Summer 8-12-2020

The Use of Online Applications to Improve Chronic Wound Care in Primary Care; A Literature Review

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Abstract

Background:

Chronic wounds are a major burden on patients, health care professionals, and the healthcare system. Primary care professionals need to be prepared with the information and skills that will help them perform high-quality wound care.

Objective: The purpose of this manuscript is to assess the use of mobile applications to support health care providers in primary care who care for patients with chronic wounds.

Data Sources: A review of the evidence was performed using CINAHL, Cochrane/ DARE, PubMed, Ovid, and Evidence-Based Journals to explore the consequences of using online wound care applications by primary care practitioners.

Conclusions: The literature showed that using smartphone applications in wound management had positive outcomes. The professionals who access the software apps were better equipped to provide wound management than those who were not.

Implications for practice: Wound care smartphone applications would allow primary care providers to overcome time stress by accessing resources needed for evaluating, recognizing, and treating wounds.

Keywords: Wound care, wound management, wound assessment, measurement, documentation, mobile application.

Background

Chronic wounds place an enormous burden on patients and the health care system. Chronic wounds have a long-term effect on patients' lives, as well as create a significant cost for the healthcare system (Lindsay et al., 2017). Each year, chronic wounds impact 6.5 million patients in the US (Sen et al., 2009), and more than $25 billion is spent yearly on wound treatment (Atkin, 2019). Viable treatment to improve healing rates for wounds might decrease costs by as much as 30 percent (Vowden & Vowden, 2016).

Primary care providers play an essential role in both health after-effects and costs related to the treatment of wounds (Yelland, 2014). Treating chronic wounds can pose a challenge for health professionals (Atkin, 2019), and wound care is a developing issue for healthcare settings over the world (Swanson, Duynhoven, & Johnstone, 2019). One of the significant obstacles to improving wound care is the lack of instruction for health professionals. Limited awareness and understanding of wound management results in lack of confidence in treating patients with wounds (Blackburn, Ousey, & Stephenson, 2019). In addition, differing organizational guidelines present obstacles to a standardized provision of care (Kulikov, Sandhu, & Van Leuven, 2019). A wound may have divergent evaluation reports made by different practitioners. This could lead to varying or conflicting interpretations (Bajay & Araújo, 2017). The use of a standardized and systematic technique assists the providers in the correct assessment of the wound (Al-Habib et al., 2018) and the reliability in the therapeutic behavior (Bajay & Araújo, 2017).

Achieving wound management outcomes is subject to accessing evidence-based wound management tools (Yelland, 2014). Smartphones are becoming more commonly used than

printed books and journals, and easily accessible because of their transportability (Salome & Ferreira, 2018). Several medical applications (apps) have been designed for smartphones and used by healthcare clinicians. These apps make smartphones valuable tools in the evidence-based practice at the point of care (Mosa, Yoo, & Sheets, 2012). The use of online mobile applications with different functions could supply the support that primary care providers need to provide care for their patients with chronic wounds (Appendix B)

Method

This literature review included a comprehensive database search of CINAHL, Cochrane/DARE, PubMed, Ovid, and Evidence-Based Journals. The search was driven by the PICOT question: In the primary care setting, among providers who treat chronic wounds (P), does the use of an online application (I), as opposed to not using the app (C), improve wound outcomes (O)? Search terms included wound care, wound management, mobile applications, wound assessment, wound measurement, and wound documentation. Initially, a total of 47 articles were found. Inclusion criteria were research studies from any country, written in English, focusing on adult patients, and providing answers to the PICOT question. Finally, seven articles were selected based on a full review and meeting the inclusion criteria. The evaluation of articles was done using the Johns Hopkins Nursing Research Evidence Appraisal Tool (Dang & Dearholt, 2017). The quantitative and qualitative studies reviewed included strength of evidence A and B, and quality of level I and II (Appendix A & H).

Literature Review

Mobile applications for wound imaging

The advancement of smartphone apps and digital medical devices offers an opportunity for major changes in wound management through the implementation of smart technologies in clinical practice (Shamloul, Ghias, & Khachemoune, 2019). Today, smartphones have become a feasible candidate for image capture and have replaced digital cameras (Niri, Lucas, Treuillet, & Douzi, 2019). Fraiwan et al. (2017) developed an ulcer detection device based on a smartphone app and mobile thermal camera (FLIR ONE). The device was tested on four images taken by the thermal image acquisition camera and smartphone to demonstrate that skin regions with hyperthermia with a temperature gradient more than 2.2°C reflect potential ulcers. They found that the proposed method was efficient and helped diabetic patients self-check their feet, and perfectly recognize vulnerable areas with effectiveness in the prevention of foot ulcers. In 2018, Nair carried out another study to assess productivity improvement using digital imagery for better documentation and analysis. The digital imagery application was designed to measure and document wounds effectively. This non-invasive software app was helpful in terms of cost-effectiveness, time-saving, productivity saving, user-friendly, greater photographic clarity to promote multidisciplinary discussion, and lowering errors in clinical wound-management documentation. Patients and caregivers may also use the application to track the wounds at home.

