used to compare differences in PSST scores across the two groups for each person.

RQ 2. Comparing the pre-intervention and post-intervention groups were there differences in length of hospital stay (hospital days directly due to the pressure ulcer)?

Hypothesis 2. When compared to the pre intervention group, the intervention group would have a reduction in the length of stay relating to pressure ulcers. Since patients could develop pressure ulcers within hours or days during an admission, the length of stay was counted from the day the patient presented with a pressure ulcer and ended when study discharge criteria were met.

RQ 3. Comparing the pre-intervention and post-intervention groups were there differences in charges for pressure ulcer management (direct cost of wound care supplies;

nursing, physical therapy, occupational therapy, dietitian and speech therapy time; and special equipment)?

Hypothesis 3. When compared to the pre-intervention group, the post-intervention group would have a reduction in the cost of care. A charge calculation form was based on price of labor for pressure ulcer care only (i.e., nursing time, nursing assistant time, and an added 33% benefit based on the hourly salary of all levels of personnel). The wound care nurse charges were calculated based on quarter hourly incremental logs of wound care activities. Charges for supplies were based on facility's supply charges and pharmacy charges. Significant differences in means supported the hypotheses.

Limitations and Potential Risk

A potential limitation for this study was the potential inconsistency in using the protocol by staff. However, this was carefully monitored weekly by the PI. Another potential limitation was the use of chart data which holds potential limitations of missing data and/or over charting of items not done.

CHAPTER IV.

RESULTS

The primary aim of this pre/post-intervention study was to examine the effects of a comprehensive, interdisciplinary, nutritional protocol on pressure ulcer wound healing, length of hospital stay, and charges for pressure ulcer management. The study was designed to address the following research questions: (a) Comparing the pre-intervention and post-intervention groups, are there differences in rate of pressure ulcer wound healing (number of patients with > 75% healing in length, width, and depth of wounds) by week? (b) Are there differences in length of hospital stay (hospital days directly due to the pressure ulcer)? (c) Are there differences in charges for pressure ulcer management (direct charges of wound care supplies; nursing; physical therapy, occupational therapy, dietitian and speech therapy time; and special equipment)? This chapter presents the characteristics of the sample and the results of the data analysis for each research question.

Sample

A total sample of 100 long-term acute care patients was recruited for the study. As is common with patients with pressure ulcer, most of the sample was elderly. Table 1 describes the general demographic characteristics of the sample. The mean age of the patients was 79.4 years (SD=9.0) with a range from 65 years to 96 years. The majority of the sample was male (58%), White Hispanic (78%) with Medicare as their primary insurance (97%). Most patients were married (35%), widowed 32.0%). Forty percent of the patients attended college; 40% percent attended high school. Patients in the 70-74 age group accounted for the largest percent of pressure ulcers (24%). Patients in the 85-89

age group was the second largest group (22%). Patients in this study were admitted to the hospital from a variety of settings including home (78%), skilled nursing facilities (SNF) (14%), and Assisted Living Facilities (ALF) (8%). However, the majority of the patients were discharged to SNF (42%) and home (34%).

Risk factors for developing pressure ulcers were also analyzed and showed no differences between the pre-intervention and post- intervention group. These risk factors included scores on the Braden Scale, albumin, pre-albumin, Body Mass Index (BMI), level of activity and caloric intake. According to the Braden Scale (Low Risk = 15-18, Moderate Risk = 13-14, and High Risk < less than 12) most of the patients in the total sample had moderate risk (44%) for developing a pressure ulcer. Levels of albumin (3.5-5.0 gm/dL normal, 3.0-3.4 gm/dL mild, 2.1-2.9 gm/dL moderate, < 2.1 severe) and pre-albumin (18-45 normal, 10-17 mild, 5-9 moderate, < 5 severe) ranged from 2 gm/dL to 4.4 gm/dL and from 5.5 to 33 respectively. Findings suggest that the majority of the patients were nutritionally compromised (albumin, M=3.0, SD=5.8, and pre-albumin, M=14.4, SD=5.8).

Body mass index (BMI) of the groups (18.5 underweight, 18.5–24.9 normal, 25–29.9 overweight, and 30 or greater obesity) ranged from 21 to 46. Whereas the BMIs of 40% of the patients were within the normal range, 34% of the patients were overweight, and 22% were obese. The activities of the patients were described as 52% bed rest (complete immobility), 21% out of bed to chair (moderate to severe impairments), and 27% ambulation (mild to no impairment). These findings suggest that the patients were at risk for developing a pressure ulcer due to limited mobility.

Calorie needs of patients were based on medical conditions and nutritional requirements. Patients in this study received 1800-2200 kcal/daily, 60-80 grams protein/daily, or disease specific diets (diabetes mellitus 1800-2000 kcal ADA). For patients on tube feeding, the rate of the tube feed was adjusted based on the type of formula and the patient's nutritional needs. Patients with pressure ulcers received multivitamins w/ minerals 1 daily, vitamin C 500 mg bid, zinc sulfate 220 mg bid, ferrous sulfate 324 mg daily, and vitamin A 10,000 units daily. In addition, patients in the post-intervention group, received Proteinex protein supplement 30 ml twice daily (18 grams protein and 97 Kcals per 30ml dose).

Results indicate that there was no significant difference in the total estimated calorie intake for both groups (t= .892, p= .795). The mean weekly estimated calorie intake (12,240.97 kcal) was significantly higher in the post-intervention group than in the pre-intervention group (10,046 kcal). Plate waste (oral food intake) was monitored and recorded daily by the certified nursing assistant (CNA). The quantity of ingested food was evaluated using a 25% increasing consumption scale (0, 25, 50, 75, and 100). Based on this calculation the estimated daily and weekly caloric intake was determined. Amount of gastric aspirate was measured daily for patients on tube feeds. The mean plate waste for the sample was 10.75% (SD=13.31). Data indicate that there were no differences in mean plate waste (F=.38, p=.69) for the pre-intervention group compared to the post-intervention group.

Table 1

Demographic Characteristics of Total Sample

Mean Age in Years (M, SD)	79.42 (SD = 9.0)	
	Frequency	**Percent**
Gender		
Male	58	58.0
Female	42	42.0
Marital Status		
Married	35	35.0
Single	19	19.0
Separated	3	3.0
Divorced	11	11.0
Widowed	32	32.0
Ethnicity		
Non-Hispanic White	15	15.0
Hispanic Black	1	1.0
Hispanic White	78	78.0
Non-Hispanic Black	5	5.0
Other	1	1.0
Insurance		
Care Plus Medicare	1	1.0
Medicare A	97	97.0
Self Pay	1	1.0
Workers Comp	1	1.0
Education		
College	39	39.0
Elementary	13	13.0
High School	41	41.0
Unknown	7	7.0
Live Category		
ALF	8	8.0
Home	78	78.0
SNF	14	14.0
Discharge Disposition		
ALF	3	3.0
Home	34	34.0
Hospice	12	12.0
Other	2	2.0
Hospital	4	4.0
Rehab	3	3.0
SNF	42	42.0

Sample Group Comparisons

Pre-intervention and post-intervention patients were matched on age (5 year increments), gender, Braden Scale score (15-16 = low risk, 13-14 = moderate risk, 12 or less = high risk) and pressure ulcer stage as shown in Table 2. Co-morbidities were also captured and described but were not used in matching the sample. There were no differences between groups in age, gender, Braden Scale score and pressure ulcer stage because the groups were matched. A greater percent of the pre-intervention group (86%) were Hispanic White compared to the post-intervention group (70%). Thirty percent of the patients in the pre-intervention group were married compared to 40% in the post-intervention group. Twenty eight percent of the patients in the pre-intervention group were widowed compared to 36% in the post-intervention group. Both groups used Medicare as their primary insurance (pre-intervention 98%, post-intervention 96%). There were more patients in the post-intervention group who attended college (n=24, 48%) than in the pre-intervention group (n=16, 32%). While 76% of the pre-intervention group was admitted from home, only 20% returned home compared to the post-intervention group who had 80% of patients admitted from home and 48% returning home post-hospitalization. Most of the pre-intervention patients (54%) were discharged to SNF compared to only 30% of the post-intervention patients.

Body Mass Index (BMI) differed between groups. While 6% (n=3) of the pre-intervention group was below the normal BMI category (<18.5), only 2% (n=1) of patients in the post-intervention group were in this category. Thirty-eight percent (n=19) of the patients in the pre-intervention group were within the normal BMI category (18.5-24.9) as compared to 42% (n=21) within the post-intervention group. More patients were

categorized as obese (BMI >25-29) in the pre-intervention group (36%, n=18) as compared to the post-intervention group (32%, n=16). However, there was a higher percentage of patients (24%, n=12) with BMI above 30 (morbidly obese) in the post-intervention group as compared to 20% (n=10) in the pre-intervention group. There was no significant difference in the albumin (p>.05) and pre-albumin levels ($p>.05$) between groups. Patients in the pre-intervention group (ambulate=42%) were more active than in the post-intervention group (ambulate=12%). The post-intervention group had a larger percent of patients (58%) on bed rest than the pre-intervention group 46%. This suggested that the post-intervention group had sicker patients than the pre-intervention group.

Table 2

Sample Characteristics

	Total (N=100)	Preinter (n=50)	Post-inter (n=50)
Age			
65-69	16	8	8
% within group	(16 %)	(16 %)	(16 %)
70-74	24	12	12
% within group	(24 %)	(24 %)	(24 %)
75-79	10	5	5
% within group	(10 %)	(10 %)	(10 %)
80-84	14	7	7
% within group	(14 %0	(14 %)	(14 %)
85-89	22	11	11
% within group	(22 %)	(22 %)	(22 %)
90-94	8	4	4
% within group	(8 %)	(8 %)	(8 %)
95-99	6	3	3
% within group	(6 %)	(6 %)	(6 %)
Gender			
Male	58	29	29
% within group	(58 %)	(58 %)	(58 %)
Female	42	21	21
% within group	(42 %)	(42 %)	(42 %)
Braden Score			
Low Risk	30	15	15
% within group	(30 %)	(30 %)	(30 %)
Moderate Risk	44	22	22
% within group	(30 %)	(30 %)	(30 %)
High Risk	26	13	13
% within group	(26 %)	(26 %)	(26 %)
Ulcer Stage at Entry			
Stage 2	28	14	14
% within group	(28 %)	(28 %)	(28 %)
Stage 3	72	36	36
% within group	(72 %)	(72 %)	(72 %)

According to the most frequently occurring health problems in the sample, co-morbidities were broken down into 42 categories. The most frequently occurring co morbidities were diabetes mellitus (N-97), renal conditions (N-55), malnutrition (N=46), anemia N=41), localize infections (N=55), systemic infection (N=56), and pulmonary problems (N=78). Co-morbidities categories were similar for both groups. However, the pre-intervention group included more patients with diabetes mellitus (n-50) and systemic infections (n=34) compared to the post-intervention group where there were more patients with pulmonary problems (n=42) and local infection (n=29).

Effects of the Nutritional Protocol on Pressure Ulcer Healing

Pressure ulcers were considered to be healed when the wounds had shown at least a 75% reduction in size, no signs of infection, and 100% granulation tissue. Rate of healing was measured weekly using the Pressure Sore Status Tool (PSST) and classified into 3 categories: Tissue Health (PSST scores 1– 13), Tissue Regeneration (PSST scores 14 – 20), and Tissue Degeneration (PSST scores $\geq$ 21). Proportions of cases in each PSST category were compared between the pre-intervention group and the post-intervention group for each week with Chi Square tests. Patients did not receive PSST scores after their discharge from the facility. The number of patients in the post-intervention group declined more quickly than the number of patients in the pre-intervention group. Both groups had 50 patients in week 1 and week 2. From week 3 through week 5, the number of patients in the pre-intervention group declined from 50 to 47, 30, and 4, respectively. However, from week 3 through week 5, the post-intervention group declined from 50 to 27, 6, and 0, respectively. So, unlike the pre-intervention group, 49 of the 50 patients in the post-intervention group had tissue health by the fourth

week. Chi square tests were not significant for the first week (baseline) and the 4th week (when only 6 post-intervention patients received PSST scores). Chi Squares for weeks 2 and 3 were statistically significant showing a greater shift toward tissue health in the post-intervention group than in the pre-intervention group

The total sample (N=100) was made up of 28% Stage 2 pressure ulcers (partial thickness loss of the dermis) and 72% Stage 3 pressure ulcers (full thickness tissue loss: subcutaneous fat may be visible, but bone, tendon, or muscles are not exposed). The sacrum/coccyx was the most frequent site for pressure ulcer development in the pre-intervention group (48%) as well as the post-intervention group (58%). The mean PSST score for the total sample at Week 1 was 32 (SD=8.1). Mean PSST scores for the total sample showed a progressive reduction from Week 1 through Week 5 (Week 2 (M=24.6, SD=9.2), Week 3 (M=18.8, SD=6.5), Week 4 (M=14.3, SD=6.5), Week 5 (M=13.5, SD=1.0).

