CLINICAL MANAGEMENT extra

Suspected Deep Tissue Injury Profile: A Pilot Study

CME 1 AMA PRA Category 1 Credit™

CE ANCC 2.8 Contact Hours

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This continuing educational activity will expire for physicians on March 31, 2015.

PURPOSE:

To enhance the learner's competence with knowledge of the results of research examining suspected deep tissue injury profiles.

TARGET AUDIENCE:

This continuing education activity is intended for physicians and nurses with an interest in skin and wound care.

OBJECTIVES:

After participating in this educational activity, the participant should be better able to:

1. **Identify assessment tools and literature reviews of precipitating and contributing factors for suspected deep tissue injury (SDTI).**
2. **Analyze data findings of precipitating and contributing factors for prediction for SDTI development based on this study's data.**

ABSTRACT

OBJECTIVE: The purpose of this study was to examine (1) the incidence of potential precipitating events of suspected deep tissue injuries (SDTIs) identified over a 7-day period prior to cutaneous manifestation, (2) physiological variables related to the formation of SDTIs, and (3) the time since precipitating events and the occurrence of the SDTI.

DESIGN: A descriptive exploratory study. A retrospective chart review was conducted.

SETTING: A 348-bed community Magnet-redesignated hospital, Baptist Health Lexington Kentucky

PARTICPANTS: Eighty-five participants with SDTIs identified between January 2008 and March 2010.

MAIN OUTCOME MEASURES: Precipitating events evaluated were tissue perfusion, surgery, transfers, mobility, and falls. Physiological variables included anticoagulation, albumin/prealbumin, hemoglobin, partial thromboplastin time, and hemoglobin A_{1c}. Timeline differences between precipitating events and SDTI were measured.

MAIN RESULTS: Precipitating events identified from most to least frequent were transfers = 67 (78.8%), tissue perfusion = 36 (42.5%), surgery = 33 (40.2%), mobility = 26 (30.9%), and falls = 14 (16.9%). Of the 85 charts reviewed, 69 of the charts met the criteria for timeline difference between precipitating event and SDTI manifestation. The range of days for precipitating events prior to SDTI manifestation was 1 to 5 days, an average of 2.41 (SD, 1.04) years. Meaningful physiological variables noted were anticoagulation 52 (61.2%), anemia (hemoglobin 6–9 g/dL) 53 (67.1%), and hemoglobin A_{1c} less than 7.5 mmol/L 29 (74.4%).

CONCLUSIONS: This exploratory pilot study evaluating patients with SDTI revealed the most common precipitating event was transfers. In addition, the physiological variables that appeared to contribute to the development of SDTIs were anticoagulation and anemia. The range of days for precipitating events prior to SDTI manifestation was 1 to 5 days, an average of 2.41 (SD, 1.04) days.

KEYWORDS: suspected deep tissue injury, pressure ulcers, pressure ulcer staging

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INTRODUCTION

Pressure ulcers (PrUs) represent one of the major health challenges that face nurses today. In 2012, the overall PrU prevalence for the United States was 10.1%, with an incidence rate of 4.1%.[1] VanGilder et al[1] report that hospital-acquired PrU prevalence decreased 2.4% in the United States from 2006 to 2013. Although the prevalence of PrUs continues to slowly decline, healthcare providers are working diligently to eliminate them.[2] Efforts to eliminate PrUs are due, in part, to the negative effect they can have on morbidity and quality of life. In a systematic review, Gorecki et al[3] report that PrUs significantly impact physical, psychological, social, and financial aspects of health-related quality of life. The economic impact is particularly meaningful. Braden[4] reports that in 2007 the average cost to treat a full-thickness PrU in the United States was $43,180. The total spent that year on treating full-thickness PrUs was $11 billion (257,412 cases). In 2008, the Centers for Medicare & Medicaid Services (CMS) included PrUs in a group of conditions that will not be reimbursed if hospital acquired. The CMS believes that PrUs are high-cost and high-volume and are reasonably preventable given an appropriate standard of care.[5]

