VISUAL PRESENTATION OF DIGITAL WOUND IMAGES: EXPLORING
COMMUNITY NURSES’ PREFERENCES AND ATTITUDES

by

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Abstract

Recent research indicates that digital wound photography is a helpful tool in the wound care management process. Previous studies have demonstrated the benefits of incorporating digital images in the wound care management process for registered nurses (RNs), however no information was found regarding the preferred visual display formats of digital wound images within wound care management software. Wound care is an important part of community care nursing work, and this study explored the community care RNs’ perceptions and attitudes towards different formats of digital wound data displays, with the aim to explore the usefulness of having more than one display format of the digital wound data within a wound care application.

The study applied a combination of Technology Acceptance Model 2 and Task Technology Fit model as a framework to guide the interview sessions with the community care RNs and to design a questionnaire to survey the perceptions and attitudes towards different formats of digital wound data display. The study consisted of two phases. Phase 1 involved extracting digital images of chronic wounds from the community database and creating wound care case scenarios with the corresponding wound display prototypes. Phase 2 included interview sessions with five community care RNs. The outcome of the study was the discovery of themes and patterns based on narrative data from interview sessions and answers to survey questionnaires. Study results suggest that the community care RNs could benefit from having access to more than one display format of the digital wound data. Digital wound images associated with the corresponding clinical narrative could provide a more complete clinical picture in one place and improve efficiency of wound assessment. Integration of the reporting
capability to generate a wound case summary could improve community care RNs planning when preparing for patients’ visits.

This small-scale study provides initial evidence that the development of optimal display formats in the wound care application could improve the wound management process in the community settings. Additional research is required to explore the display formats that would be most informative, effective and efficient in the daily routine of community care RNs.
Preface

This project is the original work of Anna Beskrovnaya. Throughout the paper, guidance and support was provided by Leanne Currie (supervisor) and Tarnia Taverner (committee member). The author was solely responsible for writing this document, under the supervision of the project committee.

Permission to conduct this study and ethical approval was requested in writing from the Clinical Research Ethics Board of the University of British Columbia (UBC). The permission was granted by the UBC Clinical Research Ethics Board with the Certificate of Approval # H17-00098. The project was also approved by the Vancouver Coastal Health Authority, which allowed to request and obtain a set of deidentified digital wound images from the Pixalere database from the Data Release Management of the Vancouver Coastal Health. The extracted and deidentified wound images were used to create the prototypes of the digital wound data visual displays.
Table of Contents

Abstract ................................................................................................................................. ii

Preface ................................................................................................................................. iv

Table of Contents ................................................................................................................. v

List of Tables ........................................................................................................................ viii

List of Figures ....................................................................................................................... ix

Chapter 1: Introduction ....................................................................................................... 1
  1.1 Introduction .................................................................................................................... 1
  1.2 Background/Significance .............................................................................................. 2
  1.3 Problem statement ....................................................................................................... 4
  1.4 Purpose ........................................................................................................................ 4
  1.5 Research questions ..................................................................................................... 4
  1.6 Summary ...................................................................................................................... 5

Chapter 2: Literature review .............................................................................................. 6
  2.1 Introduction .................................................................................................................. 6
  2.2 Literature review ......................................................................................................... 6
    2.2.1 Digital images effectively relay visual wound information .................................. 6
    2.2.2 Validity of digital photography in relation to wound care ................................. 8
    2.2.3 Digital photography and videos as a complementary tool in wound care ........ 10
    2.2.4 Digital images as an aid in remote wound management ..................................... 13
    2.2.5 Potential of using a sequence of wound images for follow-ups ....................... 14
  2.3 Summary ...................................................................................................................... 15

Chapter 3: Methods .......................................................................................................... 17
3.1 Introduction.................................................................................................................. 17
3.2 Research questions...................................................................................................... 17
3.3 Study design................................................................................................................ 17
   3.3.1 Theoretical Framework ......................................................................................... 18
   3.3.2 Study Phases ......................................................................................................... 19
3.4 Sampling plan ............................................................................................................. 21
   3.4.1 Inclusion criteria ................................................................................................... 23
   3.4.2 Exclusion criteria .................................................................................................. 23
3.5 Recruitment methods .................................................................................................. 24
3.6 Procedures & Data collection ...................................................................................... 24
3.7 Data analysis .............................................................................................................. 25
3.8 Ethical considerations ................................................................................................. 26
3.9 Plans to overcome possible difficulties ....................................................................... 27

Chapter 4: Results..............................................................................................................29
4.1 Introduction.................................................................................................................. 29
4.2 Prototypes of digital images displays .......................................................................... 30
4.3 Demographics ............................................................................................................ 34
   4.3.1 Perceived usefulness, attitude and intention to use.............................................. 34
4.4 Overarching Themes .................................................................................................. 36
   4.4.1 Improved visibility of the wound healing trend (“View All” display) .................. 37
   4.4.2 Comparative design to reduce cognitive load (“Compare Photos” display) ...... 38
   4.4.3 Views tailored to user needs ................................................................................ 38
   4.4.4 Correlation of digital image data, clinical data and nursing care plans .......... 40
Chapter 5: Conclusion ........................................................................................................................................... 42

5.1 Introduction .................................................................................................................................................. 42

5.2 Discussion .................................................................................................................................................... 43

5.2.1 Theme 1: Improved visibility of the wound healing trend ................................................................. 43

5.2.2 Theme 2: Cognitive load issue addressed by comparative design .................................................. 44

5.2.3 Theme 3: Views tailored to user needs ................................................................................................. 45

5.2.4 Theme 4: Correlation of digital image data and clinical data ........................................................... 46

5.2.5 Theme 5: Need for clinical summary including images ................................................................. 47

5.3 Limitations of the study design ............................................................................................................... 48

5.4 Implications and recommendations for nursing practice and research .............................................. 49

5.5 Summary .................................................................................................................................................... 50

References ......................................................................................................................................................... 52

Appendix A – Feedback Questionnaires ....................................................................................................... 60
List of Tables

Table 4.1 Demographic summary ........................................................................................................ 34
Table 4.2 Community care RNs: perceived usefulness, attitude and intention to use .................. 35
List of Figures

Figure 1.1 “Latest image only” display ................................................................. 30
Figure 1.2 “First and Latest Images” display ......................................................... 31
Figure 1.3 “Compare Photos” display .................................................................... 32
Figure 1.4 “View All” display ................................................................................ 33
Chapter 1: Introduction

1.1 Introduction

Chronic wounds are a serious healthcare issue, which affects well-being of an individual, results in a decreased quality of life and presents challenges to clinicians due to the complex nature of wounds. The Canadian Association of Wound Care (CAWC) estimates that chronic leg wounds affect about 60,000 Canadians, chronic diabetic foot ulcers affect 144,000 Canadians and between 28,800 to 51,300 Canadians with spinal cord injuries will develop a pressure ulcer at some time in their life (CAWC, 2010). Other sources of chronic leg wounds include venous and arterial leg ulcers, with prevalence ranging from 1.7% to 2.5% in varying healthcare settings across Canada (Canadian Institute for Health Information [CIHI], 2013). Denny et al. (2014) reported that in Canada, within the fiscal year of 2011-2012, persistent and poorly healing wounds constituted almost 4% of in-patient acute hospitalizations, more than 7% of homecare patients, almost 10% of long-term care clients, and about 30% of hospital-based continuing care clients. As noted by Denny et al. (2014) not only can wounds be debilitating and compromise mobility and the quality of life of individuals, but they also represent significant financial implications to the healthcare system, including costs of consultations, treatment, medications and dressings.

As the general population continues to age, the number of patients with diabetes and other chronic aging related diseases, including non-healing wounds, is rising, which will be placing a heavier burden on our healthcare system (Henry et al., 2014, Yao et al., 2015). Appropriate technologies and processes for providing high-quality efficient wound care have to be used to meet these increasing demands. Digital imaging is one such technology that can aid
in providing quality wound care for patients with various types of chronic wounds (Thompson, 2013).

1.2 Background/Significance

With the latest technological advances and ubiquity of handheld devices it is fairly easy to capture wound images in any clinical setting and transfer them to a computer. These digital images can provide an objective visual documentation of a wound status at a point in time, help in monitoring wound healing rate, improve communication between health care professionals involved in wound management, aid in remote consultations by wound care specialists, and facilitate the referral process.