Table 3
Pressure Ulcer Healing

	Pre-intervention			Post-intervention			
	Tissue Health	**Re-generation**	**De-generation**	**Tissue Health**	**Re-generation**	**De-generation**	**Statistic χ^2**
Week 1	0 0%	2 4%	48 96%	0 0%	6 12%	44 88%	=2.17 NS
Week 2	1 2% n=50	6 12%	43 86%	19 38% n=50	8 16%	23 46%	22.55**
Week 3	11 23.47 % n=47	10 21.3%	26 55.3%	10 37% n=27	15 55.63%	2 7.4%	17.49**
Week 4	18 60% n=30	9 30%	3 10%	5 83.3% n=6	1 16.7%	0 0%	1.35 NS
Week 5	3 75% n=4	1 25%	0 0%	0 0% n=0	0 0%	0 0%	

*p<.05, ** p<.005

Effects of the Nutritional Protocol on Length of Hospital Stay

Length of hospital stay was measured from the time the patient was identified with the pressure ulcer until the time of wound healing described above. Only the days attributed to the pressure ulcer were considered. Table 4 shows the total sample, pre/post total hospital stay, in addition to pressure ulcer stay. Length of total hospital stay ranged from 10 to 165 days. Length of stay relating to pressure ulcer ranged from 10 to 37 days. In the pre-intervention group, patients were hospitalized for a total of 10 to 165 days compared to 10 to 62 days for the post-intervention group. Hospitalization days due to

pressure ulcers ranged from 10 to 37 days in the pre-intervention group compared to 10 to 29 days for the post-intervention group. The t-test for equality of means showed significant differences between the groups for both total length of stay and pressure ulcer length of stay.

Table 4
Hospital Stay

	Total (N=100) [M(SD)]	**Pre-intervention (n=50)** [M(SD)]	**Post-intervention (n=50)** [M(SD)]	***t*- value**
Total LOS	37.1(24.6)	43.3(31.7)	30.9(12.02)	2.50*
Pressure Ulcer LOS	21.6(6.5)	25.3(5.7)	18.0(5.28)	6.59**

*$p<.05$, ** $p<.005$

Effects of the Nutritional Protocol on Charges

Charges for care of the patients' pressure ulcers included medical-surgical supplies, laboratory charges, pharmacy, wound care charges, charges for physical therapists (PT), occupational therapists (OT), speech therapists (ST), dietician consults, wound care nurse time, nursing assistant time, and equipment charges. Charges were calculated based on the charges to patients by the hospital billing department. Charges for OT, PT, and speech therapy were calculated based on the number of visits by these professionals. Charges for the dietician, wound care nurse, and certified nursing assistant (CNA) were calculated based on the employee's hourly salary plus 33% for fringe benefits. Charges are also based on 15-minute increments and are charged daily as by hospital billing. Results for charges are shown in Table 5.

There was no significant difference in total charges for the pre-intervention group ($727,245, m= $14544, SD=$8763) compared to the post-intervention group ($702,065, m=14041, SD=$6152) over the 5 weeks period. Charges for the full sample totaled $1,429,310). Charges for medical surgical supplies ranged from $107 to $8,000 (M=$1,745.02, SD=$1,908.38). Medical-surgical charges ranged from $107 to $8,000 for the pre-intervention group and from $148 to $4,793 for the post-intervention group.

Occupational Therapy charges ranged from $141 to $8,498. There were no charges for occupational therapy in the pre-intervention group because OT activities were assigned to the PT department during that period. The highest category of charges was attributed to speech therapy (range, $0 to $28,794, M=$3,848.15, SD=$5,916.81). Speech charges were significantly different with greater changes in the pre-intervention group. Speech therapy charges ranged from $0 to $28,794 in the pre-intervention group and from $0 to $9,460 in the post-intervention group.

The second largest category of charges for professionals was credited to the physical therapy department. Total charges for the groups ranged from $185 to $14, 376 (m=$4,419.98, SD=$3,300.18). Physical Therapy charges ranged from $185 to $12,705 and from $595 to $14,376 in the post-intervention group. The post-intervention group PT charges were higher than the pre=intervention group. Charges for protein supplement ranged from $20 to $58 (m= $36.44, SD=$10.53). These charges were only included in the post-intervention group according to the protocol. Pre-albumin charges ranged from $0 to $1,365 (m=$735.62, SD=$259.06). These charges were higher in the pre-intervention group ($0 to $1,365) than in the post-intervention group ($546 to $992).

Albumin charges ranged from $166 to $332 (M=$243.19, SD=$62.70) for the total groups. Pre-intervention charges ($166 to $332) were significantly higher than charges for the post-intervention group ($166 to $322). The higher charges for pre-albumin and albumin levels in the pre –intervention group were attributed to more frequent monitoring of albumin and pre-albumin levels with longer periods of hospitalization.

The total charge for the wound care nurse ranged from $45 to $240.15 (m=$140.33, SD= $43.93). The pre-intervention group had higher wound care nurse charges (range $65 to $240) and CNA charges (range $390 to $1,443) than the post-intervention group wound care nurse (range $45 to $188) and CNA charges (range $27 to $1,131).

Dietitian charges ranged from $13.5 to $108 (m=$34.2, SD=$17.9). The pre-intervention group charges ranged from $13.5 to $81.0 and post-intervention group charges ranged from $13.5 to $108. No significant differences were noted between the groups.

Equipment used in pressure ulcer management (e.g., Vacuum Assisted Closure, VAC) were noted to be costly. These charges ranged from $271 to $8,401 (m=$3,461.71, SD=$2,938.76) for the full sample. Pre-intervention group charges for equipment ranging from $572 to $8,401 were significantly higher than for those of the post--intervention group charges (range from $271 to $1,943).

Table 5
Charges for Pressure Ulcer Care

	Pre-inter Mean ($)	Pre-inter SD ($)	Post-inter Mean ($)	Post-inter SD ($)	*Statistics* t-test
MedSurg	1745.02	1908.385	1490.46	1184.401	.80
PT	3118.70	2277.743	5721.26	3655.247	4.27**
OT	0	0	2544.64	1712.863	10.51**
Speech	5885.12	7480.745	1811.18	2510.491	3.65**
Wound Care Nurse	163.720	37.6554	116.950	37.0671	6.25**
CNA	982.80	218.070	678.72	242.176	6.58**
Dietician	34.290	20.6294	34.290	4.9908	.00
Special Equipment	4667.45	3014.733	1251.17	629.958	2.70*
Pre-albumin	808.52	332.554	662.72	118.986	2.91**
Albumin	278.88	55.005	207.50	48.164	6.90*
Pharmacy	501.01	619.41	639.540	1352.12	*6.50**

*p<.05, ** p<.005

Summary

The primary aim of this study was to examine the effects of a comprehensive, interdisciplinary, nutritional protocol on pressure ulcer wound healing, length of hospital stay, and charges for pressure ulcer management. Findings suggest an improved rate of pressure ulcer healing in the post-intervention group compared to the pre-intervention group. This difference was demonstrated by a significant reduction in the PSST scores by Week 2 of the study. Moreover, by Week 4 of the study, there were no patients from the post-intervention group who remained in the tissue degeneration category. Although only

4 patients remained in the study at Week 5, they were all pre-intervention patients. Patients within the post-intervention group were healed.

Pressure ulcers length of stay was significantly less in the post-intervention group than in the pre-intervention group. Data suggest that days directly due to pressure ulcer decreased from a mean of 25.2 days (SD =5.6) in the pre-intervention group to 18.04 days (SD= 5.2) in the post-intervention group. Additionally, mean length of total hospitalization was significantly lower at 30.9 days (SD=12.02) for the post-intervention group as compared to the pre-intervention group with a mean of 43.2 days (SD=31.77). While there was no significant difference between the groups in total charges, charges for speech, pre albumin, and albumin were higher in the pre-intervention group and charges for PT and OT were higher in the post-intervention group.

This nutritional intervention was effective in improving pressure ulcer wound healing, and decreasing both hospital length of stay for treatment of pressure ulcer and total hospital length of stay while showing no significant difference between pre-intervention and post-intervention group charges for the treatment of pressure ulcers.

CHAPTER V.

DISCUSSION

As the American population ages, hospitalization related to pressure ulcers has increased by nearly 80% from 1993 to 2006 with more than one million patients developing pressure ulcers annually (American Medical Directors Association, 2004). The physical, psychological, and emotional impact of pressure ulcers on hospitalized patients is well documented in many studies. Pressure ulcers are associated with prolonged wound healing, increased length of hospital stay, and increased cost of care for many elderly patients in institutions. Studies have shown that pressure ulcers are also associated with increased mortality (Connelly, 2009; Kirkman & Molnar, 2008). In a long-term care geriatric hospital, Larsson et al. (1990) conducted studies designed to evaluate the effect of dietary supplements on clinical outcomes and nutritional status of geriatric patients (N = 501). Findings suggested that in the initially well-nourished group of more than 300 patients, the mortality rate was significantly lower in those given nutritional support (8.6%) compared to the control group (18.6%).

Current practices to manage pressure ulcers in elderly institutionalized patients are disjointed and varied. Hence, this issue has become a central focus for the government and health care institutions. Although prevention of pressure ulcers is an important gold standard, increasing numbers of elderly patients are admitted to long-term care facilities with pressure ulcers or they develop them there.

Nutrition

The current study drew upon nursing, medical and related literature that points to adequate nutrition as an important factor in the prevention and management of pressure

ulcers. Studies have shown that under nutrition and protein–energy malnutrition are prevalent in the elderly and occur in 23% to 85% of the population (Harris & Fraser, 2004; Kagansky et al., 2005). Among hospital stays primarily related to pressure ulcers, nutritional deficiencies were 23.4% of the concomitant conditions for 2006 (Russo, Steiner, and Spector, 2008). Both the Centers for Medicare and Medicaid Services (CMS, formerly HCFA) and Agency for Healthcare Research and Quality (AHRQ) specifically identify nutritional status as one of the most influential factors associated with pressure ulcer prevention, development, and treatment. The Agency for Healthcare Policy and Research (1996) defines clinically significant malnutrition as serum albumin less than 3.5 g/dl. Elderly patients in institutions are especially prone to both malnutrition and pressure ulcers for a variety of reasons, including incontinence, increased age, and medical conditions such as diabetes, stroke, limited mobility, and poor nutrition (Mayo Clinic, 2009).

Thomas, Zdrowski, Wilson, Conright, Lewis, Tariq, and Morley (2002) in a study of 837 patients, examined the prevalence of under-nutrition in a sub- acute-care facility. Patients were a mean of 76 years, predominantly women (61%), 18% were under nourished with a BMI of <19, and had low mean serum albumin concentrations of 32 ± 6.2 g/L. Only 8% of the patients were classified as well nourished, almost one-third (29%) were malnourished, and two-thirds (63%) were at risk of malnutrition.

Pinchcofsky-Devin and Kaminski (1986) found that there was a significant relationship between nutritional status and pressure ulcer. When patients' malnutrition status was classified as mild, moderate, or severe, more patients with pressure ulcers were in the severe group than in the mild or moderate group.