Wound applications improve measurements

Wound measurement is important not only as a means for monitoring wound progression but also for predicting wound healing (Wang et al., 2017). Wang et al., (2017) created a

smartphone application (Swift Wound app) that allowed non-contact surface area and temperature measurements. The study addressed periwound temperature rise as a typical sign of infection but skin temperature is not always measured during wound assessments. They concluded that the Swift Wound application provided highly reliable and accurate wound measurements. The FLIR™ infrared camera incorporated into the Swift Wound application also provided skin temperature measurements similar to the clinically validated reference thermometer. Generally, this technology had the potential to have a significant effect on clinical management and patient outcomes. The advantage of Swift Wound application was that it was a non-contact and user-friendly wound measurement tool that allowed providers to image, measure, and track wound size and temperature from one visit to the next. In addition, this method can be used for home monitoring by patients and their caregivers. Though health care practitioners can measure and inspect the wounds visually with disposable rulers, this method is not reliable with up to 44 percent error found in the measurements (Yee, Harmon, & Yi, 2016). The reliability of wound surface measurements using a mobile app against the traditional ruler method was tested by Seat and Seat in 2017. This research showed that the mobile wound assessment software (Tissue Analysis) provided reasonably reliable outcomes to be useful in the practical management of chronic wounds and looked to be greater than the ruler method. The participants (raters) had very positive feedback and interest in the software application and other wound documentation features.

Online applications promote wound management

Using healthcare technology in primary care through software applications promotes patient care and wound care assessment, diagnosis, and treatment, consequently lowering

complications and improving outcomes (Beitz, Gerlach, & Schafer, 2014). A smartphone app, named D+Wound Solution, was developed to explain the condition of the wound and provide a practical treatment idea for wound management practitioners. The D+Wound Solution app had six modules for evaluation called D.I.R.E.C.T. The aim of this application was to provide users, particularly novice in wound management, with an awareness and analysis of the essential elements (D.I.R.E.C.T.) for wound healing in addition to providing guidance on treatment solutions. The rationale and treatment guide of the algorithm were similar to those of skillful wound management professionals, and was found to be a valuable assessment tool for less-experienced wound management practitioners (Jun et al., 2016). The mobile applications also improve the diagnostic precision and early wound intervention while preventing further wound deterioration (Kulikov et al., 2019). For example, a smartphone application (WounDS) was developed to help clinical decision-making in selecting wound dressings (Jordan et al., 2018). Although the study evaluation was in progress, using the app had advantages including improvement in wound healing by better aligning with evidence-based practices in wound dressing selection, consistency from primary care to community care, and effects on patients' quality of life. In addition, this application enabled healthcare practitioners to provide wound management and helped in transferring wound management knowledge among clinicians which could result in cost savings for the health system. It was notable that Family Medicine residents were keen to collaborate with wound care specialists on this plan. WounDS was the first mHealth app for wound dressing selection and it was a proof-of-concept for this app. Delays in wound healing via substandard diagnosis and differences in treatment may lead to worse outcomes for patients and higher costs for the health care system (Vowden and Vowden, 2016).

A recent study findings revealed that the healthcare providers experience time constraints to use clinical decision-making tools in their wound care practice and perform evidence-based wound management (Grothier, 2018). An online application, called the Wound Care Buddy App, was created to support healthcare clinicians in providing standardized care and ensuring that evidence-based practices were applied to every patient. The aim was to begin the process of becoming paperless and finding solutions to allow clinicians to access clinical information in a fast, easy, and digital way. The findings demonstrated an increase in practitioners' skills and confidence. The application contained wound care and treatment guidelines, and formulary information in an understandable and reasonable style. The wound assessment and treatment guides were specifically helpful for novice staff. The application assisted professionals with their clinical decision making (selecting suitable dressings and antibiotics), documentation, and effective treatment planning to enhance patient care. This standard framework can be used by any wound management service organization (Patel, et al., 2019).

Discussion

The use of mobile apps as educational, treatment, and diagnostic devices is creative and enhances interest and motivation in learning (Salome & Ferreira, 2018), and improves data collection quality (Divall, 2013). Healthcare practitioners can benefit from software applications that give them immediate access to wound management best practice guidance at the point of care (Patel, Irwin, & Allam, 2019).