Patients with chronic wounds are often treated by multidisciplinary health care professionals in the community and hospital setting. In the community setting, chronic wounds are managed primarily by community nurses and constitute a high proportion of the nurses’ workload. It is important to note that chronic wound patients requiring homecare are typically managed by different nurses at different times. King (2014) researched the delivery of wound care in the community setting and found that housebound patients with chronic wounds were supported by the nursing team with more than 20 nurses. Each nurse could be involved in managing the same wound at different points in time, which was creating a problem with continuity of care. The author found that adding digital wound images into the community shared electronic records system improved communication among nursing staff and other multidisciplinary team members involved in wound care. Digital wound images became a valuable instrument in alerting practitioners to early signs of wound deterioration and helped in choosing the appropriate wound care treatment.
Another study involving wound, ostomy and continence care nurses (WOCN) demonstrated the benefit of adding wound photography to a standard nursing report, when WOCNs were asked to make treatment recommendations (Buckley et al., 2009). The study demonstrated that WOCN recommendations based only on the homecare nurses’ verbal reports differed from the recommendations based on the report and viewing the relevant images of the wounds. It was significant that at some point during the study, WOCNs refused to provide consultation without images due to ethical concerns.

Overall, the utility of wound photography in health care is fairly well documented. Many studies support the idea that digital photography has been effective in enhancing clinical documentation of various wounds, it has been successfully used as a teaching tool, and has allowed an improved access to wound specialists via telemedicine (Roth et al., 1999, Bradshaw et al., 2001, Braun et al., 2005, Baumgarten et al., 2009, Buckley et al., 2009, King, 2014, Wibbenmeyer et al., 2015).

It has become a common practice for the community nurses to use digital wound images to assess wound stages and the extent of healing. Fischetti et al. (2000) note that digitized wound images provide nurses with “a powerful tool to strengthen the existing documentation and communication processes of wound-care management”. However, the literature review has shown that there is a lack of published documentation about the nurses’ preferences regarding the format of visual display of digital wound images within the electronic patient records or wound care applications.
1.3 Problem statement

With electronic patient records and wound care applications being a growing part of the community care nursing work environment, it is beneficial to explore the approaches to digital wound image displays that could possibly improve the wound assessment and management process in homecare settings.

1.4 Purpose

Despite having many scientific publications reporting the usefulness of the photographic wound documentation in the wound care process, the author was unable to find published work about end-user display preferences of wound images within the context of wound care applications. Thus, the purpose of this study was to explore the perceptions of the community care RNs about several different formats of digital wound image displays and to examine how these visual formats might affect the wound assessment and care process.

1.5 Research questions

The research questions explored in this project were:

1. What are the most useful formats to present digital wound images to support wound assessment and care for community care nurses in their office setting?
2. What are the perceived benefits of having one digital wound display over the other?
3. What possible changes to the wound images display would the community RNs like to see in their wound care software application?
1.6 Summary

The increasing number of patients with chronic wounds and rising costs of health care create needs and require solutions to support wound care coordination and interprofessional communication. It has been reported that one of the technology solutions supporting efficient wound care has been digital images (Roth et al., 1999, Bradshaw et al., 2001, Thompson, 2013). In recent years, the electronic patient record and digital wound images have been introduced in many homecare agencies and community nursing services. Digital wound images help in strengthening clinical documentation and enhancing interdisciplinary communication in wound care management process (Fischetti et al., 2000). Many studies have demonstrated the benefits of digital photography in the wound care process, however, there is a lack of information with regards to how end users (nurses) prefer to view the digital wound information within electronic patient record or wound care application. The aim of this study was to investigate community care RNs’ preferences for the visual display of the digital wound images and possibly find the most helpful formats of digital wound data presentation that could improve the wound assessment and care process.
Chapter 2: Literature review

2.1 Introduction

Photographic and digital images have been used in a variety of ways in the wound care field, such as to teach wound assessment skills, educate wound care staff, evaluate the effectiveness of wound treatment, aid in the remote consultations by wound care specialists and streamline the referral process (Thompson et al., 2013, Buckley et al., 2005, Braun et al., 2005, Baumgarten et al., 2009). The purpose of this literature review was to identify published reports related to the use of digital images in the wound care process and summarize the value and use of wound images in the wound care process.

The literature search was performed in CINAHL and PubMed. The search of the literature was not limited by the year of publication; this approach allowed obtaining some historical perspectives on the use of digital images in wound care along with the recent wound management approaches using digital photography and videos. The keywords used in the search were: wound, care, digital image, photography and video in different combinations. Additional publications were retrieved from the reference lists of the literature found in the above-mentioned databases. Only studies published in English were used. Publications related to the concept of digital images in wound care were found in the medical and nursing sciences.

2.2 Literature review

2.2.1 Digital images effectively relay visual wound information

The research has demonstrated that digital images are useful in providing objective visual documentation and aiding in assessment of various types of wounds (Roth et al., 1999, King, 2014, Buckley et al., 2009, Braun et al., 2005). More than 15 years ago Roth et al. (1999)
evaluated the efficiency and validity of digital images in comparison to slides for the evaluation of different types of wounds (chronic, radiation, decubitus ulcers, and infected). Six raters, including board certified plastic surgeon, a plastic surgery chief resident, a fifth-year plastic surgery resident and a surgical intern compared 24 digital images and slides and agreed on five wound characteristics in 87% of the cases. These results supported digital images as being a helpful tool in providing effective visual information and aiding in clinical evaluation of wounds.

Buckley et al. (2009) found that in the clinical setting, digital images provided comparable visual information to a standard in-person wound examination with the resulting similar wound care strategies. The authors found that digital images of the wounds incorporated into verbal reports by the community nurses often influenced treatment recommendations by the wound care nurse, thus preventing possible under- and over treatments. The authors reported that in 58.4% (52/89) of the cases the addition of a digital wound image led to the changes in the wound care products as a result of clinically relevant disagreement between assessments with and without images. The research also demonstrated that digital images provided invaluable visual information about patients’ surroundings and their influence on the wound healing process. This study supported the idea that digital images could help overcome potential limitations of verbal or written report, where the tone of voice or wording can alter the treatment plan, and provide objective visual cues for the assessor.

It has been found that patients and health care personnel are supportive of the inclusion of wound images into wound care plans. For example, King (2014) described a case study where a patient considered it to be beneficial to have his wound photographed in order to have an objective visual documentation that could be used in his care by the next health care provider. Similarly, Buckley et al. (2009) described that at some point during their research concerning the
benefits of adding digital wound images to verbal reports, by the twentieth patient, the wound care expert refused to provide consultations to patients without digital images due to the concerns that valuable visual wound information could be missed.

A study by Braun et al. (2005) demonstrated that digital photos taken by physicians with the use of handheld phones provided good visual information about leg ulcers of venous, arterial and diabetic nature. The study evaluated the feasibility of using digital photos of leg ulcers taken with mobile phones for remote assessments. A convenience sample from an ulcer clinic where patients were randomly selected provided the research with 61 images from 52 different patients. The images were evaluated by two dermatologists over a 3-month period and their diagnoses were compared to the diagnosis of a third dermatologist who was performing face-to-face assessment. Physicians performing remote evaluation of the leg ulcers based on the digital images had 0.75 agreement with face-to-face evaluator regarding the type of the ulcers and treatment plan. This study demonstrated that digital photos of various etiologies of leg ulcers provided adequate visual information for remote consultations by physicians. In addition, the study showed the potential for using digital images for remotely addressing some of the problems related to leg ulcers without patients having to go to a hospital or physician office.

2.2.2 Validity of digital photography in relation to wound care

Digital images have been utilized in various ways within the wound care field. Digital photography has been used in distance consultations by wound specialists, research, education and referral processes (Thompson et al., 2013). Advances in current technology allow the production of high-quality digital images and videos. However, an important concern for health
professionals is to know whether clinical decisions and assessments of the wounds based on digital images are comparable to those made at bedside.

The study by Baumgarten et al. (2009) evaluated the validity of digital photographs for the assessment of the presence of pressure ulcers stage II or higher. The researchers worked with a convenience sample and recruited patients from the wound specialist’s routine clinical practice. Ninety-six pairs of digital photographs (pressure ulcer and unaffected area) were reviewed independently by two wound care specialists and categorized into stage II or higher (yes/no) for the purposes of the analysis. It was found that the diagnoses made by the wound specialists from the photos were comparable with the bedside wound assessment. The authors measured the sensitivity and specificity and found that 97% of pressure ulcers diagnosed at bedside were correctly detected on the photos, and 97% of the areas considered unaffected at bedside were identified as unaffected from the photos. Even though the results were slightly less positive when applied to black patients (92% and 93% respectively), the findings still supported the validity of digital photography for pressure ulcers stage II or higher. The study had some limitations such as having only one wound care expert performing bedside assessment and quite simple evaluation, however, the results of the study demonstrated that digital photography can provide valid information when differentiating pressure ulcers stage II or higher.