Gunter et al. (2000), who examined the nutritional status of 120 newly admitted hospitalized patients with Stage 3 and Stage 4 pressure ulcers, found a significant relationship between serum albumin and pre-albumin levels. Findings suggest that serum pre-albumin and albumin levels were below normal in the majority of subjects (88% and 92% respectively). Seventy five percent of the subjects had a moderately low or severely low serum pre-albumin level (M = 11.30 ± 6 mg/dL) and more than 59% of all the subjects had a moderately low or severely low serum albumin (M= 2.65 ± 0.5gm/dL).

According to Larsson et al. (1990), 28.5% of patients showed evidence of malnutrition on admission. The highest frequency of malnutrition was found among women older than 79 years. Among those patients well nourished on admission, who subsequently received dietary supplementation, significantly fewer (8.3%) of the intervention group met malnutrition criteria after 26 weeks, while 21.1% of the control group were considered malnourished.

Although low serum albumin and pre-albumin levels were frequently used to measure the nutritional status of patients, opinions regarding the effectiveness of this method have been controversial. Collins (2001) points out that serum albumin accounts for more than 50% of total serum proteins and is one of the most abundant proteins found in the blood. Due to long half-life and a very large serum pool, albumin is a late indicator of malnutrition. However, as pre-albumin binds and transports protein, this is a far more sensitive and timely indicator of protein status than albumin. The researcher further argues that given the conglomerate of causes for poor outcomes in hospitalized patients, more evidence is needed to determine if malnutrition causes bad outcomes such as pressure ulcers. Several large, longitudinal, cohort studies have shown that low serum

albumin (< 2.5) is a significant risk factor for pressure ulcer (Kagansky, Berner, Koren-Mogag, Perelman, Knobler & Levy, 2005; Reed et al., 2003).

The findings from the current study, indicate that most patients with pressure ulcers were nutritionally impaired with mean admitting albumin levels of 3.0 (SD=5.8), and mean pre- albumin levels of 14.4 9 (SD=5.8m), and BMI (21 to 46). Findings from the review of the literature and findings from the current study are in congruence indicating that malnutrition is a growing concern in hospitalized patients above 60 years.

Patient Characteristics

While the predisposition for pressure ulcer development is not isolated to one group, the elderly population is most at risk for the development of this disease. Normal aging is associated with morphologic and epidermal skin changes that increase the risk for injuries and infection. Additionally, the aged skin is slow to heal due to diminished elasticity and attenuated microvasculature (Orlando, 1998). Although aging increases risk in part because of reduced subcutaneous fat and decreased capillary blood flow, the risk is further increased by immobility and co-morbidities (Garcia and Thomas, 2006; Magalhães et al., 2007).

Russo, Steiner, and Spector (2008) found that, compared to stays for all other conditions, adult patients hospitalized with pressure ulcers are more than 10 years older than patients admitted with other diagnosis. Bergstrom, Braden, Kemp, and Champagne (1996) examined the effects of demographic characteristics such as race, age, and gender as risk factors for pressure ulcer development. This retrospective cohort study with convenience sampling was conducted in 95 long-term care facilities throughout the United States and was comprised of 843 randomly selected participants. The researchers

found that lower Braden Scale score results, older age, and White race were significant predictors of pressure ulcer development.

Rosen et al. (2006) found those patients with a mean age of 63 years and classified as high risk on the Braden Scale had a 22.3% to 31.7% greater chance of developing pressure ulcers. Similarly in a cross-sectional survey of 2,373 patients, conducted by Fisher, Wells, and Harrison (2004), findings suggest that among the strongest risk factors for pressure ulcers development were age, male gender, mobility, and nutrition. Williams, Stotts, and Nelson (2000) described the characteristics of patients with pressure ulcers present on admission to the hospital. The study that included 267 patients used a prospective cohort design. Findings indicated that the patients were mostly males with a mean age of 65.7 years. The majority of patients with ulcers on admission were White (58.8%) and Asian (35.3%). Blacks and others were 2.9% each of the sample. Subjects with pressure ulcers had a significantly lower albumin level. A study conducted by Lyder et al. (1999) in a 650-bed urban hospital with 74 patients age 60 years or older, found that 32% of participants developed either a Stage I or Stage 2 pressure ulcer. Black elders had a higher incidence rate (21%) of pressure ulcers than Latino/Hispanic elders (11%). However, these findings did not agree with those of Bergstrom and Braden (1992) who reported significantly higher incidents of pressure ulcers in Whites (75%) compared to Nonwhites (40%). Like the current study however, this report could have been affected by the overall ethnic makeup of the patients in the institution.

According to Kosiak (1959) one of the most important factors in the development of pressure ulcers is prolonged immobility and unrelieved pressure. Ischemia and hypoxia

resulting from pressure deprive tissues of oxygen and essential nutrients thereby resulting in necrosis and ulceration (Kosiak, 1991; Salcido, Carney, Fisher, 1993; Salcido, 1995). Baumgarten et al. (2006) found that pressure ulcers can develop after only a few hours (2-6 hours) of immobility. These findings were supported by other researchers. Salcido et al. (1994) found that if pressure is allowed to continue for a long period (more than 2 hours) it decreases capillary blood flow occludes blood and lymphatic vessels and subsequently may result in tissue death. Schubert & Heraud (1994) examined the effects of external pressure and shear on the skin microcirculation over the sacral area of 30 elderly high-risk patients (median age of 78 years). The threat for skin ischemic damage over the sacral area of elderly at risk patients was found to be high in patients lying in the supine position (Bansal, Scott, Stewart, & Cockerall, 2005).

Review of the literature clearly points to age of immobilized patients as a major risk factor for the development of pressure ulcer. Patients above 60 years were at greater risk for pressure ulcer development. Most study populations were predominantly White, hospitalized patients with multiple co morbidities. Only studies related to the Braden Scale reported inclusion of persons of color in the study population (Lyder et al., 1998). In all cases, the number of patients of color included account for a very small percentage of the total group.

The current study was comprised of hospitalized patients with ages ranging from 65 years to 96 years. The majority of patients with pressure ulcers was White Hispanic, male, married, and had a college education. Patients in this study were admitted to the hospital from a variety of settings including home, skilled nursing facilities, and assisted living facilities. The current study, in comparison to other studies used a nutritional

collaborative, interdisciplinary approach to the management of pressure ulcers. To date, little has been reported testing an interdisciplinary nutritional intervention on patients with pressure ulcers.

Co morbidities

Studies have found that causes or risk factors for pressure ulcer development include hypertension, peripheral vascular disease, cerebral vascular disease, heart failure, diabetes, obstructive pulmonary disease, and stroke (Allman, Goode, Patrick, Burst, & Bartolucci, 1995; Bergstrom & Braden, 1992; Ducker, 2002; Garcia & Thomas, 2006; Margolis, Knauss, Bilker, & Baumgarten, 2003). Psychosocial risk factors indirectly contribute to the development of pressure ulcers in the elderly. These factors are associated with social isolation from family, friends, and memory loss, which in turn influence nutritional intake (Harris & Fraser, 2004). Furthermore, alteration in thought processes in elderly patients may result in an inability to recognize the need to eat, difficulty in swallowing, and increased risk of pressure ulcer development (Kagansky, Berner, Koren-Mogag, Perelman, Knobler, & Levy, 2005).

In a prospective cohort study of 414 patients aged 75 years and over in a geriatric hospital, researchers found that dementia, low serum albumin and phosphorus concentrations were significant risk factors for malnutrition. Females were predominant (65.7%). Bed or chair bound patients comprised about one half of the participants (52.4%). Moderate to severe cognitive decline, diabetes, congestive heart failure, and cardiovascular disease were the most prevalent co-morbidities (Kagansky, Berner, Koren-Mogag, Perelman, Knobler, & Levy, 2005). Margolis et al., (2003) reported that from the 1,211 individuals who developed pressure ulcer in their institution, Alzheimer's

disease, congestive heart failure, chronic obstructive pulmonary disease, cerebral vascular accident, and diabetes, were inversely associated with the development of a pressure ulcer. Many of these conditions affect the patient's nutritional state and increase immobility thus placing the patient at a higher risk for pressure ulcer development.

Patients in the current study were admitted with multiple, complex problems. Although co morbidities were divided into 42 categories according to the most frequently occurring illness, up to 11 co-morbidities were recorded for each patient. Data from the present study indicated that although there were some conditions commonly noted in the study (diabetes, hypertension, pulmonary, and renal disease), these diseases were not unique to age, gender or pressure ulcer stage.

Intervention Protocol

The use of a nutritional protocol is not a new concept. Many researchers have examined components of the diet in an effort to prevent or treat pressure ulcers. However, the role of nutrition in ulcer management is still controversial. To assess the effect of nutritional supplementation on dietary intake and pressure ulcer development in critically ill older patients, Bourdel-Marchasson et al. (2000) conducted a multi-center, randomized trial involving 672 patients older than 65 years. Incidence of pressure ulcers was 40.6% in the nutritional intervention group versus 47.2% in the control group. The researchers concluded that it was possible to increase the dietary intake of critically ill elderly patients by systematic use of oral supplements. This intervention was associated with a decreased risk of pressure ulcer incidence. According to Ek, Unosson, Larsson, Von Schenck, and Bjurulf (1991) patients who received extra nutritional support had a

tendency to develop fewer pressure ulcers. Additionally, existing pressure ulcers healed much faster than the control group.

The present study based the calorie needs of patients on medical conditions and nutritional requirements. Results suggest that there was no significant difference in the total estimated calorie intake or in plate waste for the pre-intervention group compared to the intervention group. However, with the use of the Protinex, total caloric intake was significantly different in the post-intervention group in Weeks 1, 2, and 3. The results of this study and similar studies have shown that nutrition is important in the comprehensive care plan for the prevention and treatment of pressure ulcers (Thomas, 1996; Thomas, Goode, Targuine, & Allman, 2003; Pinchcofsky-Dvian & Kaminsk, 1986).

Pressure Ulcer Healing

Wound healing is a complex process, involving a biological cascade of cell division and the migration of macrophages, fibroblasts, and epithelia cells into the surrounding tissue. This process is enhance by increased blood flow as nutrients, new blood vessels, and epithelial cells from surrounding tissue are brought to the affected area (Casey, 1998). Nutrients are essential for the immune system that mediates the immune processes such as antibody response, leukocyte migration to the wound, and disposal of waste products produced by leukocytes (Harris, and Fraser, 2004). Once the pressure ulcer has developed, the metabolic demands of the body increase, as a result of heightened cellular activity in the region (Harris and Fraser, 2004). The metabolic demands of wound healing are significant. Healing may be delayed without the immediate and assertive nutritional intervention to provide the necessary nutrients (Harris and Fraser, 2004).

Desneves, Todorovic, Cassar, and Crowe (2005) studied the effects of various diets on pressure ulcer healing. Results suggested that only patients receiving additional arginine, vitamin C, and zinc demonstrated a clinically significant improvement in pressure ulcer healing (9.4±1.2 versus 2.6±0.6 at baseline and after week 3, respectively, $P<0.01$). Herman, Van De Looverbosch, Meijer, and Schols (2008) analyzed the effects of an oral nutritional supplement on pressure ulcer healing. The sample size included 245 patients with the mean age of 82.2 +_ 10.1 years who resided in a long-term care facility and had a stage II-IV pressure ulcer. After nine, weeks there was a 60% reduction in the area of the wound in 178 patients. It was also reported that the amount of exudates decreased post-intervention. Although the cost and tolerability of the supplement was not explored, the researchers concluded that the use of oral nutritional supplement resulted in a reduction in the size of the wound.

A study conducted by Faras, Soriano, Large Vasquez, Maristany, and Xandri (2004) evaluated the effects of oral nutritional supplements (rich in protein and enriched with argine, vitamin C and zinc) on the healing of pressure ulcers in 39 patients with Stage 3 or Stage 4 pressures ulcers. Results suggest that after 3 weeks of supplementation, median wound area was reduced significantly ($p < 0.001$) from 23.6 cm to 19 cm.