Wound care treatments depend on accurate assessment and measurement of the wounds. Novel apps have been proposed for more accurate evaluations of wound healing measurements, such as use of smartphones and apps in combination with imaging software (Shamloul et al.,

2019). While most traditional measurement methods require direct contact of the measurement instrument (ruler or plastic film) with the wound, many modern techniques are non-contact and use digital image analysis (Haghpanah, Bogie, Wang, Banks, & Ho, 2016). The high-quality imaging available on current smartphones can dramatically increase precision and reliability of wound measurements without the need for any special training. These apps substantially promote wound management documentation without the need for special equipment (Seat & Seat, 2017).

Conclusion

Primary care clinicians should be confident and able to provide routine basic care with chronic wounds and refer complex cases to experts in wound care. The use of a smartphone software app, addressing standards and guidelines that are regularly updated and easy to access, may have many positive outcomes. The software would also benefit the practitioner because it would serve as a guide and reference that can improve practitioner's confidence level in evaluating and developing a wound care plan.

References

Al-Habib, M. Y., Alsayil, S. N., Al-Qasim, O. S., Alrayyes, S. F., Al-Saedi, J. A., Alshammari, A. M., Al-Jaffar, A. A., Al-Jassim, I. M., Almutairi, M. A., Alreshidi, H. F., & Alshammari, H. N. (2018). Wound Management in Primary Care: A Review. *The Egyptian Journal of Hospital Medicine*, 70(3), 514-519.

Atkin, L. (2019, September). Chronic wounds: The challenges of appropriate Management. *Community Wound Care*, 26-32.

Bajay, H. M., & Araújo, I. E. M. (2017). Validação e confiabilidade de um instrumento de avaliação de feridas. Acta Paul Enferm;19(3), 290-5.

Beitz, M. J., Gerlach, A. M., & Schafer, V. (2014). Construct validation of an interactive digital algorithm for ostomy care. *Journal of Wound, Ostomy and Continence Nursing*, 41, 49–54.

Blackburn, J., Ousey, K., & Stephenson, J. (2019). Nurses' education, confidence, and competence in appropriate dressing choice. *Advances in skin & wound care*, 32(10), 470-476.

Dang, D., & Dearholt, S. (2017). Johns Hopkins nursing evidence-based practice: model and guidelines. 3rd ed. Indian polis, IN: Sigma Theta Tau International.

Divall, P. (2013). The use of personal digital assistants in clinical decision making by health care professionals: A systematic review. Health Informatics Journal, 19, 16–28.

Fraiwan, L., AlKhodari, M., Ninan, J., Mustafa, B., Saleh, A., & Ghazal, M. (2017). Diabetic foot ulcer mobile detection system using smartphone thermal camera: A feasibility study. *Biomed Eng Online*, 16, 117. doi:10.1186/s12938-017-0408-x

Grothier, L. (2018). What are the challenges for community nurses in implementing evidence-based wound care practice? (part 2). *Wounds UK*, 14(5), 34–9.

Haghpanah, S., Bogie, K., Wang, X., Banks, P. G., Ho, C. H. (2006). Archives of Physical Medicine and Rehabilitation, 87, 1396-1402. doi:10.1016/j.apmr.2006.06.014

Jordan, S., McSwiggan, J., Parker, J., Halas, G. A., & Friesen, M. (2018). An mHealth App for Decision-Making Support in Wound Dressing Selection (WounDS): Protocol for a User-Centered Feasibility Study. *Journal of Medical Internet Research,* 7(4), e108. doi: 10.2196/resprot.9116

Jun Y. J., Shin, D., Choi, W. J., Hwang, J. H., Kim, H., Kim, T., G., Lee, H. B., Oh, T. S., Shin, H. W., Suh, H. S., Lee, A. Y., & Hong, J. P. (2016). A Mobile Application for Wound Assessment and Treatment: Findings of a User Trial. *The International Journal of Lower Extremity Wounds*,15(4) 344–353. doi: 10.1177/1534734616678522

Kulikov, P., Sandhu, P. K., & Van Leuven, K. A. (2019, February). Can a smartphone app help manage wounds in primary care? *Journal of the American Association of Nurse Practitioners*, 31(2), 110-115.

Lindsay, E., Renyi, R., Wilkie, P., Valle, F., White, W., Maida, V., Edwards, H., & Foster, D. (2017, November). Patient-centred care: A call to action for wound management. *Journal of Wound Care,* 26(11).

Mosa, A. S. M., Yoo, I., & Sheets, L. (2012). A Systematic Review of Healthcare Applications for Smartphones. *BMC Medical Informatics and Decision Making*, 12, (67).

Nair, H. K. R. (2018). Increasing productivity with smartphone digital imagery wound measurements and analysis. *Journal of Wound Care*, 27(9), S12-S19.