Lyder and Ayello[5] suggest that prevention of PrUs is the key to reducing the incidence of these wounds. Prevention of any illness event requires a dependable method for identifying risk. In the United States, the Braden Scale is the most commonly used assessment tool. Although PrU risk assessment scales, such as the Braden scale, provide a means to direct interventions, these tools have not been shown to have predictive ability.[6,7] Multiple studies have been conducted with the intent to identify variables that predict the development of PrUs. Outcomes suggest that the probability of PrU development is associated with a complex interplay of variables.[8]

In 2007, the National Pressure Ulcer Advisory Panel updated the PrU staging system and included the addition of suspected deep tissue injury (SDTI) as a new stage.[9] Although considerable attention has been given to identifying predictors of PrU development, there is a dearth of studies conducted to identify predictors of SDTIs. The current body of knowledge suggests that SDTIs (*a*) have the highest prevalence in the intensive care unit (14% of all ulcers)[1]; (*b*) most commonly occur in the coccyx, sacral, buttocks, and heel areas; (*c*) are related to comorbidities such as anemia, diabetes mellitus, fecal incontinence, peripheral vascular disease, and malnutrition[11]; and (*d*) frequently occur in patients with orthopedic and respiratory problems.[12] Some evidence suggests that the time of injury development precedes the cutaneous manifestation of a PrU from 3 to 5 days.[13] Farid et al[14] reported that the use of thermography aids in identifying pressure-related intact discoloration areas of skin (PRIDAS) 7 days prior to SDTI manifestation. The relationship between the occurrence of events (such as falls or hypotension) and the development of PRIDAS was not explored. Further research is needed to better understand this relationship as it applies to SDTIs.

LITERATURE REVIEW

The health status of individuals who develop SDTIs is generally compromised. A conceptual schema developed by Braden and Bergstrom categorizes the host's level of compromise within the tissue tolerance construct.[15] This construct is a complex interplay of extrinsic and intrinsic factors that formed the basis for identifying risk factors in the Braden scale. Benoit and Mion[15] presented a new conceptual model for risk factors associated with PrU development in the critically ill. They expanded on the foundations laid by Braden, Bergstrom, and Defloor. They proposed that tissue tolerance moderates the relationship between pressure and PrU development. Their proposal suggests that the host's physiological environment is not an independent variable, yet has an impact on the host's tissue ability to tolerate the effects of pressure (duration and intensity) and/or shear. An abnormal response to mechanical loading–induced tissue deformation may result in PrU development.[16] In addition, Benoit augmented Braden's conceptual schema by adding metabolic supply and demand, pressure distribution capacity, and threats to skin integrity to further guide the identification of risk factors. The metabolic supply and demand item includes nutrition, perfusion/oxygenation, severity of illness, surgical intervention, and physiological alterations. Pressure distribution capacity includes intrinsic variables (ie, gender, age, ethnic, body habitus) that may impact the patient's response to tissue loading.[15] This conceptual schema provides an in-depth description of the patient and may assist in both the prediction of the occurrence of an SDTI and risk factors associated with their development. Benoit and Mion's[15] work forms the conceptual foundation for this study.

Although precipitating events may be related to the development of PrUs (such as physiologic, eg, hypotension; extrinsic, eg, transport to diagnostic procedure), little research has been conducted in this area. The question remains as to what point the injury develops and under what physiological circumstances it occurs. The purpose of this study was to examine (1) the incidence of potential precipitating events of SDTIs identified over a 7-day period prior to cutaneous manifestation, (2) physiological variables related to the formation of SDTIs, and (3) the time since precipitating events and the occurrence of the SDTI. Reading this article will help clinicians to recognize SDTIs, including the most common precipitating events and physiological variables related to this condition.

METHODS

A retrospective chart review (n = 85) was conducted using a database designed for previous research.[17] Participants provided general consent upon admission to Baptist Health Lexington, Lexington, Kentucky. Charts were reviewed from January 2008 to March 2010. The data collection form was developed to extract data points from each patient's electronic medical record (EMR) (Figure 1). With the assistance of a psychometrician and 3 clinical experts in this area, the audit form was created. The criterion for inclusion was as follows: patients with an EMR that contained data 7 days prior to the cutaneous manifestation of the SDTI. Patient records that provided evidence of progression of the wound (blister or nonintact skin) were excluded.