In a randomized, prospective, controlled, multi-center trial at 23 long-term care facilities, Lee et al., (2006) compared Pressure Ulcer Scale for Healing (PUSH) scores of patients given a nutritional protocol. A total of 89 residents with Stage 2, 3, or 4 pressure ulcers were entered into the trial. Findings suggest that after 8 weeks of treatment, residents who received standard care plus the concentrated, fortified, collagen protein

hydrolysate supplement, had significantly better PUSH tool scores compared to those patients who received standard care and a placebo (3.55 ± 4.66 versus 3.22 ± 4.II, respectively; $P < .05$).

Critical review of the literature cited above shows that nutritional protocols varied considerably across institutions. Multiple protocols suggest a lack of standardization in nutritional requirements necessary for the expeditious management of pressure ulcers. The current study shows that incorporating an interdisciplinary nutritional protocol in the plan of care resulted in a significant difference in the PSST scores for the groups in Week 2, and Week 3. Additionally, the number of patients in the post-intervention group healed at a significantly faster rate than the pre-intervention group.

Length of Hospital Stay

The average length of hospital stay for all diagnoses in 2003 was 4.6 days, down from 5.7 days in 1993 (Russo and Elixhauser, 2006). However, the length-of stay related to pressure ulcers is on the rise as noted by Russo, Steiner, and Spector (2008). These researchers argued that in 2006, there were 503,300 hospital stays during which pressure ulcers were noted. In 1993, there were about 28,300 hospital stays related to pressure ulcers. This is a marked 78.9% increase for pressure ulcers, whereas the number of hospitalizations for all other admissions increased by only 15 percent. Lengths of stay for patients with secondary diagnoses of pressure ulcers increased by 86.4% while those primarily for pressure ulcers increased by 27.2%. Moreover, stays principally for pressure ulcers were slightly longer than those with a secondary pressure ulcer diagnoses (14.1 days versus 12.7 days). Seventy two percent of the patients with pressure ulcers were 65 years or older.

Review of the literature shows that recent studies relating to length of stay due to pressure ulcers are scarce, especially in long- term care facilities. However, when compared to length of stays for all other conditions, pressure ulcers accounted for more than three times the rate of hospitalizations for all other conditions (16.2 percent). Patients with hospitalization related to pressure ulcers were more likely to be discharged to a long-term care facility (e.g. a skilled nursing facility, an intermediate care facility, or a nursing home), as compared to hospitalizations for all other conditions (Russo, Steiner, and Spector, 2008). In a study of 2,000 randomly selected participants, Graves, Birrell, and Whitby (2005) found that pressure ulcer resulted in a median excess length of stay of 4.31 days. In a study of 837 patients conducted by Thomas et al., (2002), the average length of stay for pressure ulcer was 22.4 ± 15.3 days in a sub-acute care facility.

Similarly, in a prospective cohort study comprised of 1,938 residents (301 Blacks, 1,637 Whites) age 65 years and older, Baumgarten et al., (2004) found that the median length of stay was 235 days for Blacks and 107 days for Whites ($p < 0.001$). These data highlight the growing concerns of pressure ulcers and the impact on hospitals' capacity measured in bed-days lost to this diagnosis.

In the present study, length of hospital stay was measured from the time the patient was identified with the pressure ulcer until the time of wound healing. Findings suggest that prior to the introduction of the comprehensive nutritional protocol, total hospital days for the groups ranged from 10 to 165 days, while days relating to pressure ulcer range from 10 to 37. The current study suggests that with the implementation of an interdisciplinary nutritional protocol, a significant difference is noted in total length of hospitalization (10-62 days) and in days relating to pressure ulcer (10-29 days).

Charges for Pressure Ulcer Care

Regardless of the attempt to control cost, health care spending is projected to reach 18.4% of the Gross Domestic Product, by 2013 (Heffler, Smith, Keehan, Clemens, and Zezza, et al., 2004). Government payers bear the greatest burden of hospitalizations related to pressure ulcers. According to Russo and Elixhauser (2006), 65.9% of hospital stays related to pressure ulcers in 2003 were covered by Medicare, and 23.4% were covered by Medicaid. Conversely, one percent of patients were uninsured. Although, several researchers have attempted to measure the cost of pressure ulcers (Frantz, Gardener, Harvey, and Specht, 1991) current studies are limited. Recent studies have shown that the cost of prevention and management is considerably less as compared to the cost of litigation. According to Knox (2004), pressure ulcers are the second most common claim after wrongful death and are greater than falls or emotional distress. Individual settlements range from under $50,000 to as much as $300,000 for a single event, even if the case never goes to trial.

Knox (2004) noted that even though most states mandate caps, many attorneys include pressure ulcers as part of elderly abuse complaints, which have no caps on damages in criminal cases. Additionally, lawsuit claims per occupied bed have increased at an annual rate of 14%, while the average court settlement has risen by 250,000 dollars (American Medical Directors Association, 2004). Although quantifying cost remains problematic and controversial Rijswijk, and Lyder (2003) found that the initial cost of intervention varies and is dependent on several factors. These include expenses in areas such as supplies (dressings), specialty beds, nutritional support, laboratory blood tests

(Complete blood Count (CBC), blood chemistry including albumin and pre-albumin levels), and extra staff time required as the severity of the ulcer increases.

In a study, to evaluate the effect of implementing a protocol of care (nutrition consult, support surface, and reposition every two hours) that addresses the incidence of pressure ulcers, Lyder, Shannon, Empleo-Frazier, McGehee, and White, (2002) evaluated cost and outcomes. The findings suggest that the average monthly cost of prevention for a high-risk resident was $519.73, in addition to a one-time cost of $277 for mattress and chair overlays. More than half of the monthly costs were related to labor while the most expensive cost was the support surfaces.

Opposing findings were presented by Xakellis, Frantz, Lewis, and Harvey (2001) who argued that even though there was marked reduction in the cost of treating pressure ulcers with a protocol, a corresponding increase in cost of prevention was noted. While Rijswijk and Lyder (2003) point out that even with the initial increase in cost over time, this was more likely to be offset by substantial cost savings after the recommendations were implemented. When the cost of prevention of pressure ulcers is compared to the cost of litigation, a significant increase is noted in the latter.

Frantz, Gardener, Harvey, and Specht (1991) used a retrospective research design to describe the cost incurred to treat 240-pressure ulcers over a five-year period, in an 830-bed long-term care facility. Results suggested that when compared to acute care, the cost of treating pressure ulcers was lower in long-term care facilities than in other facilities. However, other studies demonstrated that when consideration was given to the cost of time for various activities necessary for the care of pressure ulcers, cost was more varied (Rijswijk and Lyder, 2003). Pressure ulcer treatment has been estimated to cost 2.5

times the cost of preventing its occurrence. Additionally, treatment of pressure ulcers increases nursing time up to 50% and is among the most costly in time and resources (American Medical Directors Association, 2004; Rijswijk and Lyder, 2003).

Critical review of the literature shows that current studies on pressure ulcer charges are few. Additionally, most studies attempt to analyze only variable cost associated with pressure ulcer treatment rather than the total charges for pressure ulcers management. In the current study, charges for managing patients with pressure ulcers included the charges for medical-surgical supplies, laboratory, pharmacy, equipment, and employees' time. No significant difference was noted in the total ($1,429,310) charges for the pre-intervention and post- intervention groups. However, several areas of significance were noted in this study. Findings suggest that the pre-intervention group had significantly higher charges in many areas. These include Wound Care Nurse (WC) and Certified Nursing Assistant (CNA) charges, albumin and pre-albumin levels, and speech therapy charges. The increased charges were laudable given the longer periods of hospitalization. There were no charges for occupational therapists (OT) in the pre-intervention group since OT was charged to PT during this period. Significant differences were noted in the OT and PT charges between groups with these charges higher for the post-intervention group. Equipment used in pressure ulcer management (e.g. Vacuum Assisted Closure, VAC), was noted to be costly. These charges ranged from $271to $8401,

With the current focus on conserving shrinking health care dollars, cost containment in institutions has become an area of increased focus. Patients as the consumers of care are also expressing concern about escalating charges. Findings from

this study can assist institutions in planning and budgeting for the management of pressure ulcer. Moreover, the findings can assist in the development of policies and procedures that guide the management of pressure ulcers. The knowledge gained can also be used to develop and to motivate care-givers.

Study Limitations

This study was conducted in an acute care facility composed of predominantly White Hispanic patients (78%) with Stage 2 and 3 pressure ulcers. It is not known if the findings would hold in samples from different racial/ethnic groups or in samples with Stage 4 and un-stagable pressure ulcers. Generalizability of these findings may not apply to other settings. The study used chart data which holds potential limitations of missing data and/or over charting of items not done.

Policy Implications

The recent change in reimbursement practices by the US Centers for Medicare and Medicaid Services (CMS) represents a profound shift in payment policy (Armstrong et al., 2008). Centers for Medicare and Medicaid Services will no longer pay for the added costs of care related to hospital-acquired conditions such as pressure ulcers. This imposes significant financial ramifications for the health-care facility and for nurses in particular as managers of nursing care. Like any groundbreaking policy, this change in reimbursement practices provides impetus for change. This challenge has also created an opportunity for acute care facilities to eliminate or reduce hospital-acquired pressure ulcers (HAPU).

According to the CMS guidelines beginning in 2008, pressure ulcers must be documented in the medical records on admission to the health care facility in order for it

to receive reimbursement for pressure ulcer care. In this study, the comprehensive nutritional protocol improved the rate of wound healing and the reduced length of stay relating to pressure ulcer. In an era where much confusion exists about the management of pressure ulcers, findings from this study could address important professional, financial, quality of care issues for nurses and health care institutions.

Implications for Future Research

Findings from this study have provided valuable information on the effects of a comprehensive nutritional protocol on patients with pressure ulcer. Findings indicated that the comprehensive, interdisciplinary protocol had a significant effect on the rate of wound healing and the length of stay directly relating to pressure ulcers. These findings are significant but could be extended to other groups including 1) patients with Stage 4 and unstagable pressure ulcers; 2); the obese patient; 3) and other health care delivery sites.

Future research with variations on the intervention may include comparing nutritional management against surgical intervention to determine the effect on outcomes such as patients' wound healing, charges, satisfaction, length of stay, and activities of daily living.

Summary

Pressure ulcer is a devastating and life-threatening condition which is in some cases unavoidable. The purpose of this pre post experimental study was to examine the effects of a comprehensive, interdisciplinary nutritional protocol on pressure ulcer healing, length of hospital stays and charges for pressure ulcer management. Results of this study indicate that the comprehensive, interdisciplinary nutritional protocol had a

significant effect on the rate of wound healing and reduced the length of stay for the post-intervention group. Cognizant of the impact that pressure ulcers have on elderly patients, health care providers have an increased responsibility to implement more cost-effective treatment processes that promote effective and timely wound healing such as that tested here. This nutritional intervention was effective in improving pressure ulcer wound healing, and in decreasing both hospital length of stay (M= 25.2-18.04 days) for treatment of pressure ulcer and total hospital length of stay (M= 43.2-30.9 days) while showing no significant difference between pre-intervention and post-intervention group charges for the treatment of pressure ulcers.

LIST OF REFERENCES

Adunsky, A., Ohry, A., & DDCT Group .(2005). Decubitus direct current treatment (DDCT) of pressure ulcers: Results of a randomized double-blinded placebo controlled study. *Archives of Gerontology and Geriatrics, 41*(3), 261-269.

Agency for Health Care Policy and Research. (1992). Pressures ulcers in adults: Prediction and prevention Clinical Practice Guideline No.3. *AHCPR, Public Health Services, US Department of Health and Human Services.* Retrieved November 4, 2008, from www.nebi.nlm.nih.gov.

Agency for Health Care Policy and Research. (1996). Urinary incontinence in adults: Acute and chronic management. Clinical Practice Guideline No. 2, *AHCPR, Public Health Services, US Department of Health and Human Services.* Retrieved November 4, 2008, from www.medscape.com/gov.

Agren, M. (1990). Studies on zinc in wound healing. Acta Dermato-Venereologica Supplemental, 154, 1-36.