Thompson et al. (2013) examined the validity and reliability of the revised Photographic Wound Assessment Tool (revPWAT) on digital images of chronic wounds in different stages of healing. The authors reviewed 206 different photographs taken of 68 patients with 95 chronic wounds. Adult participants were recruited from 3 different health centers in Canada as a convenience sample. Eligible participants had full-thickness wounds at least 1 cm² in size that were expected to heal over a 4-6-weeks. The digital images were independently assessed by 4
health care professionals (two registered nurses, one occupational therapist and one enterostomal therapy nurse) for the wound’s size, depth, type and amount of necrotic tissue, type and amount of granulation tissue, edges, and periulcer skin viability. The authors evaluated several aspects such as intrarater reliability, test-retest, interrater reliability, digital image versus bedside assessment and professional versus clinician-derived photographs. It was found that revPWAT scores derived from the wound photographs assessed by the same assessor at different points of time and by different assessors demonstrated moderate to excellent intrarater intraclass correlation coefficients (ICCs) (ICC = 0.52–0.93), test-retest (ICC = 0.86-0.90) and interrater (ICC = 0.71) reliability (Thompson et al. 2013). This study supported the idea that the wound assessment tool based on digital photography was reliable and valid for evaluation of various aspects of chronic wounds. It also demonstrated that digital images can be a useful tool for enhancing clinical documentation related to wound assessment and care.

2.2.3 Digital photography and videos as a complementary tool in wound care

Research has shown the utility of wound photography in acute care and community settings, and the feasibility of telemedicine wound care systems (Gardner et al., 2001, Jesada et al., 2013). However, it should be noted that digital photography offers 2-dimensional images, which can mask some of the wound characteristics such as depth and tunneling, for example. Studies have suggested that the accurate evaluations of wounds based on digital images are possible if used in conjunction with a wound assessment tool and bedside evaluation (Tsai et al., 2004, Thompson et al., 2013).

A study by Jesada et al. (2013) investigated whether digital photos of the wounds obtained by acute care nurses could be used to determine staging and wound characteristics of a
pressure ulcer measured by the Bates-Jensen Wound Assessment Tool (BWAT) (Bates-Jensen et al., 1998). It was found that wound characteristics that could be observed and quantified, such as the amount of necrotic tissue, had the highest level of agreement between the bedside assessment by a wound care specialist and an off-site expert wound care specialist assessment using digital photos. Other wound parameters such as epithelization and depth of the wounds had the lowest level of agreement. The results of the study could be attributed to the fact that the photography excluded assessment based on wound palpation and did not capture variables such as pain and odour. The results of this study suggested that digital photography should be used complementary to bedside assessment of pressure ulcers. The combination of clinical information and digital images might increase the accuracy of assessment and documentation.

A study by Gardner et al. (2001) compared the assessment made by an experienced wound care nurse at bedside to the assessment of the same wounds made by the same nurse 6 months later using videotaped sessions. The authors used a convenience sample from the population of residents at a long-term care facility. Participants had one or more chronic wound (pressure, venous, diabetic foot ulcers, and incision healing by secondary intention). The accuracy of the video technology was examined by calculating the agreement between the in-person and videotaped assessments for 9 wound characteristics (tunneling, undermining, granulation tissue, necrotic tissue, epithelial tissue, purulent exudate, erythema, edema, and induration). The authors reported that 8 out of 9 wound characteristics exceeded 75% level of agreement with only one characteristic (absence or presence of epithelial tissue) falling slightly above 50%. The results of this study suggested that wound videos provided helpful visual information. However, this research had a major limitation of assuming that in 6 months’ time the wound care nurse would not remember previous bedside assessments. The study only
involved one expert wound care nurse, making it difficult to generalize the results to other wound care experts. The sample consisted only of 11 participants, which reduced confidence in the findings of this study. Further research involving more wound care experts and larger sample is needed to investigate the validity of video technology and to demonstrate how comparable it is to bedside assessment.

A randomized controlled study by Terry et al. (2009) evaluated the effectiveness of including digital wound images into electronic patient records for the purposes of improving wound management in a homecare agency. The authors recruited 103 patients with 160 pressure ulcers or non-healing surgical wounds referred to several nursing agencies. All patients were randomly assigned into three groups: A - required weekly visits from the wound care specialist with telemedicine, B - weekly visits and weekly consults and C - usual care. Group A had more patients with larger non-healing wounds and pressure ulcers. After measuring time to heal, number and cost of nursing visits, wound status, and change in size, the researchers found that group A had the most expensive home visits. The authors also found that 33% of stage III and 100% of stage IV pressure wounds required a live examination and could not be diagnosed based only on a digital image and clinical documentation. Interestingly, group A, who required more resources, had a significantly greater change in wound size over time compared to the other groups. The results of the study were most probably affected by unequal distribution of deeper and larger wounds in group A compared to groups B and C. And the significant decrease in wound sizes in group A was most probably directly related to the greater amount of resources used for that group. Importantly, the variables used by the authors to evaluate the effectiveness of including digital images into electronic patient records might not have been appropriate for the study design. As a result, the findings did not demonstrate that the inclusion of digital images
into electronic patient records shortened the number of nursing visits and time to heal. More research is needed with appropriately randomized group of patients and different study variables to determine the usefulness of wound images in the management of chronic wounds. The study findings were suggestive of the fact that digital images should be used complementary to the bedside assessment, as they might not be conveying all wound characteristics for complex stage III and IV pressure ulcers.

### 2.2.4 Digital images as an aid in remote wound management

Capturing slow healing wounds on digital media can aid in the referral process, especially when a patient needs further investigations. Digital images of poorly healing wounds can provide justification for further specialist investigations without requiring patients to visit medical offices to obtain a referral. Research has shown that digital photography combined with clinical documentation provides feasible mechanism for remote wound management by wound care specialists (Jesada et al., 2013, Langemo et al., 2006). For example, a study by Baer et al. (2004) assessed the feasibility of remote web-based consultations for leg wounds and demonstrated a reasonable agreement between assessments of wound parameters obtained by homecare nurses at bedside and assessments done with the help of telemedicine techniques. The study included 34 participants with the mean age of 71 with various types of leg ulcers (pressure, stasis and arterial ulcers). The study used kappa coefficients to assess the level of agreement and it was found that in 85% of cases the homecare nurse agreed with the remote wound care specialist with regard to the type of ulcer. The agreement on treatment strategy varied from 90% (concerning topical therapy) to 13% (concerning primary dressing). The latter was attributed to the home health nurses not having expert knowledge of wound care best practices or not
knowing best available wound care products (Baer et al., 2004). In general, the study demonstrated the feasibility of using digital images attached to electronic patients records for remote wound care consultations without physically visiting patients at home. Ultimately, using digital images for obtaining an expert opinion of a wound specialist could improve wound care management for home based patients with chronic wounds; provide an opportunity for education of homecare nurses and improve patient care.

A study by King (2014) evaluated the delivery of community services to housebound patients with wounds. Following this evaluation, a template for wound assessment was developed and it incorporated digital images of the wounds. This template was then included into the electronic records system in the community, which was shared by the community nurses and general practitioners. Using such enhanced electronic records made it possible for general practitioners and wound care specialists to view the digital images of the wounds along with the nursing reports and if necessary to prescribe antibiotics or order treatment. Timely access to an up-to-date electronic medical record including digital wound images helped to facilitate the discussion between professionals and resulted in appropriate changes in the patients’ care. The study also found that the majority of community nurses appreciated the benefits of the remote wound advice and rapid response from the general practitioners and tissue viability nurses. This research supported the idea of using digital wound images to facilitate chronic wound management in the community settings.

2.2.5 Potential of using a sequence of wound images for follow-ups

Research has shown a potential for using a sequence of wound images for follow-up and monitoring wound evolution and healing rate over time. While evaluating the feasibility of
telemedical wound care for leg ulcers, Braun et al. (2005) had 6 cases where the same wound was imaged several times in progression. The feedback received from the remote physicians was that it was easy to judge whether there was an evolution in the wound progression and its healing rate.

