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Implementing a Digital Imaging Platform Using Tissue Analytics in a Level 1 Trauma Center

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Abstract

Background: More than 2.5 million people develop pressure ulcers (PUs) annually. PUs cost the U.S. $9.1-11.6 billion per year and add about $43,180 to a hospital stay. The Centers for Medicare Medicaid Services (CMS) stopped reimbursement for hospital-acquired pressure ulcers (HAPUs). Documentation of PUs must indicate if they are present on admission (POA) and include accurate stages and treatment plan of PUs.

Aims/Objectives: To use Digital Imaging platform using Tissue Analytics (TA) along with the standard care protocol. The objectives of this study were to (1) Improve identification of PUs, (2) Increase accuracy of PU staging and (3) Improve documentation of PUs.

Methods: This quality improvement study included a convenience sample of 55 adults with HAPUs. NDNQI measures and data from chart audits were collected. Demographic information, POAs and HAPUs, and Braden scores were analyzed along with a staff attitude's survey.

Results: 5.11 POAs per 1000 patient admissions (95% *CI* = [3.33, 7.84]) pre-interventions, and 2.25 POAs per 1000 patient admissions (95% *CI* = [1.17, 4.33]) post-intervention. POA ***prevalence*** rate remained about the same.

Documentation of HAPU stages (χ^2 (5) = 9.823, p = 0.059) was not statistically significant but documentation of POA staging was significant (χ^2 (6) = 16.395, p = 0.003). The number of DTIs increased while Unstageable PUs decreased post-intervention. Braden score= 14.52 (*SD* = 3.65) pre-intervention and 14.56 (*SD* = 2.55) post-intervention. Staff Attitudes' survey scores reflected poor PU prevention attitude (33.36).

Conclusions: Digital imaging Platform using TA along with the standard protocol did not significantly improve the identification of POAs nor rate of documentation. Documented difference in staging was noted. Also, improved quality of documentation was noticed.

Introduction

The practice site of this DNP project aimed to improve the identification of pressure ulcers (PUs) that are present on admission (POA) from those that are hospital-acquired pressure ulcers (HAPUs); and, also improve documentation of PUs. In 2008, the Centers for Medicare and Medicaid Services (CMS) denied reimbursements for hospital-acquired conditions or HACs (CMS, 2015). Additionally, CMS implemented a HAC reduction program in 2014 that used performance scores to determine reimbursement payments to organizations (CMS, 2020). According to these policies, hospitals would lose reimbursement for Stages III and IV PUs that were hospital-acquired (Rogers, 2013). POAs do not come with those penalties; however, if a PU is POA but not documented, it is still considered a hospital-acquired condition and not reimbursable (Rogers, 2013). Patient safety concerns, as well as a loss of reimbursement, increases the incentive to accurately identify and document PUs that are POA (Roger, 2013). The current organization was using a bundled care program which included the following standard interventions: (1) Skin assessment of all patients upon admission, (2) Daily skin reassessment, (3) Daily skin inspections, (4) Moisture management on the skin, (5) Optimization of nutrition and hydration, and (6) Minimization of pressure (IHI, 2019)). They were also using the Braden scale risk assessment tool, "4 eyes" assessment (pairing 2 RNs to assess a patient), monthly wound rounding, specialized beds, and wound barriers. However, the site implemented a digital imaging platform using tissue analytics. With this technology, a smartphone equipped with HIPAA compliant tissue analytics software was used to capture 3D images of wounds, analyze the image, and wirelessly download the image and measurements to the hospital's EMR system. The technology was used during the admission assessment and subsequent skin assessments to capture any skin abnormalities present. The purpose of the technology was to improve

identification of POAs on admission, improve the documentation of PU staging, improve the accuracy of PU documentation in order to improve patient quality of care.

Background and Significance

According to the National Pressure Ulcer Advisory Panel and the European Pressure Ulcer Advisory Panel (NPUAP/EPUAP, 2014), a pressure ulcer (PU) is "a localized injury to the skin and/or underlying tissue, usually over a bony prominence, resulting from sustained pressure (including pressure associated with shear)." However, some PUs result from external pressure from medical devices and, therefore, do not completely fit this definition (Pittman et al., 2015). Additionally, in April 2016, the National Pressure Ulcer Advisory Panel (NPUAP) revised the NPUAP Injury Staging System to replace the term "pressure ulcer" with "pressure injury" to reflect injuries to both intact and ulcerated skin (Joint Commission, 2014). However, for this project, the term "pressure ulcers" will be used for consistency with resources, which have not all adopted the term "skin injuries." See Appendix C for PU stages.

Beal and Smith (2016) defined hospital-acquired pressure ulcers (HAPUs) as any PU assessed on a patient after 24 hours of being admitted to the hospital that was not documented upon admission. HAPUs occur at a rate of 1- 2.5 million annually in the United States (Meddings et al., 2015) and affect patient outcomes, increase pain, loss of function, increase hospital length of stay (LOS), increase patient readmissions, and increase patient mortality (Han et al., 2019). According to Lyder et al. (2012), the LOS for those with PUs was 11.2 days compared to 4.8 days for those who did not have PUs. Additionally, more than 60,000 patients in the US die each year as a direct result of PUs (AHRQ, 2014).

HAPUs are very costly and have a huge financial impact on organizations; they result in healthcare costs from $9.1-$11 billion annually (AHRQ, 2014). The costs to heal a single ulcer usually depends on the stage of the ulcer -the higher the stage, the higher the cost (Meddings et

al., 2015). It has been estimated that the cost of treating Stage 1 PUs is just over $2,000; stage 2 from $3,000-$10,000; stage 3 from $5,900-$14,840 and stage 4 PUs can cost as much as $18,730-21,410 (Leaf Healthcare, 2016). The cost of individual patient care can range from $20,900 to $151,700 per pressure ulcer (AHRQ, 2014). Medicare estimated in 2007 that each pressure ulcer added about $43,180 in costs to a hospital stay (AHRQ, 2014).

In October 2008, the Centers for Medicare & Medicaid Services (CMS), enacted a policy that stopped reimbursement for stage III to IV HAPUs unless the ulcers were present on admission (POA) (Mallah et al., 2015). Additionally, in October 2014, CMS implemented a 1% reimbursement penalty to hospitals with the lowest scores for hospital-acquired condition rates (Padula et al., 2015). The financial incentives seemed to influence hospitals to increase their efforts to prevent HAPUs (Padula, Gibbons, Valuck, et al., 2016). In a longitudinal study of HAPU incidences collected from 55 hospitals from 2007 to 2012, Padula, Gibbons, Valuck, et al. (2016) found that HAPU rates decreased significantly after enactment of the CMS nonpayment policy.

HAPUs have become a major quality indicator for healthcare organizations and the rates are measured and tracked by organizations for their safety reports and by national agencies. For instance, the National Database of Nursing Quality (NDNQI) collects and tracks the PU and HAPU prevalence rates from approximately 2000 participating facilities (Montalvo, 2007; Roe & Williams, 2014). The rates are compared between similar-sized organizations and to the national annual PU benchmark, which is currently 3.3% (Montalvo, 2007; Hillrom, 2019). An organization may use this information to devise its own internal benchmark and process improvements in order to improve their rates (VanGilder et al., 2008).

In order to successfully prevent HAPUs, a multidisciplinary, multidimensional, customized, collaborative approach is needed (AHRQ, 2014) Once a patient is admitted to the

hospital, the following strategies are implemented 1) A PU risk assessment usually via a risk assessment tool (such as the Braden Scale or Norton Scale) and 2) Standard interventions are completed. The comprehensive skin assessment is part of the standard intervention; each of these factors will be discussed below:

Risk Assessment tools

The site of this DNP project currently uses the Braden Scale risk assessment tool (RAS) (Appendix B). The Braden Scale (BS) is a commonly used RAS that identifies risk factors for developing a PU and helps to plan care (AHRQ, 2014). The Braden Scale has established reliability and validity and is made up of six subscales (sensory perception, moisture, activity, mobility, nutrition, friction, and shear). Items of the scale are scored from 1-4 (1 for a low level of functioning; 4 for the highest level or no impairment). Scores range from 6-23 with scores less than 18 indicating an at-risk status; levels are further divided into mild, moderate, high risk (AHRQ, 2019).

The BS showed good inter-rater reliability ranging from 83% to 99%) in multiple clinical settings (Jackson, 2011). The sensitivity and specificity of the BS are high (0.83-1.00 and 0.64-0.90, respectively) when the cut-off point is a score of 16 (Jackson, 2011). For BS scores ranging from 12-20, the sensitivity ranged from 29% to 93% and the specificity ranged from 67% to 97% (Jackson, 2011).

Standard Interventions

Standard interventions are used as part of the multidimensional approach to prevent HAPUs. According to the Institute for Healthcare Improvement (IHI, 2019), these ***standard PU prevention interventions*** include the following:

(1) Conducting a PU admission assessment on all patients

(2) Reassessing risk for all patients daily

(3) Inspecting skin daily

(4) Managing moisture on the skin

(5) Optimizing nutrition and hydration, and

(6) Minimizing pressure

Comprehensive Skin Assessment

A comprehensive skin assessment is part of the standard interventions and is extremely important. See Appendix A for Comprehensive Skin Assessment Components. A comprehensive skin assessment can 1) Identify factors that predispose a person to developing PUs, such as excessively dry skin, moisture-associated skin damage, or certain skin conditions; 2) Identify ulcers that are present on admission (POA); 3) Assist in risk stratification since patients with an existing PU is at risk for developing additional PUs (AHRQ, 2014). In most hospital settings, a comprehensive skin assessment should be performed on admission to the unit, daily, and upon transfer and discharge (AHRQ, 2014). In some settings, a comprehensive skin assessment is completed as frequently as every shift (AHRQ, 2014).

The DNP site was using the RAS with standard interventions in addition to a paired RN ("4 eyes") assessment, regular rounding by the wound team, and use of specialized beds and barriers. However, POA identification issues and documentation challenges persisted and a needs assessment demonstrated the need for additional interventions. Based on research and studies of other hospital practices, the organization decided to integrate a digital imaging platform using tissue analytics into their practice. With this technology, a smartphone equipped with HIPAA compliant software captures a 3D image of a wound, automatically measures and analyzes the wound, and calculates the wound dimension, perimeter, surface area, and tissue composition (Tissue Analytics, 2019). The data flows wirelessly into major EMRs such as Cerner (Tissue Analytics, 2019), which this organization currently uses.

The tissue analytics (TA) platform has proven to be 40% more accurate than standard ruler measurements (Tissue Analytics, 2019). It also saves time in documentation due to the automatic uploading of the analyzations into the EMR (2019). And finally, with analysis from measurements, tissue analytics acts as a clinical decision support tool to help staff make more informed decisions (Tissue Analytics, 2019). Tissue Analytics, which was incorporated in 2014 and based in Baltimore, Maryland, is currently used in 25 states and by major healthcare corporations, including Intermountain Healthcare, Bayfront Health, and Penn Medicine (Tissue Analytics, 2019).

In addition to more accurate wound measurements, the tissue analytics platform would improve documentation. Documentation of the skin assessment is as important as the assessment itself; documentation also is very important in communicating PU status among staff (AHRQ, 2014). Documentation of POAs is very important in decreasing reimbursement penalties and liability issues. Due to the benefits and potential positive impact on the organization, the organization made the decision to implement a digital imaging platform using TA technology, which is the focus of the DNP project.

Needs Assessment

There was a need for the organization to improve PU documentation and identification of POAs and HAPUs to not only improve patient safety, but to meet the challenges of CMS guidelines. These factors were positive motivators for stakeholders because it aligned with the organization's goals to provide high-quality patient care.

As for resources, the current environment includes interdisciplinary teams such as wound care specialists, nurses, and physicians who all work together to prevent and treat HAPUs. The previous process used by the team to decrease HAPUs RAS, standard guidelines, specialty beds, barrier creams and wipes, flotation of heels, and support surfaces, paired RN assessment.

However, despite the interventions, the experienced challenges in identifying POAs and documenting PU information, including staging, location, and laterality.

Another challenge that the organization faced was poor inter-user reliability with the Braden scale. According to Gould et al. (2018), the Braden scale is also not accurate in predicting PU risk in certain populations such as patients in the Intensive Care Unit (ICU), trauma patients, burn populations, and those with spinal cord injuries. Since the majority of the patients with HAPUs in this organization were ICU patients, Braden scores were not sufficient in assessing their risk.

As a solution, the organization decided to use a digital imaging platform using tissue analytics along with the standard interventions. Since the TA technology had demonstrated proven success in other organizations such as Intermountain Health and Penn Medicine, the organization was encouraged. Also, implementing a digital imaging platform using TA to improve the identification of POAs and improve the accuracy of documentation, aligned with the organization's mission to provide high-quality healthcare, advanced technology, and world-class service to patients (GW, 2019).

In order to examine the needs of the organization in detail, A SWOT analysis was performed. The SWOT helped to identify the strengths, weaknesses, opportunities, and threats to the organization. See Figure 1 for the SWOT analysis for this project.

Problem statement

According to a review of the literature, HAPU rates remained high nationally despite use of standard interventions (Gould et al., 2018). Several studies documented decreased patient outcomes and quality and increased financial burden due to HAPUs (Han et al., 2018). Most of the research showed that multimodal, multidisciplinary interventions are the most effective

(Mallah et al., 2015). A needs assessment conducted at a hospital in the Level 1 trauma center mid-Atlantic has documented the need for multimodal, multidisciplinary interventions to improve the identification of POAs and improve the accuracy of PU documentation. To fill this gap, the hospital implemented a digital imaging platform using tissue analytics (TA) to supplement their current standard of care.

