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Improving Nurses Wound Care Knowledge Utilizing an App

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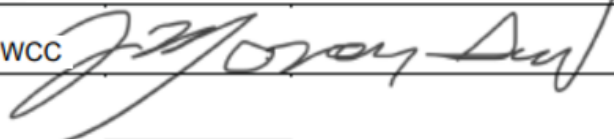
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Abstract

Practice Problem: Nurses needed additional wound care support, but formal training was not in the budget at this time. Nurses needed a quick reference guide to help them assess, documenting, and treat wounds correctly until the hospital could provide adequate training.

PICOT: The PICOT question that guided this project is; “When treating wound care patients within a hospital setting (P), how does the implementation of a wound software app. (I) as compared to pre-existing nursing knowledge (C) increase a nurse’s self-reported ability to accurately assess and treat wounds (O) during a 10-week period? (T)”

Evidence: Based on a thorough and rigorous review of the synthesized recommendations currently available, a wound software app has the capability of helping the nurses in the hospital who self-identified as having limited wound knowledge. The strength of the body of evidence is extensive, as evidenced by the quality, quantity, and consistency of the studies.

Intervention: The intervention used an educational software phone application (app) to assist nurses in referencing information pertaining to wounds. The nurses self-reported their confidence level via a baseline survey and then this data will be compared to a post survey that analyzed their confidence level after utilizing the wound software app. during a 10-week period pre and post-intervention.

Outcome: All participants (100%) indicated that they (a) felt comfortable using a wound app on phones or tablets, (b) would like to learn and participate in a training on a wound phone or tablet app, and (c) were interested in using a wound phone or tablet app for wound assessment, documentation, and treatment options. The two-tailed Wilcoxon signed rank test showed significant results based on an alpha value of .05, $V = 0.00$, $z = -2.23$, $p = .026$.

Conclusion: In an organization where staff nurses are having difficulty merely understanding the basics of wounds, being able to have a reference guide can prove to be beneficial. Hospital administrators may save on wound related costs

Improving Nurses Wound Care Knowledge Utilizing an App

Annual Medicare spending on wound care alone in the United States is estimated to range from \$28.1 to \$96.8 billion (Moore et al., 2019). Although certain types of wounds cost more due to prevalence, such as surgically infected wounds and diabetic foot ulcers, data also concludes that the site of care also plays a big role. One may presume assisted living facilities are incurring higher wound care-related costs, but data trends are actually just as significant in hospital settings (Sen, 2019). Medicare outpatient hospital expenditures are roughly estimated to cost between \$10–\$36 billion and that is followed by inpatient hospitals with costs ranging from \$5 –\$24 billion (Moore et al., 2019). These costs are not just specific to developing countries such as the United States. Current projections estimate that by 2025 there will be 400 million diabetics, mainly in Asia, Africa, and South America (Gupta et al., 2021). With immigration on the rise, this is quickly becoming a global issue. As wound care related expenditures continue to grow worldwide, research continues to verify that registered nurses and other healthcare professionals working with wounds have limited competence in this area (Kielo-Viljamaa et al., 2022; Delaplain & Joe, 2018). The inability to correctly assess, document, and recognize treatment plans tailored for specific wounds is a costly mistake for hospitals and patients.

Further complicating the care of wounds is the fact that there is no consensus or standardization of wound care management in the United States. Variation in care and outcomes are due in part by wound procedures and care being limited to certain disciplines as well as differing practices by states and countries (Association for Advancement of Wound Care, 2022). This poses a problem for all practitioners and organizations aiming to provide the best care. Cost is often a driving factor, when considering technological purchases, mobile applications (apps) have become a more affordable solution (Sirazitdinova & Deserno, 2017). The use of wound care apps can assist nursing staff by familiarizing them with categorizing wounds, defining and using the appropriate wound care terminology, documenting, and

choosing the correct treatment options (Howell et al., 2021). For those seasoned wound care professionals, wound software apps can be used to corroborate their clinical findings. If a nurse identifies, manages, and documents wounds appropriately, the patient will more likely receive the correct care and treatment and in turn have better outcomes. Most wound assessment software is superior to that of traditional wound assessment (Chen & Lo, 2022).

Significance of the Practice Problem

The organization supported the idea that the project was in a hospital located in a predominately low-income minority community. In 2021, one of the largest private, physician-owned, tax-paying operators in the nation purchased the hospital. As with any acquisition, many changes were made and are forthcoming. One of the most notable changes occurred on October 2022 when the hospital replaced its electronic health records (EHR) to Meditech. Meditech is an EHR software company that uses innovative technology in small tablets instead of what the hospital was traditionally using which required bulky computer carts and some hand written medical records. The initiative to streamline work by utilizing evidence-based technology in an effort to improve workflow and patient outcomes was a clear indication that the hospital's leadership stakeholders and board members were interested in using an app in the workplace. The EHR has a surveillance function for specific conditions and can be tailored to meet specific needs. One of the functions tailored to the healthcare providers needs is a patient alert for worsening wounds. Nurses are prompted via hospital policy to refer patients that are flagged as having a wound that is progressing and/ or is not improving with current treatment to a wound care specialist after three consecutive alerts which may occur in a day or a week.

The hospital has incurred high expenditures related to wound care complications, which in turn has led to over utilization of wound care specialists. During a planning meeting, the leadership team that included charge nurses from various nursing units, stakeholders in the community, and wound care specialists, wound referrals were one of the topics on the

forefront. There were roughly 25 referrals in September 2022, 23 referrals in August 2022, and 22 referrals in July 2022. With the new wound flagging system about to go live in January 2023 hospital-wide, the concern was the number of referrals that were going to be requested because of improper wound care documentation. The surgical supplies administrator that attended the meeting collects information on wound referrals on her own accord and reports to the leadership team bi-monthly. The leadership team debated the reasons why wound referrals were increasing and looked for suggestions on ways to decrease the number of referrals. The leadership team reconvened in January 2023 to discuss findings and possible solutions.

Following the initiative, a needs assessment was conducted November 11, 2022 to determine the direction of the EBP project. Five wound care specialists and five floor nurses participated in this discussion to determine the top five reasons they believed the referral rates were increasing. Although a few reasons were mentioned, there was one factor that was repeatedly mentioned. It is no surprise that during the meeting, there were several times that staff mentioned they felt there was inadequate nurse training on wound-specific care both during nursing school and then upon hospital orientation. Most identified that the need was lack of wound knowledge in general.

A recent focused study group concluded that undergraduate and postgraduate nursing education needs to include and focus on wound care as many nurses receive little to no formal training (Keilo-Villamae et al, 2022). It was clear that nurses needed additional wound care support, but formal training was not in the budget at this time. Nurses needed a quick reference guide to help them assess, document, and treat wounds correctly until the hospital could provide adequate training.

PICOT Question

The PICOT question became a simple one to determine based on the clinicians needs; "When treating wound care patients within a hospital setting (P), how does the implementation

of a wound software app. (I) as compared to pre-existing nursing knowledge (C) increase a nurse's self-reported ability to accurately assess and treat wounds (O) during a 10-week period? (T)" The participants in this project included any interested nurse within the healthcare organization interested in participating who cares for at least one patient who has a wound. Participants were recruited from the ICU, CCU, labor and delivery, or a surgical unit with a requirement of having at least one patient assigned and requiring care for a new or chronic wound.

Evidence -Based Practice Framework & Change Theory

The evidence-based practice framework that guided the project was the revised Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) Model. The JHNEBP has three components: inquiry, practice, and learning (Dang & Dearholt, 2018). The inquiry portion of this project is found in the PICOT question as well throughout the research conducted. Through completion of the project, the PICOT question outcomes were determined through data comparison. The practice component was determined by translating wound comfort and skill level through a self-reported survey both pre and post implementation. The learning component in the JHNEBP was conducted through a variety of ways such as locating the research literature that was conducted on wound care best practices, wound care apps, and eventually nurses training. As previously mentioned, with no established wound care standards in the U.S., this project relied heavily on the most current research studies and literature reviews. Many of the studies are endorsed by accrediting bodies and organizations in the field of wound care. The American Academy of Wound Management (AAWM), The American College of Certified Wound Specialists (ACCWS), National Alliance of Wound Care (NAWC), and National Alliance of Wound Care (NAWC) will also be used as resources.

The change theory that guided the project was the Diffusion of Innovation theory developed by E.M. Rogers. The Innovation Diffusion Theory includes five-steps an individual undergoes when understanding, adopting, or rejecting a new innovative idea (Wagner, 2018).

This theory was a guide for the PM by assessing the clinical nursing staff's readiness to adopt the new technology. According to Rogers, the first step is knowledge. The knowledge portion in this project involved exposing those that would be using the new technology to the information. Knowledge also included in this situation in terms of any prior knowledge a nurse has on wound care practices, and educating those who did not have the knowledge.

Persuasion was the second step. Nurses expressed interest in learning more about technology through the baseline survey that were distributed on each of the nursing units. They were invited to attend an informal informational meeting. The nurses who attended the meeting were reassured of a major concern that was permeating the hospital staff currently, which is a fear that participation equated to incurring additional work. Interested participants were shown a demonstration of the app and the ease of use. The app did not require additional paperwork, uploading, or time. It was presented as nurses having an encyclopedia of wound information readily available, should they need it. Those nurses who continued to show interest were encouraged to take the third step, which was making the actual decision to commit to participate in the project.

