



**UNIVERSITY
OF TURKU**

THE WOUND CARE COMPETENCE OF GRADUATING STUDENT NURSES

**Development and Testing of a Competence
Assessment Instrument**

Emilia Kielo-Viljamaa



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The originality of this publication has been checked in accordance with the University of Turku quality assurance system using the Turnitin OriginalityCheck service.

ISBN 978-951-29-8329-2 (PRINT)
ISBN 978-951-29-8330-8 (PDF)
ISSN 0355-9483 (Print)
ISSN 2343-3213 (Online)
Painosalama Oy, Turku, Finland 2021

Education is the most powerful weapon which you can use to change the world
–Nelson Mandela

UNIVERSITY OF TURKU

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EMILIA KIELO-VILJAMAA: The Wound Care Competence of Graduating Student Nurses – Development and Testing of a Competence Assessment Instrument

Doctoral Dissertation, 171 pp.

Doctoral Programme in Nursing Science

January 2021

ABSTRACT

Wound care is an essential element of clinical nursing and it requires versatile competence from nursing professionals. Patients with wounds are cared for almost everywhere in the health care system from emergency departments to care for the elderly, but chronic wounds, in particular, are a significant concern for today's health care systems due to an ageing population.

The competence of graduating student nurses has become an essential issue in relation to professional standards and patient safety. The aim of this study was i) to explore graduating student nurses' wound care competence, ii) to identify the requested competence areas for registered nurses providing wound care and iii) to develop and test a new wound care competence assessment instrument that could be used to assess the objective wound care competence of graduating student nurses.

This study was conducted in two phases: 1) theoretical and descriptive phase, 2) instrumentation and evaluation phase. Phase 1 comprised a literature review and a cross-sectional study (n=213 students) describing the topic using previous literature and empirical data. Phase 2 consisted of a qualitative study using focus-group interviews (n=23 health care professionals) and an instrument development study (n=135 students and professionals). The data were collected between 2016 and 2019 from various Finnish universities of applied sciences and health care organizations. The data were analysed using both qualitative and statistical analysis.

The results indicated that the wound care competence of graduating student nurses was insufficient, but the students showed a positive attitude towards wound care. Three main competence areas regarding registered nurses' wound care knowledge, skills and performance were identified, as well as six competence areas regarding the values and attitudes relating to wound care. The developed wound care competence instrument included a knowledge test, simulation and an attitude assessment; it demonstrated preliminary validity, reliability and sensitivity, but further testing is needed. The results of this study warrant closer examination and development of wound care education to ensure that future health care professionals have sufficient competence to perform evidence-based, best quality wound care.

KEYWORDS: Student nurse, nurse, wound care, competence, nursing education, clinical nursing

TURUN YLIOPISTO

Lääketieteellinen tiedekunta

Hoitotieteen laitos

Hoitotiede

EMILIA KIELO-VILJAMAA: Valmistuvien sairaanhoitajaopiskelijoiden haavanhoidon osaaminen – arviointimittarin kehittäminen ja testaus
Väitöskirja, 171 s.

Hoitotieteen tohtoriohjelma

Tammikuu 2021

TIIVISTELMÄ

Haavanhoito on keskeinen osa kliinistä hoitotyötä, ja se vaatii monipuolista osaamista hoitotyön ammattilaisilta. Haavaa sairastavia potilaita hoidetaan lähes kaikkialla terveydenhuollossa, päivystyksyksiköistä vanhustenhoitoon, mutta erityisesti krooniset haavat ovat merkittävä haaste tämän päivän terveydenhuollolle johtuen ikääntyvästä väestörakenteesta.

Valmistuvien sairaanhoitajaopiskelijoiden osaamisen tarkastelu on tärkeää ammatillisen tason ja potilasturvallisuuden kannalta. Tutkimuksen tarkoituksena oli i) tarkastella valmistuvien sairaanhoitajaopiskelijoiden haavanhoidon osaamista, ii) tunnistaa sairaanhoitajien haavanhoidon osaamisalueet ja iii) kehittää ja testata uusi haavanhoidon osaamismittari valmistuvien sairaanhoitajaopiskelijoiden haavanhoidon osaamisen arviointiin.

Tutkimus toteutettiin kahdessa vaiheessa: 1) teoreettinen ja kuvaileva vaihe, 2) instrumentointi- ja arviointivaihe. Vaihe 1 käsitti kirjallisuuskatsauksen sekä poikkileikkaustutkimuksen (n=213 opiskelijaa), missä kuvattiin aihetta aikaisemman kirjallisuuden sekä empiirisen aineiston kautta. Vaihe 2 koostui laadullisesta tutkimuksesta, joka toteutettiin fokusryhmähaastatteluin (n=23 terveydenhuollon ammattilaista), sekä mittarin kehittämistutkimuksesta (n=135 opiskelijaa ja ammattilaista). Aineisto kerättiin vuosina 2016–2019 useista suomalaisista ammattikorkeakouluista sekä terveydenhuollon organisaatioista. Aineisto analysoitiin sekä laadullisesti että tilastollisesti.

Tulokset osoittivat, että valmistuvien sairaanhoitajaopiskelijoiden haavanhoidon osaamisessa oli puutteita, mutta opiskelijoiden asenteet haavanhoitoa kohtaan olivat positiiviset. Kolme pääosaamisaluetta koskien sairaanhoitajien haavanhoidon tietoa, taitoa ja toimintaa tunnistettiin, sekä kuusi osaamisaluetta koskien haavanhoidon arvoja ja asenteita. Kehitetty osaamismittari sisälsi tietotestin, simulaation ja asenteiden arvioinnin, ja se osoitti alustavaa validiteettia, luotettavuutta ja sensitiivisyyttä, mutta jatkotestausta tarvitaan. Tulokset ohjaavat tarkastelemaan ja kehittämään haavanhoidon koulutusta, jotta tulevaisuuden terveydenhuollon ammattilaisilla olisi riittävä osaaminen näyttöön perustuvan ja laadukkaan haavanhoidon toteuttamiseen.

AVAINSANAT: Sairaanhoitajaopiskelija, sairaanhoitaja, haavanhoito, osaaminen, hoitotyön koulutus, kliininen hoitotyö

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Abbreviations

AAWC	Association for the Advancement of Wound Care
APuP	Attitude towards Pressure ulcer Prevention
CI	Confidence Interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
ECTS	European Credit Transfer and Accumulation System
EPUAP	European Pressure Ulcer Advisory Panel
EU	European Union
EBP	Evidence-based practice
EWMA	European Wound Management Association
DFU	Diabetic foot ulcer
ICN	International Council of Nurses
IWDGF	The International working Group on the Diabetic Foot
KR	Kuder-Richardson
NCLEX-RN	The National Council Licensure Examination-Registered Nurse
NICE	The National Institute for Health and Care Excellence
NPUAP	National Pressure Ulcer Advisory Panel
PPPIA	Pan Pacific Pressure Injury Alliance
PU	Pressure ulcer
PUKAT	Pressure Ulcer Knowledge Assessment Tool
PUKT	Pressure Ulcer Knowledge Test
PZ-PUKT	Pieper-Zulkowski Pressure Ulcer Knowledge Test
RN	Registered nurse
SAS	Statistical Analysis Software
SD	Standard deviation
SN	Student nurse
SP	Student podiatrist
TENK	The Finnish National Board on Research Integrity
UAS	University of applied sciences
VLU	Venous leg ulcer
WHO	World Health Organization

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

- I Kielo E, Salminen L & Stolt M. Graduating student nurses' and student podiatrists' wound care competence – An integrative literature review. *Nurse Education in Practice*, 2018; Mar;29: 1–7.
- II Kielo E, Salminen L, Suhonen R, Puukka P & Stolt M. Graduating student nurses' and student podiatrists' wound care competence: a cross-sectional study. *Journal of Wound Care*, 2019; Mar 3;28(3):136–145.
- III Kielo E, Suhonen R, Salminen L & Stolt M. Competence areas for registered nurses and podiatrists in chronic wound care, and their role in wound care practice. *Journal of Clinical Nursing*, 2019; 28(21-22), 4021–4034.
- IV Kielo-Viljamaa E, Suhonen R, Ahtiala M, Kolari T, Katajisto J, Salminen L & Stolt M. The development and testing of the C/WoundComp instrument for assessing chronic wound-care competence in student nurses and podiatrists. *International Wound Journal*, 2020; 1–17.

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1 Introduction

A human body is prone to injuries, and various wounds have caused problems and suffering for mankind throughout its history (Forrest 1982, Daunton et al. 2012). Even though nursing, medicine and technology have developed rapidly and new knowledge is constantly becoming available, wounds, and especially chronic wounds are still a significant health problem, affecting 1-2% of the population at some period during their lifetime in high-income economies (Järbrink et al. 2016). Among the general population, the prevalence of chronic wounds is 2.2 per 1000 people (Martinengo et al. 2019), and the prevalence of chronic wounds, especially leg ulcers, is predicted to increase as the population ages more and more rapidly (Moffat et al. 2004, Wicke et al. 2009).

Wounds are traditionally separated as acute and chronic wounds. Acute wounds usually cover surgical wounds, traumatic wounds and burn injuries (Li et al. 2007), whereas chronic wounds include leg ulcers such as venous leg ulcers (VLUs) and arterial leg ulcers, as well as diabetic foot ulcers (DFUs) and pressure ulcers (PUs) (Fletcher 2008, Kirsner 2016). All wounds can be defined as acute wounds following their incurrence, as wounds are usually caused by some kind of trauma (Nicks et al. 2010). However, defining a chronic wound is difficult, since there are various underlying reasons for the delayed healing process, such as infection, poor circulation or chronic diseases (Nicks et al. 2010, Powers et al. 2016).

Chronic wounds, hard-to-heal wounds, difficult to heal wounds, non-healing wounds and complex wounds are all terms that are used in the literature to describe a wound that has not healed in an orderly and timely manner (Troxler et al. 2006, Kyaw et al. 2018). The timeframe in which a wound is expected to heal varies in the literature between four and six weeks (Gottrup et al. 2010) and up to six months (Järbrink et al. 2016). In some cases, a (20-40%) reduction of the size of the wound should be observed after just two to four weeks of optimal treatment (Leaper & Durani 2008). The aetiology of the wound also impacts on the expected healing time. For example, DFUs and arterial leg ulcers can be defined as chronic wounds after just two weeks of their incurrence, due to decreased arterial perfusion to the lower limb that can lead to a critical ischaemia (Slovut & Sullivan 2008, Kyaw et al. 2018).

Chronic wounds, like other chronic health problems, are a burden to the patients. According to previous research, patients living with wounds have a decreased quality of life (Olsson et al. 2019) and wounds have the effect of worsening their physical, social and mental health, as well as causing them stress, pain and to become isolated (Byrne & Kelly 2010, Kapp et al. 2018, Phillips et al. 2018). Studies have also found that many patients with chronic wounds are frustrated and disappointed with the health care system and their treatment (Hareedran et al. 2005, Kapp et al. 2018). Wounds can also cause patients an excessive economic burden (Kapp & Santamaria 2017, Al-Gharibi et al. 2018). For example in Finland, patients who are receiving home care might have to pay for their own wound care products for the first three months (Ministry of Social Affairs and Health 2013) and in Australia, patients with chronic wounds spend approximately 10% of their disposable income on wound care products (Kapp & Santamaria 2017).

Wounds have also become an economic burden to health care systems (Lindholm & Searle 2016, Gray et al. 2018). For example in Wales, the average cost of chronic wounds is calculated to be 5.5% of the total expenditure of the health service, and most of the costs are related to hospital stays and health care professionals' time, whereas the cost of the dressings and other wound care material is much less (Phillips et al. 2016). The cost of care for a specific wound is also extensive. For example, in the United Kingdom, the average cost of providing care for VLUs is calculated to be £7,600 per wound per year (Guest et al. 2018). In addition, the provision of care for severe PUs may rise to hundreds of euros per day according to a Belgian study, whereas the cost of prevention of PUs is much smaller (Demarré et al. 2015).

The history of wound care dates back thousands of years, and the earliest known documents relating to wound care were written in 2500 BC (Forrest 1982). These ancient writings included, for example, guidance and advice relating to materials for the cleaning and bandaging of wounds, some of which are still valid today (Broughton et al. 2006, Shah 2011). However, wound management at that time was more likely to have been culturally dependent, in which both practical and spiritual strategies were used with varying success following trial and error (Daunton et al. 2012). Today, nursing and medicine value evidence, and wound care and wound prevention should be based on the best available evidence, integrated with patients' concerns and priorities, giving consideration to the local situation, available resources and the caregiver's competence (Brölmann et al. 2012). Evidence-based practice (EBP) also increases the quality of care and decreases the risk of potential complications (Posnett et al. 2009).

New research findings and care interventions appear constantly, and several guidelines in wound care present up-to-date information on wounds and wound care. For example, in Cochrane Library, more than a hundred reviews have been conducted in relation to the effectiveness of various interventions and products in

wound care. In addition, various national and international working groups have, and are constantly updating guidelines for health care professionals in which the available evidence relating to wound care is being collected, summarized and assessed (e.g., EPUAP/NPIAP/PPPIA 2019, AAWC 2015, NICE 2016). Nonetheless, studies have shown that evidence-based interventions in wound care are underused (Gray et al. 2018), implementation is challenging (Lloyd-Vossen 2009) and health care professionals' knowledge is often based on practice or personal/colleagues' experiences rather than research findings (Flanagan 2005).