Practice Question

In all patients admitted to the hospital, does a digital imaging platform using TA along with the standard of care compared to standard interventions alone affect identification and documentation of POAs and HAPUs within two months of implementation?

The primary clinical question to achieve the study objectives/aim is:

1. Is digital imaging platform using TA effective in identifying the presence of POAs during the admission skin assessment in order to prevent POAs from being incorrectly identified as HAPUs?

The secondary clinical question is:

1. Does using a digital imaging platform using TA improve accuracy documentation of staging and documentation of pressure ulcers in general?

Purpose Statement

The purpose of this project was to implement and evaluate a hospital-wide digital imaging platform using TA with the current standard of care at a Level 1 Trauma Center Hospital in Mid-Atlantic in order to improve identification of pressure ulcers that are POA as well as to improve the accuracy of documentation of PU staging and improve documentation of PUs and compare two months pre- and two months post-intervention.

Aim and Objectives

This DNP project aimed to properly identify POAs in admitted patients at a Level 1 trauma center in the Mid-Atlantic after implementing a digital imaging platform using tissue analytics in December 2019 along with the standard care protocol.

The objectives of this study were:

1. Improve identification of POAs during the admission process to prevent them from being counted as HAPUs later during admission
2. Improve documentation of stages of POAs and HAPUs
3. Improve documentation of all PUs

Literature Review

The literature search for this study was completed from May 2019 to July 2019. PubMed, CINAHL, and Google Scholar search databases were reviewed for articles that contained support for the research questions. Medical Subject Headings (MESH) terms “hospital-acquired” and “Pressure Ulcers” and “interventions” were combined with Boolean operators “AND” and “OR.” Additional keywords “documentation,” “rates,” acute care,” “standard care,” “digital image analysis,” “digital imaging,” “3D,” “wound” were searched to generate specific research articles evaluating the effect of skin analysis intervention on pressure ulcer prevention. A manual search for articles by references was also used to identify additional appropriate articles. The filters applied were, humans, the publication year 2012-2019.

The inclusion criteria for this study were random design studies, pre-and post-test, prospective cohort studies, quality improvement studies, adults with a diagnosis of pressure ulcers, or at risk for pressure ulcers. The exclusion criteria included dissertations or thesis papers. From the literature, the following themes emerged: risk factors for HAPUs, interventions for HAPUs, mortality rates of patients with HAPUs, digital imaging as a supplement to assessment,

and documentation challenges of PUs. See Appendix D for an Evidence Table with a synopsis of the Literature.

Risk Factors for HAPUs

It is important to identify patients' risk factors for PUs as soon as possible in order to implement appropriate interventions in a timely manner (Gould et al., 2018). In a descriptive study of 34,287 adult patients over the age of 65 admitted to the hospital from January 2011-December 2015, Han et al. (2018) identified gender, age, admission method, perfusion status, mobility, and Braden Scale Score as risk factors for HAPUs. However, unlike other studies, they found that impaired consciousness had a significant impact as well; patients with impaired consciousness had a 3.77 times rate of getting PUs versus alert patients (Han et al., 2018). In a systemic review of 54 studies, including 34,449 patients, Coleman et al. (2013) also identified age, gender, mobility status, and diagnoses such as hypertension and diabetes that caused perfusion issues as risks to developing PUs.

Interventions for HAPUs

Standard interventions exist for preventing HAPUs (IHI, 2019). However, a multimodal approach with multiple interventions is the most beneficial (Mallah et al., 2015). For instance, Lam et al. (2018) found that a 7-step care-based process reduced the incidence of HAPUs in 9,755 trauma inpatients older than 15 years old. The 7-step plan included using specialized beds, improved nutrition, repositioning protocol, staff education. Englebright et al. (2018) found that HAPU rates decreased after implementing a comprehensive program in 149 hospitals from 2011-2013. The program combined evidence-based tools along with education with supplemental data on PUs. As a result of the program, the rate of Stage 3 and 4 HAPUs decreased by 66.3%, while the overall rates of ALL HAPUs decreased by 47.1%. In a study by Mallah et al. (2015), a multidisciplinary intervention that included the use of the Braden scale, NPUAP-EPUAP 2009

guidelines, nurse champions, RN education, electronic reporting, were implemented on a total of 486 inpatients at a tertiary medical center in Lebanon. The intervention significantly reduced the prevalence of HAPU from 6.63% in 2012 to 2.47 in 2013 (Mallah et al., 2015.

Mortality rates of hospitalized patients with PUs

Along with causing discomfort and pain, HAPUs increases patient hospital LOS and patient mortality (Manzano et al., 2014). In a prospective cohort study performed over two years, Manzano et al. (2014) examined the mortality rate of ICU patients on Mechanical Ventilation who developed a PU. Of the 563 patients studied, 110 developed a PU stage >2 while in the ICU and their mortality rate was significantly higher than those who did not (60% versus 45.9%) In a case-control study of 1000 patients with PUs in a tertiary hospital in Korea, Han et al., (2019) found that hospital patients with PUs had higher mortality, LOS, costs, and hospital readmissions than those who did not despite adhering to standard prevention guidelines.

Digital image analysis of PUs and wounds

In order to identify and treat HAPUs promptly, the skin assessment must be accurate and concise. Digital imaging is increasingly being used for this purpose. Although no EBP research was found on the specific tissue analytics software proposed in this project, studies demonstrate the benefits and accuracy of using similar 3D imagery to measure and analyze wounds. In the assessment of wounds in 87 patients, Wang et al. (2017) found that an Apple smartphone with a Swift Wound app had higher-inter rater reliability and accuracy of measuring wounds and tracking wound size and temperature than rulers. Although the standard ruler method yielded reliable length and width measurements, these values were less accurate than the app. Also, Wang et al. (2017) found that ruler-based measurements were less reliable in larger, irregular wounds. Similarly, in a study of 45 wounds by Anghel et al. (2016), a 3-D wound measuring (3DWM) device showed high reliability for measuring wound area in a range of wound sizes and

types. Manual metric measurement overestimated the wound area in 41 of 45 wounds. Manual median wound area values were significantly different from 3DWM device values. The findings were consistent with other studies that showed that ruler measurements were 44% less accurate. In a study of 81 photos of wounds from 25 patients, Budman et al. (2015) also found that using a smartphone with 3D imaging and computer support increased the accuracy of measurement and characterization of chronic wounds over the ruler measurement.

Documentation Challenges of PUs

Finally, accurate documentation of PU and treatment plan is essential in communicating information amongst staff. Incorrectly documented information may delay treatment, prolong healing, increase LOS, and result in increased cost to the organization. In a retrospective cross-sectional review of 155 patient charts from 5 nursing homes, Hansen and Fossum (2016) found a discrepancy between documentation of PUs on physical exam and progress notes. Some charts indicated the presence of PUs on the exam but did not document any PU stages; other charts did not document the presence of PUs on the exam but mentioned PU in the progress notes. Many notes were also missing preventative measures used and treatment plan. Underreporting preventative measures may be a liability (Hansen & Fossum, 2016). In a retrospective comparative descriptive study of 196 ICU patients, Li (2016) also found poor documentation of PU location, appearance, staging, and incomplete documentation of treatment and plan. These documentation challenges further supported the benefits of technology such as digital imaging platform using TA in increasing the accuracy of PU documentation.

Theoretical Framework

For this QI intervention, the IOWA Model (Figure 2) best addressed the clinical issue and served as a guide for nurses and other health care providers to use research findings to improve patient care (Titler et al., 2001). In addition to the IOWA model, the Implementation Strategies

for Evidence-Based Practice Model was used to facilitate the implementation of this intervention.

In the first step of the model, identifying a priority, the organization recognized the need to improve the identification of POAs and improve the accuracy of PU documentation. After performing a needs assessment and gap analysis, the hospital's Wound Director, Director of Nursing, and Director of Nursing Education identified the need for additional interventions aside from the standard protocols and interventions. The hospital's stakeholders were receptive to this change in order to improve hospital quality and patient outcomes.

Steps 2 and 3 of the IOWA Model involve organizing a plan followed by forming a team, respectively. Since the project site is extremely large, any intervention will have a huge impact. Therefore, the immediate plan was to evaluate findings from other large institutions that had used digital imaging platform using TA, document benefits including improved quality of care and reduced hospital costs, then get buy-in from stakeholders. A team was formed that included the Principal Investigator (PI), Wound and Ostomy and Continence Nurse (WOCN) Specialists, clinicians, and the nurses in the hospital. Once the team was formed, brainstorming sessions were held to identify the next steps (Doody & Doody, 2011).

For step 4, assembling literature and relevant research, clinical questions were developed to direct the evidence search. Evidence related to the question was appraised. The researcher searched Medline and CINAHL using resources from 2012 to the present. Keywords used included "hospital-acquired," "pressure ulcers," and "interventions," combined with Boolean operators and additional keywords including "documentation," and "rate." A review of the related studies emphasized the importance of recognizing risk factors for PUs, interventions to prevent PUs, and the use of digital photography platforms to accurately capture PU

measurements. A hospital-wide tissue analytics protocol, in conjunction with the current standard of care protocol, was the proposed intervention to fill this gap.

In support of the next step, the evidence was critiqued and synthesized. Per review of the literature, there were no EBP research articles on the specific technology proposed; however, research existed on similar platforms. The organization was also encouraged to use the Platform based on the success of many large hospital systems such as Intermountain Health and Penn Medicine. According to the Tissue Analytics White paper report (Budman, 2019), the tissue analytics software significantly improved both charting time and patient wound healing rates at Intermountain's Mckay-Dee Hospital in Utah (Budman, 2019). Mckay-Dee found that using the TA software resulted in a 72% improvement in healing rate and a 12-day reduction in healing time per wound on average (Budman, 2019).

Next, the evidence was reviewed and appraised. See Appendix D. Once the evidence was sufficient, a plan was made to proceed with the pilot in November 2019. Based on pilot results, work-flow adjustments were made to improve the process. The team was encouraged by the initial results and proceeded with the hospital go-live in December 2019. A Practice policy and protocol was formulated to incorporate the new intervention into practice.

The Implementation strategies for evidence-based practice (EBP) model was used to facilitate the implementation stage. While the IOWA model provided a practical step-by-step guide to move forward, the EBP model served as a guide to carefully evaluate and plan each implementation step (Cullen, 2015). The Implementation Strategies for the EBP model was meant to supplement the IOWA Model- not replace it (Cullen, 2015). The EBP Implementation Model consists of four phases of implementation: (1) Create awareness and interest, (2) Build knowledge and commitment, 3) Promote action and adoption, and 4) Pursue integration and sustained use (Cullen, 2015).

Using the Implementation Strategies for EBP, once the problem was identified, the team created awareness and urgency through staff meetings, continuing education requirements on the topic, and involvement of senior executives. Next, to gauge staffs' attitude towards PU prevention, a staff attitude survey was conducted pre-intervention. Staff with the highest scores (and thus most positive attitudes toward PU prevention) were selected as skin "champs" on the unit. In accordance with the next step of the EBP- promoting action and adoption- staff were trained and mentored by skin champs and change agents. Also, the EMR was integrated with the TA software. The actions and adoption change took several weeks. The positive feedback from the pilot was encouraging, and the hospital-wide implementation occurred in December 2019.

Finally, the last stage was integrating the new practice into the workflow and sustaining its use (Cullen & Adams, 2012). The organization sustained the new practice by regularly monitoring quality measures and reporting successes to senior leaders with reports on the impact of the technology on patient quality of care.

Methodology

This quality improvement study evaluated patients who received the digital imaging platform using TA in conjunction with the current standard of care protocol versus those who received the current standard of care alone without digital imaging. The purpose of the project was to compare the identification of POAs, improve the accuracy of documentation of PU staging, and improve the documentation of PUs two months pre-intervention and two post-intervention.

Human Subject Determination was obtained. Data were extracted from the hospital's NDNQI measures as well as from chart audits. Measurements included POAs, HAPUs, and PU stages. Other data collected were demographic information, Braden scale, and a Pre-intervention staff attitude survey.

The presence of POA PUs was noted from the initial skin assessment. POAs are documented in the EMR within 72 hours of admission by the admitting/primary service, and information from the chart audit was used in data collection. For HAPUs, the date of onset was defined as the date that the HAPU was identified and recorded in the hospital's documentation. Demographic information was collected from chart audits. Tools used included the Braden Scale and AHRQ toolkit.

The NDNQI values and demographic information were entered into an Excel spreadsheet and analyzed in Excel. Then the Statistical Package for the Social Sciences (SPSS version 26) was used to analyze the data (IBM Corp, Armonk, NY). Descriptive statistics were used to describe the sample; for categorical data, the results were reported using frequency and percentages. The data was password protected and secured in a locked file cabinet in the author's office. Only the PI and the wound nurse had access to this data.

A logic model was used as the program planning tool for this project (McCawley, 2001). The logic model aligned with the four dissemination phases of the IOWA model and included the short-term, mid-term, and long-term goals of the implementation. See Figure 3 for a detailed Logic Model for this project.

Setting

The setting for the project was a level 1 Trauma Center in the Mid-Atlantic with 420 beds. This is an academic medical center in which patients receive specialized, complex care due to a range of specialty services, including midwifery services, rehabilitation services, cardiovascular center, and neurosciences institute, wound healing, and limb preservation Center. Additionally, there are several units dedicated to acute services such as the Intensive Care Unit (ICU), pressure ulcer management, orthopedics, acute stroke, and medical-surgical services. In 2018, there were 20,777 inpatient admissions.

Sample

The sample was a convenience sample of inpatients from multiple units since the intervention was hospital wide. The target population was patients under the care of the wound team. Inclusion criteria were all admitted patients. Exclusion criteria were hospice patients, patients with a length of stay (LOS) less than 24 hours (this included observation less than 24 hours, same-day surgery, emergency department, and other ambulatory care patients), pregnant patients, and pediatric patients.