Using sequences of digital wound images along with pertinent clinical information could facilitate the continuity of care for community care wound patients, where different nurses might care for the same wound patient on subsequent visits. Chronological digital wound images could aid in providing objective visual information to the verbal and written descriptions of the wound and enhance ongoing assessments of wound changes over time.

2.3 Summary

In summary, digital wound images and wound photography effectively relate visual information and aid in wound assessment and management. Digital photography is a valid and reliable tool providing valuable objective visual information that can facilitate distance consultations, aid in the referral processes, and help in wound care related education and research. Visual digital information provides complementary information and is best used in conjunction with relevant clinical data. Using digital images in chronological order could possibly enhance ongoing wound assessments by showcasing wound progression over time. This literature review demonstrated the benefits of incorporating digital images in the wound care process, however no information was found regarding the preferred visual display formats of digital wound images within wound care management software. Since the day-to-day responsibility for wound management is a role usually taken on by nurses, this project will focus on exploring the preferences of community care nurses in relation to the formats of the wound
visual displays that could aid the most in their practice. In particular, wound care is an important part of community RNs’ workload, and this study will investigate community RNs’ perceptions and attitudes towards different visual displays of digital wound data, with the aim to find the display formats that could possibly improve the wound assessment and care process.
Chapter 3: Methods

3.1 Introduction

In this chapter, the methods used in preparation of wound care cases with enhanced visual displays and the procedures for conducting the interview sessions with nursing participants are outlined. The study design, sampling plan, procedures and analysis adhered to scientific protocol and were overseen by the project supervisor. Ethical considerations and study limitations were considered according to the university policy.

3.2 Research questions

The research questions explored in this project included the following:

1. What are the most useful formats to present digital wound images to support wound assessment and care for community care nurses in their office setting?

2. What are the perceived benefits of having one digital wound display over the other?

3. What possible changes to the wound images display would the community RNs like to see in their wound care software application?

3.3 Study design

For this project, a qualitative case study methodology approach was chosen. The qualitative case study methodology allowed for close collaboration between the researcher and the participants, while enabling participants to tell their stories (Baxter, 2008). The case study approach was chosen for its flexibility, as it allowed data to be collected from as many sources as were considered appropriate to provide necessary study information (Tolson, et al., 2002). Yin
(2003) suggested to use this type of study to describe an intervention or phenomenon and the real-life context in which it occurred. This project examined possible impact of adding several formats of digital wound images displays to a standard wound care application that was used by the community care RNs for wound assessments and selection of wound management strategy.

3.3.1 Theoretical Framework

The study applied a combination of Technology Acceptance Model 2 (TAM2) and Task Technology Fit (TTF) model as a framework to guide the interview sessions with the participants and to design a questionnaire to survey the acceptance of the enhanced digital wound data displays by the community care RNs (Venkatesh & Davis, 2000, Hyun et al., 2009).

TAM2 examines the impact of “interrelated forces” that would make an individual adopt a particular technology (Zhang et al., 2010). TAM2 is based on the perceptions of the users and it helps to analyze if the application is useful and easy to use, and whether it influences attitude of the users and the intention to use (Hsu & Wu, 2017). TAM2 is not new to the nursing research. For example, it has been used in nursing research to predict nurses’ intention to use telemedicine technology application (Kowitlawakul, 2011), to identify the factors influencing the use of learning management systems by health science and nursing students (Chipps et al., 2015), and to investigate factors influencing adoption of mobile systems by homecare nursing personnel (Zhang et al., 2010).

The TTF model addresses the relationship between task, user acceptance, and utilization; TTF matches the capabilities of the technology to the demands of the task and the ability of information technology to support a task (Dillon et al., 1998, Dishaw & Strong, 1999). Previous studies have reported a significant relationship between task-technology fit and perceived
usefulness (Hyun et al., 2009). Consistent with TTF, nursing informaticians recognized the importance of the match between nursing practice and the technology systems designed to support it (Hyun et al., 2009). Gassert (1997) applied the TTF model to define the requirements for a mobile computing system screen that supported cardiac surgery patient care. When designing the layout of the screen for the ICU patient database screen, Ireland et al. (1997) used TTF to determine the components of the screen that the ICU nurses considered priority parameters for performing intensive nursing care tasks.

The use of TAM2 and TTF models was relevant and important to the research that is reported in this paper. This study’s aim was to elicit community care RNs’ perceptions of usefulness of having more than one display format of the digital wound data within a wound care application. To capture community care RNs’ perceptions and attitudes towards new formats of display of the digital wound data, the researchers used the survey questionnaire and interview questions informed by TAM2 and TTF models, which included concepts related to usefulness, ease of use, attitudes, and the perceived fit between the tasks of the participants and the presented prototypes of the digital wound images displays.

### 3.3.2 Study Phases

The study consisted of two phases. During the first phase of the project, the researchers obtained the permission from Vancouver Coastal Health Research Institute (VCHRI) to extract the images of chronic wounds from one of the community databases. After the permission was granted, the images were extracted by the VCH Data Release Management and deidentified, and after that provided to the researchers.
The first ten extracted series of wound images conforming to the selection criteria were evaluated by the primary researcher and three case scenarios were created from the three most appropriate series of digital wound data. The appropriateness criteria were based on the quality and the number of digital images in a given patient record. The extracted and deidentified wound images were used to create three case studies including the prototyped visual displays of digital wound data, summary of demographic patient information, clinical description of the wound, wound treatment history and nursing care plan. The prototypes of the visual displays for wound digital data were created using Axure® software (Axure Software Solutions, Inc.). For each case study there were four different visual display screens: 1) the most current wound image, 2) the very first and the most recent images of the healing wound, 3) the comparative view with the wound images from the two user-selectable weeks of treatment and 4) chronologic series of the thumbnails of all available digital wound images (screenshots provided in Chapter 4).

In the second phase of the study, three wound care case scenarios with the accompanying prototyped digital wound data screens were presented to five nursing participants at one of the VCH community site locations. Each wound care case included mock patient data that was necessary for creating clinical picture: age, sex, weight and mobility level, type of supports used to assist with activities of daily living, nursing notes with the wound description including its size, edges, exudate, tunneling, the amount of necrotic and granulation tissues, pain rating, and location. The participants were asked to read a case scenario and then browse through four available visual displays of the digital wound data. The interviewees were asked to make their comments and give their opinions regarding the usefulness of each of the displays in their wound care practice (see Appendix A for questionnaires).
The researchers explored the perceptions of the community nurses about different visual presentations of digital wound information and examined potential value of different visual formats of wound image displays in the community nursing practice. The researchers also investigated whether the enhanced digital wound information could possibly help improving the nursing wound assessment and care.

During the interview sessions, the nurses were instructed to use their own judgement in the evaluation of digital wound display prototypes and not to discuss the cases with their colleagues. The identities of the participating nurses were not disclosed in this study.

3.4 Sampling plan

In Phase 1, the types of wounds included in the extraction process were the following: 1) lower leg trauma wounds, 2) surgical wounds healing by secondary intention, 3) chronic pressure ulcers stage III or IV, and 4) diabetic foot ulcers. This was a retrospective study, which included the digital image data only for those patients who had been discharged from the system. The inclusion/exclusion criteria specified by the researchers were applied during the extraction of the digital image data from patient records.

In Phase 2, purposive sampling was used to recruit five community care RNs from one of the community nursing centers. According to Polit and Beck (2014), purposive sampling is based on the belief that the researchers’ knowledge about the population can be used to hand-pick sample members (Polit & Beck, 2014). In the context of this study, purposive sampling was based on the researchers’ belief that the selected five community care RNs were typical representatives of community care RNs tending to homecare patients and using the wound care application to track and manage various cases of wounds in the community settings. The
participants were selected according to the inclusion/exclusion criteria. The purposeful sampling technique was chosen to select the participants who had knowledge and experience in caring for chronic wounds of the community patients and who were able to communicate their opinions in an articulate, expressive and reflective manner (Palinkas et al., 2015).

This project involved user interaction with the prototyped wound images user interface. The participants were asked to browse through four available formats of digital wound data display and verbalize their thoughts about the potential usefulness and value of the enhanced digital wound data in their practice. Nielsen (2000) suggested that the best results in testing user interfaces come from working with no more than 5 users. The studies by Hudson (2001) and Faulkner (2003) supported the basic claims of Nielsen that 5 users may be used in “detailed and well-focused tests” where the users are representative of target population. Faulkner also reported that random sets of 5 participants were finding between 55 to 99% of the usability problems. However, in this study, we specifically sought to interview community care RNs having experience in wound care management and using wound care application on a daily basis.