Education and competence are key elements when implementing EBP (Lehane et al. 2019). However, consistent care protocols and multi-professional collaboration is often lacking between health care providers (Gottrup 2004). Registered nurses (RNs) and other health care professionals such as podiatrists, have an important role in evidence-based and multi-professional wound care. For example, in Finland, RNs are responsible for the wound management of all types of wounds, including wound assessment and the changing of dressings, as well as patient education and care planning. By contrast, the podiatrists' role in wound care focuses on chronic wound care and more precisely on DFU care and prevention.

Competence as a concept is multidimensional and the assessment of one's competence is important in clinical practice, in order to ensure the quality of care and patient safety, but also to control health care expenses (Robinson et al. 2009, Kajander-Unkuri et al. 2013, Numminen et al. 2014). Previous studies relating to RNs' wound care competence have identified that their competence in terms of caring and preventing wounds is limited (Ylönen et al. 2014, Welsh 2018, De Meyer et al. 2019), especially among those who are newly graduated and less experienced (Zarchi et al. 2014). A previous study has also indicated that RNs and podiatrists felt unconfident regarding their competence in providing care for wounds (McIntosh & Ousey 2008). However, both competence and confidence could be developed through education and experience (Eskes et al. 2014), and previous studies have suggested that further education and extra courses in wound care would be beneficial for RNs' wound care competence (Källman & Suserud 2009, McCluskey & McCarthy 2012). Still, the foundation for RNs' wound care competence is created already in their bachelor's level studies.

Student nurses' (SN) clinical competence has become an important topic in discussions relating to professional standards, the population's health needs, patient safety and quality of care (WHO 2010, Kajander-Unkuri et al. 2013). In Finland, graduating SNs have self-evaluated their overall competence to be good (Kajander-Unkuri 2014). However, students' self-evaluations were more optimistic compared to their supervisors' assessments of their competence during their final practical training (Kajander-Unkuri 2016). Studies in relation to the wound care competence of graduating SNs' and other students in health care, such as student podiatrists (SP),

is scarce both nationally and internationally. In addition, validated instruments measuring RNs' or SNs' knowledge of wounds are mostly focused on specific wounds and their care (Kielo et al. 2020), meaning that general competence instruments assessing one's competence of various wounds are lacking.

The main purposes of this study were: i) to explore the wound care competence of graduating SNs, ii) to identify the requested competence areas for RNs providing wound care and iii) to develop and test a new wound care competence assessment instrument that could be used to assess the objective wound care competence of graduating SNs especially in relation to chronic wound care. Graduating SPs were studied as a criterion comparison group throughout the study, as podiatrists focus on health from a lower limb perspective (IFP 2018) and their role in wound care is more specialized by comparison with RNs, since their work focuses mainly on DFU care and prevention. However, the podiatrists' role in wound care is as important as that of RNs, and the extension of podiatry education is also similar to nursing education at bachelor level in Finland. In the second phase of this study, RNs and podiatrists are studied as comparison groups to students in the instrument validation.

The study was conducted in two phases, during the years 2016-2020 in Finland (Figure 1). The ultimate goal of this study was to acquire knowledge in relation to graduating SNs' wound care competence, and to develop an instrument for assessing their wound care competence, which could be used in a competence assessment at the final stage of their studies. The goal was also to enhance the understanding of SNs' competence assessment using different assessment methods. The knowledge obtained with regard to students' wound care competence could be used to develop and standardize wound care education at bachelor study level. This study also provides up to date knowledge of RNs' and podiatrists' wound care competence. The developed instrument could be also used for RNs and podiatrists caring for patients with wounds, providing information relating to their competence and potential further educational needs.

This study focuses on nursing research, especially in the fields of clinical nursing and nursing education, and provides evidence of nursing competence and wound care, which is a key area in clinical nursing. This study also presents various methodological applications and combinations for nursing research to improve the systematic assessment of wound care competence.

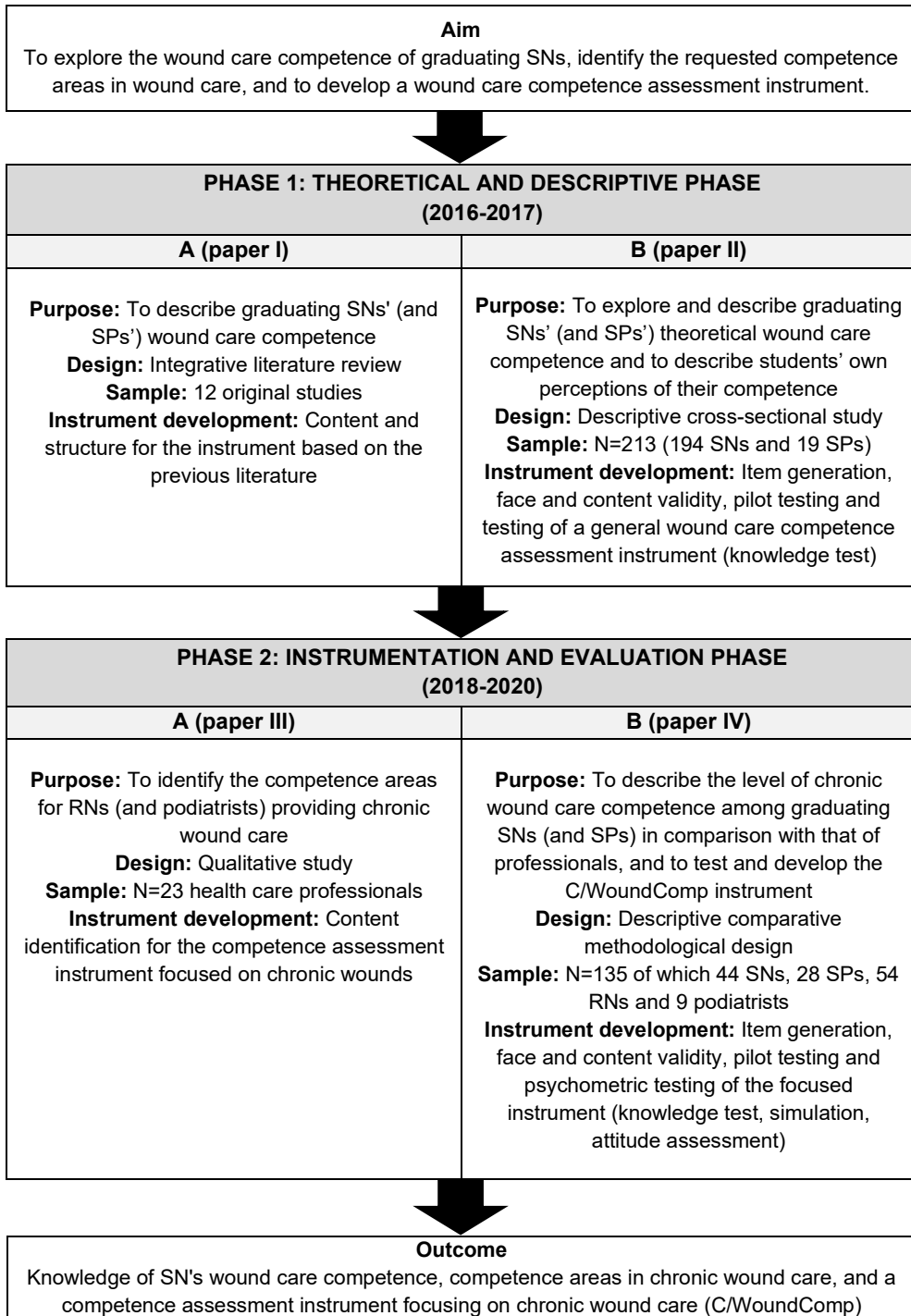


Figure 1. Study phases

2 Review of the literature

The purpose of the literature review was to 1) define the concept of competence in this study, 2) to describe and analyse previous literature relating to the wound care competence of graduating SNs, including the determination of their competence level (Paper I) and competence assessment methods, and 3) to find out what level of wound care competence is expected from RNs after graduation and how competent they should be in wound care. The research questions of this literature review were: i) how can the concept of competence be defined? ii) what is known about the wound care competence of graduating SNs' and how has their wound care competence been assessed? iii) what are the areas of competence in wound care for RNs after graduation? Studies in relation to SPs and podiatrists were also included in the literature review to establish possible similarities or differences in competences between these two key professions with regard to wound care. The literature reviews conducted in this dissertation are presented and numbered in Table 1.

Table 1. Literature reviews


Number	Review	Aim	Literature retrieval
I	Definition of the concept of competence in this study	To define the concept of competence.	Systematic literature search: 14 original studies
II	Wound care competence of graduating SNs (Part 1) (Paper I) and competence assessment methods (Part 2)	To describe the wound care competence of graduating SNs (Part 1, Paper I), and the competence assessment methods (Part 2) in previous literature.	Systematic literature search: 15 original studies (Part 1); 15+7 original studies (Part 2)
III	Wound care competence requirements for RNs	To find out what level of wound care competence is expected from RNs after graduation and how competent they should be in wound care.	Systematic literature search: 6 original studies or documents

2.1 Definition of competence

Competence in general, can be defined as ‘the ability to do something successfully or efficiently’ (Oxford Dictionaries 2020), as ‘the ability to do something well’ (Cambridge Dictionary 2020), or as ‘the quality or state of having sufficient knowledge, judgement, skill or strength for a particular duty or in a particular respect’ (Merriam-Webster 2020). In practical nursing, the concept of competence is much more multidimensional, including behaviouristic, generic and holistic approaches of competence. The behaviouristic approach refers to competence as the ability to perform individual core skills. The generic approach instead is associated with transferable attributes such as knowledge and critical thinking, and the holistic approach refers to competence as a cluster of elements including, for example, knowledge, skills and attitudes (Kajander-Unkuri 2013, Fukada 2018). According to Benner (1984, p.292), competence (competency) is ‘an interpretively defined area of skilled performance identified and described by its intent, function, and meanings’. In clinical nursing, competence can be described as a process rather than a static stage, and it can be context dependent (Lejonqvist et al. 2012). In nursing research, one’s competence has been assessed, for example, using knowledge tests (e.g., Bernhofer et al. 2017), self-evaluation instruments (e.g., Lakanmaa et al. 2014), simulated situations (e.g., Speeney et al. 2018) and interviewing (e.g., Pettersson et al. 2018). Previous studies cover both general competence assessment research (e.g., Meretoja et al. 2004), as well as context-based competence assessments (e.g., Peirce et al. 2018).

The first literature review (I) was conducted in order to identify definitions or attributes for competence in clinical nursing. This systematic search was carried out in June 2019 from five health scientific electronic databases: MEDLINE/PubMed, CINAHL, Cochrane Library, Web of Science and EMBASE using the following search terms: *competence*, *competency*, *concept*, *conceptualisation*, *definition*, *concept analysis* and *nursing* with their Boolean operators (Table 2). No time limitations were set. Articles aiming to define the concept of competence or presenting the attributes of competence in clinical nursing were included. Context based articles, such as cultural competence articles, were excluded. The systematic search provided 2353 hits in total of which 16 were chosen by the title, 14 by the abstract, and 14 by the full text. The chosen articles and the attributes and/or definitions of competence are shown in Table 3.

Table 2. Concepts and search terms of the literature review I

Concept	Search terms
Competence, competency	competence*, competency
	AND
Concept	concept*
	AND
Concept analysis, conceptualisation, definition	concept analysis, conceptualisation, conceptualization, definition*
	AND
Nursing	nurs*
	(competence* OR competency) AND (concept*) AND (nurs*) AND ("concept analysis" OR conceptualisation OR conceptualization OR definition)

According to earlier empirical literature, the most commonly used attribute to define competence was knowledge/knowing (Nigelsmith 1995, Milligan 1998, Cowan et al. 2005, Axley 2008, Scott Tilley 2008, Valloze 2009, Lejonqvist et al. 2012, Smith 2012, Church 2016, Notarnicola et al. 2016, Bergen & Santo 2018, Fukada 2018). Other commonly used attributes were skills (Nigelsmith 1995, Milligan 1998, Cowan et al. 2005, Scott Tilley 2008, Valloze 2009, Smith 2012, Caruso et al. 2016, Church 2016, Notarnicola et al. 2016, Fukada 2018) action or performance/performing (Milligan 1998, Cowan et al. 2005, Axley 2008, Valloze 2009, Lejonqvist et al. 2012, Garside & Nhemachena 2013, Bergen & Santo 2018), and attitudes (Nigelsmith 1995, Cowan et al. 2005, Caruso et al. 2016, Fukada 2018). In certain articles, competence was identified as a process (Milligan 1998, Lejonqvist et al. 2012) or as a dynamic state (Axley 2008). Competence as a concept in clinical nursing was defined in 10 of the chosen articles (Table 3).

In some of the articles, the antecedents and consequences of competence were stated. For example, Axley (2008, p.220) stated that the antecedents of competence are the following: 'The individual has completed the required educational preparation or acquired knowledge needed to demonstrate competency', 'Standards of action or behaviour have been identified and relate to the educational theory' and 'Accountability and responsibility for knowledge and actions are evident.' In addition, Notarnicola et al. (2016) stated that the antecedents of competence were clinical activities, clinical experience, the nursing process, professional practice, professional standards and nursing care. Common consequences of competence were patient safety (Axley 2008, Smith 2012, Church 2016), improved patient outcomes (Scott Tilley 2008, Church 2016) or quality of care (Valloze 2009), but also motivation (Church 2016), empowerment (Nigelsmith 1995, Valloze 2009, Church

2016) and holistic care (Smith 2012, Church 2016) as well as confidence (Church 2016, Smith 2012) and self-evaluation (Scott Tilley 2008).