Study Interventions

Patients admitted the hospital signed a consent for treatment, which included terms for the digital imaging technology (see Appendix F for consent form). Then patients received an admission assessment (ideally within 4 hours of admission), which included a risk assessment and skin assessment. If the admitting nurse detected ANY skin abnormalities, the digital imaging platform using TA was used during the assessment. This process not only improved the identification of POAs but improved documentation of any skin abnormalities that may incorrectly be identified as PUs later- including IV filtration wounds, venous ulcers, and/or skin tears. The digital imaging platform using TA intervention was implemented along with the standard protocol.

Implementation of the intervention was headed by the hospital's wound team from the Wound Healing and Preservation Center. This team includes 2 Wound Ostomy and Continence Nurse (WOCNs), 3 Nurse Practitioners (NPs). The team generally sees an average of 30 patients at a time. They consult on patients with all types of wounds - including both PU and non-PU. The DNP student worked closely with the Wound Center Director and the Director of Professional Development and Education throughout this project.

Staff was administered an AHRQ Staff Attitude Survey to determine their attitude towards PU prevention and to identify "skin champs" for the units. (See Appendix E). Staff was trained and given a step-by-step guide on how to integrate the technology into the workflow.

All nurses were equipped with a HIPAA compliant smartphone that contained the tissue analytics app. Once a skin abnormality or PU was identified during the assessment, the nurse selected the patient's name from a list of admitted patients and captured the image. The nurse selected the part of the body where the wound was found using the human body avatar depicted on the screen. The nurse entered other characteristics of the wound, such as location, laterality, and documented whether it was POA. Next, the operator selected another option that sent the analysis wirelessly to the Cerner EMR. Once downloaded to Cerner, none of the images were retained on the physical phone. See Figure 4 for Step-by-Step instructions on how to use the digital imaging platform using TA.

The tissue analytics staff was available during the implementation process to assist the organization with trouble-shooting equipment and software issues. The hospital staff received additional support from in-service meetings, professional education and development department, the wound team, skin champions, and super users on all floors.

Timeline

The project started in September 2019 and was implemented over a 22-week period, ending in February 2020. Pre-intervention data was collected from September and October 2019. The pilot month of November was excluded in data analysis. Hospital-wide implementation began on December 9. Post-intervention data were collected in January and February 2020. See below for further details. Also, refer to Figure 8 Gantt Chart for timeline.

IRB approval was obtained on September 4, 2019. Weeks 1-3-Policy and guidelines were drafted to incorporate the new technology into the existing policy. Announcements were made

about the upcoming technology and the go-live date. Weeks 4-6 -staff was trained on the new equipment and workflow.

Weeks 7-8-staff training continued; also, the wound team prepared for the pilot in November. Equipment was received and leaders continued developing the policy. During weeks 8-12, there was a pilot intervention on patients under the care of the Wound team to identify, modify, and/or adjust areas of improvement before the hospital-wide implementation in December. This pilot on a small segment of patients was done to minimize disruptions to this high-volume hospital's work-flow. The PI completed data collection from the pre-intervention months of September 2019 and October 2019. Lastly, weeks 13-22 -The PI collected and analyzed data from the post-intervention months of January 2020 and February of 2020.

Resources needed

Resources needed included staff time for meetings and initiatives, leadership time to monitor and support team efforts, training, and education time (AHRQ, 2019). Staff meetings and training sessions were incorporated into the regular work schedule and staff were paid their regular rate. Technology for the digital imaging platform using TA, software, and training material were included in the company's budget, and was funded by the hospital.

Data Collection

A non-human subject research determination from GW's Institutional review board (IRB) was obtained. Data, including HAPU rates and POA occurrences, were collected from chart audits and NDNQI reports two months pre-intervention and two months post-intervention. Braden scores were collected and the frequency, percentage, and mean scores were calculated pre-intervention and post-intervention. A staff attitude survey was completed pre-intervention (See Tables 3).

The Pilot month of November was not included in the data analysis since the patients in the pilot were already admitted; their POAs were already known. The hospital go-live month of December was also not included in the data analysis since the staff was adjusting to the technology. Therefore, pre-intervention data was collected from September and October 2019; post-intervention data were collected from January and February 2020. A data collection sheet was used to collect pertinent information (See Appendix I); this sheet, along with all data, was kept in a secure binder for the PI to access for analysis. In order to ensure patient privacy, all patient identifiers were removed. Additionally, patient charts were number coded.

Evaluation plan

Evaluation measures included (1) Measure of HAPUs, (2) Measures of POAs (3) Frequency and percentage of Braden scores. Demographics of participants of the staff attitude survey were documented (see Table 2). Scores of each item in the survey were calculated (see Table 3). Chart audits were completed to ensure that a comprehensive skin assessment AND a standardized risk assessment such as the Braden scale were completed within 24 hours of admission.

Tools used included the Braden scale (BS) and AHRQ toolkit. The BS showed good inter-rater reliability ranging from 83% to 99% in multiple clinical settings (Jackson, 2011). The sensitivity and specificity of the BS are high (0.83-1.00 and 0.64-0.90, respectively) when the cut-off score of 16 is used (Jackson, 2011). For BS scores ranging from 12-20, the sensitivity of the scale ranges from 29% to 93%, while the specificity ranged from 67% to 97% (Jackson, 2011).

The hospital wound team used the AHRQ toolkit as a framework to implement the new PU prevention strategy and sustain efforts. The toolkit draws on the literature of best practices in PU prevention and includes both validated and newly developed tools (AHRQ, 2014). The

toolkit was tested in six participating medical centers (AHRQ, 2014). A survey from the AHRQ toolkit was used in this study to assess staff attitude and to identify any knowledge gaps. The Staff Attitude Scale was used to provide useful feedback on clinical staffs' beliefs regarding pressure ulcer prevention (AHRQ, 2014). The AHRQ staff attitude survey is an 11-item questionnaire graded on a Likert 5-point scale, with total scores ranging from 11-55. Positive perceptions are presented by a score > 40 (Wong et al., 2018). The staff knowledge and attitude surveys were collected through an electronic survey through Monkey Survey. See Table 3 for the results.

Data Analysis and, Maintenance and Security

The incidence of HAPUs and POA rates was measured to evaluate the effectiveness of this QI project. The author worked closely with the wound care Director to create a report that included patients with HAPUs and POAs. Incidence of POAs and HAPUs were collected from NDNQI measures and chart audits.

Data was imported into and analyzed using SPSS version 26 for Windows (IBM Corp., Armonk, NY). Frequency tables and descriptive statistics were used to summarize the demographics of the participants (i.e., gender, race, age, and Braden score, pre-and-post intervention), documentation of the stages of POA and HAPUs (pre-and-post intervention), Braden score (pre-and-post intervention), and AHRQ staff attitudes survey (pre-intervention only).

For Aim 1, improve identification of POAs upon admission assessment, we measured the factors: POA identification rate, frequency, and percentage of all POAs, and HAPU Incidence rate. The frequency of POAs was calculated per 1000 admissions for September and October of 2019 (pre-intervention) and January and February of 2020 (post-intervention) and compared using incidence rate ratio and 95% confidence intervals (CI) (Polit, 2010; Giles et al., 2006,

Rosner, 2011). The HAPU incidence rates were also calculated to compare pre- and post-intervention. The assumption was that as more POAs were correctly identified, and less HAPUs were incorrectly identified as POAs, the number of HAPUs would decrease.

To examine aim 2, promote accurate documentation of the stages of POA and HAPUs, a chi-square test of independence was used to determine if there was a statistically significant difference in the documentation of the stages of POA and HAPUs between pre-intervention and post-intervention. Since the sample size was small, the p-value of the chi-square test was obtained via the Monte Carlo method (Mehta & Patel, 2011). For all tests, a *p*-value of less than 0.05 was considered significant. Data analyzed included stages of the PUs: Stage 1, II, III, IV, unstageable, or deep tissue injury (DTI) for both POA and HAPUs. Additionally, medical device-related (MDR) PU stages were added for HAPUs. And since POAs included ALL skin abnormalities, including non-pressure ulcer wounds, a unique category of "no stage" was added for POAs.

To examine aim 3, improve documentation of PUs, we wanted to compare the actual PU prevalence pre- and post-intervention to determine if there was a difference in the documented PU rates after using the technology. The assumption is that if PUs (either POAs or HAPUs) were being overlooked or not properly identified during assessments, the organization might see an increase in the overall PU prevalence numbers post-intervention due to the concise monitoring and tracking of the digital imaging platform using TA.

For this aim, the PU prevalence rate was calculated pre- and post-intervention using the AHRQ PU prevalence formula below:

$$\frac{\text{Number of patients of patients with HAPUs}}{\text{Total number of patients admitted}} \times 100$$

The current PU prevalence benchmark rate is 3.3% (Hill-Rom, 2019). Since this study occurred over a short time frame, the national annual rate (3.3%) was divided by 12 months in order to calculate a monthly rate (0.275%). The monthly prevalence rates calculated in this study for each pre- and post-intervention month were compared to 0.275% in order to assess the organization's status in comparison to the national benchmark.

The data was password protected and secured in a locked file cabinet in the author's office. Only the PI and the wound nurse had access to this data.

Ethical Considerations

This intervention was non-invasive and was not expected to cause any harm to the patients. An IRB approval was obtained before the study started. The study proposal was approved for non-Human Subject Determination. Consent was obtained by all patients prior to the study through the hospital's consent for treatment. See Appendix F. The consent contains a section that states, "By my signature below, I consent to laboratory studies (HIV, HBV, HCV) in the event a health care worker is exposed to my blood or body fluids. I consent to the appropriate disposal of any tissue or part removed from my body **and to the taking of photographs during the procedure/operation/treatment for research, teaching, or scientific purposes as long as my identity is not disclosed**" (GW Hospital, 2019). Video photography was covered under this section. Patients were neither paid nor given any extra incentives for this intervention.

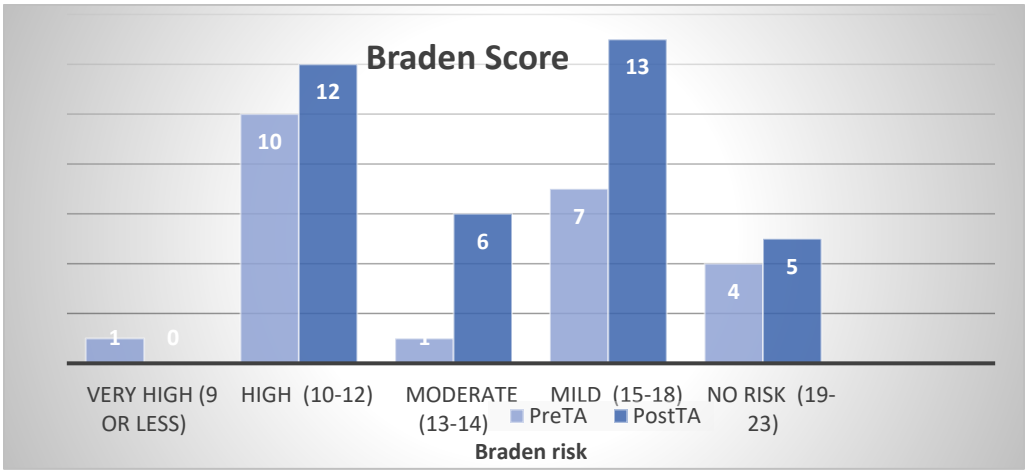
The PI created a codebook that contained the study numbers for any patient identifiers used. The codebook will be deleted within 30 days after the DNP project is submitted. The desktop computer used for this study was password protected. The desktop computer was kept in a locked office, and all data collected for this study was saved on a flash drive and kept in a secure locked cabinet to ensure privacy and protection of PHI.

Results

Characteristics of the Sample

There were 55 participants (*N* = 23 for pre-intervention and *N* = 32 for post-intervention) included in this study (which resulted in 72 incidences of HAPUs). Table 1 shows the characteristics of the sample. Of the pre-intervention participants, the majority were male (82.6%); of the post-intervention participants, half of them were male (50.0%). For both the pre- and post-intervention period, over half of the participants were Black (52.2% for pre-intervention and 59.4% for post-intervention). The average age for the participants was 66.21 years (*SD* = 11.07) and 61.88 years (*SD* = 17.20) for pre-intervention and post-intervention, respectively. The average Braden score for the participants was 14.52 (*SD* = 3.65) and 14.56 (*SD* = 2.55) for pre-intervention and post-intervention, respectively. See **Appendix G** for the descriptive statistics for the demographics of the study. See Figure 5 for Braden Score distribution.

Figure 5: Braden Score distributions Pre and Post Intervention



AIM 1: Improve Identification of POAs upon Admission Assessment

To analyze if there were any difference in the number of POAs identified pre-intervention and post-intervention, the POAs per 1000 patient admissions were computed for two periods to get the identification rate: (1) September and October of 2019 (pre-intervention) and (2) January and February of 2020 (post-intervention). For pre-intervention, there were 21 POAs

and 4112 patient admissions; for post-intervention, there were nine POAs and 3996 patient admissions. Thus, the POA identification rate for pre-intervention was 5.11 POAs per 1000 patient admissions (95% *CI* = [3.33, 7.84]), and the POA identification rate for post-intervention was 2.25 POAs per 1000 patient admissions (95% *CI* = [1.17, 4.33]) (Table 2). The incidence rate ratio of the POA identification rate between pre and post-intervention was 2.27 χ^2 (1) = 4.223, p = 0.040; 95% *CI* = [1.04, 4.95]), indicating that the POA identification rate for pre-intervention was statistically significantly higher than the POA identification rate for the post-intervention. See **Table 1**.