Allman, R., Walker, J., Hart, M., Laprade, C., Noel, L., & Smith, C. (1987). Air-fluidized beds or conventional therapy for pressure sores. A randomized trial. *Ann Intern Med,* 107(5)641-648.

Allman, R. M., Goode, P. S., Patrick, M. M., Burst, N., & Bartolucci, A. A. (1995). Pressure ulcer factors among hospitalized patients with activity limitation. *The Journal of the American Medical Association, 273*(11), 865-870.

Alung, S., Miller, W., & Bosley, L. (2001). The 1999 national pressure ulcer prevalence survey: A benchmarking approach. *Advance Skin Wound Care, 14*(6), 297-301.

Alverez, O. & Gilbrearth, R. (1982). Thiamine influences on collagen during the granulation of skin wounds. *Journal of Surgical Research 32,* 24-31.

American Medical Directors Association (2004). *Pressure ulcers: percentage of patients in facility who develop pressure ulcers while in the facility.* Retrieved May 15, 2009, from www.qualitymeasures.ahrq.gov.

Anthony, D., Reynolds, T., & Russell, L. (2000). An investigation into the use of serum albumin in pressure sore prediction. *Journal of Advance Nursing, 32*(2), 359-365.

Assantachai, P., & Lekhakula, S. (2007). Epidermiological survey of vitamin deficiencies in older Thai adults: implications for national policy planning. *Public Health Nutrition, 10,* 65-70.

Ayello, E. (2007). Predicting pressure ulcer risk. Retrieved March 1, 2009, from www.consultgerirn.org.

Ayello, E.A., Thomas, D.R., & Litchford, M.A. (1999). Nutritional aspects of wound healing. *Home Healthcare Nurse, 17*(11), 719-729.

Bååth, C., Hall-Lord, M., Idvall, E.,Wiberg-Hedma, K., and Larsson, B. (2008). Interrater reliability using Modified Norton Scale, Pressure Ulcer Card, Short Form-Mini Nutritional Assessment by registered and enrolled nurses in clinical practice. *Journal of Clinical Nursing, 17*, 618-626.

Bansal, C., Scott, R., Stewart, D., & Cockerall, C. (2005). Decubitus ulcers: A review of the literature. *The International Society of Dermatology, 44,* 805-810.

Barcia, P. (1970) Lack of acceleration of healing with zinc sulfate. *Annals of Surgery 172*(6),
1048–1050.

Bates-Jensen, B. (1997). The pressure sore status tools a few thousand assessments later. *Advances in Wound Care, 10*(5), 65-73.

Bates-Jensen, B., McCreath, H., Kono, A., Apeles, N., & Alessi, C. (2007). Sub-epidermal moisture predicts erythema and Stage 1 pressure ulcers in nursing home residents: A pilot study. *Journal of American Geriatric Society, 55*, 119-1205.

Bates-Jensen, B., Vredevoe, D., & Brecht, M. (1992). Validity and reliability of the pressure sore status tool. *Decubitus, 5*(6), 20-28.

Baumgarten, M., Margolis, A., Localio, D., Kagen, S., Lowe, R., & Kinosian, B. et al. (2006). Pressure ulcers among elderly patients early in the hospital stay. *The Journal of Gerontology Series A: Biological Sciences and Medical Sciences, 61*, 749-754. Retrieved March 29, 2007, from www.biomed.gerontologyjournal.org.

Baumgarten, M., Margolis, D., VanDoorn, C., Gruber-Baldini, A., Hebel, J., & Zimmerman, S. et al. (2004). Black/ white differences in pressure ulcer incident in nursing home residents. *Journal of American Geriatrics Society, 52*(8), 1293-1298.

Bennett, L., Kavner, D., Lee, B., Trainor, F., & Lewis, J. (1981). Skin blood flow in seated geriatric patients. *Arch Phys Med Rehabil,* 62, 392-398.

Bergstrom, N., Allman, R.M., Alvarez, O.M., Bennett, M.A., Carlson, C.E., Frantz, R.A., et al. (1994). Pressure ulcer treatment. Clinical practice guideline No. 15. Rockville, MD: U.S.

Department of Health and Human Services, Public Health Service, Agency for Health Care
Policy and Research. AHCPR Publication No. 95-0652.

Bergstrom, N., & Braden, B. (1992). A prospective study of pressure sore risk among institutionalized elderly. *Journal of the American Geriatrics Society, 40,* 747-758.

Bergstrom, N., & Braden, B. (2002). Predictive validity of the Braden Scale among black and white. *Nursing Research, 51*(6), 398-403.

Bergstrom, N., Braden, B., Kemp, M., & Ruby, E. (1996). Multi-sided study of incidence of pressure ulcers and the relationship between risk level, demographic characteristics, diagnosis and prescriptions of preventive interventions. *Journal of American Geriatrics Society, 44.* Retrieved February 17, 2009, from www.mdconsult.com.

Bergstrom, N., Braden, B., Kemp, M., Champagne, M., & Ruby, E. (1996). Multi-site study of incidence of pressure ulcers and the relationship between risk level, demographic characteristics, diagnosis and prescription of preventive interventions. *Journal of American Geriatrics Society, 44*, Retrieved February 17, 2009, from www.mdconsult.com.

Bergstrom, N., Braden, B., Kemp, M., Champagne, M., & Ruby, E. (1998). Predicting pressure ulcer risk: A multisided study of the predictive validity of the Braden scale. *Nursing Research, 47,* 261-269.

Berlowitz, D. R., & Wilking, S. B. (1989, November). Risk factors for pressure sores. A comparison of cross-sectional and cohort-derived data. *Journal of the American Geriatrics Society, 97*(11), 1043-4050.

Berlowitz, D. V., & Wilking, S. B. (1990). The short-term outcome of pressure sores. *Journal of the American Geriatrics Society, 38*(7), 748-752.

Berstorm, N., Horn, S., Smout, R., Bender, S., Ferguson, M., & Taylor, G. et al. (2005). The national pressure ulcer long-term care study: Outcomes of pressure ulcer treatment in long-term care. *Journal of American Geriatrics Society, 53,* 1721-1729.

Bethell, E. (2005). Wound care for patients with darkly pigmented skin. *Nursing Standard, 20*, 41-49. Retrieved February 16, 2009, from www.aislec.com.

Bourdel-Marchasson, I., Barateau, M., Rondeau, V., Dequae-Merchadou ,L., Salles-Montaudon, N., Emeriau, J., Manciet, G.,& Dartigues, J. (2000). A multi-center trial of the effects of nutritional supplementation in critically ill older inpatients. GAGE Group. Groupe Aquitain Geriatrique d'Evaluation. *Nutrition.*16:1-5.

Bourdel-Marchasson, I., Dumas, F., Pinganaud, G., Emeriau J., & Decamps, A. (1997). Audit of percutaneous endoscopic gastrostomy in long-term enteral feeding in a nursing home *The International Journal for Quality in Health Care, 9* (4), 297-302.

Braden, B., & Maklebust, J. (2005). Preventing pressure ulcers with the Braden scale. *American Journal of Nursing, 105*, 6. Retrieved February, 2009, from www.nursingcenter.com.

Brandeis, G., Morris, J., Nash, D., & Lipsitz, L. (1990). The epidemiology and natural history of pressure ulcers in elderly nursing home residents. *Journal of the American Medical Association, 264*(22), 2905-2909.

Brandeis, G. H., Ooi, W. L., Hossain, M., Morris, J. N., & Lipsitz, L. A. (1994, April). A longitudinal study of risk factors associated with the formation of pressure ulcers in nursing homes. *Journal of the American Geriatrics Society, 42*(4), 388-393.

Breslow, R. A., Hallfrisch, J., Guy, D. G., Crawley, B., & Goldberg, A. P. (1993). The importance of dietary protein in healing pressure ulcers. *Journal of the American Geriatrics Society, 41*(4), 357-362.

Bridel, J. (1993) Assessing the risk of pressure sores. *Nursing Standard, 7*, 32-35.

Burger, S., Kayser-Jones, J., & Bell, J. (2001). Food for thought. *Contemporary Long-Term Care, 24*, 4. Retrieved July 9, 2008, from web.escohost/delivery.

Burgio, K., Matthews, K., & Engel, B. (1991). Prevalence, incidence and correlates of urinary incontinence in healthy, middle-aged women. *Journal of Urology, 146*, 1255-1259.

Campbell, S. M., & Hall, J. (1997). *Enteral Nutrition Handbook*. Columbus, OH: Ross Products Division, Abbott Laborator.

Cannon, B., & Cannon, J. (2004). Management of Pressure Ulcers. *AMJ Health System Pharmacy, 61,* 1895-1905.

Casey, G. (1998). The importance of nutrition in wound healing. *Nursing Standards, 13*(3), 51-56.

Cavicchioli, A., & Carella, G. (2007). Clinical effectiveness of a low-tech versus high-tech pressure redistributing mattress. *Journal of Wound Care, 16*(7), 285-289.

Center for Medicare & Medicaid Services (2007). Medicare programs: Changes to the hospital inpatient prospective payment systems and financial year 2008. *Federal Register, 2007, 162,* 47130-48175.

Chandler, A., Benfield, S., & Williams, A. (2005, A.B.G. *Lansdown Journal of Wound Care, 14*(4), 155-160.

Chidester, J. & Spangler, A. (1997). Fluid intake in the institutionalized elderly. *Journal of American Dietetic Association,* (1), 23-28.

Clark, M. (2003). Guidelines on nutrition in pressure ulcer prevention and treatment. *European Pressure Ulcer Advisory Panel, 1-5*. Retrieved September 9, 2008, from ww.espen.org.

Collins, N. (2001). The difference between albumin and pre-albumin. *Advances in Skin and Wound Care, 14(50)*, 235-236. Retrieved May 29, 2006, from www.ovoidsp.tx.ovoid.com.

Connelly, N. (2009). The journey to zero-eliminating nosocomial pressure ulcers. *Healthcare Groups.* Retrieved May 15, 2009, from Remd.com.

Covinsky, K. (2002). Malnutrition and bad outcomes. *Journal of Internal Medicine, 17*(12), 956-957.

Defloor, T., & Schuijmer, J. (2000). Preventing pressure ulcers: An evaluation of four operating-table mattress. *Applied Nursing Research, 13*(3), 134-41.

Deitch, E. (1988). Does the gut protect or injure patients in the ICU? *Prospect Critical Care, 1*, 1-31.

Delmi, M., Rapin, C., Bengoa, J., Delmas, P., Vasey, H., Bonjour, J. (1990). Dietary supplementation in elderly patients with fractured neck of the femur. *Lancet.* 335, 1013-1016.

Desneves, K., Todorovic, B., Ceasar, A., & Crowe, T. (2005). Treatment with supplementary arginine, vitamin C and zinc in patients with pressure ulcers. *Clinical, 24*(6), 979-987.

Dharmarajan, T., & Ahmed, S. (2003). The growing problem of pressure ulcers. *Postgraduate Medicine, 113*, 1-10. Retrieved August 11, 2008, from www.ebscohost.com/ehost.

Donabedian, A. (1988). The quality of care: How can it be assessed? *Journal of the American Medical Association, 260*(12), 1743-1748.

Donini, L., Defelice, M., Tegliaccica, A., Debernardini, L., & Cannella, C. (2005). Nutritional status and evolution of pressure sores in geriatric patients. *The Journal of Nutrition, Health and Aging, 9*(6), 446-54.

Ducker, A. (2002). Pressure ulcers: Assessment, prevention, and compliance. *Advances in Skin and Wound Care,* 61-77. Retrieved August 20, 2008, from www.woundcarenet.com.

Ek, A. (1987). Prediction of pressure sore development. *Scandinavian Journal of Caring Sciences, 1,* 77-84.

Ek, A., Unosson, M., & Bjurulf, P. (1989). The modified Norton scale and the nutritional state. *Scandinavian Journal of Caring Sciences, 3,* 183-187.