After narrowing the participants down to those individuals interested in the project, the implementation phase began. During this fourth step, when the project intervention was implemented, the users of the wound care app decided whether this project was applicable to their unit, and determined its effectiveness. In the fifth and final stage, confirmation, the clinicians decided if they would continue using the new technology further than that of the 10-week project length, which took place in a follow up meeting on May 13, 2023. It was during this meeting that approximately 6 of the 8 nurses expressed interest in using the app beyond the project.

Evidence Search Strategy

The three databases used for this project were the University of St. Augustine, PubMed, and Google Scholar. These search engines applied, located, and reviewed

supporting literature that supported the project's PICOT question that will lead to a practice change. The digital search was completed by combining and/or utilizing individual keywords such as wounds, artificial intelligence (AI), documentation, technology, application (app), and software. The searches were limited to peer-reviewed articles published in English from 2018 through 2022. The search was further limited by applying the phrase "wound documentation" and "healthcare" since these were the specific concepts reviewed in this project. Articles that discussed orthopedic or robotic technology were excluded, as only wounds and wound apps or technology software were specific to this project. Any duplicate reports that may were duplicated were removed from the final list of articles. Using the Johns Hopkins Nursing Evidence-Based Practice (EBP) evidence level and quality guide, the studies were evaluated and selected based on the articles that best fit the criteria (Dang & Dearholt, 2018). Through evaluation, the results in the studies and reviews ranged from a level of evidence of I, II, or III and quality grades of A, B, or C (Appendices A and B). The final selections will be presented to the organizational stakeholders, staff, and leadership to provide evidence-based studies that support the project. A more complete discussion of the selection process is detailed below.

Evidence Search Results

The library of the Health Sciences at St. Augustine, Florida, was used to search the literature on the subject of wound care technology. Searches were conducted in three databases using the following keywords: "wounds," artificial intelligence (AI), documentation, and assessment (Figure 1). The initial search resulted in 1,319 options. The search was then narrowed down by the 2018-2022 date range, resulting in 607 articles. The search was further refined by setting the parameters of peer-reviewed and full texts, which then resulted in 77 articles. To finalize the search, only articles with subjects that included artificial intelligence, pressure ulcers, wounds and injuries, documentation, wound care, wound healing, mobile applications, physical examination methods, care and treatment, telehealth, telemedicine,

wound assessment, and clinical decision-making parameters were set. This narrowed the search down to the final count of 24 academic journal articles.

A search in PubMed utilizing the keywords wounds and artificial intelligence resulted in 3,669 options. The search was then narrowed down by date ranges between 2018-2022, which resulted in 1,918 articles. It was then further narrowed by peer-reviewed and full articles, which resulted in 1,058. Articles were then reviewed by abstracts that excluded the words: surgery, fractures, sports injuries, injuries, carcinoma, cancer, brain, MRI, ultrasound, and x-ray resulting in 17 articles.

A Google Scholar search using the same keywords and filters was then conducted with 17,500 results. Of those 17,500, the parameters of dates ranging from 2018-2022 and review articles were further set, narrowing the results to 1,940 results. The articles were then reviewed by relevance and abstract with 101 meeting criteria. All of the articles that were initially found in the University of St. Augustine library and PubMed were found in Google Scholar and were removed from the search, thus narrowing the results to 60. Finally, duplicates and articles that did not meet the criteria were excluded. The final number of articles from all search engines resulted in a total of 14 useful sources (Figure 1).

Themes with Practice Recommendations

The topic of wound care apps and their impact on patient outcomes were well documented. However, establishing cause and effect is often difficult to ascertain, mainly because of the complexity and variability of studies. Some of the factors affecting cause and effect include limited sample sizes, variety in experimental designs (e.g., cross-sectional, quasi-experimental, quantitative performance of AI tracing, focused group studies, etc.), and recommendation variations. Although these were among some of the factors noted as limitations, there were enough studies to substantiate the use of wound apps use in healthcare. The review was conducted in response to the PICOT question resulted in four key

themes: (a) improved outcomes, (b) a variety of settings, (c) time efficiency, and (d) a growing research field (see Figure 2).

Improved Outcomes

Improved wound documentation outcomes is a key theme that was determined in various studies. Improved outcomes refer to the ease and accuracy of documentation by the practitioner as well as the end result of patient care (Barak-Johnson et al., 2022). One study was rated IA; one was rated IIB; two were rated IIIB due to the need for further testing; one study was rated level IIIC due to its non-experimental design as it was more of a focused group, and one was rated a VC as it was a cross-sectional study with a small sample size (see Appendix A). Of these studies, two were identified as having improved patient outcomes (Barek-Johnson et al., 2022, Howell et al., 2021).

Variety of Settings

The term variety of settings is another key theme that is often mentioned in the various study sample. A variety of settings refers to the locations where wound care apps have been studied and utilized successfully. A variety of settings have successfully implemented wound apps, such as hospitals (Chen et al., 2022, Siebert et al., 2021), outpatient wound care centers (Howell et al., 2021, Mohammed et al., 2022), nursing schools (Kielo-Vijamaa et al., 2022), and telehealth (Barakat-Johnson et al., 2022, Ferreira et al., 2021). The studies were also conducted in a variety of countries. This is particularly of importance to this project as the patients in the project arrive and be discharged from the hospital to a variety of settings, such as assisted living facilities and home health agencies, or are acutely presenting.

Time Efficiency

In order to determine if the use of a wound app benefits both the patient and clinician, time was evaluated and was mentioned as a key theme as well. Practitioners recognize that time spent documenting takes away from direct patient care. It is often theorized that if less time is needed to document, then the clinician gains extra time in bedside care and therefore

are able to see additional patients. Two studies reflected the use of apps as time savers for both clinicians and patients (Barakat-Johnson et al., 2022, Mohammed et al., 2022, Moore et al., 2022). There were also systematic reviews that concluded that the use of wound apps increases wound healing through accurate documentation (Dabas et al., 2022, Kikuchi, 2020).

Growing Research Field

As healthcare continues relying to a greater degree on technology, research in the fields of accuracy and speed are in high demand. This, along with the patient's increasing need to be treated using the latest technology, also grow the need for research. With regard to wound AI and image quality, there is still a need for more research (Chan et al., 2022). The development of guidelines is also needed to help organizations when choosing the right wound care AI for their facility's needs (Ferreira et al., 2021). Research in outcomes of clinician wound knowledge, AI methods, and the need for both is also a growing field (Howell et al., 2021). All studies, however, have been limited by sample sizes. With a smaller sample size, it is difficult to reproduce results accurately and may be subjective to a particular setting or practice need. It is clear that the use of wound apps in healthcare is a growing field of research and that larger studies need to be conducted. Therefore, there continues to be a focus on healthcare educator and their role in including technology in nursing curriculum as the most efficient way to prepare future practitioners and nurses confronted with wound care patients (Kielo Vijamaa et al., 2022, Scardoni et al., 2020).

Practice Recommendation

Based on a thorough and rigorous review of the synthesized recommendations currently available, a wound software app has the capability of helping the nurses in the hospital who self-identified as having limited wound knowledge. The strength of the body of evidence was extensive, as evidenced by the quality, quantity, and consistency of the studies. The quality varied from IA to VC, which is to be expected as this research area is still in its infancy stage, but in high demand globally. As noted in the introduction, hospital wound

expenditures are in the millions (Moore et al., 2019). The hospital used in the project was facing similar financial challenges as evidenced by the over referrals completed by nurses to wound care specialists.

Although the use of an app does have the potential to help nurses in a variety of clinical setting, and they are being endorsed across the world, there are potential risks both ethically and legally that require understanding upon implementation. In the ethical realm of healthcare Gerke et al., (2020) identified four areas that an organization should address before acquiring software: (a) obtaining informed consent for use, (b) addressing safety and transparency, (c) ensuring the purchase of bias-free algorithmic technology, and (d) safeguarding data privacy. Gerke et al., (2020) also outlined five legal considerations both for patient and user such as: (a) ensuring the safety and effectiveness of the technology purchased, (b) assessing liability, (c) safeguarding data and privacy, (d) certifying cybersecurity, and (e) understanding and following through with intellectual property law.

The before mentioned ethical and legal considerations are did not affect the project or HIPPA as the app. did not store any patient information as it was used for educational purposes or reference. Recent studies supported that using wound assessment tools such as phone apps, even as a referencing tool can be an asset to an organization. Both the patient and the healthcare provider benefit from these apps as their use is recognized to lessen the time spent on documentation because a clinician has a reference tool to confirm or question their wound knowledge (Nair, 2018). There was also evidence that concludes that wound documentation apps are an asset when utilized in both developed and underdeveloped countries. They were used successfully in rural areas where access to care was limited or nonexistent (Nair, 2018). As the hospital has many nurses that are limited English proficiency and have come from countries where technology was not readily available or used, the research promotes the use of a referencing wound app for these circumstances (Nair, 2018). It is also important to note that reliability and validity in qualitative projects have no generalized consensus. The aim of this

project was in the design strategies that ensured reliability and validity of the findings. The project guaranteed this was accomplished through a variety of suggested methodologies mentioned through the literature studies. By eliminating biases of participants through a random voluntary selection process, this project created reliability and validity without relying on sample size (Noble, 2015). Another method that was employed was through rigorous data collection and transparency in outcomes (Noble, 2015). As far as the reliability of the app., studies showed that BWAT style information can be a useful for nurses with limited wound knowledge and is a reliable and valid (Bates et al., 2019).

Setting, Stakeholders, and Systems Change

The setting in which the project took place was in a hospital with 378 acute care beds. The patient ethnicities in this hospital mainly consisted of Hispanics, mixed-race Hispanics, white non-Hispanic, and African American patients. The patient's ages range from their early 20s, as they have a maternity unit, to the very elderly population, which comprises a great majority of the hospital's population. The hospital faced the constant threat of wound development as many patients had extended or prolonged bed care.