Table 1: POAs per 1000 Patient Admissions

	POAs	Patient admissions	POA identification rate [95% *CI*]
Pre	21	4112	5.11 [3.33, 7.84] POAs per 1000 patient admissions
Post	9	3996	2.25 [1.17, 4.33] POAs per 1000 patient admissions

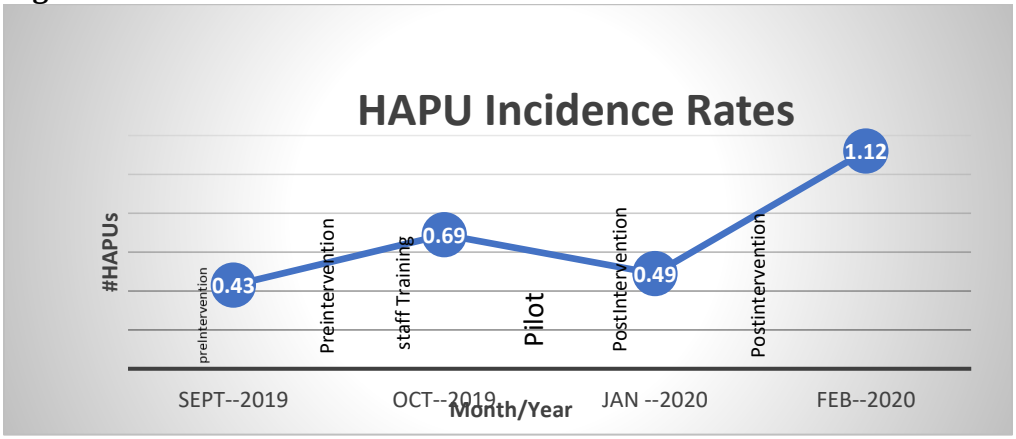
Note. POA identification rate = (Number of POAs/Number of patient admissions) *1000.

HAPU Incidence Rate

The purpose of Aim 1 was to improve the identification of POAs and prevent them from later being counted as HAPUs. The assumption was that with the digital imaging platform using TA, the number of POAs post-intervention would increase (due to improved identification), and the number of HAPUs would decrease (since less POAs would be counted as HAPUs). In order to analyze this assumption, the HAPU incidence rates were calculated and compared pre- and post-intervention using the AHRQ formula below:

$$\frac{\text{Number of patients with HAPUs}}{\text{Total number of patients admitted}} \times 100$$

Figure 6: HAPU Incidence Rates



The HAPU rates increased exponentially in February 2020. Factors contributing to this increase is discussed in the "Discussion" section of this paper.

Aim 2: Improve Documentation of Stages of POA and HAPUs

The total number of HAPUs observed in this study was 72, with 37.5% (N = 27) being in pre-intervention and 62.5% (N = 45) being in post-intervention. Of the 27 incidences of HAPUs pre-intervention, the top three stages documented were deep tissue injuries (33.3%), stage 2 ulcers (29.6%), and unstageable (25.9%). Of the 45 incidences of HAPUs post-intervention, the top three stages documented were deep tissue injuries (57.8%), stage 2 ulcers (24.4%), and unstageable (6.7%). A chi-square test of independence was performed to determine if there was a statistically significant difference in the documentation of the stages of HAPUs between pre-intervention and post-intervention. As the sample size was small, the p-value of the chi-square test was obtained via the Monte Carlo method (Mehta & Patel, 2011). The results of the chi-square test of independence indicated that there was no statistically significant difference in the documentation of the stages of HAPUs between pre-intervention and post-intervention ($\chi 2$ (5) = 9.823, p = 0.059).

The total number of POAs observed in this study was 30, with 70.0% (N = 21) being in pre-intervention and 30.0% (N = 9) being in post-intervention. Of the 21 incidences of POAs

pre-intervention, the top three stages documented were unstageable (28.6%), no stage (non-pressure ulcers) (28.6%), and deep tissue injuries (23.8%). Of the 9 incidences of POAs post-intervention, 66.7% were stage 3 ulcers and 33.3% were no stage (non-pressure ulcers). A chi-square test of independence indicated that there was a statistically significant difference in the documentation of the stages of POAs between pre-intervention and post-intervention ($\chi 2$ (6) = 16.395, p = 0.003).

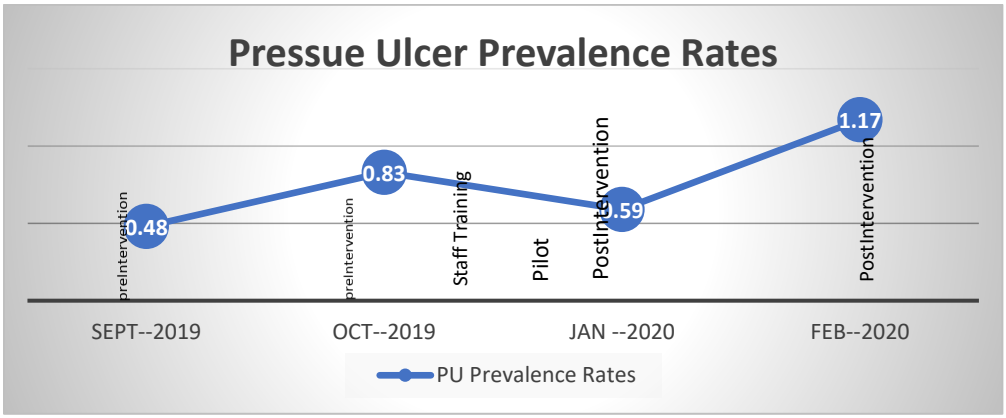
Aim 3: Improve Documentation of all PUs

In order to determine if the digital imaging platform using TA technology impacted the documentation of PUs, the PU prevalence rate was calculated pre- and post-intervention. This rate was calculated using the AHRQ formula below:

$$\frac{\text{Total number of patients with PUs (}\mathbf{both}\text{ POAs and HAPUs)}}{\text{Total number of admitted patients}} \times 100$$

The digital imaging platform using TA could affect the PU prevalence in two main ways: 1) With improved identification of both POAs and HAPUs, the post-intervention PU prevalence rate would be higher; 2) Or, alternatively, the post-intervention PU prevalence rate would be lower due to less non-PU wounds were being categorized as PUs. Either way, a change would be expected. The PU prevalence rates from the organization are found in Figure 7.

Figure 7: Pressure Ulcer Prevalence Rates



The acute care national benchmark for PU Prevalence rate is 3.3% annually (Hillrom, 2019). However, due to the short period of the study, we are interested in the monthly prevalence rate. Therefore, if we divide the national benchmark, 3.3%, by 12, the national monthly PU prevalence rate would about 0.275%. The monthly prevalence rates for this organization were higher than 0.275% and peaked at 1.17% in February 2020.

AHRQ Staff Attitudes' Survey towards Pressure Ulcer Prevention

Two-hundred and seventy-eight (278) clinical staff members participated in the AHRQ staff attitude survey. Table 2 shows the demographics of the staff. Most of the respondents were female (89.6%). Respondents indicated that they work in medical/surgical (39.5%), clinical care (21.5%), ED (11.1%), OR/PACU (13.3%), and women's health (14.6%). See Table 2 for the demographics of participants of this survey.

Table 3 summarizes the responses from the AHRQ staff attitudes survey. The top three items that the respondents disagreed on were:

(1) I do not need to concern myself with pressure ulcer prevention in my practice (Item 4, $M = 4.60$)

(2) Pressure ulcer treatment is a greater priority than pressure ulcer prevention (Item 5, $M = 4.24$)

(3) In comparison with other areas of care, pressure ulcer prevention is a low priority for me (Item 10, $M = 3.88$)

The top three items that respondents agreed on were:

(1) Pressure ulcer risk assessment should be regularly carried out on all patients during their stay in hospital (Item 11, $M = 1.50$)

(2) Continuous assessment of patients will give an accurate account of their pressure ulcer risk (Item 6, $M = 1.52$)

(3) All patients are at potential risk of developing pressure ulcers (Item 1, *M* = 1.59)

Discussion

Aim 1: The POA identification rate was significantly higher in the pre-intervention period. This finding contradicts our assumption that there would be improved identification of POAs (and, therefore, increased numbers) post-intervention due to the digital imaging platform using TA. Possible explanations include: 1) The study contained several patients with more than one POA in the pre-intervention period. For instance, one 90-year-old patient in the pre-intervention month of October had NINE POAs of varying stages; and 2) the POAs documented only came from a small convenience sample of patients. There were surely more patients outside of this sample who had POAs. Therefore, the post-intervention numbers for the hospital are likely much higher than those found in this study.

Also, contrary to our assumption, the HAPU incidence rates were higher post-intervention. This finding was mainly due to the high number of patients with device-related HAPUs in the month of February 2020. There were 14 HAPUs in February that were caused by devices such as condom catheters, endotracheal tube holders, pulse oximeters, and knee immobilizers. Most of the patients with devices were in the ICU and had limited mobility and decreased levels of consciousness. These patients required the devices for treatment. This result demonstrates that factors such as patient acuity plays a huge role in PU development. Standard guidelines and interventions such as digital imaging platform using TA are only part of the puzzle. These results also present an opportunity for improved device-related care, but this is outside the scope of this project.

Aim 2: The results demonstrated no significant statistical change in the documentation of HAPU stages pre-intervention and post-intervention. However, there was a significant documentation difference in POA stages pre-intervention and post-intervention. The POAs

included ALL skin abnormalities, including non-pressure ulcer wounds. There were a large number of non-pressure ulcer wounds and mucosal injuries in this study. These included venous stasis ulcers, IV infiltration wounds, and skin tears. These non-PU wounds and mucosal injuries cannot be assigned a stage. The decision to include them in the analysis was for tracking purposes since non-PU abnormalities may have occasionally been documented as PUs before the implementation of the digital imaging platform using TA. LeBlanc, Alam, and Langemo (2016) reported that skin tears often mimic DTIs and Stage 2 PUs; consequently, misdiagnoses may occur. Misdiagnoses can result in inappropriate prevention and treatment strategies as well as risk for re-injuries (LeBlanc, Alam, & Langemo, 2016).

Aim 3: The national annual benchmark for PU prevalence is 3.3% (Hill-Rom, 2019). In order to calculate a monthly estimate from the national benchmark, 3.3% was divided by 12, resulting in 0.275%. The PU prevalence rate for each month in this study was greater than 0.275%. In fact, the rate increased to 1.17% in February 2020. Again, as previously discussed, this was due to a large number of device-related PUs in February.

Digital imaging platform using TA more accurately tracked PU progression than the Braden Scale in this study population, which consisted mostly of ICU patients. Most of the Braden scores in the post-intervention sample were in the mild-risk category (N=13), while the actual PU prevalence in the post-intervention period was high. This finding is consistent with a study by Griswold et al. (2017) that the Braden scale is not useful in predicting the occurrence of ulcers in the trauma and burns populations. Other factors not included in the Braden Scale should be considered in this population, such as age, level of consciousness, oxygenation, and perfusion (Griswold et al., 2017).

And finally, the staff attitude survey demonstrated the need for staff training, in-services, or incentives to increase positive attitude towards PU prevention measures. The total mean score

for the survey was 33.36. Scores >40 represent positive perceptions (Wong et al., 2018). Scores lower than 40 indicate negative attitudes towards HAPU prevention and one of the organization's early goals should be to address these misperceptions (Wong et al., 2018; AHRQ, 2014).

Study Limitations

The limitations of this study included the small sample size. Out of the 8,108 patients admitted during this study period, there were 55 patients with HAPUs. Also, because the study participants included only those with HAPUs, the POA numbers were strictly from this population. This means that there were many more POAs detected than accounted for in this study. Another limitation was the sample was a convenience sample rather than a random one. Random sampling may yield the least bias.

The statistical methods used (Chi-Square and Monte Carlo methods) are usually better suited for larger-sized, random samples. However, per McHugh (2013), although inferential statistics assume random sampling, it is not uncommon for inferential statistics to be used with convenience samples. Also, the Monte Carlo method was used to find the p-value in this study. The Monte Carlo methods offer a way to draw statistical inference when traditional statistical assumptions are violated (Waller et al., 2003). However, according to some sources, the solutions of the Monte Carlo are not exact; outputs are estimates (Applied R&M, 2012). This study needs to be replicated in a large size, random sample to be further validated.

Impact on Practice and Recommendations

We recommend the continued use of digital imaging platform using TA technology to provide more precise measurements of PUs and thus improved accuracy of staging. This technology can also track PU progression and treatment, which improves communication between staff, prevents treatments from being duplicated or underused. These factors can

promote faster healing of the PU. Quicker healing of PUs saves the organization money by preventing the ulcers from progressing to a higher stage and by decreasing the hospital length of stay (LOS). Higher staged ulcers cost more money to heal than lower staged ones. For example, treatment for stage III and IV ulcers range from $5000 to $151,700 per ulcer (Meddings et al., 2015), while stage I and II PUs cost a few hundred to a couple of thousands. In terms of LOS, according to Lyder et al., (2012), PUs can increase the LOS from 4.8 for those without PUs to 11.2 days for those with HAPUs. Quicker healing could potentially decrease the LOS by several days, saving the hospital thousands of dollars per person on average

We recommend the use of this technology for accurate identification of skin abnormalities to prevent non-Pressure Ulcer wounds from being inaccurately categorized as PUs. For instance, IV infiltration wounds, venous ulcer wounds, and other skin issues may have incorrectly been identified as PUs before the intervention. The digital imaging platform using TA ensured that staff documented the etiology of wounds as well as progression. Having a visual image to refer to also confirmed the status.

We recommend using the digital imaging platform using TA in place of the Braden scale in the ICU population. For this population, digital imaging using TA, along with standard protocol, proved to be a more accurate indicator of PU risk than Braden scores. Eliminating the Braden scale may save staff time that can be utilized for other tasks.