Table 3. Definitions and attributes of competence

Authors and year	Definition of competence	Attributes of competence
Axley 2008		Knowledge, actions, professional standards, internal regulation, dynamic state
Bergen & Santo 2018	'Learning through self-awareness and deeming oneself qualified and capable of working through a problem to obtain a solution.' (p.362)	Knowledge, commitment, visions, action experiences
Caruso et al. 2016	'Nurses' professional qualification that accounts their personal characteristic and their professional function (tasks) focused on the achievement of specific outcomes and moderated by the role of organizational environment.' (p.41)	Motivation, self-efficacy, attitude, skills
Church 2016		Understanding discipline knowledge, mastery of discipline-specific skills, ability to use sound judgment, adherence to professional standards, positive interpersonal relationships, situational application of skills and knowledge, outcome evaluation by standards
Cowan et al. 2005	'Application of complex combinations of knowledge, performance, skills, values and attitudes.' (p.361)	Knowledge, performance, skills, values, attitudes
Fukada 2018	'The ability to practice nursing that meets the need of clients cared for using logical thinking and accurate nursing skills.' (p.4)	Knowledge (including professional judgment), skills, values, attitudes
Garside & Nhemachena 2013	'A combination and integration of performance and capability.' (p.544)	Performance, capability
Lejonqvist et al. 2012	'Clinical competence in practice is encountering, knowing, performing, maturing and improving and it is an ongoing process, rather than a state and manifests itself in an ontological and a contextual dimension.' (p.340)	Encountering, knowing, performing, maturing, improving
Milligan 1998	'Successful integration of theory and practice.' (p.279)	Knowledge, skills, performance, critical thinking, process
Nigelsmith 1995		Knowledge, skills, critical thinking experience, attitude of openness to life and learning

Notarnicola et al. 2016	'A mix of skills, knowledge, attitudes and abilities that each nurse must possess to perform acceptably those duties directly related to patient care, in a specific clinical context and in given circumstances in order to promote, maintain and restore the health of patients.' (p.188)	Skill, knowledge, attitude, ability
Scott Tilley 2008	'Application of knowledge, interpersonal, decision-making, and psychomotor skills expected for the practice role.' (p.58)	Knowledge, interpersonal, decision-making, psychomotor skills
Smith 2012	'Competence includes the need for knowledge, skills, and reasoning with the need for ongoing development, the importance of critical thinking, communication, recognition of the need to care for the whole person with attention to the emotional-human side, and reflection on past experiences.' (p.180)	Integrating knowledge into practice, experience, critical thinking, proficient skills, caring, communication, environment, motivation, and professionalism
Valloze 2009		Professional role model, critical thinker, expected practice, building knowledge, skills, demonstrated appropriate action, ability to apply norms to a situation

According to the review, it seems that the concept of competence and its meaning has not changed much in recent decades. In conclusion, it may be said that competence has various definitions and attributes, but the common aspect is that it is a combination of elements describing theory and practice. In this study, the definition of competence was chosen based on its attributes that could be operationalized and measured at a certain level, when developing an instrument, like knowledge and skills. Furthermore, a holistic approach was pursued in order to measure competence as a cluster of different elements that could provide a deeper understanding of one's competence in wound care. Based on the purpose and the characteristics of the study, the concept of competence was defined holistically as a complex combination of knowledge, performance, skills, values and attitudes according to Cowan et al. (2005, p.361) (Figure 2), in which knowledge is defined as theoretical competence, and skills and performance as practical competence. Values and attitudes instead enhance the holistic perspective of competence. However, there are also additional attributes from other definitions in this study, such as professional standards (Axley 2008, Church 2016) and experiences (Bergen & Santo 2018). In this study, competence focuses on wound care as a specific competence area in clinical nursing. Competence is assessed as a combination of knowledge, performance, skills, values and attitudes in wound care, compared to the professional standards in the field of wound care.

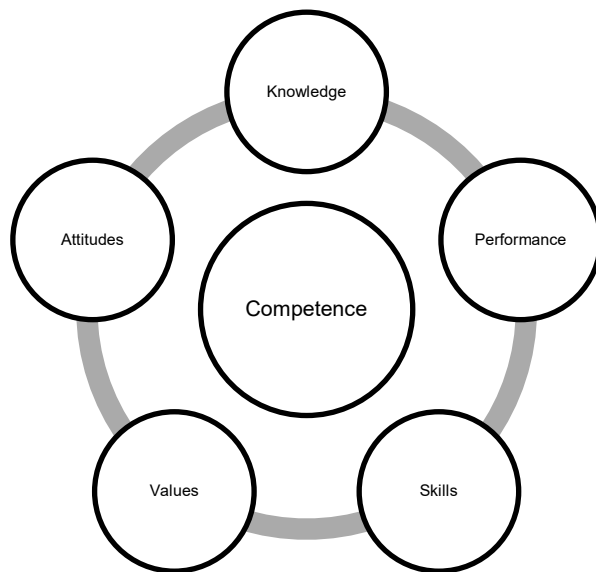


Figure 2. Concept of competence

2.2 The wound care competence of graduating student nurses

According to the International Council of Nurses (ICN) (1987), ‘a nurse is a person who has completed a program of basic, generalized nursing education and is authorized by the appropriate regulatory authority to practice nursing in his/her country’. In Finland, around 70% of the health care workforce is made up of nursing professionals (WHO 2020a), and the number of graduated registered (bachelor’s level) nurses has increased annually from approximately 3400 to 4700 during the past decade (Vipunen 2019).

In the European Union (EU), the training of RNs should comprise at least three years of studies, including no less than 4600 hours of theoretical and clinical training (2013/55/EU). The duration of bachelor level nursing programmes varies between three and four years within European countries (Lahtinen et al. 2014), and in Finland, the duration of the bachelor’s degree programme in nursing is 3.5 years of full-time studies with an extension of 210 ECTS (European Credit Transfer and Accumulation System) (Government Decree on Universities of Applied Sciences 1129/2014). The first three years (180 ECTS) of the studies are general studies based on the European Union directive of the recognition of professional qualifications (2005/36/EC); the remaining six months (30 ECTS) are advanced studies based on the needs of the region and working life and are consistent with the university’s profile (Eriksson et al. 2015). Likewise, the duration and extension of bachelor level podiatry education in Finland is similar to the nursing programme.

In Finland, a RN is entitled Sairaanhoidaja (AMK) after graduation. Registered nurses can either work in the public or private health care sector in Finland, and they are qualified to work as RNs in other EU countries too. After graduation, RNs can specialize in wound care by completing a further education programme in wound care of 30 ECTS in several universities of applied sciences (UAS) in Finland. In 2019, a master's programme in wound care consisting of 90 ECTS was introduced in Savonia University of Applied Sciences (Savonia 2020a). In this study, a graduating SN is a bachelor level student who is in their final (seventh) semester in a UAS and is going to graduate within six months.

The second literature review (II) began by carrying out research into the wound care competence of graduating SNs (Part 1). The literature search was first conducted in 2016 (Phase 1a, Paper I) and updated in June 2019 for this summary using a systematic search of the following electronic health scientific databases: MEDLINE/PubMed, CINAHL, Web of Science, EMBASE and Cochrane Library. The search terms used were: *nursing student, podiatrist student, student nurse, student podiatrist, podiatric medical student, undergraduate nurse, undergraduate podiatrist, graduating nurse, graduating podiatrist, competence, skill, knowledge, attitude, value, performance, wound, ulcer, decubitus, wound care, wound management, wound assessment* and *tissue viability* with their Boolean operators (Table 4). Studies had to be written either in English or in Finnish with an abstract available. No time limits were set. In this summary, the updated literature review is presented.

Empirical studies addressing final-stage (third or fourth year or pre-registration) nursing and/or podiatry students' wound care competence (knowledge, skills, performance, values and attitudes) were included in the literature review. Both objective and subjective (self-evaluation) competencies were accepted. Studies addressing students' overall clinical competences, as well as studies presenting educational interventions were excluded, unless they included any kind of wound care competence assessment. Articles were also searched manually from the reference lists of articles found in the systematic search. The systematic search from the five databases produced 210 records in total of which 36 abstracts and 21 whole texts were read, and 15 articles were chosen for this literature review. The seven excluded articles either did not focus on final-stage students (3), or the stage of the studies was not mentioned (1) or the final-stage students were not analysed separately (3). The data were analysed using quantitative content analysis according to Elo and Kyngäs (2008), and the major themes, namely the shortcomings of students' wound care competence, are presented in Figure 3. The selected studies are presented in Appendix 1.

Table 4. Concepts and search terms of the literature review II

Concept	Search terms
Graduating student nurse	nursing student* OR student nurse* OR undergraduate nurse* OR graduating nurse*
	OR
Graduating student podiatrist	podiatrist student* OR student podiatrist* OR podiatric medical student* OR undergraduate podiatrist* OR graduating podiatrist*
	AND
Competence	competenc* OR skill* OR knowledge OR attitude* OR value* OR performance
	AND
Wound care	wound* OR ulcer* OR decubitus OR wound care OR wound management OR wound assessment OR tissue viability
	("nursing student*" OR "student nurse*" OR "undergraduate nurse*" OR "graduating nurse*" OR "podiatrist student*" OR "student podiatrist*" OR "podiatric medical student*" OR "undergraduate podiatrist*" OR "graduating podiatrist*") AND (competenc* OR skill* OR knowledge OR attitude* OR value* OR performance) AND (wound* OR ulcer* OR decubitus OR "wound care" OR "wound management" OR "wound assessment" OR "tissue viability")

Fifteen original studies were included in this element (Part 1) of the updated literature review. The studies were published between 2003 and 2018 and most (n=11) of them were conducted in European countries, two in Brazil (Larcher Caliri et al. 2003, Moura & Larcher Caliri 2013), one in the United States (Garrigues et al. 2017) and one in Iran (Rafiei et al. 2015). Most (n=13) of the studies had a quantitative design and two had a qualitative design (Moura & Larcher Caliri 2013, Garrigues et al. 2017). All studies addressed the wound care competence of final-stage SNs, none of these were SPs. Sample sizes varied between 16 and 240 final stage SNs.

The quality of the reporting of the original studies were assessed using a critical appraising tool by Hawker et al. (2002), because the tool has been developed for the assessment of both quantitative and qualitative study designs. The tool has nine categories: 1) abstract and title, 2) introduction and aims, 3) method and data, 4) sampling, 5) data analysis, 6) ethics and bias, 7) results, 8) transferability or generalizability and 9) implications and usefulness. Each category is assessed using a 4-point scale: 1 = very poor, 2 = poor, 3 = fair, 4 = good, meaning that the minimum score of the scale is 9 and the maximum is 36. The average score of the original studies was 26/36 (mean 26). The lowest score was 16 and the highest 32. The lowest average scores were for ethics and bias (2.1/4), transferability or generalizability (2.4/4) and sampling (2.5/4). The highest average scores were for abstract and title (3.5/4), method and data (3.3/4) and results (3.3/4). Critical appraisal scores for each original study are presented in Appendix 3.

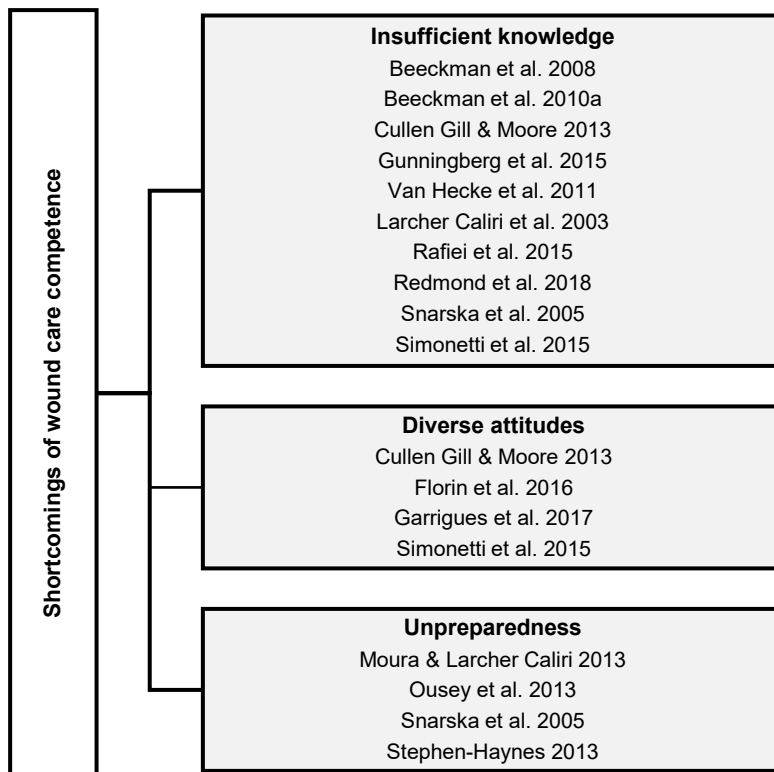


Figure 3. Shortcomings of students' wound care competence based on the previous literature

According to the analysis, three main themes were found to describe the shortcomings of graduating SNs in relation to wound care competence and the associated studies conducted in this area: 1) insufficient knowledge, 2) diverse attitudes and 3) unpreparedness (Figure 3). Student nurses' wound care knowledge level was studied in most (n=10) of the studies of which eight (Larcher Caliri et al. 2003, Snarska et al. 2005, Beeckman et al. 2008 and 2010a, Cullen Gill & Moore 2013, Gunningberg et al. 2015, Rafiei et al. 2015, Simonetti et al. 2015) studied graduating SNs' PU knowledge and the remaining two studies studied their VLU knowledge (Van Hecke et al. 2011), and knowledge in wound care in general (Redmond et al. 2018). Graduating SNs' attitudes towards wound care were examined in four studies (Cullen Gill & Moore 2013, Simonetti et al. 2015, Florin et al. 2016, Garrigues et al. 2017), which considered their attitudes to PU prevention. Finally, four studies examined the preparedness or rediness of graduating SNs in relation to wound care of which two (Snarska et al. 2005, Moura & Larcher Caliri 2013) studied SNs' preparedness with regard to PU care and prevention, and two

studies (Ousey et al. 2013, Stephen-Haynes 2013) explored their preparedness in terms of wound care in general.