A more in-depth analysis of the organization's strengths, weaknesses, opportunities, and threats (SWOT) was conducted (Appendix D). A reflected strength can be correlated to the hospital's vision and mission. As they strive to find innovative ways to create access for patients and staff, their openness to try new technology and EBP was a notable strength. This ensures that projects such as the one presented are considered a high priority. A surprising strength noted in the SWOT analysis was the hospital's newfound stability. The hospital had reported financial gains for the first time in many years after 2020 amidst the COVID-19 pandemic. As a high volume of Medicare and Medicaid patients were seen, the hospital gained some financial security but holds to the knowledge of being prudent in spending as the history of the hospital has primarily been one of financial strain. When presented to the board and stakeholders that the financial cost of a basic wound referencing app was as little as

\$4.99, their interest was further solidified. The final strength that emerged in the analysis was one that includes the IT department, the clinic management personnel, and healthcare staff support. Although the app did not require the use of the IT department as there were no changes in the current system or additions made, they were readily able and willing to assist.

A weakness that was identified in the SWOT analysis included the variability of the hospital's policies. As clinical staff navigated new administrative policies, they were unsure of regulations that may affect phone use during worktime that may be perceived as personal calls. Another weakness was the lack of incentives when successes were noted throughout the hospital. Although incentives were not in place to encourage employees to join projects, the employees themselves were willing to be trained, therefore making this an identified opportunity. This, combined with managers, staff nurses, and the cooperation of the IT department, made it a recognizable growth opportunity. A recognizable threat was that some of the staff, although willing and open to new projects and ideas, were hesitant to implement them due to all the changes already taking place over the last year. The largest threat concerning the project was the lack of consensus among staff in choosing a particular technology for wound care, as this slowed down the project itself.

In order to address the SWOT analysis, a systems change was also needed. There are a few levels of systems changes that the project will create (micro, meso, macro). The macro changes this project created began with the establishment of the financial requirements needed to fund projects within the new organization and the ability to engage stakeholders. Leadership teams looked into this project as an example of what the organization was willing to fund, how much financially they were willing to provide, and how to go about it. Another macro change was that of creating staff incentives and rewards for participation in the project. The staff had expressed a need for work incentives in the past. The project incentivized those who wanted to participate by recognizing their innovative work with a unit recognition board and/or hospital newsletter.

At the meso-level of systems change, training involvement improved as the staff has less than a year of working together. This, in conjunction with staff working together to understand the EBP context, its importance, and development, there was a greater sense of teamwork and unity among patients and staff nurses.

At the micro level, greater development of relationships among those involved were fostered (patient, staff, management, and caregivers) as they delivered accurate information regarding wound assessment, had more time to spend bedside, and improved outcomes efficiently. Another micro-level systems change that must be noted is that by the end of the project, a greater opportunity to continue planning such projects and being able to carry them out was achieved. It happens that this project was the first since the change in leadership in 2021.

Implementation Plan with Timeline and Budget

As referrals to wound care specialists increase in the hospital, the main objective was to increase nursing confidence when working with various types of wounds while in turn decreasing the reliance on a wound care specialist. As the implementation plan was to train, use, and evaluate the use of an app in a hospital setting, the objectives were therefore broken down into the following:

1. The first objective was to train 90% of the participating nurses on the use of the app. by the end of week one.
2. The second objective was to decrease wound specialist referrals from by 10% or more within one week of implementation.
3. The third objective was to increase the confidence level of nurses from 80% reporting level 1's in the baseline survey to 50% reporting level 2's and 1's in post assessment.

A survey tool was developed with the assistance of expert wound care nurses and a wound care physician. Face validity was established with all in agreement that the survey questions would be useful for nurses to self-report their comfort level with the use of the wound care app. According to Laerd Statistics, (2023) face validity is often used to subjectively determine if on the surface the tool will measure the intended construct. This type of validity evaluates the appearance of the questionnaire in terms of feasibility, readability, consistency of style and formatting, and clarity of the language used. Thus, face validity is a form of usability rather than reliability. For an EBP project, it was deemed sufficient for self-reporting on the wound care app for the purposes of this project.

The initial participants included 15 nurse volunteers, but, after the 2nd week of implementation, seven nurses had dropped out due to a variety of reasons such as leaving the workplace or no longer being assigned to a patient with a wound. The intervention used an educational software phone app to assist nurses in referencing information pertaining to wounds. The nurses self-reported their confidence level via a baseline survey and then this data was compared to a post survey that analyzed their confidence level after utilizing the wound software app. The second outcome that were measured included the number of wound referrals made during a 10-week period pre and post-intervention.

Although there are many wound care software apps that were reviewed by the project manager (PM) and preceptor team, Wound Care Pro (WCP) was determined to be the best fit for the project. WCP was chosen because it is designed as an educational tool/resource for clinicians, designed by an APRN, with a cost of \$4.00, which can be downloaded on an iPad or mobile phone. As the current studies and literature reviews do not specify whether one particular app has an advantage over another, rather than collectively using an app that fits a clinician's needs to produce positive outcomes, this WCP app was the right choice. The app covers eight of the most common wound etiologies but is not limited to malignant wounds, pressure injuries, skin tears, arterial ulcers, and surgical wounds. The app covers a variety of

treatment options that is tailored for the patient's needs whether it's healing a wound or palliation. The app also covers documentation guidelines, includes many images for each wound type, and includes video demonstrations. The information used in the software is based on current EBP guidelines and is changed on a continuous basis using the most current studies and research.

Regarding documentation, the Bates-Jensen Wound Assessment Tool (BWAT) is regarded as the gold standard tool when documenting for both compliance and quality of care (Younis et al., 2022). The BWAT has identified several components that should be included in wound documentation, such as; size, depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudate type, exudate amount, skin color surrounding the wound, peripheral tissue edema and induration, granulation tissue, and epithelialization. The WCP app included the BWAT components, with detailed pictures, videos, and descriptions. Permission to utilize the app was obtained on January 15, 2023.

Timeline

The implementation phase of the project was for a total of 10 weeks and began in March 4, 2023 after approval was obtained on February 21, 2023 by the university and the facility. During the implementation phase, staff training took place on February 28, 2023, where clinical staff were taught how to use the wound care app. Training and data collection were gathered by the PM. The PM communicated with the wound care specialist and stakeholders regarding progress during the monthly meetings and through electronic email as was needed (see Appendix C).

Budget

Given the economic history of both the hospital and the community served by this hospital, cost was a driving factor when planning this project. Upon meeting with the financial department in December 2022, it was strongly suggested that the free or affordable app version be utilized. Taking this into consideration, the PM was not paid a wage nor received

financial compensation for the project. The money required was spent on purchasing supplies that was used in printing handouts to disseminate the project, gas mileage, and the purchasing of the app (\$4.00 ea.) for 15 nurse participants that committed to participate during the initial nurse training. The budget plan reflects the plan and actual expenses for the project (see Table 1).

Change Theory Application

As the project utilized E.M. Rogers Diffusion of Innovation Theory as a guide, the theory components were also incorporated throughout the project timeline. As this theory is applied in various healthcare settings which use new and innovative technology to create change, this theory was best suited for this project where a wound app was used. According to Roger's theory, there are five steps of adoption which include: (a) knowledge or awareness, (b) persuasion, (c) decision, (d) implementation, and (e) continuation (Sirk, 2020). Because this model has been successfully applied in clinical and hospital settings, including the one where the project took place, stakeholders were willing to adopt it, thereby increasing the project's success and sustainability.

Knowledge or Awareness

This knowledge or awareness phase began as early as September 2022 through December 2022, when discussions began surrounding the benefits of wound care apps. That was also when discussions surrounding a current EBP project and the final decisions were made. During this phase, several meetings with the PM, leadership team, and stakeholders took place to discuss the feasibility needs of the hospital when determining app to use for this project.

Persuasion

Roger's theory also states that persuasion is also needed to implement change. For this project, this stage occurred after the final determination was made on the app that was to be implemented. This phase recruited 15 initially, but was reduced to 8 participants by the 3rd

week of the implementation phase. A bulletin advertisement and sign-up sheet was posted on each floor (ICU, CCU, surgical, labor and delivery, medical surgical, palliative). Interested nurses were contacted for a short zoom meeting on February 28, 2023 for an informational briefing and small training. During this phase there was clear and consistent communication, which helped keep the interest of potential adopters accept change. Once the interested nurses were identified, the PM sent out a generalized survey using Survey Monkey to determine the best mode of communication for potential participants on February 29, 2023.

Decision

The decision stage took place in late January 2023 when the app and participants were selected. During this phase, the project team had already decided on training dates, which took place March 1st and 3rd 2023.

Implementation

For the first two weeks of implementation, staff were trained to use the wound app. and use it with their patients. The remaining 8-weeks of the project timeline consisted of the implementation of the use of the app and data analysis.

Continuation

This project's final stage was the evaluation period, which Roger's theory refers to as the continuation phase (Sirk, 2020). This phase took place after project implementation. The events in this phase are noted in Appendix C. All documentation were finalized and discussed by the organization on May 13, 2023 and were collected and saved as a reference for future projects. The PM completed the final evaluation of the project and measures of success on July 5, 2023 with the help of a statistician and primary faculty member.