We recommend initiating staff activities or incentives to help improve staff attitudes towards PU prevention. Improving staff's attitude may encourage them to perform the interventions eagerly.

Sustainability

In order to sustain the new intervention, support will take the form of training new employees, offering refresher training courses for current employees; promptly filling staff

vacancies; keeping in contact with facilities management for supplies and equipment and using the assistance of information technology staff support to assist with regularly reporting monitoring data (AHRQ, 2014).

Conclusion

Despite the limitations, this innovative technology has promise for the future. It helps to improve PU documentation by providing more detailed, accurate descriptions of PUs. It also provides an easy way to track the progression and treatment of PUs with its charts and alert indicators. This intervention also helped organize PU data more efficiently in the EMR and saved staff time in documentation since the information flowed wirelessly to the EMR. We recommend that the intervention be replicated with a larger-sized, random sample and over a longer time frame to be further validated.

References

AHRQ (2014). Preventing Pressure Ulcers in Hospitals. Section 3. What are the best practices in pressure ulcer prevention that we want to use? Retrieved online from https://www.ahrq.gov/professionals/systems/hospital/pressureulcertoolkit/putool3.html

AHRQ (2014). Preventing Pressure Ulcers in Hospitals. Section 7: Tools and resources. Retrieved online from https://www.ahrq.gov/professionals/systems/hospital/pressureulcertoolkit/putool7b.html

AHRQ (2014). Quality Improvement and monitoring at your fingertips. Retrieved from https://www.qualityindicators.ahrq.gov/Default.aspx

Anghel, E., Kumar, A., Bigham, T., Maselli, K., Steinberg, J., Evans, K., Kim, P., & Attinger, C. (2019). The reliability of a novel mobile 3-dimensional wound measurement device. Wounds, 28(11): 379-386. Retrieved from https://www.woundsresearch.com/article/reliability-novel-mobile-3-dimensional-wound-measurement-device

Beal, M. E. & Smith, K. (2016). Inpatient Pressure Ulcer Prevalence in acute care hospital using evidence-based practice. *Worldviews on Evidence-Based Nursing*, 13:2, 112-117. DOI: 10.1111/wvn.12145

Braden, B., & Bergstrom, N. (1988). Braden Scale. Retrieved from http://www.bradenscale.com/images/bradenscale.pdf

Budman, J. (2019). Tissue Analytics White Paper. Time savings and healing rate improvement at Intermountain Healthcare through Cerner-integrated Tissue Analytics System Use. www.Tissueanalytics.com

Budman J, Keenahan K, Acharya S, Brat G. (2015). Design of A Smartphone Application for Automated Wound Measurements for Home Care. *iProc* 2015;1(1):e16

DOI: 10.2196/iproc.4703

Coleman, S., Gorecki, C., Nelson, E., Closs, S., Defloor, T., Halfens, R.,…&Nixon, J. (2013). Patient risk factors for pressure ulcer development: systemic review. https://doi.org/10.1016/j.ijnurstu.2012.11.019

CMS (2019). Hospital-Acquired condition reduction program fiscal year 2019 fact sheet. Retrieved from https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Downloads/HAC-Reduction-Program-Fact-Sheet.pdf

CMS (2020). HACRP. https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/HAC-Reduction-Program

CMS (2020). Hospital-Acquired condition (HAC) Reduction Program. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/HAC/Hospital-Acquired-Conditions

Creswell, J. & Creswell, J. (2018). Research Design: Qualitative, Quantitative, and Mixed-Methods Approaches, 5th Ed. Los Angeles, CA: Sage Publications

Cullen, L. (2015). Models for implementation and integration of evidence-based practice. 千葉看会誌, 20 (2). Retrieved from https://opac.ll.chiba-u.jp/da/curator/900118575/20(2)_51-60.pdf

Cullen, L. & Adams, S. (2012). Planning for Implementation of Evidence-Based Practice. JONA, 42 (2): 222-230. Retrieved from https://medcom.uiowa.edu/annsblog/wp-content/uploads/2012/10/JONA-FINAL-Cullen-2012.pdf

Doody, C. & Doody, O. (2011). Introducing evidence into nursing practice: using the IOWA Model. British journal of nursing, 20 (11): 661-4. DOI: 10.12968/bjon.2011.20.11.661

Englebright, M., Westcott, B., Mcmanus, B., Kleja, B., Helm, B., Korwek, B., & Perlin, B.

(2018). A Comprehensive Program to Reduce Rates of Hospital-Acquired Pressure Ulcers in a System of Community Hospitals. *Journal of Patient Safety*, 14(1), 54–59. https://doi.org/10.1097/PTS.0000000000000167

George Washington University Hospital (2019). GW Hospital Department of Medicine Retrieved from https://smhs.gwu.edu/medicine/divisions/rheumatology/why-gw/hospital

George Washington University Hospital (2019). Admission information-The GW hospital. Retrieved online from https://www.gwhospital.com/sites/gwhospital.com/files/files/Preregistration_General%20Admission.pdf

Gould, L., Bohn, G., Bryant, R., Paine, T.,Couch, K., Cowan, L., McFarland, f., & Simman, R. (2018). Pressure ulcer summit 2018: an interdisciplinary approach to improve our understanding of the risk of pressure-induced tissue damage. Retrieved from https://doi-org.proxygw.wrlc.org/10.1111/wrr.12730

Griswold, L., Griffin, R., Swain, T., & Kerby, J. (2017). Validity of the Braden Scale in grading pressure ulcers in trauma and burn patients. *Journal of Surgical Research*, *219*, 151–157. https://doi.org/10.1016/j.jss.2017.05.095

Han, S., Kim, Y., Hwang, J., Lee, J., & Song, M. (2018). Predictors of hospital-acquired pressure ulcers among older adult inpatients. *Journal of Clinical Nursing*, 27(19-20), 3780–3786. https://doi.org/10.1111/jocn.14600

Han, Y., Jin,Y., Taixian, J., Lee, S., Lee, J. (2019). Impact of pressure injuries on patient outcomes in a Korean Hospital. *Journal of Wound Ostomy Continence Nurs*, 46(3): 194-200. Retrieved from http://dx.doi.org.proxygw.wrlc.org/10.1097/WON.0000000000000528

Hansen, R., & Fossum, M. (2016). Nursing documentation of pressure ulcers in nursing homes:

comparison of record content and patient examinations. Nursing Open, 3(3), 159–167. https://doi.org/10.1002/nop2.47

Hill-Rom (2019). 2019 International Pressure Ulcer/Injury Prevention Survey (IPUP). Retrieved from http://www.hill-rom.com/ipup

Institute for Health Care Improvement (IHI, 2019). Pressure Ulcers. Retrieved from http://www.ihi.org/Topics/PressureUlcers/Pages/default.aspx

Jackson, S. (2011). Incidence of Hospital-Acquired pressure ulcers in acute care using two different risk assessment scales: results of a retrospective study. *Ostomy Wound Manage*. 57 (5):20-27. Retrieved from https://www.o-wm.com/content/incidence-hospital-acquired-pressure-ulcers-acute-care-using-two-different-risk-assessment-s

Lam, C., Elkbuli, A., Benson, B., Young, E., Morejon, O., Boneva, D., … Mckenney, M. (2018). Implementing a Novel Guideline to Prevent Hospital-Acquired Pressure Ulcers in a Trauma Population: A Patient-Safety Approach. *Journal of the American College of Surgeons*, 226(6), 1122–1127. https://doi.org/10.1016/j.jamcollsurg.2018.03.027

Leaf Healthcare (2016). White paper: The financial impact of pressure ulcers. Retrieved from http://www.leafhealthcare.com/pdfs/LH_WP_FinancialOverview_1563AB_101316.pdf

LeBlanc, K, Alam, T., Langemo, D., Baranoski, S, Campbell, K., Woo, K. (2016) Clinical Challenges of Differentiating Skin Tears from Pressure Ulcers. EWMA Journal. 16(1) 17-23.. EWMA. 16. 17-23. Retrieved online from https://ewma.org/fileadmin/user_upload/EWMA.org/EWMA_Journal/Articles_latest_issue/April_2016/Leblanc_Clinical_challenges_of_differentiating.pdf

Li, D. (2016). The relationship among pressure ulcer risk factors, incidence and nursing

documentation in hospital-acquired pressure ulcer patients in intensive care units. *Journal of Clinical Nursing*, *25*(15-16), 2336–2347. https://doi.org/10.1111/jocn.13363

Lyder, C., Wang, Y., Metersky, M., Curry, M., Kliman, R., Verzier, N., & Hunt, D. (2012). Hospital-acquired pressure ulcers: results from the national Medicare Patient Safety Monitoring System study. *Journal of the American Geriatrics Society*, *60*(9), 1603–1608. https://doi.org/10.1111/j.1532-5415.2012.04106.x

Mallah, Z., Nassar, N., & Kurdahi Badr, L. (2015). The Effectiveness of a Pressure Ulcer Intervention Program on the Prevalence of Hospital Acquired Pressure Ulcers: Controlled Before and After Study. *Applied Nursing Research*, 28(2), 106–113. https://doi.org/10.1016/j.apnr.2014.07.001

Manzano, F., Pérez-Pérez, A., Martínez-Ruiz, S., Garrido-Colmenero, C., Roldan, D., Jiménez-Quintana, M., … Colmenero, M. (2014). Hospital-acquired pressure ulcers and risk of hospital mortality in intensive care patients on mechanical ventilation: Pressure ulcers, ventilation and mortality. *Journal of Evaluation in Clinical Practice*, 20(4), 362–368. https://doi.org/10.1111/jep.12137

McCawley, Paul. (2001). The Logic Model for Program Planning and Evaluation. Retrieved online from https://www.researchgate.net/publication/237568681_The_Logic_Model_for_Program_Planning_and_Evaluation

McHugh, M. (2013). The Chi-square test of independence. *Biochema Medica*, 23 (2): 143-9. Retrieved online from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3900058/pdf/biochem_med-23-2-143-3.pdf

Meddings, J., Reichert, H., Rogers, M.A., Homer, T.P., McMahon, L., Grazier, K. L. (2015). Under Pressure: Financial Effect of the Hospital-Acquired Conditions Initiative-A Statewide Analysis of Pressure Ulcer Development and Payment. *Journal of the American Geriatric Society*, 63: 1407-1412. Retrieved online from https://onlinelibrary-wiley-com.proxygw.wrlc.org/doi/pdf/10.1111/jgs.13475

Montalvo, I., (September 30, 2007). "The National Database of Nursing Quality Indicators™ (NDNQI®)" *OJIN: The Online Journal of Issues in Nursing*. Vol. 12 No. 3, Manuscript 2. DOI**:** 10.3912/OJIN.Vol12No03Man02

Moore, Z., & Price, P. (2004). Nurses' attitudes, behaviors and perceived barriers towards pressure ulcer prevention. *Journal of Clinical Nursing*, *13*(8), 942–951. https://doi.org/10.1111/j.1365-2702.2004.00972.x

National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance (NPUAP, EPUAP, PPPIA, 2014). Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Western Australia. Retrieved online from http://www.internationalguideline.com/static/pdfs/NPUAP-EPUAP-PPPIA-CPG-2017.pdf

Padula, V., Mishra, K., Makic, F., & Sullivan, W. (2011). Improving the Quality of Pressure Ulcer Care With Prevention: A Cost-Effectiveness Analysis. *Medical Care*, *49*(4), 385–392. https://doi.org/10.1097/MLR.0b013e31820292b3

Padula, V., Gibbons, D., Valuck, J., Makic, B., Mishra, K., Pronovost, J., & Meltzer, O. (2016). Are Evidence-based Practices Associated With Effective Prevention of Hospital-acquired Pressure Ulcers in US Academic Medical Centers? *Medical Care*, 54(5), 512–518. https://doi.org/10.1097/MLR.0000000000000516

Padula, W., Makic, M., Wald, H., Campbell, J., Nair, K., Mishra, M., & Valuck, R. (2015). Hospital-Acquired Pressure Ulcers at Academic Medical Centers in the United States, 2008-2012: Tracking Changes Since the CMS Nonpayment Policy. Joint Commission *Journal on Quality and Patient Safety*, 41(6), 257–263. https://doi.org/10.1016/S1553-7250(15)41035-9

Padula, William, Black, Joyce, PhD, RN, CWCN, FAAN, Davidson, Patricia, PhD, RN, et al. (2020). Adverse Effects of the Medicare PSI-90 Hospital Penalty System on Revenue-Neutral Hospital-Acquired Conditions. *Journal of Patient Safety,* Advance on-line publication. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=ovftu&NEWS=N&AN=01209203-900000000-99331. https://doi.org/10.1097/PTS.0000000000000517

Pittman, J., Beeson, T., Kitterman, J., Lancaster, S., & Shelly, A. (2015). Medical Device-Related Hospital -acquired Pressure Ulcers: Development of an evidence-based Position Statement. *Journal of Wound Ostomy Continence Nurs*, 42(2):151-154. https://doi.org/10.1097/WON.0000000000000113

Polit, D. (2010). Statistics and Data Analysis for Nursing Research, 2nd Ed. Pearson Education Inc: New Jersey

Roe, E. & Williams, D. (2014). Using Evidence-based Practice to Prevent Hospital-Acquired Pressure Ulcers and Promote Wound Healing. American Journal of Nursing, vol 114 (8), p. 61-65. doi: 10.1097/01.NAJ.0000453050.31618.ec

Rogers, C. (2013). Improving Processes to Capture Present-on-Admission Pressure Ulcers. *Advances in Skin & Wound Care*, *26*(12), 573–574. https://doi.org/10.1097/01.ASW.0000437949.62301.6e

Rosner, B. (2011). Fundamentals of biostatistics. Boston, MA: Brooks/Cole.