Niri, R., Lucas, Y., Treuillet, S., & Douzi, H. (2019). Smartphone-based Thermal Imaging System for Diabetic Foot Ulcer Assessment. *Journées d'Etude sur la TéléSanté.* https://hal.archives-ouvertes.fr/hal-02161044

Patel, A., Irwin, S. L., & Allam, D. (2019). Developing and implementing a wound care app to support best practice for community nursing. *Wounds UK,* 15(1), 90-95.

Salome´, G. M., & Ferreira, L. M. (2018). Developing a Mobile App for Prevention and Treatment of Pressure Injuries. *Advances in Skin & Wound Care*, 31(2).

Seat, A., & Seat, C. (2017). A prospective trial of interrater and intrarater reliability of wound measurement using a smartphone app versus the traditional ruler. *Wounds*, 29(9), E73–E77.

Sen, K. S., Gordillo, M. G., Roy, S., Kirsner, R., Lambert, L., Hunt, K. T.,… Longaker, T. M. (2009). Human skin wounds: A major and snowballing threat to public health and the economy. *Wound Repair Regen*, 17, 763–771.

Shamloul, N., Ghias, M. H., & Khachemoune, A. (2019). The Utility of Smartphone Applications and Technology in Wound Healing. *The International Journal of Lower Extremity Wounds*, 18(3), 228 –235. doi: 10.1177/1534734619853916 journals.sagepub.com/home/ijl

Swanson, T., Duynhoven, K., & Johnstone, D. (2019). Using the new T.I.M.E. Clinical Decision Support Tool to promote consistent holistic wound management and eliminate variation in practice at the Cambourne Medical Clinic, Australia: Part 1. *Wounds International*, 10(2), 28-39.

Vowden, P. & Vowden, K. (2016). The economic impact of hard-to-heal wounds: promoting

practice change to address passivity in wound management. *Wounds International*, 7(2), 10-15.

Wang, S. C., Anderson, J. A. E., Evans, R., Woo, K., Beland, 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

Yee, A., Harmon, J., & Yi, S. (2016). Quantitative monitoring wound healing status through three-dimensional imaging on mobile platforms. *The Journal of the American College of Certified Wound Specialists,* 8, 21-27. doi: 10.1016/j.jccw.2017.11.001

Yelland, S. (2014). General practice and primary care: Making a difference at the coalface of wound management in Australia. Wound Practice & Research: *Journal of Australian Wound Management Association,* 22, 104–107. Retrieved from http://www.woundsaustralia.com.au/journal/index.php

Appendix A: Evaluation Table

Purpose of Article or Review	Conceptual Framework	Design / Method	Sample / Setting	Major Variables Studied (and their Definitions)	Measurement of Major Variables	Data Analysis	Study Findings	Level of Evidence (Critical Appraisal Score) / Worth to Practice / Strengths and Weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
APA Reference: Fraiwan, L., AlKhodari, M., Ninan, J., Mustafa, B., Saleh, A., & Ghazal, M. (2017). Diabetic foot ulcer mobile detection system using smartphone thermal camera: A feasibility study. *Biomed Eng Online*, 16, 117. doi:10.1186/s12938-017-0408-x								
To create an ulcer detection/indication system based on a mobile thermal camera and a smartphone application.	None	Feasibility study/ The thermal imaging system has a measured temperature gradient of more than 2.2 ° C, which may suggest a potential development of ulcers. The	The proposed system was introduced under MATLAB Mobile platform and thermal images, which consists of a thermal camera attached to the Samsung mobile.	IV: -FLIR ONE infrared thermal camera -Samsung Galaxy S6 Edge Plus smartphone with image processing and analysis software -MATLAB Mobile Android application DV: -Camera parameters	FLIR ONE cameras	-Otsu thresholding technique -t-test -Point-to-point difference technique	-Efficient in perfectly recognizing vulnerable areas with effective prevention of foot ulcers. -Diabetic patients self-check their feet for potential ulcers.	**Strength:** -The system can be extended to other applications such as wound healing and trauma monitoring **Limitations:** **-**It offers only an indicative tool, not a diagnostic tool, as the final diagnosis should be made by a physician. -Due to strict regulations, the system was not tested and validated in a clinical setting. **Recommendations:**

		images are processed and segmented using basic image processing techniques, which are: Otsu thresholding technique and Point-to-Point mean difference technique.		(scene temperatures range, operating temperature, sensitivity, resolution) -Images of simulate ulcer				-Upgrading the system with an advanced thermal camera with better image quality that can be attached to a cellphone in future -Further testing and validation of the system should be conducted in a clinical setting **Critical Appraisal Tool & Rating:** Johns Hopkins Research Evidence Appraisal Tool: II A

Definition of abbreviations:

Purpose of Article or Review	Conceptual Framework	Design / Method	Sample / Setting	Major Variables Studied (and their Definitions)	Measurement of Major Variables	Data Analysis	Study Findings	Level of Evidence (Critical Appraisal Score) / Worth to Practice / Strengths and Weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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To design a prototype mobile health software application called *WounDS*, intended to assist clinical decision-making in choosing wound dressings.	Lazy user model	Pilot study/ The primary criteria of *WounDS* app for user acceptance was ease of use (ability to provide a prescription for wound dressing in less than 30 seconds and under five taps on the computer). The	Wound DS app was built on the iOS platform	IV: The application design: -Small, simple, & uncomplicated software architecture -Using preset wound dressing options related to the health region's purchasing contracts -Ease of use DV: -Patient-centered wound	None	None	-Proof-of-concept: first known mHealth app for wound dressing selection -Improvement in wound healing by better aligning with evidence-based practices in wound dressing selection, consistency from primary care to	**Strengths:** -This app concept can be possibly integrated with electronic medical record systems, and SmartWoundCare for assessment and treatment of pressure ulcers & diabetic foot ulcers, also developed within the research team, as well as blood glucose & blood pressure monitoring tools. **Limitation:** -No evaluation: study evaluation was in progress **Critical Appraisal Tool & Rating:**

		app guided users to assess and makes a recommendation for wounds. The algorithms are based in using the Wound Bed Preparation Paradigm.		care approach -Assessments towards wound dressing selection			community care, and effects on patients' quality of life. -Helped in transferring wound care knowledge among clinicians which could result in cost savings for the health system	Johns Hopkins Research Evidence Appraisal Tool: II B

Definition of abbreviations:

Purpose of Article or Review	Conceptual Framework	Design / Method	Sample / Setting	Major Variables Studied (and their Definitions)	Measurement of Major Variables	Data Analysis	Study Findings	Level of Evidence (Critical Appraisal Score) / Worth to Practice / Strengths and Weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
APA Citation: Jun Y. J., Shin, D., Choi, W. J., Hwang, J. H., Kim, H., Kim, T., G., Lee, H. B., Oh, T. S., Shin, H. W., Suh, H. S., Lee, A. Y., & Hong, J. P. (2016). A Mobile Application for Wound Assessment and Treatment: Findings of a User Trial. *The International Journal of Lower Extremity Wounds*,15(4) 344–353. doi: 10.1177/1534734616678522								
The D+Wound Solution application was built to provide a practical and easy solution for professional wound management and use as an education and preparation tool for the correct dressing preference for wound caregivers.	None	Project/ D+Wound Solution app was developed and equipped with a simple wound assessment algorithm, called D.I.R.E.C.T (had six components) and a guide to an appropriate	N= 118 nurses, divided into two groups (experienced and less-experienced groups) were surveyed.	IV: D+Wound Solution mobile application, photos DV: debridement, infection control, revascularization, and exudate control, chronicity of the wound, top surface of the skin	-Survey -D.I.R.E.C.T. algorithm	χ 2 test	-The software was helpful in setting up a treatment plan during clinical use. -Application was greatly more helpful for less-experienced providers during clinical assessme	**Recommendations:** -Further study is needed regarding how this app can be helpful as an educational and training tool for accurate dressing selection and reduces the time needed to make a treatment decision. -This app may assist users to provide guidance on how to achieve healing in different wounds. **Critical Appraisal Tool & Rating:** Johns Hopkins Research Evidence Appraisal Tool: I A

		dressing solution					nt of the wound. -Algorithm's logic and treatment guideline were similar to those of experienced wound management practitioners	

Definition of abbreviations:

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APA Reference: Nair, H. K. R. (2018). Increasing productivity with smartphone digital imagery wound measurements and analysis. *Journal of Wound Care*, 27(9), S12-S19.								
To assess productivity improvement using digital imagery for better documentation and analysis.	None	Project: Wounds were cleaned & debrided before imaging, documenting, measuring & analysing. Mobile app was directed parallel to the wound to obtain precise measurements. A longitudinal study was	N=60 patients with different wounds & N=203 measurements and analyses over a period of seven months at the Wound Care Unit, Hospital Kuala Lumpur	IV: wound length <20cm and width <20cm, age, gender, race, smartphone app & camera, internet or 4G connection, android or iOS platform DV: Cost/hour, cost & time savings/patient, productivity increase in time	-Smartphone app to measure wounds -Smartphone camera to take photo & video	Not provided	-Required less than two hours' training -App provided a cost-effective, time-saving, productivity saving, non-contact, user-friendly, reliable & accurate solution for practitioners to monitor wound healing -Provided greater photographic clarity to promote	**Strengths:** -Non-invasive nature of app -Patients and caregivers may use app to track the wounds at home. **Limitations:** -Not compared with traditional methods for comparative analysis -Time measurement was an estimation based on author's experience rather than actual timing **Critical Appraisal Tool & Rating:** Johns Hopkins Research Evidence Appraisal Tool: II A

		produced for each wound & results showed progress of the wound healing until the wound was closed.					multidisciplinary discussion, improve workflow, and lowering errors in clinical wound-management documentation.	