Ethical Approval

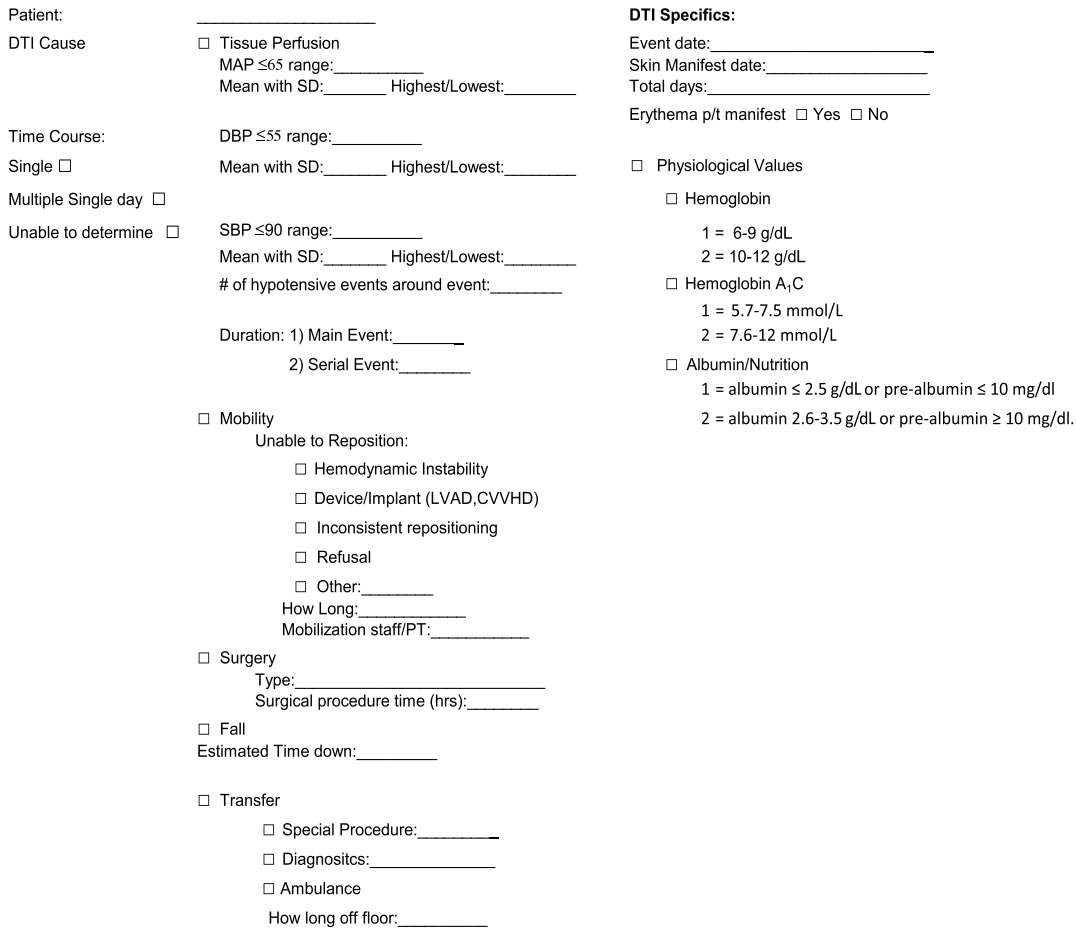
An addendum to the prior institutional review board application for another study on SDTIs[17] was submitted and accepted in order for the investigator to access the database.

Chart Audit

For the purpose of data extraction, precipitating events were categorized as tissue perfusion, falls, mobility, surgery, and transfer. Tissue perfusion was defined as a hypotensive event with, at minimum, 2 consecutive blood pressure (BP) readings below the established threshold. The thresholds were as follows: systolic BP 90 mm Hg or less, diastolic BP 55 mm Hg or less, and mean arterial pressure 65 mm Hg or less. Patient falls were identified in the patient's EMR. All falls identified were present on admission. There were insufficient data to assess length of time the patient spent on the floor following a fall. Mobility was defined as patients' inability to be repositioned because of patients' refusal, hemodynamic instability, or the presence of support devices (eg, continuous renal replacement therapy). Mobility was categorized as no if one of these criteria was present. The transfer category (yes or no) was defined as patients who required ambulance transportation or transportation to a diagnostic (eg, computed tomography scan) or special procedure (interventional radiology). In addition, the length of time documented for the transfer was recorded. Finally, whether patients had surgery, as well as the length of time of the procedure, was recorded. The data were categorized as follows: 1 = less than 4 hours, 2 = 4 hours or more.