Tissue Analytics (2019). Tissue Analytics: Simplifying Woundcare. Retrieved from https://www.tissue-analytics.com/#page=home

Titler, et al (2001). The IOWA model of evidence- based practice to promote quality of care. *Critical Care Nursing Clinics of North America*, 13(4):497-509. Retrieved from DOI: 10.1016/S0899-5885(18)30017-0

VanGilder, C., MacFarlene, G., Meyer, S. (2008). Results of Nine International pressure ulcer prevalence surveys: 1989 to 2005. Ostomy Wound, 54(2): 40-54. Retrieved from https://www.o-wm.com/content/results-nine-international-pressure-ulcer-prevalence-surveys-1989-2005

Wang, S., Anderson, J., Evans, R., Woo, K., Breland, B., Sasseville, D., Moreau, L. (2017). Point-of-care wound visioning technology: reproducibility and accuracy of a wound measurement app. PLoS One., 12(8): e0183139. DOI:10.1371/journal.pone.0183139

Waller, L., Smith, D., Childs., J., Real, L. (2003). Monte Carlo Assessments of goodness of fit for ecological simulation models. https://digitalcommons.unl.edu/zoonoticspub/67

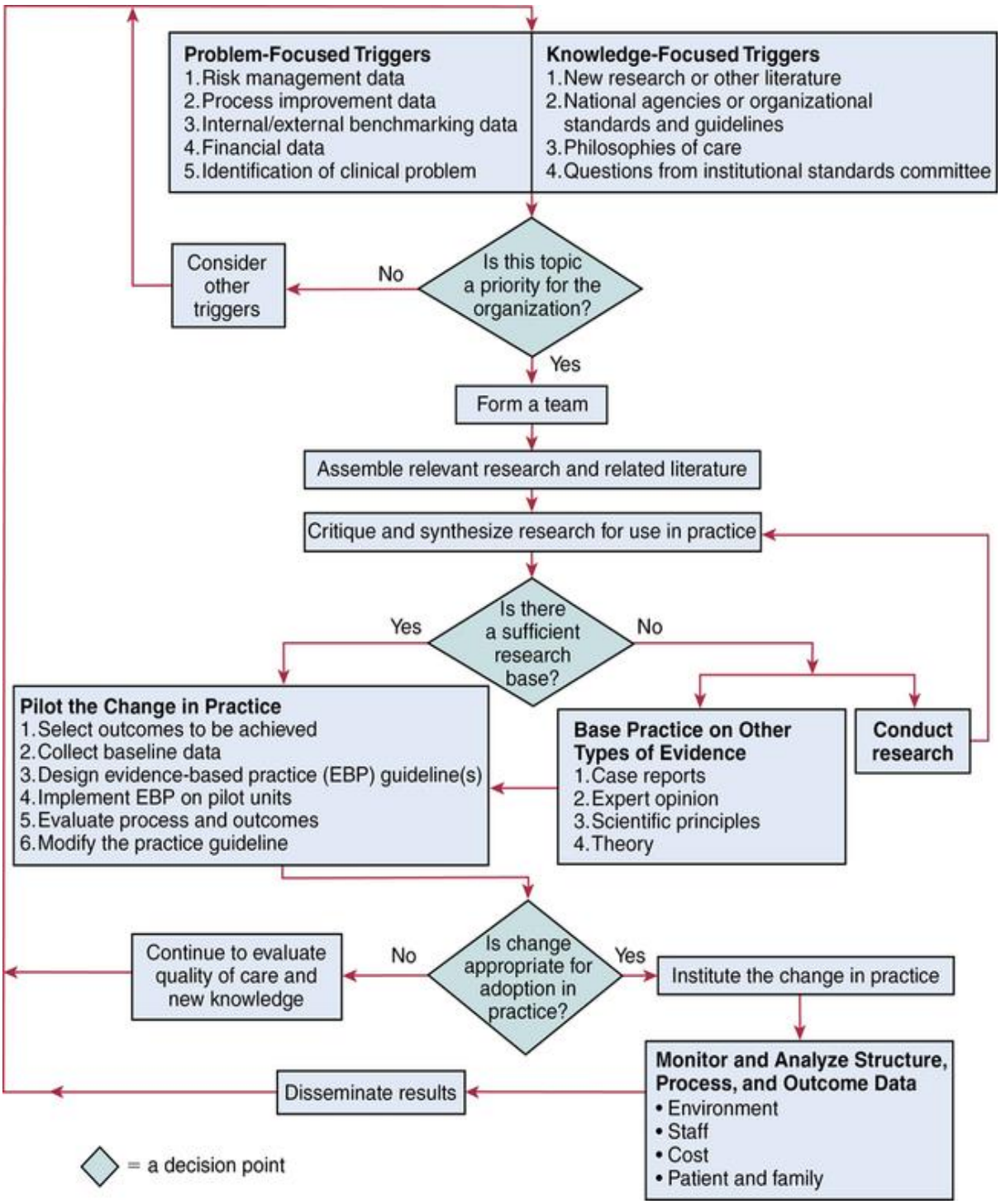
Wong, A., Walia, G., Bello., R., Aquino, C., Sacks, J. (2018). Pressure ulcer prevalence and perceptions on prevention: a hospital-wide survey of health professionals. *Journal of Wound Care* 27(Sup4):S29-S35. DOI: 10.12968/jowc.2018.27.Sup4.S29

Figures

Figure 1: SWOT Analysis

	Helpful To achieving the objective	**Harmful** To achieving the objective
Internal Origin {Attributes of the organization}	**Strengths** • Support of nursing leadership. • Routine meetings with nursing leadership. • Nursing leaders prt of hospital committees. • Hospital charter. • Partnered with risk and quality. • Solid wound care RNs • Monthly audits • Rebirth of skin champions	**Weaknesses** • High Nurse turnover. • High resources spent tracking and staging PUs. • Serious gaps in staging accuracies despite best efforts. • No 'F-314' Language in acute care.
External Origin {Attributes of the organization}	**Opportunities** • Clarify PU staging guidance (for better surveillance). • Re-align resources for care instead of for regulatory Defense. • Build evidence. • Get policy clarification on unresolved issues in acute care. • Design safe PU work systems amongst sectors. • Harmonize PU adverse events across healthcare settings.	**Threats** • Need better leverage between regulatory and financial focus. • Need higher level expertise to achieve best practice PU care. • Institutional mismatch of PU expertise with authority.

Figure 2: IOWA MODEL



* Titler, M., et al (2001). The IOWA model of evidence-based practice to promote quality care. Critical Care Nursing clinics of north America. 13(4); 497-509.

Figure 3: Logic Model for Skin Analytics Implementation

Program: Skin Analytics software integrated with standard protocol

Situation: Need for more accurate skin assessment during admission, need to reduce HAPU rates, need to distinguish HAPU vs POA pressure ulcers

Inputs (What we invest)	**Outputs (What we do and who we do it to)**		**Outcome-Impact (The incremental events/changes that occur as a result of the outputs)**		
	Activities	***Participation***	**Short**	**Medium**	**Long**
Funding Technology Staff Time Health IT Trainers Facilitators Computers Software Patient and practice level data	Needs and Resource Assessment Software Training Action Planning Technology Use	Staff WOCN team Nurses Providers Stakeholders Advocates Patients	Gather evidence from literature and research Create staff awareness and urgency for the change. Identify staff gaps in knowledge Train staff on knowledge deficits and new intervention	Gather evidence from literature and research Create staff awareness and urgency for the change. Identify staff gaps in knowledge Train staff on knowledge deficits and new intervention	Integrate change into practice in entire hospital Decreased hospital rate of HAPUs closer to 3.3% national benchmark Improved documentation of HAPUs vs POAs Improved patient outcomes (ie decreased mortality, decreased LOS) Sustenance of intervention through frequent posting of success A program evaluation through staff surveys and review of data to assess the effectiveness of these inputs in accomplishing the goals.

Assumptions
All units of the hospital will be open to participation

External Factors
Software, technical, or training difficulties may delay rollout

Figure 4: Step by Step Instructions to use Digital Imaging Platform using Tissue Analytics

User opens Cerner and add the patient to the TA app by clicking on the Tissue analytics Mpage view tab in the patient's chart. Then the patient will appear in the TA app.

i. Using the TA app, take a wound image

ii. Select the appropriate type of wound:

1. Pressure injury (ulcer) general
2. Pressure injury (ulcer) device-related
3. Non-pressure injury

iii. Enter a wound number to assist in tracking. This number is not part of the patient's record.

Iv. Document in the dynamic group fields, as appropriate, but must include the following fields:

1. Incision, wound laterality
2. Incision, wound location
3. Incision, wound location description
4. Present on Admission

V. These fields are the same as in iView

Tap continue to send the wound photo and documentation to the patient's chart

vi. Navigate to Tissue Analytics mpage view. Navigate to new wound documentation >click on button for "Sign & Lock" . Image will now appear in multimedia manager and discrete data will appear in iView>Incision, wound dynamic group

Discrete data will pull into iView as new dynamic group (if user added a new wound) or in existing dynamic group (if user added a new evaluation to an existing wound). If issues with data being downloaded, refresh and/or log in and out of Cerner

Figure 8: GANTT CHART -Project Timeline

	August '19	Sept '19	Oct '19	Nov '19	Dec '19	Jan '20	Feb '20	March '20	April '20	May '20
IRB Application										
IRB Exemption										
Intervention/Data Collection										
Data Analysis										
Submit 1st Draft of Project Paper										
Submit Final Paper										
Submit electronic project Poster										
Submit Project to DNP repository										
Submit final DNP project dissemination on Bb										

Tables

Table 2: *Demographics of the Clinical Staff who took AHRQ Staff Attitude's Survey*

		N (%)
Gender	Female	249 (89.6)
	Male	29 (10.4)
	Missing response	0
Work unit	Medical/Surgical	92 (39.5)
	Critical care	50 (21.5)
	ED	26 (11.1)
	OR/PACU	31 (13.3)
	Women's Health	34 (14.6)
	Missing response	45

Table 3: *Summary of AHRQ Staff Attitudes Survey Responses*

	% of survey response						
Item	1	2	3	4	5	*N*	*M*
1. All patients are at potential risk of developing pressure ulcers	57.82	32.36	4.00	4.73	1.09	275	1.59
2. Pressure ulcer prevention is time consuming for me to carry out	5.49	16.48	21.25	36.63	20.15	273	3.49
3. In my opinion, patients tend not to get as many pressure ulcers nowadays	2.19	10.58	24.45	45.99	16.79	274	3.65
4. I do not need to concern myself with pressure ulcer prevention in my practice	1.09	1.45	2.54	26.09	68.84	276	4.60
5. Pressure ulcer treatment is a greater priority than pressure ulcer prevention	2.54	3.26	.42	37.32	47.46	276	4.24
6. Continuous assessment of patients will give an accurate account of their pressure ulcer risk	52.19	45.62	0.73	0.73	0.73	274	1.52
7. Most pressure ulcers can be avoided	36.50	51.09	9.12	2.55	0.73	274	1.80
8. I am less interested in pressure ulcer prevention than other aspects of care	2.19	11.68	21.90	40.88	23.36	274	3.72
9. My clinical judgment is better than any pressure ulcer risk assessment tool available to me	4.38	14.96	31.39	37.96	11.31	274	3.37
10. In comparison with other areas of care, pressure ulcer prevention is a low priority for me	2.55	7.66	15.69	47.08	27.01	274	3.88
11. Pressure ulcer risk assessment should be regularly carried out on all patients during their stay in hospital	57.97	38.04	1.81	0.72	1.45	276	1.50

Appendices

Appendix A: Elements of a Comprehensive Skin Assessment

Skin Temperature

- Most clinicians use the back rather than the palm of their hand to assess the temperature of a patient's skin.
- Remember that increased skin temperature can be a sign of fever or impending skin problems such as a Stage I pressure ulcer or a diabetic foot about to ulcerate.
- Touch the skin to evaluate if it is warm or cool.
- Compare symmetrical body parts for differences in skin temperature.

Skin Color

- Ensure that there is adequate light.
- Use an additional light source such as a penlight to illuminate hard to see skin areas such as the heels or sacrum.
- Know the person's normal skin tone so that you can evaluate changes.
- Look for differences in color between comparable body parts, such as left and right leg.
- Depress any discolored areas to see if they are blanchable or nonblanchable.
- Look for redness or darker skin tone, which indicate infection or increased pressure.
- Look for paleness, flushing, or cyanosis.
- Remember that changes in coloration may be particularly difficult to see in darkly pigmented skin.

Skin Moisture

- Touch the skin to see if the skin is wet or dry, or has the right balance of moisture
- Remember that dry skin, or xerosis, may also appear scaly or lighter in color.
- Check if the skin is oily
- Note that macerated skin from too much moisture may also appear lighter or feel soft or boggy.
- Also look for water droplets on the skin. Is the skin clammy?
- Determine whether these changes localized or generalized.

Skin Turgor

- To assess skin turgor, take your fingers and "pinch" the skin near the clavicle or the forearm so that the skin lifts up from the underlying structure. Then let the skin go.
- If the skin quickly returns to place, this is a normal skin turgor finding.

- If the skin does not return to place, but stays up, this is called "tenting," and is an abnormal skin turgor finding.
- Poor skin turgor is sometimes found in persons who are older, dehydrated, or edematous, or have connective tissue disease.