Definition of abbreviations:

Purpose of Article or Review	Conceptual Framework	Design / Method	Sample / Setting	Major Variables Studied (and their Definitions)	Measurement of Major Variables	Data Analysis	Study Findings	Level of Evidence (Critical Appraisal Score) / Worth to Practice / Strengths and Weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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To create a wound care smartphone app to support healthcare clinicians in providing standardized care and ensuring that evidence-based practices were applied to every patient.	None	Project: Wound Care Buddy App was created & displayed current organization's protocol on wound assessment, treatment, wound dressings. Healthcare clinicians were equipped with iOS	N=118 active users The app was developed by Entec Health & implemented for community nurses' iphones with collaboration of Tissue Viability Team at the HRCH NHS	IV:The Wound Care Buddy App, iOS phones, app's content (organisation's current guidelines on wound care) -DV:Staff skills & confidence, documentation, decision making for dressings & antibiotics, formulary listing, wound treatment guidelines	-Communication plan via emails -Meetings with ten District Nursing Teams -Comments & report from clinicians & a small focus group	Not provided	-Increase in practitioners' skills and confidence. -The app as a guide was specifically helpful for novice staff -The app assisted professionals with their clinical decision making (selecting suitable	Strengths: -Healthcare clinicians can use the application on both iOS & Android. -Notable opportunity for adding further improvements & new developments to the Wound Care Buddy App. -This standard framework can be used by any wound management service organization **Limitations:** -Difficult adoption for some clinicians to accept app **Critical Appraisal Tool & Rating:**

		platforms with the Wound Care Buddy app for communication & easily access to guidelines and wound formulary product	Trust for 12 months in 2017				dressings & antibiotics), documentation, and effective treatment planning.	Johns Hopkins Research Evidence Appraisal Tool: II A

Definition of abbreviations:

Purpose of Article or Review	Conceptual Framework	Design / Method	Sample / Setting	Major Variables Studied (and their Definitions)	Measurement of Major Variables	Data Analysis	Study Findings	Level of Evidence (Critical Appraisal Score) / Worth to Practice / Strengths and Weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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To test the reliability of wound surface measurements using a mobile app (Tissue Analysis) against the traditional ruler method	None	Prospective study: Raters measured a set of wound images. Every rater measured the same photos twice (once using a ruler & then using a mobile app) on day one. Then repeated these two measure	N=25 volunteers (raters) including medical students, residents, attendings, & nurses N=12 set of images of different sizes and shapes of wounds	IV:Mobile app, camera, machine learning and computer vision algorithms, raters with different clinical experiences, images of wounds with different sizes & shapes DV:Wound surface area (length & width)	-Mobile app (Tissue Analysis) available both iOS and Android platforms -Linear measurement with a ruler	-SPSS -Excell -t-test -Interrater reliability -Intraclass correlation coefficient (ICC) -Two-way mixed effect model -Fleiss' Kappa scale	-Tissue Analysis app provided reliable outcomes -The app was useful in practical management of chronic wounds -The app appeared superior to the ruler method The participa	**Limitations:** -Use of wound images as substitutes for real wounds (images reflect glare, causes miscalculation of wound borders by app's algorithms) - Images did not show app measurements from various angles -Analysts were not able to evaluate algorithms of app for lighting, distance & camera angle **Recommendations:** -Future studies with the same app &

		ments on the same set of images one week later.					nts (raters) had very positive feedback and interest in the software applicati on and other wound documen tation features.	research agreement on actual wounds **Critical Appraisal Tool & Rating:** Johns Hopkins Research Evidence Appraisal Tool: I A

Definition of abbreviations:

Intraclass correlation coefficient (ICC)

Purpose of Article or Review	Conceptual Framework	Design / Method	Sample / Setting	Major Variables Studied (and their Definitions)	Measurement of Major Variables	Data Analysis	Study Findings	Level of Evidence (Critical Appraisal Score) / Worth to Practice / Strengths and Weaknesses / Feasibility / Conclusion(s) / Recommendation(s) /
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To design the Swift Wound application that measures non-contact wound surface area and temperature, & determine its inter-rater reliability & accuracy.	None	Project/ Assessed patients' wounds using the Swift Wound app and measured skin surface temperature using infrared FLIR™ camera integrated into the app & thermometer Exergen DermaT	N=124 patients & N=5 expert raters from Wound Care Centre at Women's College Hospital (Canada	IV: Swift Wound app, iPhone 6 devices running iOS version 8.4, ruler, infrared FLIR™ camera, clinically accepted reference thermometer Exergen DermaTemp 1001 DV: wound (length, width, surface area)	-FLIR one infrared camera -Swift Wound app -Standard temperature probe	-Psych package in R -ANOVA -t-test	-Swift Wound app provided highly reliable & accurate wound measurements -Standard ruler method also offered relatively accurate measurements of length and width,	**Strengths:** -This app calculates wound dimensions fast and easily without touching the wound surface. -Infrared FLIR one camera detects localized changes in skin surface temperature to identify signs of inflammation or infection, and monitoring changes in wound size over time. -Patients and their caregivers may use this tool for home monitoring