According to the studies, an assessment of the knowledge of graduating SNs in relation to PU care and prevention was found to be inadequate (Larcher Caliri et al. 2003, Snarska et al. 2005, Beeckman et al. 2008, 2010a, Cullen Gill & Moore 2013, Gunningberg et al, 2015, Rafiei et al, 2015, Simonetti et al. 2015). In two studies (Larcher Caliri et al. 2003, Rafiei et al. 2015) graduating SNs scored only 67.7% (Larcher Caliri et al. 2003) and 67% (Rafiei et al. 2015) in the knowledge test questions whereas the cut-off point for sufficient knowledge is 90% (Pieper & Mott 1995). In the study conducted by Rafiei et al. (2015), the students scored higher percentages in PU classification (78%) and PU evaluation (70%) than the average score. Still, their PU classification knowledge score was only 50%. In addition, graduating SNs' scores in another PU knowledge test varied from 47% (Beeckman et al. 2010a) to 56.5% (Simonetti et al. 2015) to 61% (Gunningberg et al. 2015). In the study carried out by Gunningberg et al. (2015), students scored most highly in nutrition (92%) and risk assessment (80%). The lowest scores instead were in reduction in the amount of pressure and shear (49%) and classification and observation (54%). Furthermore, in a single knowledge test, graduating SNs scored only 15/26 (58%) in PU prevention and the majority (92%) of students, scored less than 18/26 (69%) (Cullen Gill & Moore 2013). Finally, according to the remaining studies, SNs' PU classification skills were low (Beeckman et al. 2008) and their PU prevention knowledge was found to be insufficient, especially their knowledge of factors relating to the cause of PUs (Snarska et al. 2005).

Only two studies (Van Hecke et al. 2011, Redmond et al. 2018) assessed knowledge other than PU knowledge among the graduating SNs. According to Van Hecke et al. (2011), students' knowledge of VLU knowledge was low. The mean score in the knowledge test was only 32%. In addition, in a study by Redmond et al. (2018), graduating SNs evaluated that their knowledge increased after wound care education. The most significant changes related to the ability of students to recognize a wound infection, follow an infection control policy during wound care, and assess and treat pain during wound care.

Graduating SNs' attitudes towards wound care were investigated in four studies (Cullen Gill & Moore 2013, Simonetti et al. 2015, Florin et al. 2016, Garrigues et al. 2017) which assessed students' attitudes towards PU prevention. Students scored highly in terms of attitude in two studies (Simonetti et al. 2015, Florin et al. 2016) using the PU prevention attitude instrument of Beeckman et al. (2010b). In the study by Simonetti et al. (2015), graduating SNs' mean attitude score was 41.1/52 (79%), and in the study by Florin et al. (2016), their mean attitude score was 46/52 (89%). However, according to Florin et al. (2016), graduating SNs had lower confidence in their ability to prevent PUs than assistant nurses, but students found that they had a

more important task in PU prevention than assistant nurses and RNs. Moreover, in the study by Cullen Gill and Moore (2013), graduating SNs exhibited positive attitudes towards PU prevention and their mean attitude score was 40/47 (85%). However, in the study conducted by Garrigues et al. (2017) graduating SNs displayed diverse experiences and attitudes towards PU prevention.

Four of the studies investigated graduating SNs' preparedness in relation to wound care (Snarska et al. 2005, Moura & Larcher Caliri 2013, Ousey et al. 2013, Stephen-Haynes 2013), which found that students had rather diverse opinions relating to their preparedness. Two of the studies (Snaska et al. 2005, Moura & Larcher Caliri 2013) described the preparedness of graduating SNs' with regard to PU prevention. According to Snarska et al. (2005), more than half (54%) of the students evaluated their knowledge of PU prevention as being insufficient, and according to a study by Moura and Larcher Caliri (2013), students evaluated that they did not apply the presupposed policy or practices of the PU risk assessment. In addition, two studies investigated the preparedness of pre-registration nurses in relation to skin integrity (Ousey et al. 2013) and tissue viability (Stephen-Haynes 2013) in general. According to Ousey et al. (2013), most (70%) of the students maintained that they felt confident in undertaking the majority of the wound care procedures. However, with regard to certain procedures, the percentages were lower, for example, less than half (47%) of the students felt confident when choosing an appropriate wound product. Finally, according to a study by Stephen-Haynes (2013), most (84%) of the students claimed that they did not feel well prepared as regards tissue viability nursing. However, most of them (83%) believed that they could carry out a PU risk assessment.

2.3 Instruments and evaluation methods used to assess the wound care competence of student nurses

The same studies established through the aforementioned literature review (II) that the wound care competence of graduating SNs was used to analyse how wound care competence has been assessed in previous literature (Part 2). In addition, the full texts that were excluded in the final stage of the literature search were also checked, in order to identify any instruments or methods used to assess the wound care competence of SNs at any stage of their studies, not just at the final stage. The studies (n=15 + the seven, previously excluded full texts) were grouped based on the competence assessment methods, and the instruments and other evaluation methods used to assess the wound care competence of SNs at any stage of the studies, are presented in Figure 4.

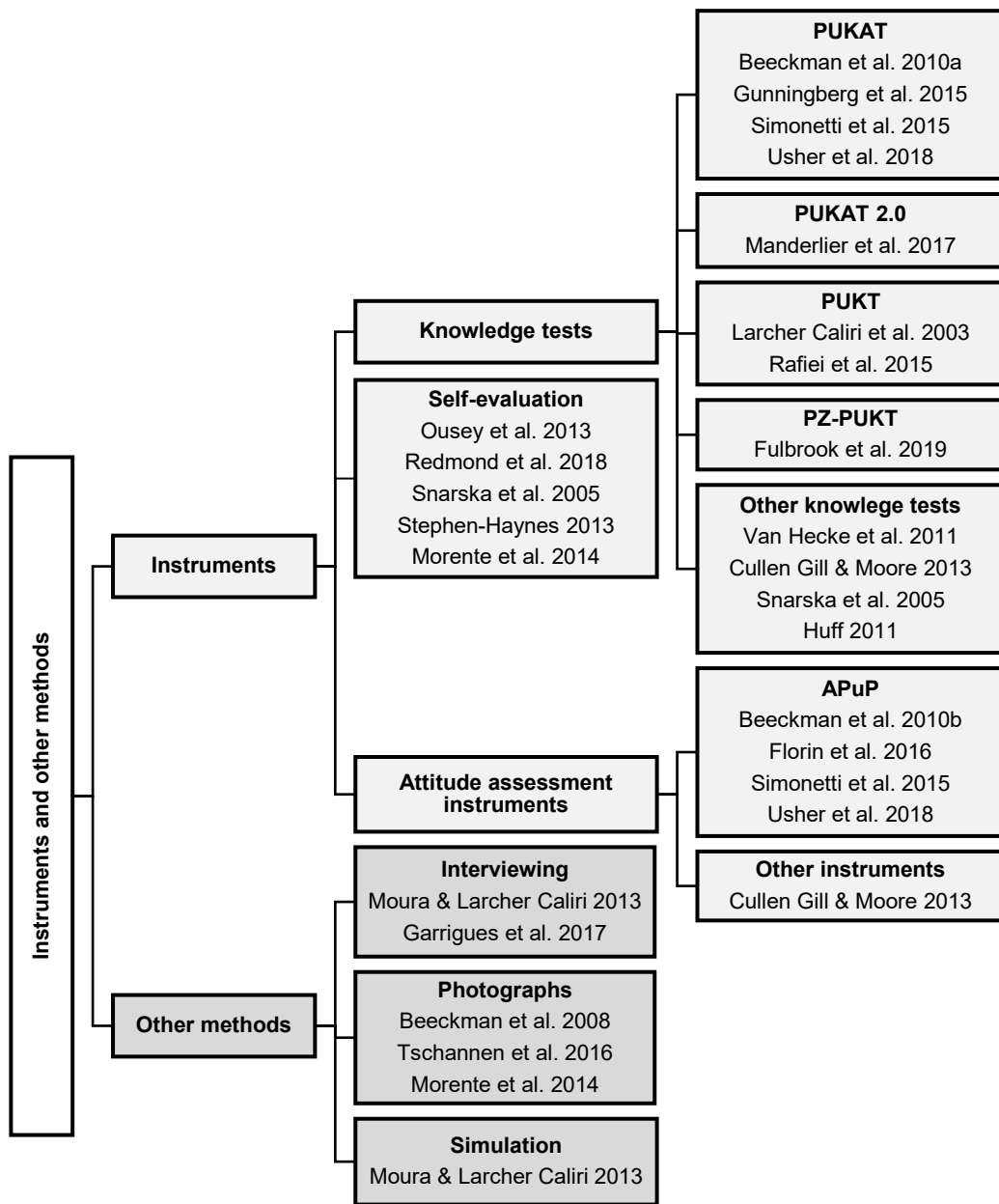


Figure 4. Instruments and other methods used to assess the wound care competence of student nurses according to the literature review

The wound care competence of SNs at any stage of their studies has been assessed using various instruments and evaluation methods. According to the grouping of the methods, instruments were most commonly used to assess the wound care competence of SNs, most of which consisted of knowledge tests in 12 studies (Larcher Caliri et al. 2003, Snarska et al. 2005, Beeckman et al. 2010a, Huff 2011, Van Hecke et al. 2011, Cullen Gill & Moore 2013, Gunningberg et al. 2015, Rafiei et al. 2015, Simonetti et al. 2015, Manderlier et al. 2017, Usher et al. 2018, Fulbrook et al. 2019). Three of these studies (Beeckman et al. 2010a, Van Hecke et al. 2011, Manderlier et al. 2017) were instrument development and validation studies. The instrument developed by Beeckman et al. (2010a) is a 26-item test known as the Pressure Ulcer Knowledge Assessment Tool (PUKAT), and its newer 25-item, version 2.0 has been developed and validated by Manderlier et al. (2017). The instrument developed by Van Hecke et al. (2011) is a 19-item VLU knowledge assessment instrument. Two of the studies (Larcher Caliri et al. 2003, Rafiei et al. 2015) used a validated 47-item test called the Pressure Ulcer Knowledge Test (PUKT) by Pieper & Mott (1995), and three studies (Gunningberg et al. 2015, Simonetti et al. 2015, Usher et al. 2018) used the validated and aforementioned knowledge test, PUKAT by Beeckman et al. (2010a). Finally, two studies (Snarska et al. 2005, Cullen Gill & Moore 2013) used PU knowledge tests that they themselves developed for the study purposes, and one study (Huff 2011) used an instrument also developed for the study purposes but aimed at assessing the general wound care knowledge of SNs (Figure 4).

Student nurses' attitudes towards wound care were studied using attitude instruments. A 13-item PU prevention attitude instrument known as Attitude towards Pressure ulcer Prevention (APuP) was developed and validated by Beeckman et al. (2010b). The same validated instrument was used in three later studies (Simonetti et al. 2015, Florin et al. 2016, Usher et al. 2018). One study (Cullen Gill & Moore 2013) used an attitude instrument developed for the study purposes. The students' perceived wound care competence was studied using self-evaluation questionnaires developed for the study purposes across five studies (Snarska et al. 2005, Morente et al. 2014, Ousey et al. 2013, Stephen-Haynes 2013, Redmond et al. 2018) (Figure 4).

Other methods used to assess the wound care competence of SNs were interviewing, photographs and simulation. Interviewing was used in two studies; in the first study, students' attitudes towards wound care were studied through interviews (Garrigues et al. 2017) and in another study, focus group interviewing was used for the self-evaluation of students' perceived wound care competence (Moura & Larcher Caliri 2013). Photographs were used in three studies (Beeckman et al. 2008, Morente et al. 2014, Tschannen et al. 2016) for the classification and

staging of PUs. Finally, simulation was used in one study (Moura & Larcher Caliri 2013) to assess the PU risk assessment competence of SNs (Figure 4).