Skin Integrity

- Look to see if the skin is intact without any cracks or openings.
- Determine whether the skin is thick or thin.
- Identify signs of PUritis, such as excoriations from scratching.
- Determine whether any lesions are raised or flat.
- Identify whether the skin is bruised.
- Note any disruptions in the skin.
- If a skin disruption is found, the type of skin injury will need to be identified. Since there are many different etiologies of skin wounds and ulcers, differential diagnosis of the skin problem will need to be determined. For example is it a skin tear, a pressure ulcer, or moisture-associated skin damage or injury?
- **Use Digital Imaging Platform using Tissue Analytics (NEW)**

*AHRQ (2019). AHRQ Toolkit. Retrieved from https://www.ahrq.gov/professionals/systems/hospital/pressureulcertoolkit/putool7a.html#Tool2H

Appendix B: Braden Scale

BRADEN SCALE FOR PREDICTING PRESSURE SORE RISK

Patient's Name _____ Evaluator's Name _____ Date of Assessment

SENSORY PERCEPTION ability to respond meaningfully to pressure-related discomfort	**1. Completely Limited** Unresponsive (does not moan, flinch, or grasp) to painful stimuli, due to diminished level of consciousness or sedation. OR limited ability to feel pain over most of body	**2. Very Limited** Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness OR has a sensory impairment which limits the ability to feel pain or discomfort over ½ of body.	**3. Slightly Limited** Responds to verbal commands, but cannot always communicate discomfort or the need to be turned. OR has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.	**4. No Impairment** Responds to verbal commands. Has no sensory deficit which would limit ability to feel or voice pain or discomfort..				
MOISTURE degree to which skin is exposed to moisture	**1. Constantly Moist** Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is moved or turned.	**2. Very Moist** Skin is often, but not always moist. Linen must be changed at least once a shift.	**3. Occasionally Moist:** Skin is occasionally moist, requiring an extra linen change approximately once a day.	**4. Rarely Moist** Skin is usually dry, linen only requires changing at routine intervals.				
ACTIVITY degree of physical activity	**1. Bedfast** Confined to bed.	**2. Chairfast** Ability to walk severely limited or non-existent. Cannot bear own weight and/or must be assisted into chair or wheelchair.	**3. Walks Occasionally** Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair	**4. Walks Frequently** Walks outside room at least twice a day and inside room at least once every two hours during waking hours				
MOBILITY ability to change and control body position	**1. Completely Immobile** Does not make even slight changes in body or extremity position without assistance	**2. Very Limited** Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.	**3. Slightly Limited** Makes frequent though slight changes in body or extremity position independently.	**4. No Limitation** Makes major and frequent changes in position without assistance.				
NUTRITION usual food intake pattern	**1. Very Poor** Never eats a complete meal. Rarely eats more than ⅓ of any food offered. Eats 2 servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement OR is NPO and/or maintained on clear liquids or IV's for more than 5 days.	**2. Probably Inadequate** Rarely eats a complete meal and generally eats only about ½ of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement. OR receives less than optimum amount of liquid diet or tube feeding	**3. Adequate** Eats over half of most meals. Eats a total of 4 servings of protein (meat, dairy products per day. Occasionally will refuse a meal, but will usually take a supplement when offered OR is on a tube feeding or TPN regimen which probably meets most of nutritional needs	**4. Excellent** Eats most of every meal. Never refuses a meal. Usually eats a total of 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation.				
FRICTION & SHEAR	**1. Problem** Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures or agitation leads to almost constant friction	**2. Potential Problem** Moves feebly or requires minimum assistance. During a move skin probably slides to some extent against sheets, chair, restraints or other devices. Maintains relatively good position in chair or bed most of the time but occasionally slides down.	**3. No Apparent Problem** Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.					
				Total Score				

Appendix C: Updated Pressure Injury* Stages
*Formerly Pressure Ulcers

Guidelines for Staging of Pressure Injuries*

*National Pressure Ulcer Advisory Panel (NPUAP) – Accessed April 2016.

Stage 1 | Stage 1 with Edema | Stage 2 | Stage 3 | Stage 3 with Epibole | Stage 4 | DTI | Unstageable with Dark Eschar | Unstageable with Slough & Eschar

PRESSURE INJURY
A pressure injury is localized damage to the skin and/or underlying soft tissue usually over a bony prominence or related to a medical or other device. The injury can present as intact skin or an open injury and may be painful. The injury occurs as a result of intense and/or prolonged pressure or pressure in combination with shear. The tolerance of soft tissue for pressure and shear may also be affected by microclimate, nutrition, perfusion, co-morbidities and condition of the soft tissue.

STAGE 1
Intact skin with a localized area of non-blanchable erythema, which may appear differently in darkly pigmented skin. Presence of blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes. Color changes do not include purple or maroon discoloration; these may indicate deep tissue pressure injury.

STAGE 2
Partial-thickness loss of skin with exposed dermis. The wound bed is viable, pink or red, moist, and may also present as an intact or ruptured serum-filled blister. Adipose (fat) is not visible and deeper tissues are not visible. Granulation tissue, slough and eschar are not present.

STAGE 3
Full-thickness loss of skin, in which adipose (fat) is visible in the injury and granulation tissue and epibole (rolled wound edges) are often present. Slough and/or eschar may be visible. The depth of tissue damage varies by anatomical location; areas of significant adiposity can develop deep wounds.

STAGE 4
Full-thickness skin and tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage or bone in the injury. Slough and/or eschar may be visible. Epibole (rolled edges), undermining and/or tunneling often occur. Depth varies by anatomical location.

DEEP TISSUE INJURY
Intact or non-intact skin with localized area of persistent non-blanchable deep red, maroon, purple discoloration or epidermal separation revealing a dark wound bed or blood filled blister. Pain and temperature change often precede skin color changes. Discoloration may appear differently in darkly pigmented skin. This injury results from intense and/or prolonged pressure and shear forces at the bone-muscle interface. The wound may evolve rapidly to reveal the actual extent of tissue injury, or may resolve without tissue loss.

UNSTAGEABLE
Full-thickness skin and tissue loss in which the extent of tissue damage within the injury cannot be confirmed because it is obscured by slough or eschar.

MEDICAL DEVICE RELATED PRESSURE INJURY
This describes an etiology. Medical device related pressure injuries result from the use of devices designed and applied for diagnostic or therapeutic purposes. The resultant pressure injury generally conforms to the pattern or shape of the device. The injury should be staged using the staging system.

MUCOSAL MEMBRANE PRESSURE INJURY
Mucosal membrane pressure injury is found on mucous membranes with a history of a medical device in use at the location of the injury. Due to the anatomy of the tissue these injuries cannot be staged.

WOUND ASSESSMENT CHECKLIST
- Location
- Size
- Dressing Used
- Drainage (Amount/Color/Odor)
- Undermining/Tunneling
- Stage
- Pressure Redistribution
- Nutritional Assessment
- Viable Tissue in Wound

Images used with permission from http://www.npuap.org/resources/educational-and-clinical-resources/pressure-injury-staging-illustrations/

*Retrieved online from Hill-ROM clinical resource center https://library.hill-rom.com/Global/Supporting-Evidence/US%20-%20EN/Pressure%20Ulcer%20Management/CTG090rcr11-Wound%20Staging%20BradenCard-LR.pdf

Appendix D: Evidence Table

Authors	Journal Name/WGU Library	Year of Publication	Research Design	Sample Size	Outcome Variable Measured	Leve (I-III)	Quality (A, B, C)	Results/Author's Conclusions
Anghel, E., Kumar, A., Bigham, T., Maselli, K., Steinberg, J., Evans, K., Kim, P., & Attinger, C. (2019).	Wounds	2016	Quasi-experimental	45	Accuracy of wound measurement of smartphone 3DWM	II	B	3Dwound measuring device more accurate than manual ruler measurement in assessing wound area
Budman J, Keenahan K, Acharya S, Brat G. (2015).	iProc	2015	Quasi-experimental	81	Accuracy of wound measurement of a smartphone 3D system	II	B	3D measuring device more accurate in measuring than ruler measurement
Coleman, S., Gorecki, C., Nelson, E., Closs, S., Defloor, T., Halfens, Ruud…&Nixon, J. (2013)	International Journal of Nursing Studies	2013	Systemic review	34,449	Risk Factors of HAPUs	III	B	Identified that there is no single risk factor for PU development in adults but a complex interplay of factors, with the top 3 being mobility/activity, perfusion and skin/pressure ulcer status
Englebright, M., Westcott, B., Mcmanus, B., Kleja, B., Helm, B.,	Journal of patient safety	2018	Quasi-Experimental	149 facilities	Rates of reduction of Pressure Ulcers (PUs)	II	B	The implemented Reducing HA PUs program resulted in reduction of HAPUs across the system

Korwek, B., & Perlin, B. (2018).								
Han, S., Kim, Y., Hwang, J., Lee, J., & Song, M. (2018)	Journal of Clinical Nursing	2017	Descriptive Study	34,287	Predictors of PUs in older patients	III	B	Older patients with altered consciousness are at increased risk of PUs and PU specific interventions should be provided to them regularly beginning with admission
Hansen, R. & Fossum, M. (2016)	Nursing Open	2016	Cross-sectional descriptive design	155	Documentation of PUs stages, prevention methods	III	B	There was a discrepancy in documentation of PUs on physical exam and progress notes. Missing documentation on stages and preventative measures.
Han, Y., Jin,Y., Taixian, J., Lee, S., Lee, J. (2019)	Journal Wound Ostomy Continence nurs	2019	Case-Control Study	1000	Mortality Rate, Hospital LOS, Hospital Cost, readmissions	III	B	There is an increased rate of mortality, LOS, Hospital costs, readmissions in pts with PUs.
Lam, C., Elkbuli, A., Benson, B., Young, E., Morejon, O., Boneva, D., … Mckenney, M. (2018).	American College of Surgeons	2018	Quantitative nonexperimental study	9,755	Rate of reduction of HAPUs	III	B	There was a significant rate of decrease in HAPU incidence after process changes were implemented.

Li, D. (2016)	Journal of Clinical Nursing	2016	Retrospective comparative descriptive design	196	Documentation of PUs, descriptive factors, treatment, plan	III	B	There was no relationship between documentation quality and presence of PU; but documentation on PU lacked important information on staging, location, descriptive factors, treatment
Mallah, Z., Nassar, N., & Kurdahi Badr, L. (2015).	Applied Nursing Research	2015	Descriptive Design	468	Rate of prevalence of HAPUs	III	B	Study showed that a multidisciplinary approach effectively decreased rate of HAPUs
Manzano, F., Pérez-Pérez, A., Martínez-Ruiz, S., Garrido-Colmenero, C., Roldan, D., Jiménez-Quintana, M., … Colmenero, M. (2014)	Journal of Evaluation in Clinical Practice	2014	Observational study	563	Hospital mortality	III	B	PU development increases the mortality in patients who require MV for 24 hours or longer
Padula, V., Gibbons, D., Valuck, J., Makic, B., Mishra, K., Pronovost, J., & Meltzer, O. (2016).	Wolters Kluwer health, Inc.	2016	Retrospective-observational study	55	Rate of HAPUs	III	B	HAPU rates were significantly lower after CMS reimbursement changes took effect. The CMS changes influenced adoption of EBPs for HAPU prevention that led to the reductions.

Wang, S., Anderson, J., Evans, R., Woo, K., Breland, B., Sasseville, D., Moreau, L. (2017).	PLos	2017	Quasi-Experimental	87	Accurate measurement of PUs	II	B	Study showed that using a wound measuring app resulted in higher accuracy than using ruler.

Appendix E: AHRQ Staff Attitudes Survey

Your role: _____ Date: _____

	Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
1. All patients are at potential risk of developing pressure ulcers					
2. Pressure ulcer prevention is time consuming for me to carry out					
3. In my opinion, patients tend not to get as many pressure ulcers nowadays					
4. I do not need to concern myself with pressure ulcer prevention in my practice					
5. Pressure ulcer treatment is a greater priority than pressure ulcer prevention					
6. Continuous assessment of patients will give an accurate account of their pressure ulcer risk					
7. Most pressure ulcers can be avoided					
8. I am less interested in pressure ulcer prevention than other aspects of care					
9. My clinical judgment is better than any pressure ulcer risk assessment tool available to me					
10. In comparison with other areas of care, pressure ulcer prevention is a low priority for me					
11. Pressure ulcer risk assessment should be regularly carried out on all patients during their stay in hospital					

AHRQ (2019). AHRQ Toolkit. Retrieved from https://www.ahrq.gov/professionals/systems/hospital/pressureulcertoolkit/putool7a.html#Tool2H

Reference: Moore Z, Price P. Nurses' attitudes, behaviors, and perceived barriers towards pressure ulcer prevention. *J Clin Nurs* 2004;13:942-52.

Appendix F: Hospital Consent Form

GENERAL POLICY: All patients shall be treated, admitted and assigned accommodation without distinction to race, religion, color, national origin, sexual orientation, age or handicapping condition.

CONSENT TO TREATMENT. I have come to The [redacted] Hospital for medical treatment. I ask the health care professionals at the Hospital to provide care and treatment for me that they feel is necessary. The undersigned consents to the procedures, which may be performed during this hospitalization, or on an outpatient basis including emergency treatment or services. I consent to undergo routine tests and treatment as part of this care. These may include but are not limited to laboratory, radiology, medical or surgical tests, treatments, anesthesia or procedures as directed under the general and special instruction of the physician or surgeon. I understand that I am free to ask a member of my health care team questions about any care, treatment or medicine I am to receive. Because The [redacted] Hospital is a teaching hospital, I understand that my health care team will be made up of hospital personnel (to include nurses, technicians, and ancillary staff) under the direction of my attending physician and his/her assistants and designees (to include interns, residents, fellows and medical students). I am aware that the practice of medicine is not an exact science and admit that no one has given me any promises or guarantees about the result of any care or treatment I am to receive or examinations I am to undergo.