Evaluation Results

The evaluation assessed a wound app. and whether its use improved the nurse's confidence level in working with patients who present with wounds within a 10-week period. Post-implementation data was analyzed using SPSS statistical software (IBM Corp, 2021) as

well as the Intellectus Statistics [Online computer software], (2023). A direct comparison between the nurses' self-reported pre and post wound care comfort scores were compared by question. Additionally, participants pre and post referrals to a wound care specialist were obtained and compared by the wound care specialist in charge of recording the data at the hospital. As this EBP project aimed to determine if nursing comfort level before and after using an app when addressing wounds care, it was important to compare data pre and post app intervention. There is no general consensus in determining sample size when conducting an EBP project due to the specific needs of the study (RusuMocanasu, 2020). Therefore, detailed information on type of wound and floor is also discussed as this will determine the clinical significance that can be useful with particular wounds or specialties (ICU, CCU, labor and delivery, etc.)

Data Collection

The site hospital does not have an IRB committee; therefore, approval from the University of St. Augustine for Health Sciences EBP project committee and the hospital's safety committee was granted prior to project implementation. The data collection process did not include personal information. For the baseline survey each nurse had a number they used as their identifier; therefore, the risk of missing data was minimal. Nonetheless, the data collected pre and post intervention included the interventional before mentioned, reduced the risk of lost information. Additionally, the PM was involved in moving the project through the various phases, coordinating all communication among teams via email, documenting and analyzing progress, validating the data, and adjusting the project when change was needed.

Analysis Methods

Data from pre-implementation and post-intervention were imported into and analyzed using SPSS version 23 for Windows (IBM Corp, 2021) as well as the Intellectus Statistics [Online computer software] (2023). Frequency tables and descriptive statistics were used to summarize the survey data. Statistical analysis was used to determine if there was a difference

in a nurse's ability to accurately assess and treat wounds before and after the implementation of the wound software assessment app. A nurse's ability to accurately assess and treat wounds was measured by the 7-survey questions regarding how comfortable a nurse felt when using the app when assessing wounds, documenting wounds, treating pressure wounds, treating arterial wounds, treating surgical wounds, treating diabetic foot ulcers, and treating chronic wounds.

Response scores for the 7-survey items were on continuous scale, and a paired *t*-test measures the differences between two sets of values on a continuous scale. However, the Shapiro-Wilk test indicated the data were not normally distributed. Thus, the Wilcoxon signed-rank test was used instead of the paired *t*-test (Kim et al., 2022). For any test, a *p*-value less than 0.05 indicated significance. In addition, frequency distributions and measures of central tendency were determined. Graphs and box plots were used to display the data.

Analysis Results

A nurse's ability to accurately assess and treat wounds was measured by the 7-survey questions regarding how comfortable a nurse was with assessing wounds, documenting wounds, treating pressure wounds, treating arterial wounds, treating surgical wounds, treating diabetic foot ulcers, and treating chronic wounds using the wound app, for pre-implementation and post-implementation. Eight nurses participated in this study, except one participant missed one question post-implementation, leaving a total of seven participant data points pre and post intervention for analysis. Nearly two-thirds of the nurses (62.5%, *n*=5) were working at the medical surgical unit, and one-third of the nurses (37.5%, *n*=3) had 0-5 years of experience (Table 2).

It was important to determine if there was a difference in a nurse's ability to accurately assess and treat wounds before and after the implementation of the wound software app. The normality assumption was assessed using the Shapiro-Wilks test, which indicated that data were not normally distributed. The two-tailed Wilcoxon signed rank test is a non-parametric

alternative to the paired samples *t*-test and does not share its distributional assumptions (Kim et al., 2022).

The survey results are based on a 3-point Likert-type scale and summarized in Table 3. The Likert type terms used included Comfortable, Moderately Comfortable, or Not Comfortable with assessing or treating wounds. The mean response scores for these seven items ranged from 1.13 to 1.75 for pre-implementation and from 1.13 to 2.57 for post-implementation. It seemed that nurses in general had better ability to accurately assess and treat wounds after the implementation of the wound software app (Figure 3). Frequency tables and descriptive statistics were used to summarize the survey data. The two-tailed Wilcoxon signed rank test showed significant results based on an alpha value of .05, $V = 0.00$, $z = -2.23$, $p = .026$. This indicates that the differences between Pre and Post data are not likely due to random variation. The median of Pre ($Mdn = 1.50$) was significantly lower than the median of Post ($Mdn = 2.38$). Figure 5 presents a boxplot of the ranked values of Pre and Post intervention (Intellectus Statistics, 2023).

Formative and Summative Evaluation

The measures and outcomes were based on the project objectives along with the survey outcomes. Outcome objectives were identified during the project training upon the completion of week 1. These objectives reflected that nurses gained confidence in their wound assessment and management skills as noted by the survey scores as well. Data was also collected from leadership team meeting to compare data on wound specialist referrals pre and post intervention that demonstrated overall confidence was increased. Table 4 summarized some survey results for pre-implementation. Participants indicated that they have received some continuing education in the past 5-years regarding wound assessment (12.5%, $n=1$) and wound documentation (25.0%, $n=2$). However, they never received any continuing education in the past 5-years regarding wound treatment options or wound technology. All participants (100%, $N=7$) indicated that they (a) felt comfortable using a wound app on phones or tablets, (b) would

like to learn and participate in a training on a wound phone or tablet app, and (c) were interested in using a wound phone or tablet app for wound assessment, documentation, and treatment options. The results are meaningful to the nurses in the hospital, leadership team, and stakeholders, therefore having clinical significance.

During the pre-implementation survey, nurses were asked to rank areas they needed the most help with when treating patients with wounds (Table 7 and Figure 4). The top three areas identified were lack of wound care knowledge in general ($M = 1.25$, $SD = 5.00$), assessing wounds in general ($M = 2.00$, $SD = 1.16$), and lack of wound care terminology knowledge in general ($M = 2.25$, $SD = 5.00$). Table 8 summarized some of the survey results for post-implementation. Nurses used the wound app with all (37.5%) or some (62.5%) of their patients. All nurses (100%) felt they have gained knowledge they did not previously have regarding wounds and wound care prior to using this app. Three-quarters of the nurses (75%) indicated that they referred less patients to a wound care specialist than they normally would before using the wound app. All participants (100%, $N=7$) indicated that they felt comfortable using a wound app on phones or tablets. All nurses believed that the wound app helped their patients receive better care, would recommend the wound care app to other nurses, and the wound app helped them improve in areas they needed help. From data collected on referrals for a wound care specialist, there was a decrease from roughly 25 referrals in September 2022 and October 2022 to 15 during the 10-week project period. This is further clinical evidence of success.

Impact

The project has addressed the practice problem identified through the SWOT analysis and administrative meetings, and feedback from staff. The organization was looking for ways to assist nurses with limited wound knowledge that increases confidence when working with the patients that in turn would decrease the number of referrals for additional assistance from wound care specialist. Although this project was conducted using a small sample size, it is clear

that there are benefits to providing a simple, yet effective app to assist nurses did help meet the organization's needs.

The final question answered in the post survey was open-ended. The question inquired whether there were any additional comments participants would like to comment on after the completion of the project. Two nurses stated the app was a helpful tool for nurses who are limited English proficient. Another nurse stated that the app was, "a very nice back-up to have to make decisions and learn along the way." As the results demonstrate, it has altered practice by providing a basic tool that enables nurses who have not had training or do not feel comfortable working with wounds to have some assistance when needed. It is also important to note that this was the first project conducted since the administrative changes occurred in the hospital that sets a precedent for future projects conducted. The implications of the project will continue beyond this implementation stage as discussion with stakeholders and administrative staff on May 13, 2023. Adding more apps and technology was proposed at a meeting and to add it to the budget. This would further improve the practice problem and to maintain the sustainability of the intervention over time.

Previous studies have demonstrated that variations between wound apps exist and could pose changes in results (Barakat-Johnson et al., 2022). A limitation of this study is that the rate of use by the nurses was not clearly stated (e.g., how many minutes were spent using the app with certain wounds) as well as which particular floors and/ or types of wounds were benefiting the most or least. Further studies will need to be conducted to discuss analyze these factors. This could pose a challenge for further studies that discuss traditional as well new digital wound imaging tools as the technology is evolving at a rapid pace. Another potential limitation that poses challenges continues to be costs, and limiting the use of these tools in organizations where finding funds for technology may be difficult. A solution proposed through this project was to take advantage of recent advances in mobile technology by utilizing an app that is an inexpensive, easy-to-use, reliable and accurate. Affordable apps such as the

one used was further able to use photos, examples, documentation suggestions, and treatment options. Finally, it is noted that there are several additional benefits to patients, clinicians, researchers and policy makers inherent in adopting these types of apps to assist nurses in making sound decisions when working with wound care patients.

Dissemination Plan

The first presentation regarding the project results was conducted at the hospital site on May 13, 2023. The project team, such as the clinicians who participated and the stakeholders, were invited to attend. A poster presentation at the University of St. Augustine for Health Sciences (USAHS) was August 6, 2023. Publication to SOAR@USA will shortly follow upon approval. The professional publication where the paper was submitted is the *Advances in Skin & Wound Care Journal*. The professional society that was appropriate for publication regarding this project is the Association for the Advancement of Wound Care (AAWC).

Conclusion

In the organization, nurses were in need of additional wound care support in order to provide improved patient outcomes when assessing wounds accurately. The literature supported this EBP project using an app as studies had shown that apps are useful for helping the nurse clinicians in assessing, documenting, and treating wounds. The project took place over a 10-week time frame. Permission from the university and an official letter was obtained from the hospital administration before data collection began. Roger's Diffusion of Innovation theory guided the project with its five steps of adoption which include awareness, persuasion, decision, implementation, and continuation.