2.4 Wound care competence requirements for registered nurses

According to the Medical Dictionary (2009), wound care refers to ‘any technique that enhances the healing of skin abrasions, blisters, cracks, craters, infections, lacerations, necrosis, and/or ulcers’, and a nursing intervention is defined as the ‘prevention of wound complications and promotion of wound healing’. Traditionally wound care has been part of nursing practice, encompassing dressing changes and infection control, but it also includes other interventions such as nutrition promotion and the psychosocial support of the patient (Corbett 2012). However, wound care, like health care in general, has changed in recent years and is predicted to continue to change to a great extent in the future, due to new technological solutions and innovations in health care (Moore et al. 2015, Piaggese et al. 2018). According to the European Wound Management Association (EWMA), wound care and especially chronic wound care should be provided by a multi-professional team to address the needs of patients who should benefit from the expertise of health care professionals (Moore et al. 2014).

In Finland, RNs’ duties often include wound care, depending on their place of work. The wound care that RNs provide includes general wound care, such as wound assessment, dressing changes, patient education and prevention of wounds. Diagnosing the patient is not the responsibility of RNs or podiatrists in Finland. Registered nurses’ duties usually include the care and prevention of different types of wounds, both acute and chronic. By contrast, podiatrists’ duties focus mostly on DFU care and prevention. In this study, the concept of wound care is defined as a main activity in clinical nursing and includes the care and prevention of different types of wounds, which require the diverse competence of nursing professionals.

Several national and international care guidelines have been formulated with regard to different types of wounds and their care in international and multi-professional working groups. These guidelines cover, for example, DFUs (IWGDF 2019), PU prevention (EPUAP/NIPAP/PPPIA 2019) and atypical wounds (EWMA 2019). Furthermore, national (Finnish) care guidelines cover guidelines focused on preventing PUs (NRF 2015) and the care of chronic leg ulcers (Current Care Guidelines 2014). In addition, in Cochrane Library, more than a hundred systematic reviews have been conducted to identify, appraise and synthesize the empirical evidence regarding the care and prevention of different types of wounds (Cochrane Library 2020). Still, despite the large repertory of care guidelines and systematic

reviews, they do not designate the roles and competence requirements of health care professionals who provide care for wounds.

In Finland, nursing education is based on the latest evidence and guidelines, and the UAS plan their own curriculums, according to the Finnish Universities of Applied Sciences Act (932/2014). However, the content of the Finnish nursing curriculums is regulated by the EU directive in recognition of the professional qualifications (2005/36/EC), and the content of the general studies (180 ECTS) is based on the Finnish project of RNs' professional competence that defines the core competence areas in Finnish nursing education (Eriksson et al. 2015) (Table 5). However, neither the EU directive nor the core competences specify the detail or the type of wound care education that should be included in nursing studies at the Finnish UAS, meaning that the UAS in Finland can determine the quantity and quality of wound care education independently based on these guidelines. Furthermore, the general studies (180 ECTS) should be based on more detailed competence requirements and content for general nursing education, developed in 2019 (Savonia 2020b). According to these competence requirements, 'a SN demonstrates knowledge of the principles of wound treatment and is able to apply his/her knowledge in the treatment of chronic wounds, including 1) structure, function and blood circulation, as well as the wound healing process of the skin, 2) types of chronic wounds, 3) aetiology and prevention of wounds, 4) local treatment, healing and evaluation of wounds.' Still, these competence requirements are quite general, and they were published after this study had been started. By contrast, the Finnish podiatry education is based on the Finnish Act of the Recognition of Professional Qualifications (1384/2015), but the same principles in terms of autonomy in planning the curriculum, are applied.

Table 5. The professional competence of a nurse responsible of general care (Eriksson et al. 2015, p.60)

Competences for Nursing Education	ECTS
Client-centredness	10
Ethics and professionalism in nursing	5
Leadership and entrepreneurship	5
Clinical nursing	105
Evidence-based practice and decision making	30
Education and teaching competence	5
Promotion of health and functional ability	10
Social and health care environment	10
Quality and safety of social and health care services	5
total	180

The purpose of the third and final literature review (III) was to ascertain the level of competence expected from RNs after graduation and in particular their competence in relation to wound care. In addition, the purpose was to identify the areas of competence in wound care in the case of RNs. Studies relating to podiatrists' competence areas and requirements were also assessed if identified. The literature search was conducted in June 2019 using a systematic search from the following electronic health scientific databases: MEDLINE/PubMed, CINAHL, Web of Science, EMBASE and Cochrane Library. The search terms used were: *wound care, wound management, wound assessment, tissue viability, competence, knowledge, skill, performance, value, attitude, requirement, expectation, qualification, demand, claim, level, area, minimum, minimum data set, nurse and podiatrist* with their Boolean operators (Table 6). Publications were limited to articles written either in English or in Finnish, and the number of years since publication was limited to 10 as the field of wound care has developed quickly over the past decade.

Table 6. Concepts and search terms of the literature review III

Concept	Search terms
Wound care	wound care OR wound management OR tissue viability
	OR
Competence	competenc* OR skill* OR knowledge OR attitude* OR value* OR performance
	AND
Requirement	requirement* OR expectation* OR qualification* OR demand* OR claim* OR level* OR area* OR minimum OR minimum data set
	AND
Nurse/podiatrist	Nurs* OR podiatr*

➔ ("wound care" OR "wound management" OR "tissue viability") AND (competenc* OR skill* OR knowledge OR attitude* OR value* OR performance) AND (requirement* OR expectation* OR qualification* OR demand* OR claim* OR level* OR area* OR minimum OR "minimum data set") AND (nurs* OR podiatr*)

Articles addressing RNs' or podiatrists' basic wound care competence requirements and expectations, as well as articles discussing the general competence areas in wound care for RNs and podiatrists were included in this review. Articles relating to the competence of RNs or podiatrists specializing in wound care or in tissue viability were excluded. Articles were also searched for manually from the reference lists of the articles and from the internet using the same search terms in a web browser. A systematic search of the five databases provided 998 records in total, of which 23 were selected by their title and 10 by their abstract. Of the 10 full texts, five were chosen for this literature review. The full texts which were excluded, addressed the

wound care competence of RNs but did not address any kind of requirements or areas of wound care competence (2), or they addressed the competence of specialized wound care nurses (3). One article was found as a result of a manual search. The selected articles are presented in Appendix 2.

Six articles were included in this part of the literature review relating to the wound care competence requirements of RNs and podiatrists, of which three (Cowman et al. 2012, Redmond et al. 2016, Coleman et al. 2017) were research papers and three (TRIEPoD-UK 2012, Pokorná et al. 2017, Van Acker et al. 2018) were expert working group documents. The expert working group documents were included in this review as only a limited number of research papers were found, and the experts of these documents can be characterized as long-term researchers in the field of wound care. The publications were published between 2012 and 2018 and all studies were conducted in European countries; the expert working group documents were compiled from studies across several countries around the world. The publications addressed both the competence and work of RNs and podiatrists.

The research papers (n=3) of this part of the literature review were assessed using the same critical appraising tool devised by Hawker et al. (2002). The expert working group documents were not assessed as they were not research papers. The average score of the research papers was 24/36 (mean 25). The lowest score was 21 and the highest 27. The lowest average scores were for ethics and bias (1.7/4), transferability or generalizability (1.7/4) and sampling (2/4). The highest average scores were for abstract and title (4/4), introduction and aims (4/4), results (3.3/4) and implications and usefulness (3.3/4). The critical appraisal scores for each research paper are presented in Appendix 3.

Studies by Coleman et al. (2017) and Cowman et al. (2012) were intended for the multi-professional wound care community. A study by Cowman et al. (2012) listed the top educational and multi-professional priorities in wound care from 360 experts in 24 countries around the world. The top educational priorities were: 1) the standardization of all foundation education programmes in wound care, 2) the inclusion of wound care in all professional undergraduate and postgraduate education programmes, 3) the selection of dressings and 4) the prevention of PUs. The top research priorities instead were: 1) the selection of dressings, 2) PU prevention and 3) wound infection. In addition to a study by Coleman et al. (2017), the minimum data set of the generic wound assessment included general health information, wound history/baseline information, wound assessment parameters, wound symptoms, infection and specialist information. However, these studies did not specify any areas of competence or requirements, especially for RNs or podiatrists working in wound care.

Two of the publications addressed wound care education (Redmond et al. 2016, Pokorná et al. 2017). A document by Pokorná et al. (2017) introduced a curriculum

for a post-registration qualification for nurses in wound care in Europe, in collaboration with the EWMA. This post registration curriculum represents 10 ECTS and includes face-to-face teaching, supervised practice, work-based learning and an exam. The curriculum is divided into 16 units: role and prevention in wound care; EBP; patient education and promoting self-care; case management; wounds and wound healing; nutrition and wound healing; microbiology and wounds; antimicrobial agents, hygiene and wounds; debridement and wounds; moist wound healing; alternative treatment options for wounds; PUs; diabetic foot syndrome; lower leg ulcers; health care delivery and health economics and documentation. However, this curriculum is intended for RNs who have already graduated. In addition to a study by Redmond et al. (2016), an educational package was developed for undergraduate SNs that would provide them with the theoretical knowledge and clinical judgement skills to care for patients with wounds. This educational package included lectures on the general physiology of wound healing, the pathophysiology of chronic wounds and the assessment and management of chronic wounds including pair working. It also included a demonstration of use of negative pressure dressings and profore dressings, and sessions relating to the psychosocial aspects of caring for a patient with a wound. This educational package could assist nurse educators in creating documentation for wound care education programmes for SNs. Still, there are no existing guidelines or curriculums that specify how much and what kind of wound care education should be included in nursing and podiatry studies at bachelor level.

The remaining two publications (TRIEPoD-UK 2012, Van Acker et al. 2018) addressed podiatrists' competences in diabetic foot care. The expert working group document by TRIEPoD-UK (2012) is a competence framework for podiatrists caring for patients with diabetes. The framework includes competences in diabetic foot care, and according to the framework, a podiatrist should be competent, for example, in the recognition and classification of active foot ulceration, debridement and wound bed management, offloading and dressing selection. They should also understand the psychosocial impacts of active foot ulcers on the patient, and comprehend the healing process of the wound and how to control infections, etc. In addition, an expert working group document by Van Acker et al. (2018) has been formulated for all clinicians working with patients with diabetic foot problems, especially podiatrists. The document includes knowledge, skills and behaviours relating to DFU care, which includes, for example, knowledge of diabetic foot ulceration and infections, skills in dressing changing and pressure relieving devices, and debridement, etc. Still, these documents are limited to DFU care, even though podiatrists' work focuses mainly on DFUs in wound care.

2.5 Summary of the literature review

Based on the literature review, previous empirical research relating to the general wound care competence of graduating SNs and their areas of competence in wound care was limited. Fourteen studies defining the concept of competence in clinical nursing were found, in which competence was defined as a complex combination of knowledge, skills, performance, values and attitudes. In addition, fifteen studies addressing the wound care competence of graduating SNs were found, and according to the analysis, graduating SNs had insufficient knowledge in wound care, diverse attitudes towards wound care and felt unprepared to care for wounds. Studies assessing the wound care knowledge of graduating SNs, primarily assessing their PU knowledge, stated that this knowledge was not at a sufficient level. However, SNs showed positive attitudes towards PU prevention in most of the studies. However, in most studies, students did not feel well prepared for wound care. Studies focusing on the general wound care competence of SNs were scarce, as most studies focused on specific type of wounds such as PUs.

Various methods have been used to assess the wound care competence of SNs. In this part of the review, studies assessing the wound care competence of all SNs were accepted whether or not the students were at their final stage. The most common methods of assessing the wound care competence of SNs were instruments, most of which comprised various types of knowledge tests, again focusing primarily on their PU knowledge. Instruments were also used to assess students' attitudes and perceived competence in wound care. Instruments assessing general wound care competence were scarce. Other methods less used to assess the wound care competence of SNs were interviews, photographs and simulation.

The third literature review focused on the required and expected competence areas of RNs. Certain previous studies were intended for a multi-professional community, which is important in wound care, but did not provide a clear statement as to what was expected from RNs or podiatrists providing wound care. However, two expert working group documents were published that outlined the duties and competence requirements for podiatrists caring for patients with diabetes. However, the documents only focused on DFU care, as DFUs are the most common wounds which podiatrists treat. Nevertheless, these documents provide a solid base for the requirements of podiatrists' wound care competence which could probably be utilized in wound care in general. Some evidence was also found in relation to the required content of wound education for SNs and post-graduate nurses. However, a clear statement of the level of competence expected from general RNs providing wound care and their roles and duties in wound care and wound prevention were not found in this literature review. The information gaps in relation to the literature reviews and the need for further research, are presented in Figure 5.