It is important to note that the focus of this project was on attaining a better understanding of the perceptions of the community care RNs towards different formats of digital data display (within wound care application). It was not the intention of the researchers to extensively test the prototyped wound images displays, rather the prototypes were used to facilitate the interview process and to solicit the opinions of the participants about their preferences of wound image displays that could improve their wound management process.
3.4.1 Inclusion criteria

The digital images of the wounds were included if they were clear and had adequate resolution, as well as, extracted from the records of the patients with the following criteria:

1. A patient must have been cared for in the community for at least 9 months.
2. A patient must have had at least 20 or more weekly consecutive digital photos of the same wound that ultimately healed.
3. A patient must have been discharged from the system.

The inclusion criteria for nursing participants:

1. The RNs must have been employed in the community (homecare) settings for at least one year and had 2 or more years of experience in providing wound care on a regular basis.
2. The RNs must have had experience in caring for wounds of various etiology.

3.4.2 Exclusion criteria

The digital images of the wounds were excluded if:

1. A patient had a non-healing wound that was more than 9 months old.
2. Digital images were blurry, with mismatched formats and taken from various angles.

The nursing participants were excluded if:

1. The RN had insufficient prior experience in wound care (for example, less than 2 years of practice and lack of experience in caring for wounds of various etiology).
2. The RN was unable to commit time for the interview.
3. The RN chose not to participate in the study.
3.5 Recruitment methods

Participants were sought from the one community health unit. An introductory email was sent to the nursing manager, followed by an invitation email to the prospective participants (community care RNs). A poster with the relevant study and contact information was placed in the community health unit to facilitate signing up for the interviews. Participants were selected according to the inclusion/exclusion criteria.

3.6 Procedures & Data collection

A room for the interviews was booked at the community health unit. All participants signed the consent form prior to conducting the interviews. To collect demographic data, nursing participants were asked to complete a demographic questionnaire without writing their name on the form. The participants were asked to dedicate up to one hour of their time for the interview. They were also instructed that they could leave the session at any time without adverse consequences to them.

Participants were asked to read a wound care case scenario, clinical notes describing the wound and after that they were shown the prototypes of four formats of digital wound data displays. While browsing through the visual displays of the wound images, the participants were asked to verbalize their thoughts, the process known as a “Think Aloud” protocol (Crutcher, 1994).

At the end of the session, the participants completed a questionnaire which included concepts related to the usefulness of visual displays, their ease of use, attitudes, and the perceived benefits of different wound image presentations. The interviewees were asked to choose the format of the digital wound data presentation that they considered to be the most
helpful in wound assessment process and clinical decision making. The comments made by the nurses about the digital wound images were recorded by the researcher.

The sessions were audio recorded and a video recording of the screen was also captured with MORAE® software (TechSmith Corporation) installed on investigator’s laptop. There was no video recording or photography of the participants. Audio recordings were transcribed by the primary researcher. All participants remained anonymous. No data about patients was used or recorded. All information obtained from the participatory session was de-identified.

3.7 Data analysis

The data collected from the participants were analyzed by the researcher and the relevant findings were grouped together so that patterns and contradictions could be seen between participants (Tolson, 2002). Yin’s (2003) strategy was followed and the researcher analyzed the data for each participant separately, searching for themes, patterns and contradictions within each participant’s data. The interview sessions allowed the participants to describe their “views of reality”, which in the context of this study were related to their approach to wound management process and the role of the digital image data in it. The “views of reality” enabled researchers to better understand the participants actions or interactions with the prototyped wound displays (Lather, 1992). To promote the integrity of the data the following strategies were used:

- For each participant, the data summary tables were created.
- For each participant, the consistency of their responses was identified.
- The analyses of the interviews and the relevant questionnaires were discussed between the supervisor and the primary investigator to discover the meanings of the found themes and patterns.
The initial codes were assigned to the text. Similar codes were grouped into the same units of analysis. Once this process was completed, units were grouped around themes. Data analysis and interpretation focused on the specific interview questions asked by the primary researcher during the interview sessions, as well as, the survey questionnaires completed by the participants.

### 3.8 Ethical considerations

According to Polit and Beck (2014), researchers must address ethical issues when their research involves human beings. Permission to conduct this study and ethical approval was requested in writing from the Clinical Research Ethics Board of the University of British Columbia. The value of this research was outlined in the Summary of Study and Recruitment section of the application form. The ethical principles that were considered in conducting this research study were: respect for persons, confidentiality and beneficence. All participants had the right to decide whether or not they would be involved in this research. Informed consent was sought from the nursing participants prior to the interviews and a copy of the consent form was given to each participant at the start of the session. The participants were provided in writing the details about the nature and purpose of the research, the details about research data access and the proposed outcome of the research.

A written guarantee was given to the participants that the data collected will remain confidential and only the primary investigator and the supervisor, whose names were written on the consent form, would have access to it.

When accessing electronic patients records from the community center database, the wound images were used in a manner in which the patients could not be identified. The wound
images did not include patients’ faces or any other identifying characteristics. This retrospective study included the digital wound images of discharged patients only.

3.9 Plans to overcome possible difficulties

Community care agencies should be supported and encouraged to participate in research studies to inform the development of high quality, patient-centered care. The involvement of the community health units in research allows to gain insights into their working environments, including their interactions with computers and digital information. Some of the possible difficulties that could have arisen in the course of this project were related to busy schedules of the participants. The research was conducted at the workplace of the community nurses, and the participants might have become concerned about work disruption and increased demands on their time (Cleary 2004). To facilitate the recruitment of the participants, the information letter was sent to three prospective community nursing agencies. The letter, along with the introductory email was also sent to the community nursing managers. The introductory material highlighted the fact that the participation in the research was voluntary and anonymous, and the interview session would not last for more than one hour. The letter assured that that the participants would be able to withdraw from the interview session at any time. The prospective interviewees were offered a gift card in the amount of CAD $20 to show the appreciation for the time spent participating in the research.

The intention of this project was to explore homecare RNs’ preferences for the visual display of the wounds. During the interview sessions, it was highlighted by the researchers that the opinions of the participants were important to this project and the results of this study
potentially might contribute to positive changes in the existing format of visual display of the
digital wound information in the wound care application.
Chapter 4: Results

4.1 Introduction

The purpose of this project was to examine the perceptions of the community care RNs about different visual presentations of digital wound data and investigate the perceived value of different formats of wound displays. The method to obtain the results first involved extracting digital images of chronic wounds from one of the community databases. The next step was to create three wound care cases with each case including four types of prototyped visual displays to present wound images in different formats. In the last step, the wound care cases with accompanying enhanced digital wound data were presented to five community care RNs in order to discover their opinions regarding the usefulness and value of the presented wound image displays in their wound care practice.

This study involved interaction of the participants with the prototypes of the digital wound data displays. To determine the number of research participants, the researchers referred to the studies by Nielsen (2000), Hudson (2001) and Faulkner (2003) related to the user interface testing. These authors suggested that having five homogeneous users would allow to learn about most of the findings in user preferences and behaviour when testing a user interface. All five participants involved in the study were community care RNs with experience in the wound care management process in community settings and all of them were using the same wound care documentation application on a daily basis. To ensure homogeneity of the participants, inclusion and exclusion criteria for the nursing participants were developed and outlined in Methods section of this document. The following chapter will demonstrate the prototypes that were used in this study and outline the themes that emerged during the interview sessions. The results of the study are presented in an integrated manner based on both quantitative and think aloud data.
4.2 Prototypes of digital images displays

Prototypes of the digital wound image displays were created with Axure® software (Axure Software Solutions, Inc.). The screenshots below show the prototype for one of the cases used during the interview sessions (patient case with a lower leg ulcer).

In the prototype, the most current wound image would open by default when the user tried to access the digital wound images in the wound care application (Figure 4.1). The side panel on the right side showed basic patient information: name, date of birth, diagnosis and the number of weeks the wound had been treated for.

Figure 4.1 “Latest image only” display
To view the initial and the most recent wound images side-by-side, the user had to select “First and Latest Image” option (Figure 4.2). The corresponding wound images would be displayed side-by-side and marked with the dates that the photos were taken on.

**Figure 4.2 “First and Latest Images” display**
To access the comparative view, the user would have to press the “Compare Photos” button (Figure 4.3). The comparative view had two drop-down menus, which allowed the user to select the weeks of treatment. In the example below, the user selected to compare images for the weeks of October 05, 2015 and October 12, 2015. Once the images populated the screen, the corresponding weeks would show in upper right corner of the images.