Laboratory values were assessed to aid in understanding the physiological environment. Anemia is an indirect measure of hypoxia and is measured by assessing a patient's hemoglobin and hematocrit. Hemoglobin was categorized as 1 = 6 to 9 g/dL, 2 = 10 to 12 g/dL. Given questions regarding the relationship between the development of SDTIs and anticoagulants, the partial thromboplastin time (PTT) was recorded and categorized as follows: 1 = 40 seconds or less, 2 = more than 40 seconds. In order to assess control of blood glucose levels, the level of hemoglobin A_{1c} was recorded and categorized as follows: 1 = 5.7 to

Figure 1.
DATA COLLECTION FORM



Patient: _____

DTI Cause

☐ Tissue Perfusion
MAP ≤65 range:_____
Mean with SD:_____ Highest/Lowest:_____

Time Course:

Single ☐

Multiple Single day ☐

Unable to determine ☐

DBP ≤55 range:_____
Mean with SD:_____ Highest/Lowest:_____

SBP ≤90 range:_____
Mean with SD:_____ Highest/Lowest:_____
# of hypotensive events around event:_____

Duration: 1) Main Event:_____
2) Serial Event:_____

☐ Mobility
Unable to Reposition:
☐ Hemodynamic Instability
☐ Device/Implant (LVAD,CVVHD)
☐ Inconsistent repositioning
☐ Refusal
☐ Other:_____
How Long:_____
Mobilization staff/PT:_____

☐ Surgery
Type:_____
Surgical procedure time (hrs):_____

☐ Fall
Estimated Time down:_____

☐ Transfer
☐ Special Procedure:_____
☐ Diagnositcs:_____
☐ Ambulance
How long off floor:_____

DTI Specifics:

Event date:_____
Skin Manifest date:_____
Total days:_____

Erythema p/t manifest ☐ Yes ☐ No

☐ Physiological Values
☐ Hemoglobin
1 = 6-9 g/dL
2 = 10-12 g/dL
☐ Hemoglobin A_1C
1 = 5.7-7.5 mmol/L
2 = 7.6-12 mmol/L
☐ Albumin/Nutrition
1 = albumin ≤ 2.5 g/dL or pre-albumin ≤ 10 mg/dl
2 = albumin 2.6-3.5 g/dL or pre-albumin ≥ 10 mg/dl.

7.5 mmol/L, 2 = 7.6 to 12 mmol/L. There are multiple challenges in the clinical interpretation of albumin and prealbumin levels for measuring nutritional status, which include recent surgery, acute disease state, burns, and excess excretion from the kidneys. However, the measurement of albumin and prealbumin may be a clinical guide, with prealbumin providing a more accurate snapshot of the nutritional status. Nutritional status was categorized as follows: 1 = albumin 2.5 g/dL or less or prealbumin 10 mg/dL or less, 2 = albumin 2.6 to 3.5 g/dL or prealbumin 10 mg/dL or greater. Inclusion of this laboratory value was dependent on availability within the chart during the time frame of the retrospective data collection; if both values were noted during this timeframe, the prealbumin was used. There is speculation that the presence of anticoagulation may contribute to the formation of SDTIs.[18] In order to establish the presence of anticoagulation, use of the following medications were recorded: enoxaparin, fondaparinux, lopidogrel, prasugrel, heparin, or warfarin.

RESULTS

Descriptive and inferential statistics were used to analyze the data. If patients had a single precipitating event or multiple events on 1 day, data were reported as a range. If multiple single events occurred over the 7-day period of time prior to SDTI

development, data from those charts were excluded from the timeline difference between precipitating event and SDTI manifestation category.