PHYSICIANS NOT AS EMPLOYEES: I understand that each physician is an independent contractor who is self employed and is not the agent, servant or employee of the hospital. I understand that I may receive separate billing from each of these providers for services rendered.

_____ Initials

RELEASE OF INFORMATION: The [redacted] Hospital is authorized to release any information necessary, including copies of my hospital and medical records, to process payment claims for health care services which have been provided, and to duly authorized local and federal regulatory agencies and accrediting bodies as required or permitted by law. [redacted] Hospital is further authorized to release demographic information to organizations performing patient satisfaction surveys. Such records may include information of a psychological or psychiatric nature, pertaining to my mental condition or treatment for conditions relating to the use of alcohol or drugs. In addition, I authorize my insurance carrier, employer or person otherwise responsible for payment to provide The [redacted] Hospital information necessary to determine benefits or process a claim. This release will be valid for the period of time to process the claim or until consent is revoked by myself. I release and forever discharge The [redacted] Hospital, its employees and agents, and my attending physician from any liability resulting from the release of my medical records or information from them for payment purposes. I understand that my name will be displayed in the signage system outside my hospital room.

PERSONAL VALUABLES: THE [redacted] HOSPITAL WILL NOT BE RESPONSIBLE FOR LOSS OR DAMAGE TO CLOTHES, PERSONAL PROPERTY OR VALUABLES.

NON-SMOKING POLICY: In accordance with regulatory agency standards, the Hospital is a non-smoking facility.

FINANCIAL AGREEMENT/ASSIGNMENT OF BENEFITS: I assign any and all insurance benefits payable to me to The [redacted] Hospital. I understand that I am responsible for payment for services rendered at the Hospital including excluded services from my insurance either because the plan deems such services not medically necessary, or for any other reason including pre-certification requirements, second opinions or preexisting conditions. Should the account be referred to any attorney or collection agency for collection, I understand that I will be responsible for attomey or collection expenses. I give permission to my insurance provider(s), including Medicare and Medicaid, to directly pay The [redacted] Hospital for my care instead of paying me. I understand that I am responsible for any health insurance deductibles and co-insurance and non-covered services.

I certify that the information I have provided is true and accurate to the best of my knowledge. I understand that the information that I submit is subject to verification, including credit agency scoring, and subject to review by federal and/or state agencies and other as required, I authorize my employer to release to [redacted] Hospital proof of my income. I understand that if any information I have given proves to be untrue, The George Washington University Hospital will re-evaluate my financial status and take whatever action becomes appropriate. I acknowledge by my signature that I have read and received a copy of this statement. I understand that by signing it, I am agreeing to it.

TO BE SIGNED AT THE HOSPITAL

Unable to sign

x _____) Serious Condition

of patEnt or responsiNe party) _____

Date Witness Hospital RepresentativeDate

Section 1:	
Did you bring an Advance Dlrectlve (Living Will/Heaith Care Power of Attorney) form with you? Yes (If YES, place a copy in the front of the patients chart / If NO, go to Section 2)	By my signature below, I consent to laboratory studies (HIV, HBV, HCV) in the event a health care worker is exposed to my blood or body fluids. I consent to the appropriate disposal of any tissue or part removed from my body and to the taking of photographs
Section 2:	

1. I was given Information on formulating an Advance Directive (including how to obtain assistance with completing the Advance Directive form). _____ Initials OR 2. I do not have an Advance Directive and do not wish to formulate one. Initials	during the procedure/operation/treatment for research, teaching, or scientific purposes as long as my identity is not disclosed. Signature _____ Date _____
THE [redacted] HOSPITAL PATIENT AUTHORIZATION FORM C04000 80-010 (05/13)	Patient Label

Appendix G: Descriptive Statistics of Study Participants

	Pre-Digital Imaging N=23	**Post-Digital Imaging N=32**	**Statistics**
Demographics	N(%)	N(%)	
Age			
18-30	0	1 (3.1)	
31-45	1 (4.3)	6 (18.8)	
46-60	7 (30.4)	6 (18.8)	
61-75	11 (47.8)	12 (37.5)	
76-90	4 (17.4)	6 (18.8)	
>91	0	1 (3.1)	
Gender			
Male	19 (82.6)	16 (50.0)	
Female	4 (17.4)	16 (50.0)	
Race/Ethnicity			
Hispanic	0	0	
White, not Hispanic	5 (21.7)	5 (15.6)	
Black, not Hispanic	12 (52.2)	19 (59.4)	
Other, not Hispanic	4 (17.3)	4 (12.5)	
Not reported or unknown	2 (8.7)	4 (12.5)	
Clinical Condition (any skin assessment on admission)			
POA diagnosis on admission (POA)			
Stage 1 ulcers	1 (4.8)	0	$\chi^2(6) = 16.395$, $p = 0.003$
Stage 2 ulcers	1 (4.8)	0	
Stage 3 ulcers	1 (4.8)	6 (66.7)	
Stage 4 ulcers	1 (4.8)	0	
Deep tissue injuries	5 (23.8)	0	
Unstageable ulcers	6 (28.6)	0	
No stage (Non-pressure ulcers POA)	6 (28.6)	3 (33.3)	
Total	21 (70.0)	9 (30.0)	
Braden Score			
Very high (9 or less)	1 (7.1)	0	
High (10-12)	1 (7.1)	2 (7.4)	
Moderate (13-14)	1 (7.1)	9 (33.3)	
Mild (15-18)	7 (50.0)	14 (51.9)	
No risk (19-23)	4 (28.6)	2 (7.4)	

Documentation of admission assessment			
Yes	100%	100%	
No			
HAPUs			
Stage 1 ulcers	0	2 (4.4)	$\chi^2(5) = 9.823$, $p = 0.059$
Stage 2 ulcers	8 (29.6)	11 (24.4)	
Stage 3 ulcers	1 (3.7)	1 (2.2)	
Stage 4 ulcers	0	0	
Deep tissue injuries	9 (33.3)	26 (57.8)	
Unstageable ulcers	7 (25.9)	2 (4.4)	
Other (Medical device related mucosal pressure injury)	2 (7.4)	3 (6.7)	
Total	27 (37.5)	45 (62.5)	

Appendix H: Variable Definition Table

Variables	**Type of Variable**	**Theoretical Definition**	**Operational Definition**	**Level of measurement (such as nominal, ordinal, interval or ratio**
POA (Present on Admission)	Dependent	Abbreviation for pressure ulcers that are already present on admission to the hospital.	1= POA Stage 1 ulcers 2= POA Stage 2 ulcers 3= POA Stage 3 ulcers 4= POA Stage 4 ulcers 5=POA Deep tissue injuries 6=POA Unstageable ulcers	Nominal
HAPUs (Hospital Acquired Pressure Ulcer)	Dependent	Abbreviation for hospital acquired pressure ulcers or ulcers that occur during hospital admission.	1= HA Stage 1 ulcers 2= HA Stage 2 ulcers 3= HA Stage 3 ulcers 4= HA Stage 4 ulcers 5=HA Deep tissue injuries 6=HA Unstageable ulcers	Nominal
Stage I ulcer	Independent	-Intact skin with non-blanchable redness of a localized area usually over a bony prominence.	1=Stage I present 2=No stage I 1=Skin turgor	Nominal
Stage 2 ulcer	Independent	-Partial thickness - Loss of dermis with a shallow open ulcer, red pink wound bed, without slough. -or intact or open/ruptured serum-filled blister.	1=Stage 2 present 2=No stage 2	Nominal

Stage 3 ulcer	Independent	-Full thickness tissue loss. -Subcutaneous fat may be visible; -No bone, tendon or muscle is exposed. -Slough may be present but does not obscure the depth or tissue loss. -May include undermining and tunneling.	1=Stage 3 present 2=No stage 3 present	Nominal
Stage 4 ulcer	Independent	-Full thickness tissue loss -Bone, tendon or muscle is EXPOSED. -Slough or eschar may be present on some parts of the wound bed. -Often include undermining and tunneling.	1=Stage 4 present 2=Stage 4 not present	Nominal
Deep Tissue Injury	Independent	-Purple/maroon localized area of discolored intact skin. -Blood filled blister due to damage of underlying soft tissue from pressure and/or shear. -Surrounding tissue may be painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue. -may be difficult to detect in people with darkly pigmented skin.	1=Deep Tissue Injury present 2=Deep tissue injury not present	Nominal
Unstageable ulcer	Independent	-Full thickness tissue loss in which the wound bed is covered by slough (yellow, tan, gray, green or brown) and /or eschar (tan, brown or black) and	1=Unstageable wound present 2=Unstageable not present	Nominal

		depth and measurements cannot be done. -therefore stage of the wound cannot be determined.		
Tissue Analytics/Digital Imaging	Independent	Software designed to work with wound photography IPODs and integrate wound information and measurements into Cerner	New software integrated with Cerner	Nominal
If ulcer present, what stage is it per Digital Imaging analyzation?	Dependent	Staging of PU per Digital Imaging software	1=Stage 1 2=Stage 2 3=Stage 3 4=Stage 4 5=Deep Tissue Injury 6=Unstageable	
Braden Scale	Independent	A tool that helps assess a patient's risk for developing a pressure ulcer	1=very high risk (score of 9 or less). 2=High risk (Total score of 10-12). 3=Moderate risk (Total score of 13-14) 4=Mild risk (Total score of 15-18) 5=No risk (Total score of 19-23)	
AHRQ Pressure Ulcer tool	Independent Dependent	Toolkit designed to assist staff in implementing effective pressure ulcer prevention practices.		
Variables from Patient Demographics from Admission documents				

Age	Independent	Chronic age in years of the patients	As recorded in Medical Records 1=18-30 2=31-45 3=46-60 4=61 -75 5=76-90 6= >91	
Gender		Patient's biological sex	0=male 1=female	
Race/Ethnicity	Independent/ Demographic	Reported self-identification with the person or population group having shared genetic or biological traits	1=Hispanic 2=White, not Hispanic 3=Black, not Hispanic 4=Other, not Hispanic 5=Not reported	
Diagnosis		Stage of pressure ulcer patient has documented during admission	1= Stage 1 ulcers 2= Stage 2 ulcers 3= Stage 3 ulcers 4= Stage 4 ulcers 5=Deep tissue injuries 6=Unstageable ulcers 7=No ulcer present	

Appendix I: Data Collection Table

Admission Date (month/day/year)	Name	Pt ID	Age cohort 1=18-30.9;2=31-45.9;3=46-60.9;4=61 and more	Gender 1=Male;2=Female	Ethnicity 1=Hispanic; 2=white(non Hisp); 3=black (non-Hisp); 4=other; 5=Not reported	PU Admission assessment completed? 1=Yes;2=No	Date of PU Admission Assessment	Wound Photography completed/document 1=Yes: 2=No	Any POAs present 1=yes; 2=NO	PU Location	Stage of POA PU	Any HAPUs*? 1=Yes; 2=No	A-Day HAPU	HAPU Location	HAPU stage	Notes	Discharge Date	Final Stage

Appendix J: Data Codes

Patient ID code	
Admission Date	
Discharge Date	
Medical Record Number	
Age	Age cohort 1=18-30 2=31-45 3=46-60 4=61 -75 5=76-90 6= >91
Gender	1=Male 2=Female
Ethnicity	1=Hispanic 2=White, not Hispanic 3=Black, not Hispanic 4=Other, not Hispanic 5=Not reported
Admission Assessment completed	1=Yes 2=No
Date of PU Admission Assessment	(Month/Day/Year)
Pressure Ulcer Present on Admission (POA)	1=Yes 2=No
If skin abnormality present on Admission (POA), what stage is it?	1=Stage 1 2=Stage 2 3=Stage 3 4=Stage 4 5=Deep Tissue Injury (DTI) 6=Unstageable 7=No stage *for non PU skin abnormalities
Braden Scale completed?	1=Yes 2=No

Braden Score	1=Very high risk: total score 9 or less 2=High risk: total score 10-12 3=Moderate risk: total score 13-14 4= Mild risk: total score 15-18 5=No risk: total score 18-23
Wound Photography completed/documented?	1=Yes 2=No
Preventative Measures documented in chart?	1=Yes 2=No
Hospital Acquired Ulcer (HAPU)	1=Yes 2=No
If HAPU present, what stage?	1=Stage 1 2=Stage 2 3=Stage 3 4=Stage 4 5=Deep Tissue Injury (DTI) 6=Unstageable 7=Medical Device Related (MDR)
Admission Day(s) that HAPU occurred	1= Days 1-3 2=Days 4-6 3=Days 7-10 4= Days 11-15 5=>15 days

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

Research documents

Dear Dr. Echevarria and Ms. Donaldson,

Regarding the determination request for the proposal entitled, "Implementing a Skin Analytic Protocol in a Level I Trauma Center Hospital to decrease rates of Hospital Acquired Pressure Ulcers (HAPUs)," a determination has been made that your project does not meet the definition of research. That is, a systematic investigation intended to contribute to generalizable knowledge.

This determination is being made after review of the project documents. The project nature as quality improvement intends to inform internal practice. The project does not aim to inform new theories or external standards of practice. Therefore, further review by the GW Nursing Office of Research or the GW Institutional Review Board is not required (per GW IRB Policy HRP-010, Human Research Protection Program).

Should your project change in any way that it would meet the definition of research, please contact the GW Nursing Office of Research at sonresearch@gwu.edu so we may assist you in proceeding. As a reminder, you are to conduct all projects in an ethical manner regardless of review requirements.

Please do not hesitate to contact me with any questions or concerns regarding this determination.

Kind regards,

Angela M. McNelis, PhD, RN, FAAN, ANEF, CNE

Professor and Associate Dean for Scholarship, Innovation, and Clinical Science

Governor-At-Large, National League for Nursing

George Washington University School of Nursing

Member, GW Institutional Review Board