**Figure 4.3 “Compare Photos” display**
To view the chronological display of all available wound images on one screen, the user had to select the View All option (Figure 4.4). By showing the thumbnails of all available wound images on one screen, the chronological display allowed the user to see how the wound had changed over time. Each thumbnail was marked with the week of treatment, which provided an information about the time the wound picture was taken. The thumbnails were clickable; once clicked, the corresponding wound image would appear in full size in another screen to allow for more detailed assessment of the wound.

**Figure 4.4 “View All” display**
4.3 Demographics

All participants were female, and ranged in age from 21 to 50. The participants’ community care nursing experience, including wound care, ranged from 1 to 15 years, with the most experienced participants being a WOCN and a wound care educator.

Table 4.1 Demographic summary

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Age Group</th>
<th>Sex</th>
<th>Clinical Profession</th>
<th>Degree</th>
<th>Years of nursing experience</th>
<th>Years of community nursing experience</th>
<th>Frequency of computer use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31-40</td>
<td>F</td>
<td>Staff RN</td>
<td>BSN</td>
<td>3</td>
<td>3</td>
<td>Several times a day</td>
</tr>
<tr>
<td>2</td>
<td>21-30</td>
<td>F</td>
<td>Staff RN</td>
<td>BSN</td>
<td>3.5</td>
<td>1.5</td>
<td>Once a day</td>
</tr>
<tr>
<td>3</td>
<td>41-50</td>
<td>F</td>
<td>RN, Wound Care Educator</td>
<td>BSN</td>
<td>21</td>
<td>10</td>
<td>Several times a day</td>
</tr>
<tr>
<td>4</td>
<td>41-50</td>
<td>F</td>
<td>RN, WOCN</td>
<td>BSN</td>
<td>20</td>
<td>15</td>
<td>Several times a day</td>
</tr>
<tr>
<td>5</td>
<td>21-30</td>
<td>F</td>
<td>Staff RN</td>
<td>BSN</td>
<td>3</td>
<td>1</td>
<td>Several times a day</td>
</tr>
</tbody>
</table>

4.3.1 Perceived usefulness, attitude and intention to use

After reviewing feedback questionnaires, it was possible to create individual and summary tables reflecting the reaction of the participants to the enhanced digital wound data that could be potentially available for them in their daily use. The summary table below reflects perceived usefulness and attitude towards having enhanced digital wound data in the context of wound care management software in the community setting. Each visual format was scored on a scale from 1 to 7 with 1 being the lowest score and 7 being the highest. The scores mirrored the format of the Likert scale type survey questionnaires used during the interview sessions (Crites et al., 1994, Davis (1989), Venkatesh & Bala (2008)). The scale from 1 to 7 was assigned to 7 types
of scores: Extremely likely = 7, Quite likely = 6, Slightly likely = 5, Neutral = 4, Slightly Unlikely = 3, Quite Unlikely = 2 and Extremely Unlikely = 1.

Table 4.2 Community care RNs: perceived usefulness, attitude and intention to use

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Visual Format</th>
<th>Latest Image only</th>
<th>First and Latest Images</th>
<th>Compare Images</th>
<th>View All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived usefulness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  Help to recognize wound changes more efficiently</td>
<td></td>
<td>5.2</td>
<td>3.6</td>
<td>6.4</td>
<td>5.6</td>
</tr>
<tr>
<td>2  Help to manage treatment of wounds better</td>
<td></td>
<td>5.8</td>
<td>3.4</td>
<td>6.4</td>
<td>6.2</td>
</tr>
<tr>
<td>3  Help to recognize changes in wound status quicker</td>
<td></td>
<td>5.2</td>
<td>4.0</td>
<td>6.4</td>
<td>6.6</td>
</tr>
<tr>
<td>4  Help to revise wound care plan for changes quicker</td>
<td></td>
<td>5.4</td>
<td>3.4</td>
<td>6.4</td>
<td>6.2</td>
</tr>
<tr>
<td>5  Help to promote healing and prevent wound progression more effectively</td>
<td></td>
<td>5.2</td>
<td>3.4</td>
<td>5.2</td>
<td>5.4</td>
</tr>
<tr>
<td>6  Make it easier to do my job</td>
<td></td>
<td>6.0</td>
<td>3.8</td>
<td>6.2</td>
<td>6.2</td>
</tr>
<tr>
<td>7  Useful in my job</td>
<td></td>
<td>6.2</td>
<td>4.4</td>
<td>6.6</td>
<td>6.6</td>
</tr>
<tr>
<td><strong>Summary Score</strong></td>
<td></td>
<td><strong>5.57</strong></td>
<td><strong>3.71</strong></td>
<td><strong>6.23</strong></td>
<td><strong>6.11</strong></td>
</tr>
<tr>
<td>Attitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8  Beneficial in performing my tasks</td>
<td></td>
<td>6.6</td>
<td>4.4</td>
<td>7.0</td>
<td>6.8</td>
</tr>
<tr>
<td>Intention to use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9  Would use in practice</td>
<td></td>
<td>6.6</td>
<td>4.4</td>
<td>6.6</td>
<td>6.8</td>
</tr>
</tbody>
</table>
Based on the scores of the feedback questionnaire it was possible to conclude that the participants considered comparative (Compare Images), chronological (View All) and current image (Latest Image only) views as useful tools in their daily work. First and Latest Images view received the lowest overall score of 3.71. The attitude of the participants towards using four different formats of wound displays was positive. The interviewees indicated that comparative, chronological and most current images would be the most beneficial views in performing their tasks. The higher scores in the “Intention to use” section for the comparative (6.6), chronological (6.8) and most current images (6.6) views suggested that the participants would use them in their practice, if these formats of digital data display were available to them. The “First and Latest Image only” view received consistently low scores among all visual formats (3.71 - 4.4), which suggested that this format would not likely be used by the community care RNs in their daily practice.

During the interview sessions, all participants highlighted the importance of wound photography in their daily practice, stating that it provided them with valuable visual enhancement to the written clinical assessment notes. All interviewees appreciated the ability to switch between four different wound image displays; they mentioned that it would allow them to choose a visual format that would best suit their needs in a particular wound care case.

### 4.4 Overarching Themes

Several themes that emerged during the interview sessions are outlined below.
4.4.1 Improved visibility of the wound healing trend (“View All” display)

“View all” screen allowed participants to view the thumbnails of all photographic images of a wound on one screen in chronological order labeled with the weeks of treatment. All participants stated that such chronological display would be useful in their job, it would help them to recognize changes in the wound status earlier, which in turn would allow them to revise wound care plan quicker. The majority of the participants, 4 out of 5, agreed that looking at the thumbnails of the wound images in chronological order would help them to recognize wound healing trend more efficiently and it would help them to prevent wound progression more effectively. “View All” screen received the second highest score for its overall usefulness of 6.11 out of 7 in the survey. All participants indicated that the chronologic display of the wound image thumbnails would be beneficial in their work and that they would use it in their daily practice. This was supported by the high scores from the survey: 6.8 out of 7.

Some of the participants (3 out of 5) noted that displaying the thumbnails of all available wound images on one screen created “crowdedness” and was hard on the eyes. However, these participants still liked the idea of displaying the thumbnails in chronological order, and suggested to make it a user-selectable option to choose the number of consecutive weeks of wound treatment be displayed (for example, showing only the last 5 weeks of treatment).

During the interview sessions, the majority of the participants (4 out of 5) stated that they would like to have the display similar to “View All” in their wound care application. One participant said that she would not use this option as often due to the nature of her interactions with the photographic images. This participant was a manager and a WOCN with 20 years of experience who usually did a consulting type of work for the difficult wound cases where healing had slowed down. This participant stated that in order to advise the nursing staff about
the wound care plan changes, it would be sufficient for her to use the “Compare photos” view to compare the most current wound image with the one from 1 or 2 weeks ago.

### 4.4.2 Comparative design to reduce cognitive load (“Compare Photos” display)

“Compare Photos” display allowed the participants to use the drop-down menus to select 2 digital wound images from 2 weeks of treatment. All participants indicated that viewing comparable wound images side by side on one screen would be very valuable in their work. All interviewees stated that it is much easier to pick up the differences between the wound images when they are placed side by side. The participants mentioned that the recognition of the changes in wound appearances would aid them in the timely changes in the wound care plans. The majority of the participants (4 out of 5) stated that the comparative view would help them to promote wound healing and prevent wound progression more effectively. The comparative view received the highest score in the survey for its usefulness and value in the wound care management process (6.8 and 7.0 respectively).