χ^2 tests examining (*a*) associations between transfers and anticoagulants and (*b*) transfers and hemoglobin were calculated. Significance was not reached, however; trends included a large number of patients who had (*a*) transfers and were taking blood thinners (n = 42, 63.6%) and (*b*) transfers and very low hemoglobin (n = 42, 68.9%). Using descriptive statistics, the precipitating events identified from most to least frequent were transfers = 67 (78.8%), tissue perfusion = 36 (42.5%), surgery = 33 (40.2%), mobility = 26 (30.9%), and falls = 14 (16.9%). For those with tissue perfusion as a precipitating event, 23 of the patients (64%) experienced 3 or fewer hypotensive events.

Length of time for hypotensive events ranged from 30 minutes to 8 hours. Twenty-nine patients (82.9%) who experienced surgery were in surgery for less than 4 hours. Among those patients who experienced a fall prior to SDTI development, 9 of the 14 patients fractured a hip. Of the 85 charts reviewed, 69 of the charts met the criteria for timeline difference between precipitating event and SDTI manifestation. The range of days for precipitating events prior to SDTI manifestation was 1 to 5 days, an average of 2.41 (SD, 1.04) days.

In relation to physiological variables, anemia was the most common condition noted among SDTI patients. Of patients with anemia, 53 (67.1%) had a low hemoglobin between 6 and 9 g/dL. Hemoglobin A_{1c} less than 7.5 mmol/L was noted for 29 patients (74.4%) diagnosed with diabetes mellitus. This finding was surprising, given that it would appear that these individuals had good overall control of their blood glucose and yet had developed an SDTI. Twenty-four of the patients (36.4%) with abnormal albumin/prealbumin levels had very low (albumin 2.5 g/dL or prealbumin 10 mg/dL) and 36 (54.5%) had low albumin/prealbumin levels (albumin 2.6–3.5 g/dL or prealbumin 10 mg/dL). Although 52 patients (61.2%) were receiving anticoagulants, the PTT laboratory level did not reveal clinically meaningful findings: 1 = 28 (62.2%) and 2 = 15 (33.3%). Often the PTT was not assessed, and rarely was the protime assessed in SDTI patients in the 7-day window time frame. These laboratory levels are used to assess a patient's coagulation status; however, the affectivity of certain anticoagulants cannot be assessed by either protime or PTT.

DISCUSSION

Age was not examined in this study as a precipitating factor related to the development of SDTIs, but prior research[17] at this institution revealed a mean age of 72.35 (SD, 15.56) for 85 patients who had an SDTI. Given that the incidence of comorbidities increases with age, it is not surprising that older individuals may experience SDTIs more often than their younger counterparts. Another common variable within this population, noted from prior research,[17] was fecal incontinence (60 [70.5%]). This is not an unexpected finding as other studies have identified moisture-related skin damage (urinary/fecal incontinence) as a variable that may be predictive of PrU development.[6,8]

In relation to variables examined in this study, the issue of transferring patients seems important. The care of a patient with compromised health during hospitalization often necessitates transferring patients that may involve healthcare providers from physical therapy, radiology, surgery, emergency department, and nursing. The patient may experience numbers of transfers for various diagnostics or procedures. Each transfer places the patient at risk for shear injury. Shear is the parallel mechanical stress that is a result of 2 surfaces sliding in opposing directions.[19] Shear deformations have the potential for causing muscle damage, as a result of exceeding stress thresholds of tissue cells, and may damage blood and lymphatic vessels of tissues within the zone of injury.[16] In addition, procedural tables and stretchers often place patients at risk for inadequate pressure redistribution due to thin foam pads.[19,20]

As shearing has the potential for damaging deeper tissues, anticoagulation medications may promote an exaggerated microhemorrhage that could further complicate a compromised tissue environment. The collection of blood, secondary to blood vessel damage, may increase interstitial and tissue edema, further impeding blood flow and diffusion of nutrients to the zone of injury.[18,21,22] Paradoxically, Matsuyama et al[23] suggested the use of antiplatelet aggregation medications might be assistive in preventing PrU development due to the increased aggregation activity of platelets experiencing static pressure. Further research is necessary to evaluate the potential contribution of anticoagulation medication on SDTI development.