The selection of a wound care software app provided ease of access for nurses to the assessment of patient's wounds. The survey was developed in collaboration with the wound care nurses as a way to determine whether the app made a difference in their efforts at assessing and documenting wounds. A total of eight nurses volunteered to participate in the project, but only seven completed all survey data. Pre-intervention and post-intervention data

were reviewed, comparing pre and post intervention survey results. Data were analyzed using both SPSS and Intellectus software, and demonstrated clinical significance. All participants said they felt comfortable using the wound care app on phones or tablets. In an organization where staff nurses are having difficulty merely understanding the basics of wounds and assessment, this tool was beneficial. Hospital administrators can save on wound related costs by implementing more accurate and effective treatments. The project helped a local community hospital find an affordable way to assist nurses who have not had a chance to get properly trained on wounds. In an organization where staff nurses are having difficulty merely understanding the basics of wound care, being able to have a reference guide was beneficial. By implementing this wound care app hospital administrators may save on wound care related costs

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Table 1*Implementation EBP Project Budget for Wound Care app Project*

Expenses	Dollar amount	Revenue	Dollar amount
Wound care app	est. \$60.00 actual = \$32		
Supplies – office (including app basic fee)	\$100		
Gas mileage to and from hospital	\$100		
Estimate Total Expenses	\$260	Revenue from PM	\$232
Net Balance			0

Note: All budget entries are estimates. Expenses are based on means. Revenue estimates do not include potential cost avoidance due to realized outcomes. All costs associated to salary and benefits, patient care supplies, and overhead are fixed indirect expenses not associated with this project. Project costs are nominal for printing and laminating, under \$100.

Table 2*Unit and Years of Experience of Participants for the Wound Care app Project Implementation*

	Number of participants	Percent of participants
Unit		
Labor & delivery	1	12.5
Medical surgical	5	62.5
Emergency room	2	25.0
Years of experience		
0-5	3	37.5
6-10	2	25.0
11-15	1	12.5
16-20	2	25.0

Table 3

Summary of Survey Responses for Questions of “How Comfortable a Nurse Was With” the software app

	Survey responses for pre-implementation				Survey responses for post-implementation			
	Not Familiar	Moderately Familiar	Familiar	<i>M</i> (<i>SD</i>)	Not Familiar	Moderately Familiar	Familiar	<i>M</i> (<i>SD</i>)
	1	2	3		1	2	3	
Assessing wounds	4 (50.0)	3 (37.5)	1 (12.5)	1.63 (0.74)	0	5 (62.5)	3 (37.5)	2.38 (0.52)
Documenting wounds	4 (50.0)	3 (37.5)	1 (12.5)	1.63 (0.74)	0	5 (62.5)	3 (37.5)	2.38 (0.52)
Treating pressure wounds	5 (62.5)	2 (25.0)	1 (12.5)	1.50 (0.76)	0	3 (42.9)	4 (57.1)	2.57 (0.54)
Treating arterial wounds	7 (87.5)	1 (12.5)	0	1.13 (0.35)	7 (87.5)	1 (12.5)	0	1.13 (0.35)
Treating surgical wounds	2 (25.0)	6 (75.0)	0	1.75 (0.46)	1 (12.5)	5 (62.5)	2 (25.0)	2.13 (0.64)
Treating diabetic foot ulcers	5 (62.5)	3 (37.5)	0	1.38 (0.52)	0	4 (50.0)	4 (50.0)	2.50 (0.54)
Treating chronic wounds	5 (62.5)	2 (25.0)	1 (12.5)	1.50 (0.76)	1 (12.5)	4 (50.0)	3 (37.5)	2.25 (0.71)

Note. For survey responses, 1 = not comfortable, 2 = moderately comfortable, and 3 = comfortable. One participant did not answer “Treating pressure wounds” during post-intervention.

Table 4*Summary of Survey Results for Pre-implementation of Wound Care app Project*

	<i>N</i>	<i>%</i>
Received continuing education in the past 5 years regarding		
Wound assessment	1	12.5
Wound documentation	2	25.0
Wound treatment options	0	0
Wound technology	0	0
Comfortable using a wound app on phones or tablets		
Not comfortable	0	0
Moderately comfortable	0	0
Comfortable	8	100
Would like to learn and participate in a training on a wound phone or tablet app		
Yes	8	100
No	0	0
Interested in using a wound phone or tablet app for wound assessment, documentation, and treatment options		
Yes	8	100
No	0	0

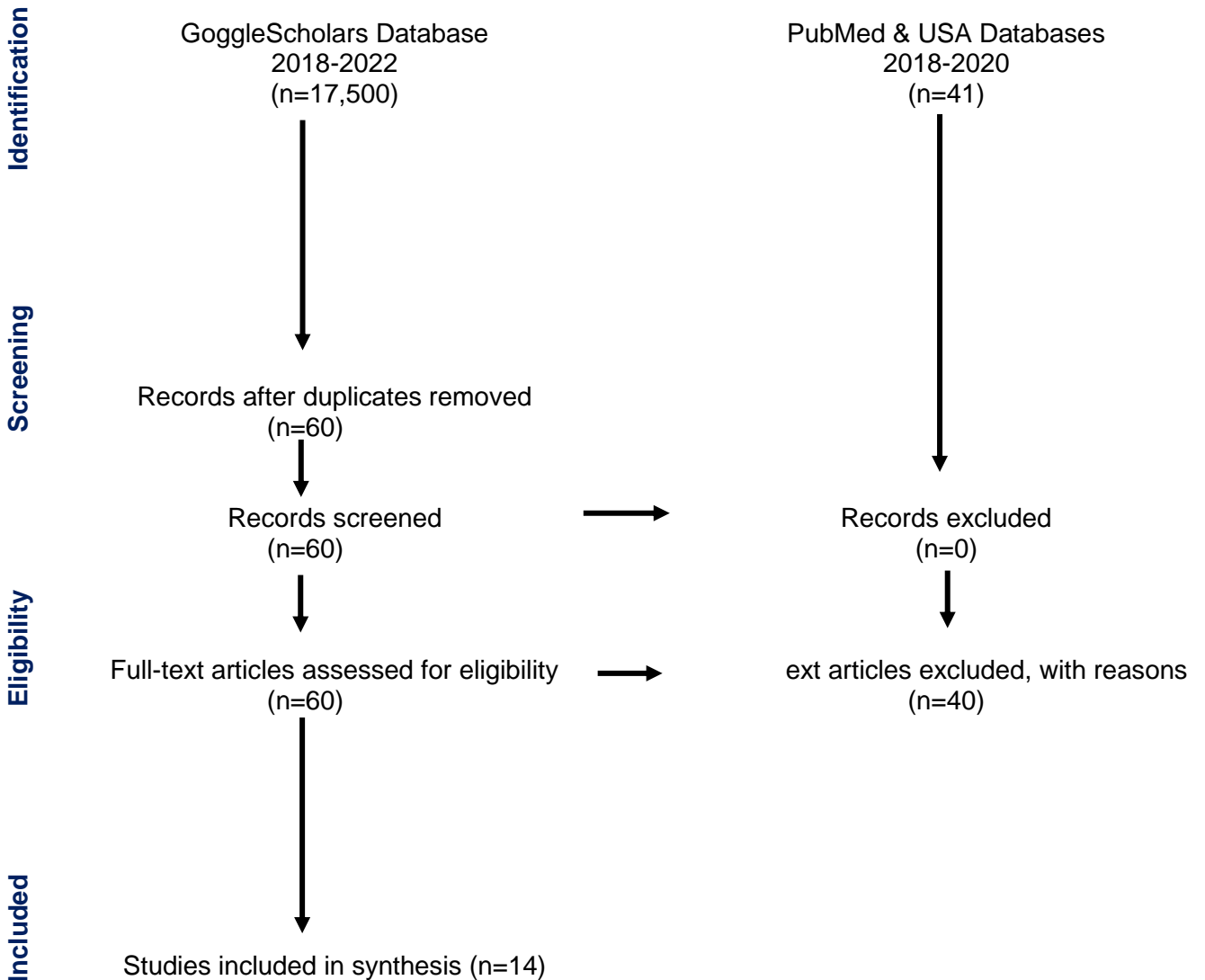
Table 7

Areas Nurses Need the Most Help with When Treating Patients with Wounds (1= Most Help and 5 = Least Help) (Pre-implementation)

Area of Need	<i>N</i>	<i>M (SD)</i>
Time involved assessing wounds	8	3.88 (1.46)
Documenting wounds	5	3.60 (0.89)
Time involved documenting wounds	4	3.25 (1.71)
Assessing wounds in general	7	2.00 (1.16)
Choosing treatment options	6	3.50 (1.23)
Knowing when to request the help of wound support specialist	2	4.50 (0.71)
Lack of wound care knowledge in general	4	1.25 (5.00)
Lack of wound care terminology knowledge in general	4	2.25 (5.00)

Table 8*Summary of Survey Results for Wound Care app Project Post-implementation*

Nurses Survey Selection	N	%
Used the wound app with		
None of the patients	0	0
Some of the patients	5	62.5
All of the patients	3	37.5
Gained knowledge		
Yes	8	100
No	0	0
Referred less patients		
Yes	6	75.0
No	2	25.0
Wound app helped patients receive better care		
Yes	8	100
No	0	0
Comfortable using a wound app on phones or tablets		
Not comfortable	0	0
Moderately comfortable	0	0
Comfortable	8	100
Recommend the wound care app to other nurses		
Yes	8	100
No	0	0
Wound app helped address the areas previously identified as areas needed help with		
Yes	8	100
No	0	0

Figure 1*PRISMA Flowchart*

Note. Prisma flow chart diagram from “Preferred Reporting Items for Systematic Reviews and Meta-analyses: The PRISMA Statement,” by D. Moher, A. Liberati, J. Tetzlaff, & D.G. Altman, 2009, *Annals of Internal Medicine*, 151(4), p.267 (<http://dx.doi.org/10.7326/0003-4819-151-4-200908180-00135>). Copyright 2009 by The American College of Physicians.