All participants indicated that the comparative view would be beneficial in performing their daily wound care activities and that they would like to use a view similar to it in their wound care software application. The high score of 6.6 in the “Intention to use” criteria (Table 4.2) indicates that if the comparative view became available to the interviewees, they would use it in their daily practice.

### 4.4.3 Views tailored to user needs

During the interview sessions, all participants stated that they liked the ability to switch between different views and select the visual display of the wound images that would best suit
their needs. The interviewees indicated that they would use different visual displays at different times. For example, when preparing for a visit with a patient whose wound is unfamiliar, most participants (3 out of 5) agreed that they would look at the continuous chronological display of the digital wound data to be able to see the wound progression over the weeks of treatment. For the familiar patients, all participants agreed that comparing the most current wound image with another image from the previous week would be the most helpful. All participants also agreed that having a view with the most current wound image is appropriate and helpful in making a general impression of the wound.

The majority of the participants indicated that the comparative view with the initial and latest wound images side by side (“First and Latest Images” screen) would not be helpful in their practice. They explained their dislike by the fact that many chronic wounds are healing over a prolonged period of time, and comparing the images that were taken weeks or even months apart would not be changing their wound care plan decisions. In their daily practice, the community nurses would be more interested in the recent changes of the wounds to determine the dressing type and care plan to address the most recent changes and wound progression. However, one of the interviewees who was a wound care educator stated that she would use the side by side display of the oldest and latest wound images for educational purposes in order to demonstrate the overall progress in the wound healing process. Based on the participants’ feedback, it is possible to conclude that the needs of the users were suited better with the ability to choose from different visual display formats.
4.4.4 Correlation of digital image data, clinical data and nursing care plans

During the interview sessions, 3 out of 5 nurses stated that they would like to see the photographic wound images associated with the wound care plans on the same screen. All nurses agreed that the display of demographic and clinical data along with the wound care plan summary next to the corresponding wound images would be helpful in quickly grasping an important information about the wound in question. This information suggests that clinical narrative and digital image data is required for the full picture of the wound.

It is interesting to note that at present, the wound care application that is used by the VCH community nurses only displays a single digital image for a selected week of treatment. The care plan has to be searched for in a separate tab and in a different screen, which potentially disrupts the flow of the task.

4.4.5 Need for clinical summary including images

Some of the nurses (2 out of 5) suggested that it would be beneficial to be able to generate a summary report page with the most current digital wound image and the associated wound care plan, including the most recent changes in wound treatment, relevant lab results or appointments. The participants indicated that such report would be a useful tool in preparing for a home visit for patients with wounds.

4.5 Summary

The study found that RNs working with the wound care patients at the community centers prefer to visualize digital wound data using different views at different times depending on their task and familiarity with the wound case. The majority of the RN participants indicated that it
would help them to have the digital wound images associated with relevant clinical, demographic and lab data, as well as the care plan. The display of a wound image and the relevant clinical narrative summary would help them to create a better picture about the wound case. Some participants suggested that the ability to generate a report with a wound image and associated summary of clinical and treatment data could better prepare them for a patient visit and serve as a reference to the care plan and wound appearance.
Chapter 5: Conclusion

5.1 Introduction

This project sought to use scientific inquiry to explore the perceptions of community nurses about four different formats of digital wound image displays in the context of wound care management software application in the community care center settings. The researchers explored the perceived benefits of using one digital wound display over the other, as well as investigated possible improvements to the wound image displays that would help to improve the wound care management process. In summary, incorporating an enhanced visual presentation of the digital wound data as part of the everyday wound care practice in the community care settings was positively regarded by all participants. Community nurses consistently use wound images in determining care, and this study suggests that they would prefer one view over the other in performing different activities.

When preparing for a wound care patient visit, all nursing participants stated that they relied on visual wound information, relevant clinical data and the care plan from the patient’s record. These findings supported previous studies that confirmed the value of combining clinical information with the digital photography in the wound care process (Roth et al., 1999, Bradshaw et al., 2001, Braun et al., 2005, Baumgarten et al., 2009). However, this project has also indicated that although digital wound photography was being used by the community nurses on a regular basis, a number of improvements to the visual display of the digital wound data would be essential in order to facilitate more accurate wound-care assessment, better aid in choosing appropriate treatment strategies, and enable more effective collaboration between wound care team professionals.
5.2 Discussion

Mirroring the Results section format, the discussion will be organized by themes.

5.2.1 Theme 1: Improved visibility of the wound healing trend

All participants indicated that the view with the thumbnails of the photographic images in the chronological order would improve the visibility of the wound healing trend and would help them to recognize wound changes in a more efficient and timely manner, which in turn could aid in choosing a more appropriate wound care strategy. There were differences in the interviewees’ preferences with regards to the number of images displayed on a screen, however all of them agreed that the view of continuous chronological digital wound data would be beneficial and useful in their work. The value of chronology in viewing wound images data was emphasized in the study by Rennekampff et al. (2015), who examined the reliability of photographic analysis of wound epithelization. The authors reported that arranging the wound area pictures in chronological order successfully helped to establish wound closure by identifying the image within the chronologic series where wound closure was judged to be complete.

The chronology of wound size and surface could provide valuable information on wound status and healing. Considering the chronic nature of the wounds in the community patient population, the chronological sequence of digital images with time stamps would be a desirable option for showing the progress of the wound over a long period of time. Bates (2016) noted that screening for wound changes and wound size could serve as a predictor of wound healing likelihood. A chronological overview of the wound photos could provide an improved visibility of the healing trend, enable more accurate wound assessment, and as noted by Bates (2016) it could help in assessing a patient’s prognostic chance to heal.
5.2.2 Theme 2: Cognitive load issue addressed by comparative design

Graphic displays such as visual interfaces have long been used to present information in a form intended to be easy to comprehend (Massironi, 2002, Tufte, 2001, Ware, 2008). Roda (2011) describes a phenomenon known as a “selective coherence” where an original image alternates with a modified image with a brief pause between the images and the observers have greater difficulty noticing changes between the alternating images. In the context of the current study, the participants highlighted the benefit of comparing wound images from different weeks of treatment on one screen instead of viewing such images in two different screens. All participants noted the inconvenience of their current application that allows them to view only one wound image at a time on a single screen. The prototyped comparative screen used in this study allowed the participants to view the comparable wound images side by side, which improved the perception of change. All participants stated that viewing photos side-by-side allowed them clearly see the changes in wound appearance and size.

When completing the survey, the participants unanimously gave the “Compare photos” screen the highest score of 7.0 for the potential benefits in their practice and stated that they would use it if they had access to it (see “Intention to use” section in Table 4.2 – score 6.6). These high scores suggested that the “Compare photos” view made the changes in the wound appearance and size more obvious and visible since no visual information was lost while switching between the screens and the participants did not have to recall what they had seen in the previous screen. Another factor that contributed to the users’ liking this view was probably related to the fact that the comparative screen allowed the users to accomplish the task of comparing two wound images with the fewer mouse clicks.
5.2.3 Theme 3: Views tailored to user needs

Another theme that emerged during the interview sessions was related to the ability to choose the digital wound data view that best suited the needs of a user. All participants stated that it would be beneficial to have multiple views of digital wound data and to be able to switch between them. The participants mentioned that they would choose the view with the latest image only when they were familiar with the patient and the associated wound care plan. However, at other times, when the patient was not previously known to the wound care nurses, the participants emphasized the benefits of having the chronological sequence of wound image thumbnails and the ability to view the wound progression and healing. These findings correspond to user-centered design principles, where the applications with polarized user populations and various user needs must provide different styles of user interfaces for different users (Nielsen, 1993, Abras, 2004).

In the context of the community care, there are several types of nursing professionals who access the application with wound images on a regular basis – community nurses, educators and WOCNs. These users need different visual information at different times. A visual display that would be appropriate for the community nurse prior to home visit, might not be useful to a WOCN providing consultation for a patient with poorly healing wound. The need for the views’ customization is suggested by this study’s findings. All community nursing participants working directly with the patients stated that they liked the idea of having the latest wound image displayed by default and they would use the chronological sequence of wound image thumbnails to evaluate the healing progress. The participant who was a WOCN, in turn, stated that she would seldom use the chronological sequence of wound image thumbnails, and that she would
use the comparative view instead to compare the latest image with one of the previous images in order to make her suggestion in care plan changes.