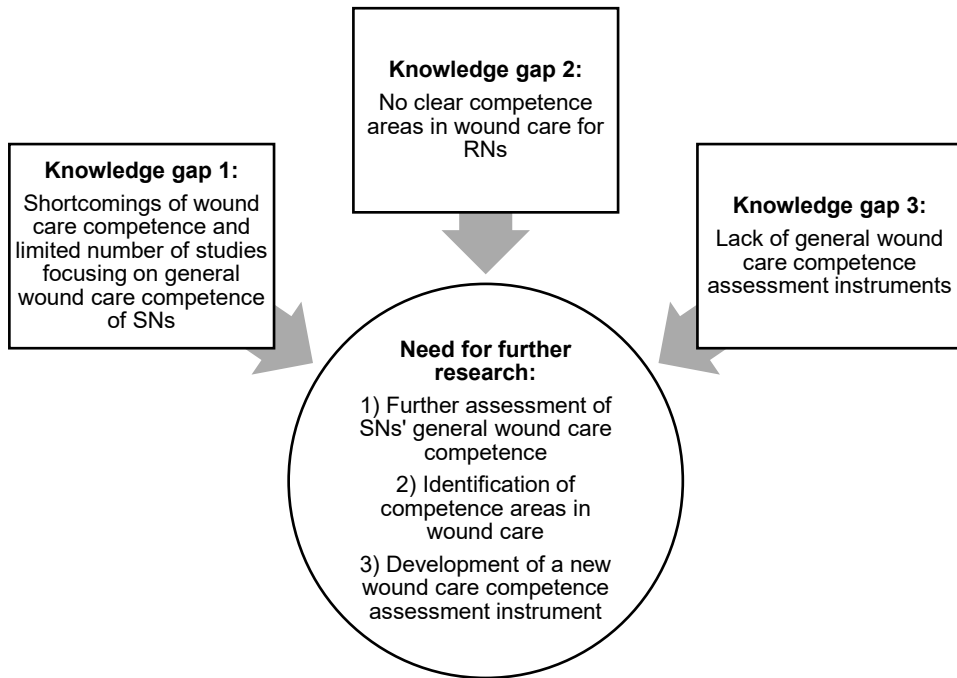


Figure 5. Knowledge gaps in relation to the literature reviews and need for further research

3 Aims

The main purposes of this two-phased study were to explore the wound care competence of graduating SNs, identify the requested competence areas in wound care and develop and test a competence assessment instrument that could be used to assess the wound care competence of graduating SNs objectively, especially with regard to chronic wound care.

The goal of this study was to promote knowledge in relation to the wound care competence of graduating SNs, and to provide a new competence assessment tool that could be used for wound care competence assessment at the final stage of bachelor level nursing studies. Another goal was also to enhance understanding of the competence assessment of SNs, using different and new assessment methods. The research questions of the study were:

Theoretical and descriptive phase (Phase 1)

- What is known about SNs' wound care competence and how has their wound care competence been measured? (Paper I and summary)
- What is graduating SNs' vs SPs' theoretical and perceived (self-evaluated) wound care competence level and what factors associate on graduating SNs' wound care competence? (Paper II)

Instrumentation and evaluation phase (Phase 2)

- What are the required general areas of competence for RNs providing chronic wound care? (Paper III)
- How do the theoretical and practical chronic wound-care competence levels of graduating student nurses and podiatrists compare with those of professionals? (Paper IV)
- How valid, reliable and sensitive is the developed instrument (C/WoundComp) for assessing graduating student nurses' and student podiatrists' competence in chronic wound care? (Paper IV)

4 Materials and methods

This study was divided into two phases: 1) theoretical and descriptive phase and 2) instrumentation and evaluation phase. The theoretical and descriptive phase included an examination of the wound care competence of graduating SNs by means of an integrative literature review (Phase 1a) and a cross-sectional study (Phase 1b) of the theoretical wound care competence of graduating SNs and SPs in Finland. The instrumentation and evaluation phase related to the identification of competence areas in wound care, in order to develop a wound care competence instrument for graduating SNs (Phase 2a), and to evaluate the chronic wound care competence of graduating SNs, in addition to the instrument validation (Phase 2b). Graduating SPs were studied as a criterion comparison group, and RNs as well as podiatrists were studied as gold standard comparison groups (Table 7). The theoretical and descriptive phase focused on all wounds, both acute and chronic wounds. However, the instrumentation and evaluation phase focused only on chronic wound care, as chronic wound care was found to be more demanding and the competence was targeted on hard-to-heal wounds.

4.1 Design, setting and sampling

Theoretical and descriptive phase

The theoretical phase of this study included two sub-phases and its purpose was to explore the general wound care competence of graduating SNs (and SPs). The first sub-phase (1a, Paper I) was an integrative literature review (Whittemore & Knalf 2005) aiming to establish the level of knowledge of SNs' (and SPs) wound care competence at the final stage of their studies, and to evaluate how their wound care competence has been assessed in previous literature. The literature search was conducted using a systematic search process, including a critical appraisal of previous research. In total, 12 original studies (Data 1) were included in the literature review (Table 8).

Table 7. Research phases of the study

Phase	Aims	Methods	Data (No.)	Analysis
1a Theoretical and descriptive	To describe the general wound care competence of graduating SNs (and SPs)	Integrative literature review	12 original studies (1)	Qualitative content analysis
1b Theoretical and descriptive	To describe the theoretical wound care competence of graduating SNs (and SPs), as well as students' own perceptions of their wound care competence and their opinions of the received wound care education	Cross-sectional study General wound care competence assessment instrument	N=213 (194 graduating SNs and 19 graduating SPs) (2)	Statistical analysis and inductive-deductive content analysis (Table 11)
2a Instrumentation and evaluation	To identify general competence areas for RNs (and podiatrists) providing chronic wound care	Qualitative study Focus-group interviewing	N=23 (5 RNs, 7 authorised wound care nurses, 3 nurse educators, 3 physicians, 2 podiatrists, 3 podiatry educators) (3)	Inductive-deductive content analysis
2b Instrumentation and evaluation	To assess the objective wound care competence level of graduating SNs (and SPs) compared to professionals, and to develop and test a new chronic wound care competence assessment instrument (C/WoundComp)	Descriptive, comparative methodological study Focused version of the instrument including theoretical and practical competence assessment	N=135 (44 graduating SNs, 28 graduating SPs, 54 RNs, 9 podiatrists) (4)	Statistical analysis (Table 11)

The second sub-phase (1b, Paper II) was an empirical study with a cross-sectional design that explored the theoretical wound care competence of graduating SNs and SPs in five Finnish UAS. The UAS were selected as a sample to represent larger and smaller cities in Finland across different parts of the country. The SNs were recruited from these participating UAS as a cluster sample (Grove et al. 2013, p.360, Parahoo 2014), and the graduating SPs were recruited as a census, due to the small number of graduating SPs in Finland annually. The sample size was estimated to be at least 30 participants for each study variable (Grove et al. 2013, p.376); in this sub-study there were six variables (knowledge test score, patient case score, total score, associations between knowledge and previous education, association between knowledge and received wound care education, association between knowledge and self-evaluation), with a minimum sample size of 180. In total, 213 students (Data 2) participated in the study of which 194 were graduating SNs and 19 were graduating SPs. Of these participants, 73 (34%) had a previous degree in health care (Table 8). The response rate was 85.5%.

Instrumentation and evaluation phase

The instrumentation and evaluation phase of this study included also two sub-phases. The first sub-phase (2a, Paper III) employed a qualitative study design (Holloway & Wheeler 2010). In this study, health care professionals, experienced in wound care were interviewed in focus groups (Jayasekara 2012) in order to ascertain the requested general competence areas for RNs (and podiatrists) providing wound care, especially in terms of chronic wound care. This information was intended to be used as a construct for the new version of the wound care competence instrument. The participants of this study were recruited using a purposeful sample, and they were recruited from various organizations, but all focus-group members within the same group came from the same organization. The participants represented various health care professions in the field of wound care and expressed their own thoughts and opinions, based on their experience and proficiency. The target sample was five participants per focus group (Jayasekera 2012), 30 participants in total, however there were fewer wound care experts in certain organizations, resulting in some of the groups being smaller than planned (Jayasekara 2012). The total sample included 23 health care professionals (Data 3), five RNs, seven authorized wound care nurses, three nurse educators, three physicians, two podiatrists and three podiatry educators (Table 8). The size of each focus group varied from two to seven members.

Table 8. Samples and sample characteristics

Phase	Sample	Sample characteristics
1a	12 original studies	<ul style="list-style-type: none"> • 11 quantitative studies (10 observational, 1 intervention) • 1 qualitative study • Sample sizes: 29-217
2a	213 students (194 SN, 19 SP)	<ul style="list-style-type: none"> • Mean age: 27 years • Women: 184 (86%); Men: 29 (14%) • Prior health care profession: 73 (34%)
1b	23 health care professionals	<ul style="list-style-type: none"> • 5 RN • 7 authorised wound care nurses • 3 nurse educators • 3 physicians • 2 P • 3 podiatry educators
2b	135 (44 SN, 28 SP, 54 RN, 9 P)	<ul style="list-style-type: none"> • Students <ul style="list-style-type: none"> • Prior health care profession: SN: 10 (23%); SP: 7 (25%) • Professionals (more detailed information: paper IV) <ul style="list-style-type: none"> • Primary care: RN: 28 (52%); P: 4 (44%); Specialised care: RN: 26 (48%); P: 5 (56%) • Median working experience: RN: 15 years; P: 4 years • Median experience in wound care: RN: 10 years; P: 2 years

SN=student nurses, SP=student podiatrists, RN=registered nurses, P=podiatrists

The second sub-phase (2b, Paper IV) was a descriptive, comparative methodological study including an assessment of the objective wound care competence of both graduating students and professionals. The purpose of this phase was to develop and test a new and focused version of the instrument used in Phase 1b and to assess the objective wound care competence level of graduating SNs and RNs as well as graduating SPs and podiatrists as a criterion comparison group. The new instrument was named as *C/WoundComp* and it focused on chronic wound care competence, including both theoretical and practical competence assessments. The instrument development process continued from the focus group interviews in the previous phase to item generation, face validity, expert panel and content validity, and psychometric testing (DeVellis 2017). The target group of this phase of the study comprised graduating SNs and SPs studying in their final semester at UAS in

Finland, and RNs and podiatrists working with patients with wounds in Finland. Registered nurses and podiatrists were intended as a gold standard for the students undergoing the competence assessment and psychometric testing. As stated in the definition of competence, this is viewed as a continuing process and experienced professionals are regarded as a gold standard (Figure 6). The student participants were recruited using a cluster sample from three UAS, two of which educated SNs and two, SPs. Registered nurses and podiatrists were recruited from three hospital districts in Finland including, specialized care and primary care, using a cluster sample. The estimated sample required to calculate the confidence interval (CI) for the mean score in the knowledge test was 100, and for the simulation, 50, meaning that the total target was 100 participants divided into four groups (SNs, SPs, RNs and podiatrists). Of these 50 would participate in both the knowledge test and the simulation, and the remaining 50 in the knowledge test only. The smaller sample for simulation was justified by the fact that data collection using simulation requires much more time and effort. In addition, it was expected that the groups would not be equal, since the number of graduating SPs and professional podiatrists is smaller compared to the SNs and RNs. The goal was to recruit 40 graduating SNs, 40 RNs, 10 graduating SPs and 10 podiatrists, all of whom would take part in the knowledge test and half of whom would participate in the knowledge test and the simulation. The total sample was 135 (Data 4), 44 SNs, 28 SPs, 54 RNs and nine podiatrists (Table 8). Fifty of them participated in the whole competence assessment (knowledge test and simulation) and the remaining 85 participants in the knowledge test only.



Figure 6. The transition from student nurse to registered nurse and the continuity of competence

4.2 Instruments

In this study, two instruments were developed; the first was developed during Phase 1b (Paper II) and assessed the theoretical wound care competence of graduating SNs in relation to different types of wounds, both acute and chronic; this was, therefore, an assessment of general wound care competence. The second instrument (Paper IV) was based on the first instrument but focused solely on chronic wound care as a general instrument measuring the competence of both acute and chronic wounds would have been too time-consuming for the respondents, especially if it included both theoretical and practical components. In addition, chronic wound care was found to be more demanding than acute wound care in Phase 1b, resulting in the researcher wanting to explore the competence related to chronic wound care more comprehensively. The development process of these two instruments is presented in Figure 7.

Theoretical and descriptive phase

The competence assessment instrument for assessing the general theoretical wound care competence of graduating SNs (and SPs) was developed during Phase 1b (Paper II). The instrument was called the *Graduating student nurses' and student podiatrists' wound care competence instrument* and was divided into three sections: 1) demographic data and the wound care education received by students, and their attitude towards wound care, 2) wound care knowledge test and 3) students' self-evaluation of their wound care competence (Table 9). The instrument consisted of both objective (knowledge test) and subjective (self-evaluation) competence assessments, in order to establish the possible similarities or differences between students' objective and subjective competence. The knowledge test was based on wound care education material such as textbooks and international and national wound care guidelines. Eight questions used were adapted from the Documentation of Various Wounds questionnaire by Huff (2011) identified during the literature review to increase the validity of the developed instrument. The items in the questionnaire by Huff (2011) were translated from their original language (English) into Finnish with permission, and an answer choice "I don't know" was added to each item. This instrument was chosen because it was a general wound care competence instrument without focusing on any specific wounds, even though the instrument was not tested on students at the final stage of their studies and it was not psychometrically tested.