Figure 2

Wound Application Themes



Figure 3

Summary of Survey Responses for Questions Under “How Comfortable a Nurse Was With” the application software

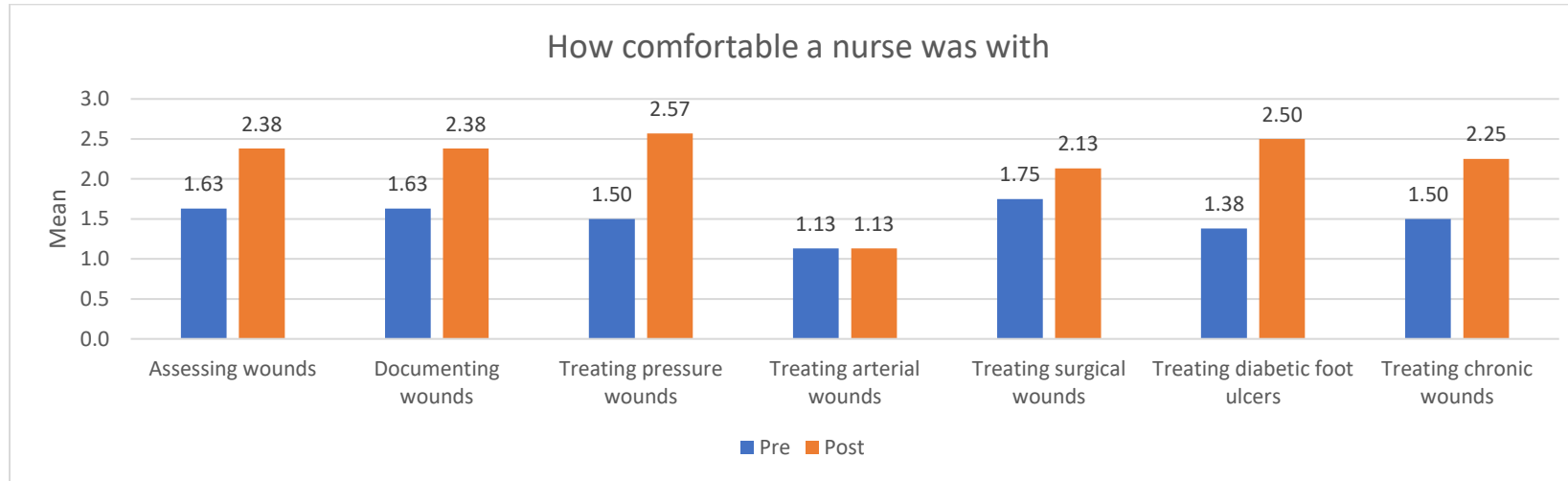


Figure 4

Areas Nurses Need the Most Help with When Treating Patients with Wounds (Pre-implementation)

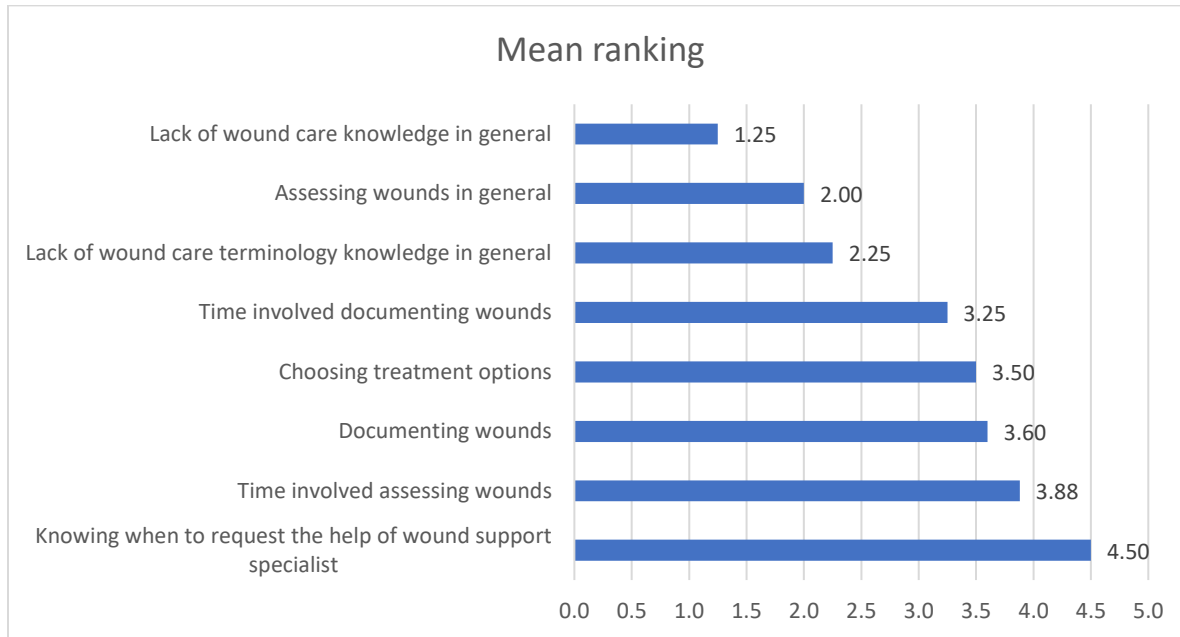
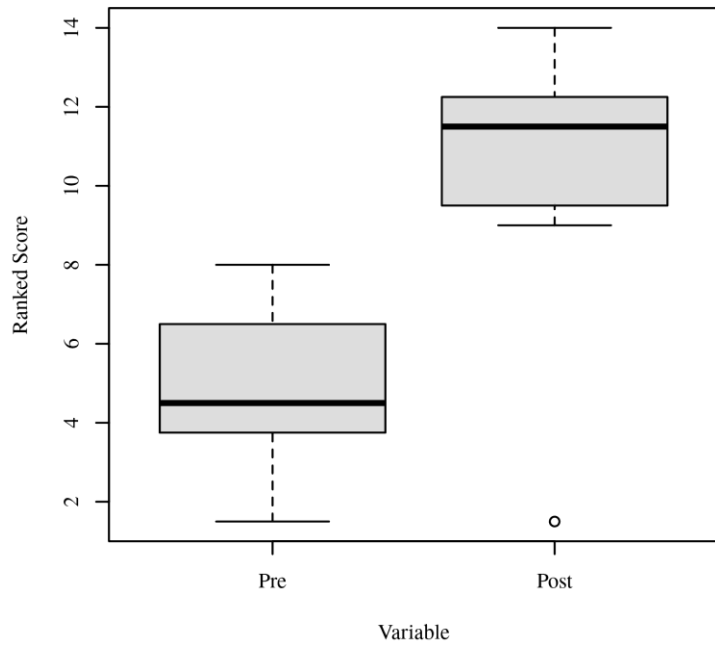


Figure 5

Intellectus Two-Tailed Wilcoxon Signed Rank Test Ranked values of Pre and Post Project Implementation Scores



Appendix A

Summary of Primary Research Evidence

Citation	Design, Level Quality Grade	Sample Sample size	Intervention Comparison	Theoretical Foundation	Outcome Definition	Usefulness Results Key Findings
<p>Barakat-Johnson, M., Jones, A., Burger, M., Leong, T., Frotjold, A., Randall, S., Kim, B., Fethney, J., & Coyer, F. (2022). Reshaping wound care: Evaluation of an artificial intelligence app to improve wound assessment and management amid the COVID-19 pandemic. <i>International Wound Journal</i>, 19(6), 1561–1577. https://doi.org/10.1111/iwj.13755</p>	<p>Quasi Experimental Study Design</p> <p>Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIB</p>	<p>Sample: patients with wounds as well as healthcare workers</p> <p>Sample Size: Data were collected from patients in the standard group (n = 166, 243 wounds) and intervention group (n = 124, 184 wounds), at baseline and post-intervention. Clinicians participated in a survey (n = 10) and focus group interviews (n = 13) and patients were interviewed (n = 4).</p>	<p>Intervention Group: An artificial intelligence application used by clinicians and patients for wound assessment and management</p> <p>Comparison: Standard methods of wound monitoring</p> <p>Validity: The survey was reviewed for face validity by wound care expert clinicians and pilot tested on five clinicians.</p> <p>Patient data collection tool developed by authors used consultation with wound care expert clinicians and reviewed for face validity by senior registered nurses (RNs) and senior researchers.</p> <p>Reliability: Not reported.</p>	<p>None reported</p>	<p>The outcome measures of this study were: (a) patient and clinician usability, and acceptability of the TA app; (b) reduction in wound size at the point of discharge (inpatient cohort) and at the end of 3 months after enrolment (community and outpatient cohort); (c) completeness of wound-related documentation determined by the documentation of pain, wound size, exudate, odor and a management schedule.</p>	<p>During the intervention, 101 out of 132 wounds improved (mean wound size reduction = 53.99%).</p> <p>Positive evaluations identified improvements such as instantaneous objective wound assessment, shared wound plans, increased patient adherence and enhanced efficiency in providing virtual care. The use of the application facilitated remote patient monitoring and reduced patient travel time while maintaining optimal wound care.</p>
<p>Chan, K. S., Chan, Y. M., Tan, A. H. M., Liang, S., Cho, Y. T., Hong, Q., Yong, E., Chong, L. R. C., Zhang, L., Tan, G. W. L., Chandrasekar, S., & Lo, Z. J. (2022). Clinical validation of an artificial intelligence-enabled wound imaging mobile application in diabetic foot ulcers. <i>International Wound Journal</i>, 19(1),</p>	<p>Cross-sectional study</p> <p>Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: VC</p>	<p>Sample: patients with wounds as well as healthcare workers</p> <p>Sample Size: 28 patients with DFUs from June 2020 to January 2021</p> <p>75 wound episodes from 28 patients were collected and a total of</p>	<p>Intervention: AI enabled wound imaging mobile application</p> <p>Comparison: Standard methods of wound monitoring length and width of traced wound on graphical paper</p> <p>Validity: Based on Tetsuyu's internal</p>	<p>None reported</p>	<p>There is an excellent inter-rater and intra-rater reliability of C4W measurements against traditional wound assessment by a trained specialist wound nurse, with C4W being a useful adjunct in monitoring DFU wound progress.</p>	<p>Technical limitations still exist as wound image quality requires accurate wound boundaries that require manual adjustment, nonetheless, they are serving useful in managing DFU.</p>