Ek, A., Unosson, M., & Larsson, J. (, 1991). The development and healing of pressure sore related to the nutritional state. *Clinical Nutrition, 5,* 99-103.

Ek, A. C., Unosson, M., Larsson, J., Von Schenck, H., & Bjurulf, P. (1991). The development and healing of pressure sores related to the nutritional state. *Clinical Nutrition, 10,* 245-250.

Evans, J., Andrews, K., Chutka, D., Fleming, K., & Garness, S. (1995). Pressure ulcer prevention and management. *Mayo Clinic Proceedings, 70*(8), 789-99.

Exton-Smith, A., & Sherwin, R. (1961). The Prevention of Pressure Sores. *Significance of Spontaneous Bodily Movements, Lancet. 2*(7212), 1124-1126.

Farage, M., Miller, K., Berardesca, E. & Maibach, H. (2007). Incontinence in the aged: Contact dermatitis and other cutaneous consequences. *Contact Dermatitis, 57,* 2II-217.

Faras Soriano, L., Large Vasquez, M., Maristany, C., Xandri, G. (2004). The effects of oral nutritional supplement. *Journal of Wound Care, 13*(8), 319-322.

Ferguson-Pell, M. (1990). "Seat cushions selection". *J. Rehab. R&D Clinical Supplement,*
2: 49-74.

Fergunson, M., Cook, A., Rimmasch, H., Bender, S., & Voss, A. (2000). Pressure ulcer management: The importance of nutrition. *Med surge Nursing, 9*(4), 163-177.

Fisher, A., Wells, G., & Harrison, M. (2004). Factors associated with pressure ulcers in adults in acute care hospitals. *Advance in Skin and Wound Care, 17*(2), 80-90.

Fleishman, A. (2005). Management of pressure ulcers. *Adult Wound Care.* Retrieved February 1, 2009, from www.fortherecordmag.com.

Foltz, M., Schiller, R., & Ryan, A. (1993). Nutrition screening and assessment: Current practices and detains' leadership roles. *Journal of American Dietetic Association, 93*(12), 1388-1395.

Ford, C., Reinhard, E., Yeh, D., Syrek, D., De las Morenas, A., & Bergman, S. et al. (2002). Interim analysis of a prospective, randomized trial of vacuum-assisted closure versus the healthpoint system in the management of pressure ulcers. *Annals of Plastic Surgery, 49,* 55-61.

Frantz, R. A., Gardener, S., Harvey, P., Specht, J. (1991). The cost of treating pressure ulcers in a long-term care facility. *Decubitus, 4 (3),* 37-45.

Frantz, R. A., Gardener, S., Specht, J. K., & McIntire, G. (2001). Integration of pressure ulcer treatment protocol into practice: Clinical outcomes and care environment attributes. *Outcome Management Nurse Practice, 5*(3), 112-20.

Garcia, A., & Thomas, D. (2006). Assessment and measurement of pressure ulcers in the elderly. *Medical Clinics of North America, 90,* 925-944.

Gardener, S., Frantz, R., Bergquist, S., & Shin, C. (2005). A prospective study of the pressure ulcer scale for healing (PUSH). *Journal of Gerontological and Biological Science, 60*(1), 93-7.

Gersovitz, M., Motil, K., Munro, H., Scrimshaw, N., & Young, V. (1982) Human protein requirements: Assessment of the adequacy of the current recommended dietary allowance for dietary protein in elderly men and women. *American Journal of Clinical Nutrition, 35*(1), 6–14.

Geyer, M. Brienza, D.Karg, P.Trefler, E. & Kelsey, S. (2001) A randomized control trial to evaluate pressure-reducing seat cushions for elderly wheelchair users. *Advances in Skin and Wound Care, 4*(3), 120-129;

Gibbons, W., Shanks, H. T., Kleinhealter, P., & Jones, P. (2006). Eliminating facility-acquired pressure ulcers at Ascension Health. *Joint Commission Journal on Quality Patient Safety, 32*(488-496).

Glickman, S., Baggett, K., Krubert, C., Peterson, E., & Schulman, K. (2008). Promoting quality: The health-care organization from a management perspective. *International Journal for Quality in Health Care.* Retrieved May 18, 2009, from www.medscape.com.

Gode, H., & Burns, F. (1992). Vitamin C depletion and pressure sores in elderly patients with femoral neck fractures. *British Medical Journal, 305,* 925-7.

Goodridge, D., Sloan, J., McDoyen, Y., McKenzie, J., Knight, W., & Gayari, M. (1998). Risk assessment scores, prevention strategies, and the incidence of pressure ulcers among the elderly in four Canadian health-care facilities. *Canadian Journal of Nursing Research, 30*(2), 23-44.

Graumlich, J., Blough, L., Mclaughin, R., Milbrandt, J., Calderon, C., & Agha, S. et al. (2003). *Healing pressure ulcers with collagen or hydrocolloid: Randomized controlled trial.* Retrieved July 20, 2008, from www.ncbi.nlm.gov.

Graves, N., Birrell, F., & Whitby, M. (2005). Effect of pressure ulcers on length of hospital stay. *Infect Control Hosp Epidemiology, 26*, 293-297.

Grey, J., Harding, K., & Enoch, S. (, 2006). Pressure ulcer. *British Medical Journal, 332*, 472-475. Retrieved August 11, 2008, from www.bmj.com.

Grey, M., & Jones, D. (2004). The effect of different formulations of equivalent active ingredients on the performance of two topical wound treatment products. *Ostomy/Wound Management, 50(*3), 34-44. Retrieved September 12, 2008, from www.o-wm.com.

Gunningberg, L. (2004). Pressure ulcer prevention: Evaluation of an educational program for Swedish nurses. *Journal of Wound Care, 13*(3), 84-89.

Gunningburg, L., Lindholm, C., Carlson, M., & Sjoden, P. (1999). Implementation of risk assessment and classification of pressure ulcer as a quality indicator for patients with hip fractures. *Journal of Clinical Nurse, 8,* 396-404.

Gunter, P., Malyszek, R., Bliss, D., Steffe, T., O'Hara, D., & LaVan, F. (2000). Survey of nutritional status in newly hospitalized patients with Stage III or Stage IV pressure ulcers. *Advance in Skin and Wound Care, 13*(4), 164-168.

Granick, M. S., & McGowan, E. (2001). Long CD Outcome Assessment of an In-Hospital Cross-functional Wound Care Team. *Plastic and Reconstructive Surgery, 5,* 101-105.

Guralink, J., Harris, T., White, L., & Cornoni-Huntley, J. (1988). Occurrence and predictors of pressure sores in the national health and nutrition examination survey follow-up. *Journal of the American Geriatrics Society, 36*(9), 807-812.

Halfens, R., Achterberg, T., & Bal, R. (2000). Validity and reliability of the Braden scale and the influence of the risk factors: a multi-centre prospective study. *International Journal of Nursing Studies, 37*(4), 313-319.

Harris, C., & Fraser, C. (2004). Malnutrition in the hospitalized elderly: The effects on wound healing. *Ostomy Wound Management, 50(10)*, 1-12. Retrieved August 22, 2008, from www.o-wm.com.

Hart, J. (2002). Inflammation 2: It's role in the healing of chronic wounds. *Journal of Wound Care, 11*(7), 245-249.

Hartgrink, H., Willie, J., Konig, P., Hermans, P., & Breslau, P. (1998). Pressure sores and tube feeding in patients with a fracture of the hip: a randomized clinical trial. *Clinical Nutrition, 17*(6), 287-292.

Heffler, S., Smith, S., Keehan, S., Clemens, M., Zezza, M., & Truffer, C. (2004). Health spending projections through 2013. *Health Affairs, The Policy Journal of Health Sphere.* Retrieved September 24, 2008, from http://content.healthaffairs.org.

Henderson, C., Ayello, E., Sussman, C., Lelby, D., Bennett, M., & Dungog, M. (1997). Draft definition of pressure ulcer. *Advance Wound Care, 10*(5), 16-19.

Himes, D. (1999). Protein-caloric malnutrition and involuntary weight loss: The role of aggressive nutritional intervention in wound healing. *Ostomy Wound Management, 45*(3), 46-55.

Horn, S., Bender, S., Stout, M., Bergstrom, N., Taler, G., & Cook, A. et al. (2004). The national pressure ulcer long term care study: Pressure ulcer development in long-term care residence. *Journal of American Geriatric Society.* Retrieved October 4, 2006, from www.medscape.com.

Houwing, R. H., Rozendaal, M., Wouters-Wesseling, W., Beulens, J. W., Buskens, E., & Haalboom, J. R. (2003, August 22). A randomized, double-blind assessment of the effect of nutritional supplementation on the prevention of pressure ulcers in hip-fracture patients. *Clinical Nutrition, 22*(4), 401-405.

International Functional Stimulation Society (2002). Electrical Stimulation for the management of bladder and bowel incontinence. Retrieved September 29, 2009 from www.ifess.org.

Institute for Health care Improvement (2007). *Relieve the pressure and reduce harm.* Retrieved August 11, 2008, from Him.org.

Kagansky, N., Berner, Y., Koren-Mogag, N., Perelman, L., Knobler, H., & Levy, S. (2005). Poor nutritional habits are predictors of poor outcomes in very old hospitalized patients. *American Journal of Clinical Nutrition, 82,* 784-790.

Kelly, L., & Mobily, P. (1991). Iatogenesis in the elderly: Impaired skin integrity. *Journal of Gerantological Nursing, 12,* 24-29.

Kirkman, C., & Molnar, J. (2008). Pressure ulcers nonsurgical treatment and principles. , , . Retrieved August 6, 2008, from www.emedicine.com.

Knox, L. (2004). . *Clinical and legal aspects of Wound Care and Pressure Ulcers.* Retrieved April 14, 2006, from www.amacmedirect.com.

Knox, D., Anderson, T., & Anderson, P. (1994). Effects of different turn intervals on skin of healthy older adults. *Advance in Wound Care, 7*(1), 48-56.

Kosiak, M. (1959).Etiology and pathology of ischemic ulcers. *Arch Phys Med Rehabil. 40*(2), 62-69.

Koaiak, M. (1966, November). An effective method of preventing decubital ulcers. *Archives of physical Medicine and Rehabilitation, 47*(11), 724-729.

Kosiak, M. (1991). Prevention and rehabilitation of pressure ulcer. *Decubitus.*, *4*(2):60-2, 64, 66.

Kudsk, K., Croce, M., Fabian, T., Minard, G., Tolly, E., Porter, M, (1992). Enteral versus parenteral feeding: Effects on septic morbidity after blunt and penetrating abdominal trauma. *Annals of Surgery, 215*(5), 503–513.

Kugler, J. & Husted (2000 Impact of aging on water metabolism. *The American Academy of Family Physician.* Retrieved October 4, 2009 from www.aafp.org.

Landis, E. (1930). Micro-injection studies of capillary blood pressure in human skin. *Heart, 15*:209-28.

Langkamp-Hanken, B., Stechmiller, J., & Herrlinger-Garcia, K. (2005). Mini nutritional assessment and screening scores are associated with nutritional indicators in elderly people with pressure ulcers. *Journal of American Dietetics Association, 105,* 1590-1596.

Larsson, F., Unosson, M., Ek, A., Nilsson, L., Thorslund, S., & Bjurulf, P. (1990). Effects of dietary supplement on nutritional status and clinical outcome in 501 geriatric patients- a randomized study. *Clinical Nutrition,* 179-184.

Lee, S., Posthauer, M., Dorner, B., Redovian, V., & Molone, M. (2006). Pressure ulcer healing with a concentrated, fortified, collagen protein hydrolysate supplement: A randomized controlled trial. *Advances in Skin and Wound Care, 19*(2), 92-96.

Lewko, J., Demianiuk, M., Krot, E., Krajewska-Kulak, E., Sireakowska, M., & Nyklewicz, W. et al. (2005). Assessment of risk for pressure ulcers using the Norton scale in nursing practice. *Annals Academia Medicine, 50.* Retrieved February 28, 2009, from www.advms.pl/roczniki.