		emp 1001.		measurement, photos of plastic wounds, surface skin temperatures of wound and the contralateral limb			but was less vigorous than the app. -Swift Wound and FLIR1 infrared camera temperature measurements were equivalent to scientific standard instruments. -Swift Wound app provided a better assessment of wound healing over time compared to basic ruler length and width measurements	-Being able to visualize difficult-to-see wounds using digital imaging can enhance patient satisfaction, adherence to treatment & engagement in their own wound management -Swift Wound app is a cost-effective, friendly-use, reliable and accurate tool for wound measurement. -It is also capable of photo-documenting and monitoring wound healing over time. -This tool has the potential to significantly improve the efficiency of assessing and recording improvements in wound healing & sharing this information between stakeholders. -This is the first study to validate clinically a smartphone app for measurement of

							-The app was reliable for various wound shapes -Overall, this technology had the potential to have a significant effect on clinical management and patient outcomes.	wound size and temperature -Swift Wound software can be used efficiently by both expert and non-experts in wound management **Limitations:** -Plastic model wounds have clear margins, while the wound edge in a real patient is often not well defined. Difference between wound measurements is a challenge for both traditional & modern digital wound imaging tools. **Recommendations:** -Swift Wound software automatically identifies wound edges with clear colour contrast. But, when there is encircling inflammation and poor colour contrast, it is important to manually classify wound margins. -Also, this app enables providers to

								retrieve and overlay previous marks of the wound edge on newly acquired images. -Further studies may obtain a large samples of wound shapes and sizes to expand the outcome **Critical Appraisal Tool & Rating:** Johns Hopkins Research Evidence Appraisal Tool: I A

Definition of abbreviations:

Appendix B: Wound care mobile applications

Name	Description	Cost
Hartmann Australia	Assists with dressing selection	Free
Mobile Wound Care 2.0	Made for practitioner, automated wound measurements, tracking of wound, photograph capture and documentation, availability of graphs for analysis	Free
MobileWoundCare for Patients	Patients document and share images with providers. Includes wound measurement too	Free
PointClickCare Skin and Wound	Improves clinical efficiency by enabling automated wound assessments, image capturing and eliminating redundant documentation	Free
Skin Health Product Selector	Customizable dressing selector too	Free
SmartWoundCare	Assist in documentation and assessment of wounds	Free
SuprathelAssist	Communication and assessment tool	Free
Swift Skin and Wound 2.0	Provides images, data, and best practices on wound care; practice management	Free (requires subscription)
The Wound Care Notebook	Assists health care professionals to find information of wound care products	Free
Trust Robin Wound care	Comprehensive wound examination tool with educational videos and product recommendations	Free (requires subscription)
Wound Assessment	Decision support for wound assessment	Free
Wound Care	Provides instructional videos, image library, anatomical reference guides, diagrams, and documentation	Free
Wound Central	Made for practitioners, nurses, and physical therapists, wound descriptions, wound photographs, wound care videos, documentation guidelines, wound care guideline	Free
Wound Desk	Made for practitioners, wound care analysis evolution, wound imaging, wound measures encryption, documents wound progression	Free
WoundVision Scout Mobile	Wound image capturing	Free
WoundWiseIQ	Wound image capturing and measurement	Free

Johns Hopkins Nursing Evidence-Based Practice
Appendix H: Synthesis Process and Recommendations Tool

EBP Question: In the primary care setting, among providers who treat chronic wounds (P), does the use of an online application (I), as opposed to not using the app (C), improve wound outcomes (O)?

Category (Level Type)	**Total Number of Sources/ Level**	**Overall Quality Rating**	**Synthesis of Findings** **Evidence That Answers the EBP Question**
Level I ■ Experimental study ■ Randomizedcontrolled trial (RCT) ■ Systematic review of RCTs with or without meta-analysis ■ Explanatory mixed method design that includes only a Level I quaNtitative study	3	A	-The D+Wound app was helpful in setting up a treatment plan and for novice providers during the clinical assessment of a wound, and the algorithm's logic and treatment guidelines were similar to those of experienced wound management practitioners (Jun et al., 2016). -Tissue Analysis app appeared superior to the ruler method & had reliable outcomes, and the raters had very positive feedback and interest in this app (Seat & Seat, 2017). -Swift Wound app provided highly reliable & accurate wound measurements. The standard ruler method also offered relatively accurate measurements of length and width but was less vigorous than the app (Wang et al., 2017). -Swift Wound and FLIR1 infrared camera temperature measurements were equivalent to scientific standard instruments & it provided a better assessment of wound healing over time compared to basic ruler length and width measurements. The app was reliable for various wound shapes (Wang et al., 2017).