The incidence of anemia has been a commonly reported comorbidity within the few studies conducted on SDTI.[11,17,24,25] Coleman et al[8] identified that anemia is an important factor, but did not appear as often in their systematic review of risk factors associated with PrU development. Although anemia has been identified as a potential contributor to the development of SDTI, grading of anemia severity and its association with SDTI development has not been explored. Of the patients who developed SDTIs, 75 (88.1%) had anemia, and frequently patients were noted to have very low hemoglobin (67.1%). For patients who had very low hemoglobin, 23 SDTIs (43.4%) progressed to an unstageable, Stage III, or Stage IV PrU. Twenty-one patients of this subsample (91.3%) also had a transfer-associated event. Anemia impacts the cellular environment by affecting cellular hypoxia and the potential for necrosis. In addition, the reduction

of hemoglobin content may moderate tissue tolerance.[26] Further research is needed to evaluate the contributions of anemia and transfer events on the development of SDTI.

Tissue perfusion occurring as the second most common (42.5%) precipitating event associated with SDTI development was not a surprising finding. However, a surprising finding was the low number of hypotensive events noted for those with hypotension. The number of events noted was 1 to 7 events, with the majority occurring in the 1-to-3 range (64%). For those noted with a tissue perfusion event (n = 36 [42.5%]), 14 SDTIs (38.8%) progressed to be an unstageable, Stage III, or Stage IV PrU. Eleven of the 14 patients (78.5%), of this subsample, experienced 3 to 7 tissue perfusion events. This finding highlights the potential contribution of repetitive ischemic reperfusion injury (IRI) on the development of SDTI. Ischemic reperfusion injury is additional cellular injury, caused by free radicals, which occurs following reperfusion of blood into a previously ischemic area of tissue. The repetitive nature of IRI is experienced in patients who have repetitive ischemic events that occur as a result of either repositioning or hypotension and is another potential contributor to SDTI development.[27]

Although tissue perfusion was noted as a precipitating event in the authors' study population, patients who experience hypotension do not always develop SDTI. A complex interplay of variables causes the development of SDTI and their progression, yet a potential explanation could be the gradual versus acute onset of hypotension. Muscle tissue that experiences the gradual onset of hypotension tissue ischemia can undergo preischemic conditioning and periods of reduced blood flow followed by reestablishment of blood flow, which may be a protective mechanism that increases the resistance of muscle tissue against cell death due to IRI-based tissue injury.[28] Further research is needed to evaluate the number of hypotensive events and the effect of acute versus gradual onset of hypotension on SDTI development.

The inability for a patient to be repositioned due to hemodynamic instability, refusal to be repositioned, or prolonged periods in a chair were noted in 30.9% of this population. The identification of mobility events as a precipitating event was expected, but was the fourth most occurring precipitating event within the study population. Coleman et al[8] support this event as one of the major domains associated as independent predictors of PrU development in studies using multivariate analysis. The least common precipitating event in this study's population was falls. The observation that patients who fall and subsequently have a bone fracture is not an unexpected finding and has been observed in other studies.[8] Another expected finding was that patients who developed SDTIs had laboratory indices suggesting malnutrition. As with anemia, Coleman et al[8] identified nutrition as a factor that did not emerge as often with PrU development.

A growing body of knowledge is emerging to support common risk factors between patients who have surgery and subsequently develop intraoperative acquired PrUs. The most common variable that placed patients at risk for intraoperative PrU development was the length of surgery.[13,20] Aronovitch[20] reports the median operative time for PrUs was 4.48 hours. For patients who had surgery as a precipitating event, 28 SDTIs (82.9%) developed in patients with a surgery time of less than 4 hours. As PrU development is a complex interplay of variables, relying on length of surgery time alone as a risk variable has its limitations. For example, Schoonhoven et al[13] report that patients with a diastolic BP less than 60 mm Hg had a higher risk of developing PrUs. Although intraoperative hypotension was noted during data collection, no significance was noted. Hypotension, however, may be a contributor to the risk of developing an SDTI during surgery.