Lindgren, M., Unosson, M., Krantz, A., & Elk, A. (2002). A risk assessment scale for the prediction of pressure sore development: reliability and validity. *Journal of Advanced Nursing, 38(2)*, 190-199. Retrieved February 28, 2009, from www.journalofadvancednursing.com.

Livesley, N. J., & Chow, A. W. (2002). Infected Pressure Ulcers in Elderly Individuals. *Aging and Infectious Disease, 35,* 1390-1396.

Llorens Pharmaceutical (2009) Proteinex Liquid Protein Supplements. Retrived July 27, 2009 from www.dietdirect.com.

Long, C., Nelson, K., Akin, J., Geiger, J., Merrick, H., & Blakemore, W. (1990) A physiologic basis for the provision of fuel mixtures in normal and stressed patients. *Journal of Trauma, 30*(9), 1077–1086.

Lyder, C. (1991). Conceptualization of the Stage I pressure ulcer. *Journal of ET Nursing, 18*(5), 162-165.

Lyder, C. (2002). Pressure ulcer prevention and management. *Annual Review Nursing Research, 20,* 35-61.

Lyder, C. (2003). Pressure ulcer prevention and management. *Journal of American Medical Association, 289*, 223-226. Retrieved August 18, 2008, from www.jama.com.

Lyder, C. (2005). Is pressure ulcer care evidence based or evidence linked? *Science of Surfaces Meeting*. Warwickshire UK, January 20-21.

Lyder, C., Shannon, R., Empleo-Frazier, O., McGhee, D., & White, C. (2002). A comprehensive program to prevent pressure ulcers in long-term care: Exploring costs and outcomes. *Ostomy Wound Management, 46*(4), 52-61.

Lyder, C., Yu, C., & Stevenson, D. et al. (1998). Validating the Braden scale for the prediction of pressure ulcer risk in blacks and Latino/Hispanic elders: a pilot study. *Ostomy/Wound Management, 44,* 42S-50S.

Lyder, C., Yu, C., Emerling, J., Maget, R., Stevenson, D., & Empleo-Frazier, O. et al. (1999). The Braden scale for pressure ulcer risk: Evaluating the predictive validity in black and Latino/Hispanic elders. *Applied Nursing Research, 12*(2), 60-68.

Magalhães, M., Gragnani, A., Veiga, D., Blanes, L., Galhardo, V., & Kallas, H. et al. (2007). Factors for pressure ulcers in hospitalized elderly without significant cognitive impairment. *Wounds, 19*(1), 20-24.

Maklebust, J., & Sieggreen, M. (1996). Pressure ulcers: Guidelines for prevention and nursing management (2nd Ed), Springhouse, PA. Springhouse Corporation.

Margolis, D., Knauss, J., Bilker, W., & Baumgarten, M. (2003).Medical conditions as risk factors for pressure ulcers in an outpatient. *Age and Ageing, 32*: 259–264.

Mathus-Vliegen, E. (2004). Old age, malnutrition, and pressure sores: an ill-fated alliance. *Gerontological andBiological Science, 59*(4), 355-60.

Mawson, A., Siddiqui, F., & Biundo, J. (1993). Enhancing host resistance to pressure ulcer: a new approach to prevention. *Preventive Medicine, 22*(3), 433-50.

Mayo Clinic (2009). *Bedsores (pressure scores): Risk factors.* Retrieved May 14, 2009, from www.MayoClinic.com.

Mayo Clinic (2009). Dehydration. Retrieved July 14, 2009, from www.MayoClinic.com

Meauum, S., Vallet, D., Morere, M., & Teot, L. (2005). *Evaluation of a silver-releasing hydroalginate dressing in chronic wounds with signs of local infection.* Retrieved July 20, 2008, from www.nebi.hlm.nih.gov.

Medline Plus (2008). Bowel incontinence. Retrived August 29, 2009 from www.nlm.nih.gov.

Meehan, M. (1994). National pressure ulcer prevalence survey. *Advance in Wound Care, 3,* 27- 38.

Mei-che, P., & Kwok-shing, W. (1998). Predicting pressure sore with the Norton, Braden, and Waterloo scales in a Hong Kong rehabilitation hospital. *Nursing Research, 47,* 147-153.

Meijers, M., Schols, J., Jackson, M., Phil, P., Langer, M., Clark, G., et al. (2008). Differences in nutritional care in pressure ulcer patients whether or not using nutritional guidelines. *Nutrition, 24*(2), 127-132.

Merck Manual of Health & Aging (2004). Retrieved August 21, 2009 from *www.merckmanuals.com.*

Morley, J. & Silver, A. (1998). Anorexia in the elderly. *Neurobiology of Aging, 9*, 9-16.

Mukamel, D., & Williams, S. (2000). Nursing home cost and risk adjusted cost. *Outcome measures of Quality Medical Care, 38*(1), 79-89.

Mullner, T., Mrkonjic, L., Kwasny, O., & Vecsel, V. (1997). The use of negative pressure to promote the healing of tissue defects: a clinical trial assessing the vacuum sealing technique. *British Journal 1f Plastic Surgery, 50*(3), 194-9.

National Institute on Aging (2009). *United States population aging 65 years and older: 1990 to 2050 (in millions).* Retrieved May 15, 2009, from www.nia.nih.gov.

National Pressure Ulcers Advisory Panel (2007). *Updating staging system.* Retrieved July 13, 2007, from http://www.npuap.org.

National Pressure Ulcers Advisory Panel, (1989). Pressure ulcers prevalence, cost and risk assessment: Consensus development conference statement. *Decubitus, 2*, 24-28.

Nixon, J., Cranny, G., Iglesias, C., Nelson, E., Hawkins, K., & Phillips, A. et al. (2006). Randomised, controlled trial of alternating pressure mattresses compared with alternating pressure overlays for the prevention of pressure ulcers: PRESSURE (pressure relieving support surfaces) trial. *British Medical Journal*. Retrieved October 17, 2009, from http://www.bmj.com.

Norley, J., & Silver, A. (1998). Anorexia in the elderly. *Neurobiology of Aging, 9,* 9-16.

Norton, D. (1987). Norton revised risk scores. *Nursing Times, 83*(6).

Norton, D., McLaren, R., & Exton-Smith, A. N. (1979). *An Investigation of Geriatric Problems in Hospitals* (3 Ed.). : Churchill Livingstone.

Nussbaum, E., Biemann, I., & Mustard, B. (1989). Comparision of ultrasound/ultraviolet-c and laser for treatment of pressure ulcers in patients with spinal cord injury. *National Pressure Ulcers Advisory Panel, 2,* 24-28.

Orlando, P. (1998). Pressure ulcer management in geriatric patient. *The Annals of Pharmacology, 32,* 1221-1227.

Pancorbo-Hidalgo, P., Garcia-Fernandez, F., Lopez-Medina, I., & Alvarez-Nieto, C. (2006). Risk assessment scales for pressure ulcer prevention: A systematic review. *Journal of Advanced Nursing, 54*(1), 94-110.

Pang, S., & Wong, T. (1998). Predicting pressure sore risk with the Norton, Braden, and waterloo scales in Hong Kong rehabilitation hospital. *Nursing Research, 47*(3), 147-153.

Papanikolao, P., Clark, M., & Lyne, P. (2002). Improving the accuracy of pressure ulcer risk calculators: some preliminary evidence. *International Journal of Nursing Studies, 39*(2), 187-194.

Parnell, L., Ciufi, B., & Gokoo, C. (2005). *Preliminary use of a hydrogel containing enzymes in the treatment of Stage II and Stage III pressure ulcers.* Retrieved July 28, 2008, from www.o-wm.com.

Perneger, T., Gaspoz, J., Rae, A., Borst, F., & Heliot, C. (1998). Contribution of individual items to the performance of the Norton pressure ulcer prediction scale. *Journal of American Geriatric Society, 46*(10), 1282-1286.

Peterson, V., Moore, E., Jones, T., et al. (1988). Total enteral nutrition versus total parenteral nutrition after major torso surgery: Attenuation of hepatic protein reprioritization. *Surgery, 104*(2), 199–207.

Pinchcofsky-Devin, G. D., & Kaminski, M. V. (1986, June). Correlation of pressure sores and nutritional status. *Journal of the American Geriatrics Society, 34*(6), 435-440.

Pompeo, M. (2009) Misconceptions about protein requirements for wound healing: Results of a prospective study. *Ostomy Wound Management, 53*(8). Retrieved September 27, 2009 from www.o-wm.com.

Pories, W., Henzel, J., Rob, C., & Strain, W. (1967). Acceleration of Wound Healing in Man with Zinc Sulphate given by mouth. *Lancet, 1*(7482), 121-124.

Raffoul, W., Far, M., Cayeux, M., & Berger, M. (2006). Nutritional status and food intake in nine patients with chronic low limb ulcers and pressure ulcers: importance of oral supplements. *Nutrition, 22*(1), 82-88.

Ratliff, C., &. Rodeheaver, G. (2005).Use of the PUSH Tool to measure venous ulcer healing. *Ostomy Wound Management, 51*(5). Retrieved August 22, 2009 from www.o-wm.com.

Redelings, M. D., Lee, N. E., & Sorvillo, F. (2005, September). Pressure ulcers: more lethal than we thought? *Advances in Skin & Wound Care, 18*(7), 367-372.

Reed, R., Hepburn, K., Adleson, R., Center, B., & McKnight, P. (2003). Low serum albumin levels. Confusion and fecal incontinence are the risk factors for pressure ulcers in mobility-impaired hospitalized adults. *Gerontology, 49,* 255.

Rijswijk, L., & Lyder, C. (, 2003). Pressure ulcer prevention and care: implementing the revised guidelines to surveyors for long-term care facility. *Ostomy Wound Management, 48*(4), 52-62.

Rodriguez, G., & Garber, S. (1994, March). Prospective study of pressure ulcer risk in spinal cord injury patients. *Paraplegia, 32*(3), 150-158.

Rojas, A., & Phillips, T. (1999). Patients with chronic leg ulcers show diminished levels of vitamins A and E, carotenes and zinc. *The American Society for Dermatologic Surgery, 25,* 601-604

Romo, T. (2008). *Wound Healing Skin.* Retrieved June 1, 2009, from www.emedicine.medscape.com.

Rosen, J., Mittal, V., Degenholtz, H., Castle, N., Nace, D., & Rubin, F. (2006). Pressure ulcer prevention in black and white nursing home residents: a QI initiative of enhance ability, incentives, and management feedback. *Advances in Skin and Wound Care, 19*, 262-268.

Rosenthal, M., Felton, R., Naiboff, B., Hacker, J., & Navach, J. (2003). Healing of advanced pressure ulcers by a genetic total contact seat: 2 randomized comparison with low air loss bed treatment. *Archives of Physical Med Rehabilitation.* Retrieved August 27, 2008, from www.ncbi.niah.gov.

Rousseau, P. (1998). Pressure ulcers and the aged: a preventable problem? *Continuing Care, 17,* 35-42.

Rudman, D., & Feller, A. (1989). Protein-calorie malnutrition in the nursing home. *Journal of America Geriatric Society. 37*(2), 173–183.

Russell, L. (2001). The importance of patient's nutritional status in wound healing. *British Journal of Nursing, 10*(6S), S42-49.

Russell, L. (2002). Pressure ulcer classification: Defining early skin damage. *British Journal of Nursing, 11*, S33-S41. Retrieved January 29, 2009, from www.internurse.com.

Russo, A., & Elixhauser, A. (2006). Hospitalizations related to pressure sores, 2003. Statistical Brief #3. Retrived July 5, 2009 from www.hcup-us.ahrq.gov.

Russo, A., Steiner, C., & Spector, W. (2008). Hospitalizations related to pressure ulcers among adults 18 years and older, 2006. *Agency for Health care Research and Quality.* Retrieved February 1, 2009, from www.hcup-us.ahrq.gov/reports/statbriefs/sb64.

Rycroff-Malone, J., & McInnes, E. (2001). Pressure ulcer risk assessment and prevention guideline: Technical report. *London Royal College of Nursing.* Retrieved January 12, 2009 from www.ren.org.uk.