Level II ■ Quasi-experimental studies ■ Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis ■ Explanatory mixed method design that includes only a Level II quaNtitative study	4	3A 1B	-The thermal imaging system was efficient in perfectly recognizing vulnerable areas with effective prevention of foot ulcers (Fraiwan et al., 2017). -WounDS app could improve wound healing & help in cost-saving for the healthcare system (Jordan et al., 2018). -Smartphone digital imagery app provided a cost-effective, time-saving, productivity saving, non-contact, user-friendly, reliable & accurate solution for practitioners to monitor wound healing, & a greater photographic clarity to promote multidisciplinary discussion, improve workflow, and lowering errors in clinical wound-management documentation (Nair, 2018). -Wound Care Buddy App increased practitioners' skills and confidence, was specifically helpful for novice staff, and assisted professionals with their clinical decision making (selecting suitable dressings & antibiotics), documentation, and effective treatment planning (Patel et al., 2019).
Level III ■ Nonexperimental study ■ Systematic review of a combination of RCTs, quasi-experimental and nonexperimental studies, or nonexperimental studies only, with or without meta- analysis ■ QuaLitative study or meta-synthesis ■ Exploratory, convergent, or multiphasic mixed-methods studies ■ Explanatory mixed method			

design that includes only a level III QuaNtitative study			

Category (Level Type)	**Total Number of Sources/ Level**	**Overall Quality Rating**	**Synthesis of Findings Evidence That Answers the EBP Question**
Level IV ■ Opinions of respected authorities and/or reports of nationally recognized expert committees or consensus panels based on scientific evidence			
Level V ■ Evidence obtained from literature or integrative reviews, quality improvement, program evaluation, financial evaluation, or case reports ■ Opinion of nationally recognized expert(s) based on experiential evidence			

Based on your synthesis, which of the following four pathways to translation represents the overall strength of the evidence?

✓ Strong, compelling evidence, consistent results: Solid indication for a practice change is indicated.
Good and consistent evidence: Consider pilot of change or further investigation.

Good but conflicting evidence: No indication for practice change; consider further investigation for new evidence or develop a research study.

Little or no evidence: No indication for practice change; consider further investigation for new evidence, develop a research study, or discontinue project.

If you selected either the first option or the second option, continue. If not, *STOP*—translation is not indicated.

Recommendations based on evidence synthesis and selected translation pathway
-The thermal imaging system can be extended to other applications such as wound healing and trauma monitoring (Fraiwan et al., 2017). -Upgrading the proposed system with an advanced thermal camera with better image quality can be attached to a cellphone in the future (Fraiwan et al., 2017). -Further testing and validation of the thermal imaging system should be conducted in a clinical setting (Fraiwan et al., 2017). -The WounDS app concept can be possibly integrated with electronic medical record systems and SmartWoundCare (Jordan et al., 2018). -Further study is needed regarding how the D+Wound app can be helpful as an educational and training tool for accurate dressing selection and reduces the time needed to make a treatment decision (Jun et al., 2016). -The D+Wound app may assist users to provide guidance on how to achieve healing in different wounds (Jun et al., 2016). -Patients and caregivers may use the smartphone digital imagery app to track the wounds at home (Nair, 2018). -Healthcare clinicians can use the Wound Care Buddy app on both iOS & Android platforms (Patel et al., 2019). -There is a notable opportunity for adding further improvements & new developments to the Wound Care Buddy App, and this standard framework can be used by any wound management service organization (Patel et al., 2019). -Future studies are suggested to be done with the Tissue Analysis app & the same research agreement on actual wounds (Seat & Seat, 2017). -Swift Wound software can be used efficiently by both experts and non-experts in wound management, and patients and their caregivers may use this tool for home monitoring. Further studies may obtain a large sample of wound shapes and sizes to expand the outcome (Wang et al., 2017).
Consider the following as you examine *fit:*
Are the recommendations: ■■ Compatible with the unit/departmental/organizational cultural values or norms? ■■ Consistent with unit/departmental/organizational assumptions, structures, attitudes, beliefs, and/or practices? ■■ Consistent with the unit/departmental/organizational priorities?
Consider the following questions as you examine *feasibility:*

- Can we do what they did in our work environment?
- Are the following supports available?
  - Resources
  - Funding
  - Approval from administration and clinical leaders
  - Stakeholder support
- Is it likely that the recommendations can be implemented within the unit/department/ organization?