Another major domain, associated with independent predictors of PrU development, noted within the study of Coleman et al,[8] was the presence of diabetes. A total of 46 patients (54%) were diagnosed with diabetes in the study population. Hemoglobin A_{1c} is a laboratory level that measures how well blood glucose is managed. Hemoglobin A_{1c} assesses the average blood glucose level over a 3-month period. The American Diabetes Association recognizes patients who have a 7.5% or less hemoglobin A_{1c} as good control.[29] Of the patients in the study population diagnosed with diabetes who had a hemoglobin A_{1c} recorded, 29 (74.4%) had a hemoglobin A_{1c} less than 7.5%. Although 29 of the patients were under good control, they still developed SDTIs. Of those PrUs developed, 9 patients progressed to an unstageable, Stage III, or Stage IV PrU. Upon further evaluation, the following common comorbidities and secondary conditions were noticed: hypertension = 8 (88.8%), anemia = 8 (88.8%), cerebrovascular accident = 4 (44.4%), smoker = 4 (44.4%), low albumin/prealbumin = 5 (55.5%), fecal incontinence = 7 (77.7%), palliative care = 4 (44.4%), vasopressors = 6 (66.6%), anticoagulation = 6 (66.6%), and ventilator support = 5 (55.5%). An even distribution of precipitating events was noted within this subsample of the population. These findings highlight the multifactorial contribution of variables on PrU development.

As SDTI and/or PrU development is considered complex and multifactorial, even more so is the assessment of a potential timeline of development of the injury to cutaneous manifestation. Farid,[30] who applied forensic principles to deep tissue injury to aid in identifying wound evolution from time of injury to maturation, suggests that SDTIs may take up to 7 days to manifest from the time of injury. Next, Farid et al[14] utilized thermography to assess deep tissue thermal changes in patients with PRIDAS. Their findings suggest that 7 to 14 days after blanchable erythema develops, purple discoloration or the presence of necrosis can be

noted. In contrast, the timeline difference between precipitating event and SDTI manifestation revealed a range of 1 to 5 days with an average of 2.41 days. This supports anecdotal findings noted in the study of Schoonhoven et al.[13] These data are observational and do not suggest that the precipitating events were the beginning point for SDTI development. However, the exploratory data provide a beginning point for further studies evaluating the timeline between deep tissue injury and cutaneous manifestation.

PRACTICE PEARLS

- The treatment of PrUs creates a heavy burden for the US healthcare system, requiring up to $11 billion annually to care for patients with PrUs. As hospitals are no longer able to be reimbursed for hospital-acquired PrUs, new methods to predict and prevent the development of PrUs in patients are warranted.
- The SDTI stage is a recent addition to the National Pressure Ulcer Advisory Panel staging system. Little research has been conducted observing the possible contributions of precipitating events to SDTI, and the associated time course to cutaneous manifestation. This may provide a novel approach to identifying new approaches to preventing PrUs.
- Pressure ulcer precipitating events may be a result of intrinsic (such as physiologic, eg, hypotension) and/or extrinsic (eg, transport to diagnostic procedure) variables. The question remains as to what point the injury develops and under what physiologic circumstances does it occur.
- Some evidence suggests that the time of injury development precedes the cutaneous manifestation of a PrU from 3 to 5 days. In this study, the timeline difference between precipitating event and SDTI manifestation revealed a range of 1 to 5 days with an average of 2.41 days.
- The precipitating events associated with SDTI development, from most to least frequent, were transfers = 67 (78.8%); tissue perfusion = 36 (42.5%); surgery = 33 (40.2%); mobility = 26 (30.9%); falls = 14 (16.9%).
- Future research focused on further development of profiles of patients who are likely to develop SDTIs may lead to meaningful clinical care of these patients.

CONCLUSION

This exploratory pilot study evaluating patients with SDTIs revealed the most common precipitating event was transfers. Physiological variables of anticoagulation and anemia were also of concern. As transfers were the most common precipitating event noted in patients with SDTIs, staff education and interventions geared to reduce friction/shear and promote safe patient handling are warranted. Little research has been conducted observing the possible contributions of precipitating events to SDTI development and the associated time course to cutaneous manifestation; however, many of the variables assessed in this study are consistent with risk factors associated with PrU development.[8] Prediction of PrU and SDTI development is a complex process. Future research focused on further development of profiles of patients who are likely to develop SDTIs may lead to meaningful clinical care of these patients.

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