<p>114–124. https://doi.org/10.1111/iwi.13603</p>		<p>547 wound images were analyzed</p>	<p>validation, the baseline mean accuracy is 90% Reliability: ICC statistics was used to analyze intra-rater and inter-rater reliability</p>			
<p>Ferreira, F., Pires, I.M., Ponciano, V., Costa, M., Villasana, M.V., Garcia, N.M., Zdravevski, E., Lameski, P., Chorbev, I., Mihajlov, M., Trajkovic, V. (2021). Experimental Study on Wound Area Measurement with Mobile Devices. <i>Sensors</i>, 21(5762), 5762. https://doi.org/10.3390/s21175762</p>	<p>Experimental Study Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIIB</p>	<p>The algorithm presented in this study consists of an experimental algorithm that uses the OpenCV framework and other image processing techniques that measure the wound area over time to check for possible pathologies associated with the development of skin-related diseases.</p>	<p>Intervention: use of mobile wound capturing app to measure wound accurately Comparison: desktop computer wound imaging Validity and Reliability not reported.</p>	<p>None reported</p>	<p>The method implemented in a desktop machine retrieved a higher error value for the wound area than the same method implemented in a mobile device</p>	<p>Further testing needed, notifications to patient and clinicians must be developed, usability must be further tested.</p>
<p>Howell, R. S., Liu, H. H., Khan, A. A., Woods, J. S., Lin, L. J., Saxena, M., Saxena, H., Castellano, M., Petrone, P., Slone, E., Chiu, E. S., Gillette, B. M., & Gorenstein, S. A. (2021). Development of a Method for Clinical Evaluation of Artificial Intelligence-Based Digital Wound Assessment Tools. <i>JAMA Network Open</i>, 4(5), e217234. https://doi.org/10.1001/jamanetworkopen.2021.7234</p>	<p>Quantitative performance of AI tracings Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIA</p>	<p>Sample: the diagnostic study was performed across 2 independent wound centers A total of 199 photographs from 199 patients were included. The mean patient (SD) age was 64 (18) years (range, 17- 95 years), and 172 patients (63.8%) were women. The eligible wound photographs represented a wide spectrum of wound types, with venous leg ulcers (VLU), pressure ulcers (PU), surgical wounds, traumatic wounds, and diabetic foot ulcers (DFU) making up the majority (166 [83%]) Sample Size: site #1, 110 photographs taken between May 1 and 31, 2018; site #2, 89 photographs taken</p>	<p>Intervention: evaluate the performance of AI-based software for wound assessment Comparison: against manual wound assessments performed by wound care clinicians Validity & Reliability: Not reported</p>	<p>None reported</p>	<p>The authors hypothesize that a structured approach to wound assessment using advanced technology, such as AI, can lead to greater treatment efficacy and improved outcomes for patients with chronic wounds</p>	<p>Such AI wound imaging tools will require rigorous validation to ensure equivalent performance with standard measurement methods, but there is currently no accepted methodological framework for the clinical evaluation of AI-based digital wound assessment tools.</p>

		between January 1 and December 31, 2019) Four wound specialists (2 per site) also utilized in study				
Kielo-Viljamaa, E., Suhonen, R., Jalonen, L., & Stolt, M. (2022). Areas of nursing competence in acute wound care: A focus group study. <i>Collegian</i> , 29(1), 44–53. https://doi.org/10.1016/j.colegn.2021.04.003	Focused Group Study utilizing Qualitative Design Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIIC	Sample: Healthcare practitioners Sample Size Focus group interviews were used to collect the data (N = 20).	Intervention: None Comparison Focused group of nurses vs. Separate focus groups were held for participants representing the following professions: (i) registered nurses; (ii) authorized wound care nurses; (iii) nurse educators; and (iv) physicians. Validity & Reliability: N/A	None reported	Nursing education should include EB acute wound care as a focus along with other competencies.	Schools should develop and improve wound care education and training at the undergraduate and postgraduate level.
Mohammed, H. T., Bartlett, R. L., Babb, D., Fraser, D. J., & Mannion, D. (2022). A time motion study of manual versus artificial intelligence methods for wound assessment. <i>PLOS ONE</i> , 17(7), e0271742. https://doi.org/10.1371/journal.pone.0271742	Time-motion study using Quantitative Measurement Methods Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIIB	Sample: Patient wounds Sample Size: 91 patients with 115 wounds	Intervention: SWIFT AI digital tool Comparison: standard digital camera Validity & Reliability: N/A	None reported	The digital application was significantly faster by 77% at accurately measuring and calculating the wound surface area with an average of 45.05 seconds (P<0.001). Using Swift was significantly faster by 79% staff completed all steps in about half of the time (54%) the normal time digital tool over manual methods (92.2% vs. 75.7%, P<0.004) more accurate	Using digital assessment tools saved significant time for clinicians in assessing wounds. It also successfully captured quality wound images at the first attempt.
Moore, Z., Ayng, G. E., Carr, C. G., Horton, A. J., Jones, H. A., Murphy, N. S., Payne, M. R., McCarthy, C. H., & Murdoch, J. M. (2022). A Clinical Support App for routine wound management: reducing practice variation, improving clinician confidence and	Time-motion study using Quantitative Measurement Methods Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIIB	Sample: Patient wounds Sample Size: 91 patients with 115 wounds	Intervention: SWIFT AI digital tool Comparison: standard digital camera Validity & Reliability: N/A	None reported	The digital application was significantly faster by 77% at accurately measuring and calculating the wound surface area with an average of 45.05 seconds (P<0.001). Using Swift was significantly faster by 79%	Using digital assessment tools saved significant time for clinicians in assessing wounds. It also successfully captured quality wound images at the first attempt.

<p>increasing formulary compliance. <i>International wound journal</i>, 19(5), 1263–1275. https://doi.org/10.1111/iwi.13868</p>					<p>staff completed all steps in about half of the time (54%) the normal time</p> <p>digital tool over manual methods (92.2% vs. 75.7%, P<0.004) more accurate</p>	
<p>Rochon, M., Jurkiewicz, J., Morais, C., & Gondo, T. (2020). Using artificial intelligence to improve wound image quality: a feasibility study. <i>Wounds UK</i>, 16(4), 54–59.</p>	<p>Feasibility Study</p> <p>Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: VC</p>	<p>Sample: wounds images</p> <p>Sample Size: N=266</p>	<p>Intervention: A training set (clear and blurred images and reviewed existing solutions, models and documentation)</p> <p>Comparison: A test set (An AI model that classifies wound images between blurry and clear images)</p> <p>Validity & Reliability: Not Reported</p>	<p>None reported</p>	<p>Limited sample size, however, implementation of AI, computer vision (CV) and ML have a huge part to play in the future of healthcare and the opportunities just within the scope of wound surveillance of wounds.</p>	<p>AI opens up opportunities for improved accuracy, efficiency and consistency in care and management for higher-quality patient care.</p>

Legend: Artificial intelligence or AI, computer vision (CV), machine learning (ML), Diabetic foot ulcer (DFU)

Appendix B

Summary of Systematic Reviews (SR)