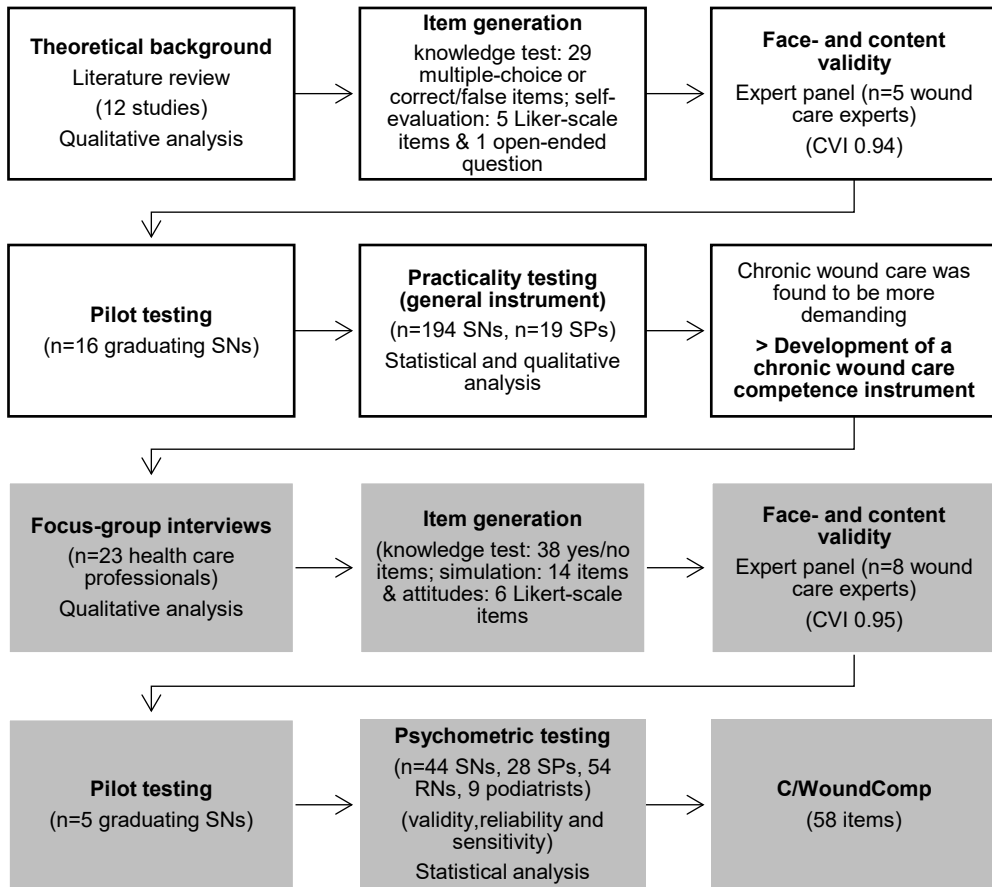


Figure 7. Instrument development process (general wound care competence instrument in white and the focused chronic wound care instrument in grey)

The demographic data of the general wound care competence instrument included five items: age, gender, institute (UAS), future profession and previous education. In addition, five background items were added which included the students' perception of wound care education and their attitude towards wound care. Three of the items were Likert-scaled (1–5) in relation to students' perceptions of the level of wound care education (1=very little, 2=little, 3=neither little nor much, 4=much, and 5=very much), and two items measured their attitude towards wound care, with three possible answers (1=yes, 2=no, and 3=can't say). The purpose of these demographic items and background items were to describe the sample and to establish possible factors related to the participants' competence (Gray et al. 2017, p.499-500). For

example, the level of wound care education received was found to relate to higher competence in certain previous studies.

Table 9. Structure of the general wound care competence instrument

Demographic data	<p>Demographic data</p> <ul style="list-style-type: none"> • Age • Gender • University of Applied Sciences • Profession the respondent is graduating to • Possible earlier education <p>Education (Likert-scale 1-5)</p> <ul style="list-style-type: none"> • The amount of received theoretical education • The amount of received practical education • The amount of received practical training at clinical training periods <p>Attitudes (yes/no/I don't know)</p> <ul style="list-style-type: none"> • Interest in wound care • Attitudes towards wound care 		
Knowledge test	<p>Multiple-choice or correct/false items</p> <table border="0" style="width: 100%;"> <tr> <td style="vertical-align: top;"> <p>SNs and SPs (18)</p> <ul style="list-style-type: none"> • Wound proliferation • Wound bed • VLUs • Arterial ulcers • DFUs • Wound infection • Maceration • Biofilm • Pain management • Hydrophobic dressings • Silver dressings • Healing process • Wound healing • Debridement • Slough • Wound size measurement • High exudate wounds • Epithelial tissue </td> <td style="vertical-align: top;"> <p>SNs only (7)</p> <ul style="list-style-type: none"> • Surgical wounds • Traumatic wounds • Burn injuries • PU risk management • Wound staging system • PU risk factors • PU staging </td> </tr> </table> <p>Open ended patient case items (4)</p> <ul style="list-style-type: none"> • Wound identification • Documentation • Decision making • Wound management 	<p>SNs and SPs (18)</p> <ul style="list-style-type: none"> • Wound proliferation • Wound bed • VLUs • Arterial ulcers • DFUs • Wound infection • Maceration • Biofilm • Pain management • Hydrophobic dressings • Silver dressings • Healing process • Wound healing • Debridement • Slough • Wound size measurement • High exudate wounds • Epithelial tissue 	<p>SNs only (7)</p> <ul style="list-style-type: none"> • Surgical wounds • Traumatic wounds • Burn injuries • PU risk management • Wound staging system • PU risk factors • PU staging
<p>SNs and SPs (18)</p> <ul style="list-style-type: none"> • Wound proliferation • Wound bed • VLUs • Arterial ulcers • DFUs • Wound infection • Maceration • Biofilm • Pain management • Hydrophobic dressings • Silver dressings • Healing process • Wound healing • Debridement • Slough • Wound size measurement • High exudate wounds • Epithelial tissue 	<p>SNs only (7)</p> <ul style="list-style-type: none"> • Surgical wounds • Traumatic wounds • Burn injuries • PU risk management • Wound staging system • PU risk factors • PU staging 		
Self-evaluation	<p>Self-evaluation (Likert-scale 1-5)</p> <ul style="list-style-type: none"> • Wound products • Evidence based information • Chronic wounds • Surgical wounds (SNs only) • Burn injuries (SNs only) <p>Open-ended self-evaluation item</p>		

The knowledge test included 25 multiple-choice or correct/false items regarding various wounds, wound care and wound prevention, and a patient case with four open-ended questions (29 questions in total). Graduating SNs answered all 25 multiple-choice items and the four patient case items (wound identification, documentation, decision making and wound management), but the graduating SPs' instrument was limited to the first 18 multiple-choice items and to the four patient case items. The seven remaining multiple-choice items focused on acute wounds (e.g., surgical wounds and burn injuries) and PUs, both of which are uncommon in podiatric practice. The knowledge test as a measurement method was chosen to assess students' objective wound care competence, and to test the practicality and suitability of the assessment method for the later phases of the instrument development process. Knowledge tests are commonly used to measure one's knowledge, as knowledge itself cannot be directly observed (Hunt 2003). The problem, however, with knowledge tests is that they only measure one component of competence or knowledge relating to a particular concept. Yet knowledge tests can be used to measure one's cognitive ability, as this has been described as a key determinant of knowledge acquisition and learning (Kanfer & Ackerman 1989, Salas & Cannon-Bowers 2001).

Alongside the knowledge test, students' wound care competence was assessed using certain self-evaluation items. Self-evaluation is associated with current performance (objective knowledge) and measures one's certainty and belief in relation to their knowledge (Kanfer & Ackerman 1989, Hunt 2003). The self-evaluation section consisted of five Likert-scaled items (1=I don't know at all, 2=I don't know well, 3=I neither know it poorly nor well, 4=I know well and 5=I know very well). The purpose of these items was for students to evaluate how familiar they were with wound care products and their ability to find evidence-based information relating to wound care, chronic wound care, surgical wound care and burn injury care. Student podiatrists were limited to the first three items. Finally, all students were asked to answer the final open-ended item, in which students could comment freely on their wound care competence and/or the wound care education received.

Items in the knowledge test were formulated by the researcher and evaluated by the research group and a panel of five wound care experts: an RN, an authorized wound care nurse, a physician, a nurse educator, a podiatrist and a researcher. Experts evaluated each item in relation to its clarity, relevance and importance on a 4-point scale (e.g., 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant and 4 = highly relevant). The content validity index (CVI) of the knowledge test was calculated as follows: an item-CVI (I-CVI) was calculated as the number of experts giving a rating of either 3 or 4, divided by the number of experts evaluating each item. The average item CVI (I-CVI) in terms of clarity was 0.88, 0.97 for relevance and 0.96 for importance. The overall content validity index (S-CVI/ave) of the

knowledge test was 0.94. (Grant & Davis 1997, Polit et al. 2007). The whole instrument was pilot tested with 16 graduating SNs testing the usability of the developed instrument (Rattray & Jones 2007). No changes were made to the instrument or its items after the pilot. This instrument was developed for the screening of wound care competence, in general, on the part of graduating SNs and it aimed to establish students' competence gaps and challenges.

Instrumentation and evaluation phase

In the instrumentation and evaluation phase, health care professionals in wound care were interviewed in groups, using a semi-structured interview frame (Holloway & Wheeler 2010, p.89-90) in order to identify more specifically the areas of competence in chronic wound care for the instrument focusing on chronic wounds (Phase 2a, Paper III). The interview frame was formulated to cover the five main areas of competence according to Cowan et al. (2005): knowledge, skills, performance, values and attitude. These five competence areas were incorporated into questions which included prompts relating to different types of wounds and wound care, identified in wound care literature and guidelines, such as wound care products, pain management and documentation. The interview frame was assessed by senior researchers and three PhD candidates in nursing science at the University of Turku before data collection. The semi-structured interview frame is presented in Appendix 4. The development process of the focused version of the instrument – *C/WoundComp* – started with these focus-group interviews.

In the final phase (Phase 2b, Paper IV), the structure and content of the instrument were created, based on the themes identified in the interviews. The instrument was intended to cover both theoretical and practical competence in wound care, as well as values and attitudes towards wound care. The instrument consisted of four parts: 1) demographic data, 2) a theoretical wound care competence assessment, focusing on chronic wounds and using the knowledge test, 3) a practical wound care competence assessment and 4) an assessment of attitudes (and values) (Table 10).

The instrument was developed to focus on chronic wound care, because when testing the general wound care competence instrument, the items related to chronic wound care were found to be more demanding for the students. Students also assessed their chronic wound care competence as being lower than acute wound care competence (Phase 1b, Paper II). In addition, and the general instrument did not give a sufficiently comprehensive description of participants' chronic wound care competence. Chronic wounds are also an increasing health problem (Martinengo et al. 2019), and the researcher intended to make the instrument more specialized, in order to keep it shorter and simpler focusing only on chronic wounds. Within this

instrument, the knowledge test was more structured, and the items were modified in relation to the general instrument, by adding new items and removing some of the old items that did not fit within the structure. The response options of the knowledge test items were also modified, and more items were added to measure individual attitudes towards wound care. The practical competence assessment part was a completely new addition to the instrument. The instrument development process was based on the scale development process by DeVellis (2017, Chapter 5), including item generation, face validity, content validity, pilot testing and psychometric testing.

The demographic data part was different for students and professionals. With regard to the students' background, six items related to the wound care education they received during their studies and their possible previous degree in health care. Questions relating to the professionals' background included 11 items regarding their place of work, field, work experience and further education in wound care. The objective of these background items was to establish whether the level of wound care education in both groups and in the place of work of the professionals' group, related to the participants' competence (Gray et al. 2017, p.499-500).

The second and the third parts of the instrument consisted of both theoretical and practical components of competence according to Cowan et al. (2005): knowledge, performance and skills. The competence assessment included 52 items; the first 38 items tested participants' theoretical competence using the knowledge test with answer choices yes/no/I don't know, and the final 14 items observed participants' practical competence using the simulation and think-aloud method (Lundgrén-Laine & Salanterä 2010) in which the observer (researcher) assessed whether or not the participant performed the expected tasks. Simulation as a competence assessment method can be used to evaluate individual practical competence in clinical skill acquisition with the help of checklists to document the skills (Hagler & Wilson 2013, Kiernan 2018). However, the problem with simulation as a research method is the potential Hawthorne effect, which causes study participants to act in a different way than they would usually, because they are being studied and observed (McCambridge et al. 2013). In this instrument, the simulation was based on an imaginary patient-case in which the patient had a diabetic foot ulcer.

Finally, the fourth part of the instrument included six Likert-scaled items relating to participants' attitudes (and values) towards wound care (1=totally disagree, 2=disagree, 3=do not agree or disagree, 4=agree, 5=totally agree). Values are in brackets because values in wound care are difficult to operationalize or measure, indicating that the items in this part of the instrument are more focused on participants' attitudes towards wound care rather than their values. However, attitudes and values are strongly related to one other (Woodruff & DiVesta 1948). A Likert-scale with five answer options was chosen in order to establish a possible

variation between participants' attitudes (Likert 1932). Participants were asked to answer questions relating to chronic wound care in general, wound prevention, EBP, autonomy and economics. The second, third and the fourth parts of the instrument were similar to all participating groups, and the structure of the instrument was based on the competence areas identified in the second phase of the study. The theoretical part covered all competence areas; the practical part covered the competence areas primarily in wound management and assessment, and the final part covered attitudes and values.