During the interview sessions, the majority of the participants, 4 out of 5, stated the “First and Latest images” view was not particularly useful for them in their practice. The “First and Latest images” screen received the lowest score in the survey questionnaire – overall score of 3.71 out of 7 for its potential usefulness. However, one participant, who was an educator, stated that she would use this view in her education sessions to showcase the progress of the wound from the beginning of treatment until it has healed.

These findings highlight the importance of supporting the needs of various users, which has already been conveyed in previous research studies that suggested the inclusion of users with diverse needs in development of healthcare applications (Shah, 2006, Moody, 2015).

5.2.4 Theme 4: Correlation of digital image data and clinical data

Digital photography plays an important role in the wound management process by providing objective visual information that is essential for developing a comprehensive plan of care. However, some parameters such as location, depth, odour, condition of the surrounding tissue, tunneling, the amount of exudate and other parameters are best captured in written clinical documentation. Studies have suggested that digital wound data should be used in conjunction with the clinical narratives to increase the accuracy of the assessment (Tsai et al., 2004, Thompson et al., 2013, Jesada et al., 2013). Similarly, in this study, the majority of the participants indicated that their assessments would be more accurate if they saw digital wound images being associated with the summary of relevant clinical information, along with the nursing care plan and a recent laboratory data. A screen with the wound image could provide
important visual information, however, a summary of relevant clinical narrative on the same screen could complete a clinical picture by making the invisible visible (e.g. tunneling).

The importance of correlating wound images data with the clinical data was also apparent when the participants used the comparative screen. All participants appreciated the ability to compare the wound images from certain weeks by selecting the weeks of treatment from the drop-down menus in the “Compare Photos” screen. The interviewees stated that such side by side comparison would give them an ability to view the progress of the wound healing in relation to the changes in treatment or wound care (for example, before and after antibiotic therapy, or before and after changes in dressing type).

This project’s findings suggest that associating digital wound data with the clinical information and care plan could improve clinicians’ interpretation of the wound status and potentially improve wound care process.

5.2.5 Theme 5: Need for clinical summary including images

Dittrich et al. (2013) noted that an efficient and effective user interface is beneficial and valuable to its audience. Such an interface might improve the visibility of the patients’ data and offer quick access to important patient information. The current design of the wound care application used by the participants offered limited ability to connect wound images data with the corresponding clinical narrative, laboratory results and care plan. Participants’ recommendations to add a functionality that would provide an ability to generate a clinical summary including wound images demonstrated the need to enhance current design of the wound care application. Two participants suggested that a summary report page including the
most current digital wound image and the associated wound care plan, relevant lab results and appointments was needed to improve their planning when visiting patients at home.

These findings suggested that the addition of a summary report generating ability including digital image data along with the clinical summary narrative could make all relevant wound care information transparent and available in one document or screen, which in turn, could potentially improve communication between the wound care providers and offer better support for the nurses in wound care planning.

5.3 **Limitations of the study design**

This small-scale study had a limitation of being conducted in only one community center with a small number of participants. Due to the small scale of the project, the results of the study are not transferrable to other community practice settings.

The participants in this research had varied levels of experience in providing wound care to community patients. The years of interviewees’ experience ranged from 1 year to 15 years, which could have influenced the results of the study. However, having diversity in the participants’ experiences and roles (WOCN, wound care educator and staff RNs) allowed the researchers to show the importance of user-tailored approach in health care applications.

The intention of this study was not to perform an exhaustive testing on the digital wound data display prototypes and it was not meant to involve a large group of wound care application users to determine all possible themes related to the perceptions of the community care RNs towards possible different formats of digital wound data display. This research focused on exploring the attitudes of the small group of community RNs towards different formats of digital wound data display within the wound care application. It is recommended that other studies,
both qualitative and quantitative be carried out in various community settings, involving more nursing participants and more extensive digital wound images data, so that a more general picture of preferences of digital wound data display could be established.

It is the intention of the researchers to share the findings of the study with the management of the participating community health center. It is hoped that this study offered some insight into what the community nurses perceive as the most effective visual presentation of digital wound images within wound care software application.

5.4 **Implications and recommendations for nursing practice and research**

Accurate assessment of chronic wounds is an important factor in identifying the most appropriate wound treatment. To effectively manage wounds, it is essential to have complete wound documentation including a narrative description of the wound and corresponding wound images, which provide objective visual information. The results of this study suggested that the format of visual display of the digital wound data is an important factor in the wound management process. Community nursing participants indicated that in their practice they would prefer having more than one visual format for digital wound data display. Different formats of visual display would serve different purposes depending on the task and the familiarity of the user with the wound case. The study also suggested that correlation of the wound image data with the clinical narrative was an important factor in creating a comprehensive picture of the chronic wound when making wound assessment and developing wound care plan. An ability to generate a summary report containing wound image data and associated care plan and clinical notes could potentially aid community nurses in preparing for a homecare visit.
These findings provided some insight about the current attitude of the community care RNs towards different formats of visual display of digital wound data, as well as, indicated that community care RNs could potentially benefit from improving their current wound care management software application. These results were representative of the importance of user-centered approach when designing user interface, and highlighted the necessity of creating the screens that would be reflective of the users’ perspectives. The participants’ assessment was informed by TAM2 and TTF as the theoretical foundation. The findings from the survey questionnaire and narrative comments during the interview sessions provided initial evidence that more than one format of digital wound data display is needed to match community RNs’ tasks related to wound care management process.

A bigger scale study is needed to establish the most efficient workflows in the context of the wound care application used in the community setting. Possibly, the improvements in digital wound data display will enhance the effectiveness and efficiency of the wound assessment ultimately leading to improvements in wound care and wound healing process.

5.5 Summary

Community care RNs consistently use digital wound images in wound assessments and determining plan of care. The results of this project demonstrated the importance of different formats for displaying digital wound data. The research suggested that that community care RNs would prefer one wound visual display over the other in performing different nursing activities. These results were consistent with the data from medical and non-medical studies. For example, the study by Gurushanthaiah et al. (1995) found that the anesthesiologists’ ability to obtain objective data from different visual monitoring displays was related to the format of the...
displayed information on the screen. Proaps & Bliss (2014) found that different text and content presentation styles affected the ability of military trainees to perform tasks when engaging in video simulation training. This research suggested that the community care RNs providing wound care could benefit from having access to more than one display format of the digital wound data. For example, viewing digital wound data in chronological order could improve visibility of the wound healing trend and help the nurses in more accurate assessment and choosing appropriate wound care strategy. Comparing wound images side-by-side on one screen without having to switch between different screens would make the visual changes in wound appearance more obvious. The association of the wound images with the corresponding clinical data, lab results and care plan on one screen would eliminate the need for multiple mouse clicks and it would improve the efficiency of the wound assessment by providing a complete clinical picture in one place. Report generation is an important functionality in any software application. This study’s findings suggested that integration of the reporting capability allowing to generate a wound care summary, including digital images and clinical narrative with care plan, into the existing wound care application could improve community nurses’ planning when visiting patients at home.

Based on the themes that emerged in the study, this small-scale project suggests that the development of optimal display formats in the wound care application could improve the wound management process in the community settings. Additional research is required to explore the display formats that would be most informative, effective and efficient in the wound assessment and care process.
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### A. Questionnaire to assess perceived usefulness

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2. Using a _____ would help me to manage treatment of existing wounds better.

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3. Using a ________ would help me to recognize changes in wound status quicker.

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4. Using a ________ would help me to revise wound care plans for changes quicker.

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5. Using a ________ would help me to promote healing and prevent wound progression more effectively.

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6. Using a ________ would make it easier to do my job.

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A. (continued) Questionnaire to assess perceived usefulness

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<td>16. Using the <em>View All</em> makes me feel _____:</td>
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</tbody>
</table>
C. Questionnaire to assess intention to use

<table>
<thead>
<tr>
<th>Intention to use</th>
<th>Strongly disagree</th>
<th>Moderately disagree</th>
<th>Somewhat disagree</th>
<th>Neutral (neither agree nor disagree)</th>
<th>Somewhat agree</th>
<th>Moderately agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Given that I had access to the <strong>Latest Image Only</strong>, I predict that I would use it.</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>2. Given that I had access to the <strong>First and the Latest</strong>, I predict that I would use it.</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>3. Given that I had access to the <strong>Compare Images</strong>, I predict that I would use it.</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>4. Given that I had access to <strong>View All</strong>, I predict that I would use it.</td>
<td>1 2 3 4 5 6 7</td>
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</tbody>
</table>