Citation	Quality Grade	Question	Search Strategy	Inclusion/Exclusion Criteria	Data Extraction and Analysis	Key Findings	Usefulness/Recommendation/Implications
Dabas, M., Schwartz, D., Beeckman, D., & Gefen, A. (2022). Application of Artificial Intelligence Methodologies to Chronic Wound Care and Management: A Scoping Review. <i>Advances in Wound Care</i> . https://doi.org/10.1089/wound.2021.0144	Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: VA	Does the application of Artificial Intelligence Methodologies to Chronic Wound Care and Management result in positive and accurate results based on the latest scoping reviews?	Google Scholar search engine	Inclusion: Studies describing a novel AI method or a novel use of an AI method for acute/chronic wound diagnosis or management, published in English Exclusion: exclusion of studies that did not describe any AI approach or a novel use of an AI approach for acute/chronic wound diagnosis or management, or that considered wound types that were out of scope for this study.	Data Extraction: MEDLINE, Compendex, Scopus, Web of Science, and IEEE databases were all searched for new AI methods or novel uses of existing AI methods for the diagnosis or management of hard-to-heal wounds. Data Analysis: 75 studies show positive impact on AI on wound assessment, care, and management.	-AI algorithms reported accurate -AI accurate in diagnosing -AI useful for remote consultation systems -AI has strong impact on wound management	-AI methods positive impact on in wound care and management. -Promising for hard to heal wounds. -Promising for hospital wound management -Time savers for clinicians and patients
Chan, K. S., & Lo, Z. J. (2020). Wound assessment, imaging and monitoring systems in diabetic foot ulcers: A systematic review. <i>International Wound Journal</i> , 17(6), 1909. https://doi.org/10.1111/iwj.13481	Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIB	How does AI software help wound identification and monitoring as opposed to traditional clinician-based methods?	Google Scholar search engine	Inclusion criteria were: (a) description, (b) measurement accuracy, or (c) clinical use or challenges of imaging systems, technology, applications, or software in wound assessment of diabetic foot ulcers. Exclusion criteria were: (a) other types of wound such as pressure ulcers, (b) conventional radiological imaging such as plain radiograph, ultrasound, computed tomography or magnetic resonance imaging, (c) review articles, letter to editors or editorials, (d) non-English articles or (e) articles without full texts.	Data Extraction: Data information was extracted from each study separately: Author, year of study, type of wound assessed, name of system, clinical use, parameters of wound assessed, measurement statistics, ability to integrate into Electronic Health Records (EHRs) or Electronic Medical Records (EMRs) other advantages and challenges. Analysis: 35 articles were assessed and 17 articles were included. Authors were only able to provide a descriptive analysis of the studies as the studies varied in intervention and outcome measures.	Documentation and assessment using computer software, handheld and mobile devices, optical imaging, spectroscopy, and artificial intelligence have superior accuracy over traditional wound care methods.	Results concluded that most imaging systems are superior to traditional wound assessment, especially relating to diabetic foot ulcers.
Kikuchi, R. (2020). Application of Artificial Intelligence Technology in Nursing Studies: A Systematic Review. <i>Online Journal of Nursing Informatics</i> , 24(1), 2.	Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIB	Does incorporation of artificial intelligence in nursing school impact nursing jobs viability in aid in	Google Scholar search engine	Inclusion: (1) the nursing study employed AI technology; (2) publication was in English or Japanese; (3) the original article was in a peer-reviewed journal; and (4)	Data Extraction: The last name of the first author, published year, objective(s) of the study, role of AI, machine learning, deep learning, or artificial neural networks in the study, dataset, limitations and	AI technology demonstrated high-performance capability and attained the objectives in	The research suggested that AI technology can significantly aid in developing nursing research. In some studies, the performance of AI technology was higher

Citation	Quality Grade	Question	Search Strategy	Inclusion/Exclusion Criteria	Data Extraction and Analysis	Key Findings	Usefulness/Recommendation/Implications
		future nursing study direction?		<p>publication was on or before November 7, 2018.</p> <p>Exclusion: (1) not a nursing study and/or not employing AI technology; (2) publication in a language other than English or Japanese; (3) not an original article in a peer-reviewed journal.</p>	<p>key findings regarding the technology, and discipline of nursing were extracted from each article. The discipline of nursing was then categorized based on a focused theme for each article.</p> <p>Analysis: The summary of the articles is presented in Table 2. The findings for this review were based on the following: (1) methodology, (2) discipline of nursing, (3) types of AI technology, (4) research objectives and role of AI technology, (5) dataset, (6) key findings, and (7) limitations regarding the AI technology.</p>	<p>most relevant studies. AI technology can adapt to various nursing disciplines.</p>	<p>than that of traditional statistical methods, such as hierarchical stepwise regression</p>
<p>Scardoni, A., Balzarini, F., Signorelli, C., Cabitza, F., & Odone, A. (2020). Artificial intelligence-based tools to control healthcare associated infections: A systematic review of the literature. <i>Journal of Infection and Public Health</i>, 13(8), 1061–1077. https://doi.org/10.1016/j.jiph.2020.06.006</p>	<p>Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IIB</p>	<p>As Healthcare-associated infections (HAIs) are a global problem, how does the use of AI or machine learning (ML) help real time detection?</p>	<p>Google Scholar search engine</p>	<p>Inclusion was restricted to full text papers; conference abstracts, posters and study protocols were excluded. Outcomes of interest included all possible performance measures, as well as all possible clinical, organizational and economic outcomes.</p> <p>Exclusion: No restrictions identified by authors,</p>	<p>Data extraction included: authors' affiliation, journal, publication year, country of studies' implementation, study design, study setting, study period, type of infection, sample size, machine learning model (intervention), comparison model, information on analysis performed, outcomes of interest, prediction metrics and results.</p> <p>Analysis: analysis to report the characteristics of included studies. Variables' categories regrouping was carried out as following: authors' affiliation was categorized into clinical departments and/or information technology (IT) departments; information on private sector involvement in the authorship was acknowledged. Study setting was divided into surgery and emergency departments, intensive care units (ICU) or general hospital inpatient setting. ML models were categorized in <i>predictive</i> – helpful to detect real-time patients' risk of</p>	<p>When it comes to HAI surveillance there continues to be a need for testing and detection of AI models in health care settings. Further research is needed, although preliminary studies are moderate at the moment.</p>	<p>In the future, ML-based HAI's may reduce cost to patients and hospitals and improve safety, improve understanding of risk factors, as well as real time detection and control.</p>

Citation	Quality Grade	Question	Search Strategy	Inclusion/Exclusion Criteria	Data Extraction and Analysis	Key Findings	Usefulness/Recommendation/Implications
					HAI – and <i>retrospective</i> – helpful for surveillance and epidemiological analysis.		
<p>Seibert, K., Domhoff, D., Bruch, D., Schulte-Althoff, M., Furstenu, D., Biessmann, F., & Wolf-Ostermann, K. (2021). Application Scenarios for Artificial Intelligence in Nursing Care: Rapid Review. <i>Journal of Medical Internet Research</i>, 23(11). https://doi.org/10.2196/26522</p>	<p>Johns Hopkins Nursing EBP Level of Evidence / Quality Grade: IA</p>	<p>What are the ethical, legal, and social issues surrounding the application of AI in nursing care?</p>	<p>Google Scholar search engine</p>	<p>Inclusion criteria: data privacy, safety, and technology acceptance. Ethical, legal, and social implications reflect the discourse on technology use in health care but have mostly not been discussed in meaningful and potentially encompassing detail.</p> <p>No exclusion criteria expressed by authors.</p>	<p>Data extraction: Author, year, country of origin, setting, target group of users or benefactors, Methods used or addressed, purpose of the AI application</p> <p>Analysis: We used established evidence-based nursing and evidence-based medicine hierarchies and ranked LOEs from level I (highest evidence) to level VII (lowest evidence),</p> <p>-7016 publications and 704 full texts were screened, and 292 publications were included.</p>	<p>Although there is potential for AI use in various settings, real-world scenario outcomes in nursing still require further testing.</p>	<p>Implications for Policy Makers: increase in research funding for AI, and nursing research regarding the use of AI for nurses</p>
<p>Vaughan, G., Prizeman, G., Eustace-Cook, J., & Byrne, G. (2021). Use of mHealth apps by nurses in the management of chronic wounds: a scoping review protocol. <i>JBI Evidence Synthesis</i>, 19(10), 2783–2789. https://doi.org/10.11124/JBIES-20-00401</p>	<p>Johns Hopkins Nursing EBP Level of Evidence: IIA</p>	<p>1) What mHealth apps are nurses using to assist in the management of chronic wounds?</p> <p>2) Have these apps been evaluated, and if so, what types of evaluation have been conducted and what are the outcomes of the evaluation?</p>	<p>Google Scholar search engine</p>	<p>Inclusion: Studies involving nurses of all grades in all clinical settings who are involved in the care and management of chronic wounds will be included. Also, nurses' use of mHealth in the management of chronic wounds and any methods used to evaluate these apps.</p> <p>Exclusion: Full-text studies that do not meet the inclusion criteria.</p>	<p>Data Extraction; See appendix II: which include a number of items such as but not limited to: Methodology, was app evaluated, type of evaluation used</p> <p>Analysis: summarize data on the use of mHealth apps by nurses in the management of chronic wound care and the evaluation of such apps to map available evidence and identify gaps in the literature.</p> <p>10 articles</p>	<p>Protocols for search strategies and data extraction tool developed.</p>	<p>Tools can be utilized when making decisions to use a certain wound app.</p>

Legend: Artificial Intelligence (AI)

Appendix D

SWOT Analysis

Strengths:	Weaknesses:
<p>Core Value and Mission- The organization strives to find innovative ways to create access for patients and staff.</p> <p>Stability with New Acquisition- The hospital reported financial gain in 2020 amidst the COVID-19 pandemic due to their high volume of need in the community and patients with Medicare and Medicaid as primary insurance. The hospital then was purchased in 2021 creating a broader financial security with the other 44 hospitals in network to provide financial backup for innovative projects and improvements.</p> <p>IT Growth- IT capacity and support are available to implement the project once it has been agreed upon by stakeholders/owners.</p> <p>Support -There is support from clinic management and healthcare staff.</p>	<p>Policies are Changing –The hospital’s policies are changing and concerned about proposing investing capital in a project.</p> <p>Employee Incentives- Due to the changes in employees and administration, incentives are currently not in place to involve staff in projects.</p>
Opportunities:	Threats:
<p>The employees are willing to be trained.</p> <p>Outcome management can be feasible through staff and IT cooperation.</p> <p>Reasons why the EBP change project should be considered and implemented is understood by leadership personnel (safety, time efficiency of employees, and positive outcomes for patients).</p>	<p>Staff are hesitant to change due to the ongoing changes.</p> <p>The project still requires a particular app to be selected to guide the implementation process. This may slow down the project itself.</p>