Salcido, R., & Carney Thomas, D. (1997). The role of nutrition in prevention and healing of pressure ulcers. *Clinics in Geriatric Medicine, 13*(3), 497-511.

Salcido, R, Donofrio, J., Fisher, S., et al. (1994). Histopathology of pressure ulcers as a result of sequential computer- controlled pressure sessions in a fuzzy rat model. *Advances in Skin and Wound Care, 7*(5):23-4, 26, 28.

Salcido, R., & Popescu, A. (2006). Pressure ulcers and wound care. *EMedicine,* 1-33. Retrieved August 11, 2008, from www.emedicine.com.

Salcido R, Carney J, Fisher S, et al. (1993). A reliable animal model of pressure sore development: The role of free radicals. *Journal of American Paraplegia Society*, 16-61.

Salcido, R., Donofrio, J., Fisher, S., LeGrand, E., Dickey, K., & Carney, J., Schosser, R., Liang, R. (1994). Histopathology of pressure ulcers as a result of sequential computer-controlled pressure sessions in fuzzy rat model. *Advance in Wound Care, 7*(5), 23-40.

Salcido, R., Fisher, S. B., & Donoifrio, J. C. et al. (1995). An animal model and computer-controlled surface pressure delivery system for the production of pressure ulcers. *Journal of Rehabilitation Research Development, 32*(2), 149-61.

Salva, A., Coll-Planas, L., Bruce, S., De Groot, L., Andrieu, S., & Abellan, G. et al. (2009). Nutritional assessment of residents in long-term care facilities (LTCFS): Recommendations of the task force on nutrition and ageing of the lagg European region and the Iana. *The Journal of Nutrition, Health and Aging, 13*(6), 475-483.

Scanlon, E., & Stubbs, N. (2004). Pressure ulcer risk assessment in patients with darkly pigmented skin. *Professional Nurse, 19*(6), 339-341.

Schmidt, T. (2002). Nutrition Strategies that make a difference. *Caring Magazine,* 18-25.

Scholl, D., & Langkamp-Henken, B. (2001). Nutrient recommendation for wound healing. *Journal of Intravenous Nursing, 24*(2), 124-132.

Schoonhoven, L., Defloor, T., & Grypdonck, M. (2002). Incidence of pressure ulcers due to surgery. *Journal of Clinical Nurse, 11*(4), 479-87

Schubert, V., & Heraud, J. (1994). The effects of pressure and shear on skin microcirculation in elderly stroke patients lying in supine or semi-recumbent position. Retrieved November 8, 2008, from www.O-galenet.galegroup.com.

Shara, S., Vin Chee, K., & Wan Chik, W. (2002). Food intake and preference of hospitalized geriatric patients. *BMC Geriatric, 23.* Retrieved August 27, 2008, from www.pubmedcentral.nih.gov.

Sharp, C., & McLaws, M. (2005). A disclosure on pressure ulcer physiology: The implication of reposting and staging. *World Wide Wounds,* 1-14. Retrieved August 18, 2008, from www.worldwidewounds.com.

Sharp, C., & McLaws, M. (2006). Estimating the risk of pressure ulcer development: is truly evidence based. *Internal Wound Journal, 3,* 344-353.

Sinclair, L., Berwiczonek, H., Thuston, N., Butler, S., Bulloch, G., & Ellerey, C. et al. (2004). Evaluation of an evidence-based education program for pressure ulcer prevention. *Journal of Wound, Ostomy and Continence Nurse, 31*(1), 43-50.

Smith, N. (, 2004). The benefit of VAC therapy in the management of pressure ulcers. *British Journal of Nursing, 13*(22), 1359-1366.

Soriano, L., Vazquez, M., Maristany, C., Graupera, J., & Wouters-Wesseling, W. & Wagenaar, L. (2004). The effectiveness of oral nutritional supplementation in the healing of pressure ulcers. *Journal of Wound Care, 13*(8), 319-322.

Stotts, N., Rodeheaver, G., Thomas, D., Frantz, R., Bartolucci, A., & Sussman, C. (2001). An instrument to measure healing in pressure ulcers: Development and validation of pressure ulcer scale for healing (PUSH). *The Journal of Gerontology, 56A* (12), M795-799.

Sullivan, D., & Robertson, P. (2002). Understanding the risk of life threatening complications among hospitalized elders. *Journal of General Internal Medicine, 17,* 925-932.

Sussman, C., & Bates-Johnson, B. M. (1998). *Wound Care*. Maryland: Aspen Publication Inc.

Takahashi, J., Yokota, O., Fujisawa, Y., Saaki, K., Ishzu, H., & Aoki, T. et al. (2006). An evaluation of polyvinylidine film dressing for treatment of pressure ulcers in older people. *Journal of Wound Care, 15*(10), 449-454.

The Royal College of Nursing (2005). The management of pressure ulcers in primary and secondary care: A clinical practice guideline. *Royal College of National Institute of Health and Clinical Excellence,* 187-245.

Theilla, M., Singer, P., Cohen, J., & Dekeyser, F. (2007). A diet enriched in eicosapentanoic acid, gama-linolenic acid and antioxidants in preventing critically ill patients with acute lung injury: A randomized, prospective controlled study. *Clinical Nutrition, 26,* 752-757

Thomas, D. (1997). The role of nutrition in prevention and healing of pressure ulcers. *Clinics in Geriatric Medicine, 13*(3), 497-511.

Thomas, A. (1998). Nutrition and the elderly. Nursing Times - Nutrition in Practice 10

Thomas, D. (2001). Improving outcome of pressure ulcers with nutritional interventions: a review of evidence. *Nutrition, 17,* 121-5.

Thomas, D. (2002). Under nutrition in the elderly. *Clinical Geriatric Medicine, 18*(4), XIII-XIIIV.

Thomas, D. (2006). Prevention and treatment of pressure ulcers. *Journal of American Medical Directors Association, 7,* 46-59.

Thomas, D., Goode, P., Tarquine, P., & Allman, R. (1996). Hospital-acquired pressure ulcers and risk of death. *Journal of the American Geriatrics Society, 44*(12), 1435-1440.

Thomas, D., Goode, P., LaMaster, K., & Tennyson, T. (, 1998). Assessing hydrogel dressing versus saline dressing for pressure ulcers. A randomized controlled trial. *Advances in Wound Care, 11,* 273-6.

Thomas, D., Verdery, R., Gardner, L., Kant, A., & Lindsay, J. (1991) A prospective study of outcome from protein-energy malnutrition in nursing home residents. *Journal of Parenteral and Enteral Nutrition, 15*, 400-404.

Thomas, S. (2001). An introduction to the use of vacuum assisted closure. *World Wide Wounds,* 1-12. Retrieved August 6, 2008, from www.worldwidewounds.com.

Thomas, D., Zdrowski, C., Wilson, M., Conright, K., Lewis, C., & Morley, S. et al. (2002). Malnutrition is sub-acute care. *American Society of Clinical Nutrition, 75*(2), 308-313.

Thompson, P., Langemo, D., Anderson, J., Hanson, D., & Hunter, S. (2005). Skin care protocols for pressure ulcers and incontinence in long-term care: A quasi-experimental study. *Advances in Skin and Wound Care, 18*(8), 422-429.

United States Department of Health and Human Services. Healthy People 2010. Retrieved August 20, 2009 from www.healthypeople.gov.

Visvanathan, R. (2003). Under nutrition in older people. A serious and growing global problem. *Journal of Postgraduate Medicine, 49*(4), 352-360.

Visvanathan, R., Penhall, R., & Chapman, I. (2004). Nutrition screening of older people in a sub-acute care facility in Australia and its relation to discharge outcomes. *Age and Ageing 3,* (3), 260-5.

Westrate, J., Hop, W., Aalbers, A., Vreeling, A., & Bruining, H. (1998). The clinical relevance of the waterloo pressure sore risk scale in the ICU. *Intensive Care Magazine, 24*(8), 815-820.

Whittingham, K., & Briones, R. (2004). National prevalence and incidence study: 6-year sequential acute care data. *Advance Skin Wound Care, 17*(9), 490-494.

Williams, D., & Stotts, N. et al. (2000). Patients with existing pressure ulcers admitted to acute care. *Journal of Wound, Ostomy, & Continence Nursing, 27*(4), 216-26.

World Union of Wound Healing Societies (WUWHS) (2008). Principles of best practice: Vacuum assisted closure: Recommendations for use. *A Consensus Document.* Retrieved June 6, 2009, from www.wuhs.org.

Wound Care Protocols (2001). *Protocols.* Retrieved October 16, 2009, from www.woundcareprotocols.com.

Wound Ostomy and Continence Nurses Society (2003). *Clinical practice guideline series: Guidelines for prevention and management of pressure ulcers.* Glenview IL: WONC Society.

WoundSkin-ce (2008). *Etiology of common chronic wounds.* Retrieved August 28, 2008, from www.woundskin-ce.com.

Xakellis, G., & Frantz, R. (1996). The cost of healing pressure ulcers across multiple health care settings. *Advance Wound Care, 9*(6), 18-22.

Xakellis, G., Frantz, R., Lewis, A., & Harvey, P. (2001). Translating pressure ulcer guidelines onto practice it's harder than you think. *Advance Skin and Wound, 14*(5), 249-2.

VITA

BEVERLIN ALLEN

EDUCATION	DEGREE	DATE	MAJOR
Florida International University Miami, FL 33199	Ph.D. in Nursing (Candidate)	2004-present	Nursing
Florida International University Miami, FL 33181	Master of Science in Nursing (M.S.N.) Nurse Practitioner	1995	Nursing
Florida International University Miami, FL 33181	Bachelor of Science in Nursing (B.S.N.)	1991	Nursing
Kingston School of Nursing	Certificate in Nursing	1975	Nursing
University of The West Indies	Certificate in Obstetric	1980	Nursing

ROFESSIONAL EXPERIENCE

Position	Organization	Date
Chief Nursing Officer Present	Sister Emmanuel Hospital Miami, FL331333	2003 -
Nurse Manager	Mercy Hospital Miami FL 33133	996 – 2003
Advanced Registered Nurse Practioner (ARNP)	Planned Parenthood Miami FL 33133	1995-1997
Interim Nurse Manager Charge Nurse/Staff Nurse	Mercy Hospital Miami FL 33133	1995-1996
Adjunct Clinical Instructor	Florida International University Miami, FL33133	1993 - 2001
Adjunct Clinical Instructor	Miami Dade College Miami FL	1993 - 2007

Staff Nurse	Mercy Hospital Miami, FL 33133	1981 - 1993
Staff Nurse	National Chest Hospital Kingston, Jamaica	1975 -1981

PROFESSIONAL QUALIFICATIONS
Nurse Practitioner, State of Florida Licensure, ARNP1260652
National Alliance of Wound Care, Certified
Managing Quality Health Care Systems, Certified
ACLS for Healthcare Providers, Certified
Critical Care, Certified

PROFESSIONAL MEMBERSHIPS
Sigma Theta Tau International, Pi Alpha Chapter
National League of Nurses
Florida Nurses Association
Florida Organization of Nurse Executives
Board Member, South Florida Organization of Nurse Executives
Immediate Past President, Jamaica Nurses Association of Florida
Orthopedic Nurses Association
Miami-Dade County Public Schools Division of Applied Technology
Health Science Education Advisory Committee
Advisory Member Mercy Hospital School of Practical Nursing
Advisory Member Florida International School of Nursing
Kiwanis Club of Kendall-South Dade

AWARDS
Recipient of multiple nursing excellence awards including:

Florida International University Outstanding Alumni Award	2002
Nightingale Nursing Excellency Award,	2002
Florida Nurses Foundation, Research Grant Recipient	2009
South Florida Organization of Nurse Executives, Leadership Award	2009
Miami Dade Collage Hall of Fame,	2010

Research Grants 2008
Pressure Ulcers and Nutritional Deficits in Elderly Long-term Care Patients: Effects of a Comprehensive Nutritional Program on Pressure Ulcer Healing, Length of Hospital Stay, and Charges to Patient. Funded by Florida Nurses Association.