Following item formulation, the developed instrument underwent a face and a content validity process. Eight PhD students in nursing science conducted the face validity process, focusing on the structure of the instrument. Subsequently, an expert panel of eight health care professionals (two RNs, an authorized wound care nurse, two wound care researchers, a podiatrist, a vascular surgeon with a specialization in wound care and a plastic surgeon with a specialization in wound care) reviewed the clarity, relevance and importance of each item of the instrument, using a four-point scale (e.g., 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant and 4 = highly relevant). The CVI relating to theoretical and practical competence, as well as attitudes was calculated in the same way as the first version of the instrument giving an overall content validity index (S-CVI/Ave) of 0.95 (Grant & Davis 1997, Polit et al. 2007). Experts were also asked to prioritize the items of the knowledge test and to suggest a cut-off point indicating an acceptable competence level. Certain changes and clarifications were made to the items after the expert panel review. The instrument was pilot tested with five graduating SNs in September 2019, in order to test the clarity and usability of the instrument. Five knowledge test items were edited, and some minor changes were made to the spelling and formulation of the items. No changes were made to the practical component of the instrument.

Finally, the instrument was psychometrically tested (Phase 2b, Paper IV) with a larger sample that consisted of SNs, SPs, RNs and podiatrists. The purpose of the testing was to assess the construct validity, sensitivity and reliability of the instrument, including the internal consistency, inter-item correlation and inter-rater reliability of the instrument. The results of the psychometric testing are presented in the Results chapter.

Table 10. Structure of the chronic wound care competence instrument (*C/WoundComp*)

Demographic data	<p>Students</p> <p>Demographic data</p> <ul style="list-style-type: none"> • Profession the respondent is graduating to • Possible earlier education in health care <p>Education (Likert-scale 1-6)</p> <ul style="list-style-type: none"> • The amount of received theoretical education • The amount of received practical education • The amount of received practical training at clinical training periods • The amount of independent studying in wound care 	<p>Professionals</p> <p>Demographic data</p> <ul style="list-style-type: none"> • Profession • Working sector • Working unit • Specialty • Working experience in health care • Experience in wound care • Frequency of caring wounds <p>Education (yes/no)</p> <ul style="list-style-type: none"> • Authorization in wound care • Specialised wound care education • Further education in wound care • Independent studying in wound care
Knowledge test	<p>Correct/false items (38)</p> <p>Anatomy and physiology</p> <ul style="list-style-type: none"> • Skin and tissue viability (2) • Circulation (2) • Wound healing process (2) <p>Aetiology, care and prevention</p> <ul style="list-style-type: none"> • Aetiology (4) • Care and prevention (8) <p>Wound assessment and management</p> <ul style="list-style-type: none"> • Asepsis and environment (2) • Open wounds and wound bed (2) • Infections (2) • Cleansing and debridement (2) • Wound products (2) • Nutrition (2) • Pain management (2) • Documentation (2) • Patient education (2) • Co-operation (2) 	
Simulation and think-aloud	<p>Patient-case (14)</p> <ul style="list-style-type: none"> • Pain management (2) • Asepsis and environment (2) • Open wounds and wound bed (1) • Infections (2) • Cleansing and debridement (1) • Wound products (1) • Care and prevention (1) • Documentation (2) • Patient education (1) • Co-operation (1) 	
Attitudes (and values)	<p>Attitudes (Likert-scale 1-5) (6)</p> <ul style="list-style-type: none"> • Care (1) • Prevention (1) • EBP (1) • Holistic care (1) • Respect (1) • Economics (1) 	

4.3 Data collection

Theoretical and descriptive phase

The systematic literature search in Phase 1a (Paper I) was conducted in 2016 using six databases (MEDLINE/PubMed, CINAHL, Cochrane Library, Web of Science, Scopus and Medic) with the following search terms: *nursing student, podiatrist student, student nurse, student podiatrist, podiatric medical student, undergraduate nurse, undergraduate podiatrist, graduating nurse, graduating podiatrist, competence, skill, knowledge, attitude, value, performance, wound, ulcer, decubitus, wound care, wound management, wound assessment* and *tissue viability* with their Boolean operators. The inclusion criteria for the articles were that the articles had to be original studies addressing the wound care competence of final stage (third or fourth year students, or pre-registration students) SNs (or SPs). Studies were limited to those that had an abstract, and those that were written either in English or Finnish. Articles were excluded if they were instrument development studies or educational intervention studies unless these studies included empirical data relating to students' wound care competence. In total 12 original studies (Data 1) addressing the wound care competence of final stage SNs were found during the literature search but none were found that specifically related to SPs.

The data for Phase 1b (Data 2, Paper II) were collected in 2016 from five Finnish UAS all of which educated SNs and two of which educated SPs. Data were collected using the general wound care competence instrument, including a wound care competence questionnaire adopted from Huff (2011). The data were collected in 2016 using paper and pencil questionnaires at UAS immediately after lectures. The researcher collected part of the data and the students' teachers collected the remainder. The questionnaires were distributed to all students who were present in the class. If the student did not wish to participate, they returned an empty questionnaire. All questionnaires were anonymous.

Instrumentation and evaluation phase

Initial data for the instrumentation and evaluation phase (Data 3, Phase 2a, Paper III) were collected in 2018 using semi-structured focus-group interviews. The health care professionals were divided into six focus groups according to their profession: RNs, authorized wound care nurses, physicians, nurse educators, podiatrists and podiatry educators. Registered nurses, authorized wound care nurses, nurse educators and physicians discussed the wound care competence areas of the RNs, and podiatrists and podiatry educators discussed the podiatrists' competence areas. The researcher conducted all of the interviews by herself. Each interview took approximately one

hour, and were carried out individually at the participants' place of work or another venue. Interviews were recorded and a professional transcriber transcribed the recordings.

The second series of data (Data 4, Phase 2b, Paper IV) were collected between September and December 2019 from three UAS and three hospital districts, including units from primary and specialized health care services. The data for the theoretical part were collected using paper and pencil questionnaires. All participants answered the questionnaire under the researcher's supervision, preventing the participants from searching for the answers on the internet. Those participants, who also took part in the simulation, conducted the simulation individually under the researcher's supervision either on completion of the theoretical part or on another day. The simulation was based on an imaginary patient case and the ulcer used in the simulations was a false ulcer in a wound model by VATA Inc. US, however, the dressings and other wound care products were real (Picture 1, Appendix 5). The participants were asked to assess the wound and to perform dressing changing, documentation, patient education and consultation. The simulations were videotaped so that the researcher could view them later when carrying out analysis with another researcher in the research team. No one else was present during the simulation other than the researcher and the participant.

Answering the theoretical part of the instrument including attitudes, took approximately 15 minutes per participant. The duration of the simulations varied between six and 35 minutes (mean 16 minutes). The total duration of videotaped simulation data was approximately 13 hours. Data collection was carried out in participants' UAS, practical training locations, workplaces or in other educational establishments. All eligible participants who were present in the data collection took part in the theoretical part of the instrument. The data collection for the simulations continued until the target sample was achieved.

4.4 Data analysis

Theoretical and descriptive phase

In Phase 1a (Paper I), the original articles (Data 1) found during the literature search were analysed using an inductive content analysis (Table 11) according to Elo and Kyngäs (2008). At first, notes and headings were written, and subsequently, the lists of categories were grouped under higher order headings describing the same phenomena; finally, the categories were named and organized into themes. The quality of reporting in relation to the original selected studies were assessed using a critical appraisal tool developed by Hawker et al. (2002) (Appendix 3).

In Phase 1b (Paper II), the quantitative data (Data 2) including knowledge test scores, the level of wound care education received, students' attitudes towards wound care and students' perceived wound care competence were analysed using statistical analysis (Table 11). Data were analysed using the SAS 9.3 software package (SAS Institute Inc., Cary, North Carolina, US). The descriptive statistics and the knowledge test scores were calculated. Each correct answer to the multiple-choice items gave the respondent 1 point, meaning that the maximum possible score from the multiple-choice items was 25 for SNs and 18 for SPs. The maximum score in the patient case was 4 points meaning that the maximum score in the knowledge test was 29 (25+4) for SNs and 22 (18+4) for SPs. Total and mean scores for the knowledge test were analysed for both groups and individually. The associations between the knowledge test scores and students' previous education, the wound care education they received and the students' perception of their wound care competence were analysed too. The total scores and the demographic variables were compared using t-tests and an analysis of variance (ANOVA) was used to compare the means between the two groups (Mackridge & Rowe 2018, p.93). Pairwise comparisons between the groups using the Tukey-Kramer post-hoc test were conducted to adjust for multiple comparisons, and the results were verified using the Wilcoxon two-sample test and the Kruskal-Wallis test if the normal distribution could not be achieved (Mackridge & Rowe 2018, p.105,133). The relationship between numeric variables and the knowledge test were examined using Pearson's and Spearman's correlation coefficient. Lastly, the students' knowledge test scores were analysed together with the students' perceived competence level, using Spearman's correlation coefficient (Mackridge & Rowe 2018, p.173).

The answers to the last open-ended question of the instrument were analysed using an inductive content analysis (Table 11) in accordance with Elo et al. (2014), and the analysis was carried out using NVivo 11 software (QSR International Pty Ltd., UK). At first, the most frequently written words were sought from the answers. Then, the coding process started with open coding, based on these most frequently written words. Answers were coded according to similarities in the words and their meanings and synonyms, and specific nodes representing their similarities were created. Subsequently, the componential coding of the nodes was carried out, in which connections and relationships between the different nodes were sought. Finally, the selection was carried out, in which the nodes were organized into the final themes. (Leech & Onwuegbuzie 2011). Two main themes "education" and "competence" were formulated from the question, and the sub-themes formulated from the analysis ("insufficient theoretical and practical education", "students learn more during practical training than at school", "insufficient knowledge" and "little practical experience") were organized deductively under the two main themes.



Picture 1. Simulation equipment (© Emilia Kielo-Viljamaa)

Instrumentation and evaluation phase

Focus-group interviews (Data 3) in Phase 2a (Paper III), were analysed using a two-step inductive-deductive content analysis (Table 11) with the help of NVivo 12.0.0 (QSR International Pty Ltd., UK) software. The inductive content analysis was conducted first in accordance with Elo and Kyngäs (2008), which comprehended open coding, creating categories and the abstraction of the data. At first, similarities and connections in participants discussions were assigned to specific categories. Next, the categories were examined and their connections and similarities were analysed. Lastly, the created categories were abstracted and organized by competence area: knowledge, skills, performance, values and attitudes. (Leech & Onwuegbuzie 2011). After the inductive content analysis, competence areas were deductively grouped as competences, in which knowledge, skills and performance formed a collective competence as these areas of competence are strongly related to both theoretical and practical competence in wound care. In addition, values and attitudes also formed a collective competence, as these are also closely related to one other.

Finally, in Phase 2b (Data 4, Paper IV), the competence levels and attitudes towards wound care, as well as the psychometric testing of the instrument were statistically analysed (Table 11) using the SAS 9.4. software package (SAS Institute Inc., Cary, North Carolina, US). The categorical variables were described with counts and percentages, and the continuous variables, which did not follow normal distribution, were summarized with the median and lower quartile and the upper quartile, and were compared using the Wilcoxon rank sum test (Mackridge & Rowe 2018, p.133). The mean score comparisons of the theoretical and practical competences were performed using a one-way analysis of variance (ANOVA, F, degrees of freedom (DF) with p-value), and the comparisons regarding attitudes were performed using the Kruskal-Wallis test (Mackridge & Rowe 2018, p.105). The correlations between the participants' theoretical and practical competence were examined using Spearman's correlation coefficient (Mackridge & Rowe 2018, p.173). The internal consistency of the knowledge test and simulation was evaluated using the Kuder-Richardson (KR) formula (Kimberlin & Winterstein 2008, Streiner et al. 2015, p.86), and the Cohen's Kappa coefficient was used in the inter-rater reliability assessment for the observations of two researchers in the simulations (Streiner et al. 2015, p.172, DeVellis 2017, p.67) Finally, discriminant analysis was used to establish which knowledge test subscales indicated differences in students' and professionals' knowledge. All tests were performed as two-sided with a significance level set at 0.05 (Kirkwood & Sterne 2003, p.73).

Table 11. Analysis methods used in the study

Method	Phase 1a Data 1	Phase 1b Data 2	Phase 2a Data 3	Phase 2b Data 4
Qualitative analysis				
Inductive	x	x	x	
Deductive		x	x	
Statistical analysis				
Descriptive statistics				
Demographic data		x		x
Total and mean scores		x		x
Standard deviation (SD)		x		x
Confidence interval (CI)				x
Inferential statistics				
T-test				
Comparison between scores and demographic variables		x		
Analysis of variance (ANOVA)				
Comparison of means between groups		x		x
Tukey-Kramer post-hoc test				
Multiple comparisons		x		
Wilcoxon rank sum test				
Comparison between two groups (non-parametric data)		x		x
Kruskal-Wallis test				
Comparison between three or more groups (non-parametric data)		x		x
Pearson's correlation coefficient				
Relation between numeric variables and scores		x		
Spearman's correlation coefficient				
Relation between numeric variables and scores (non-parametric data)		x		x
Cohen's Kappa coefficient				
Inter-rater reliability				x
Kuder-Richardson Formula				
Internal consistency (dichotomous variables)				x
Discriminant analysis				
Indication of differences in scores of different groups				x

4.5 Ethical considerations

This study was conducted according to the guidelines of The Finnish National Board on Research Integrity (TENK 2012) and The European Code of Conduct for Research Integrity (ALLEA 2011 & 2017). In this study, the key moral principles in biomedical ethics were followed: respect of autonomy, nonmaleficence, beneficence and justice (Beauchamp & Childress 2013, p.13). In addition, the justification to conduct this study was gained as a result of a comprehensive literature review, which indicated that there was a need to research this area. Participation in the sub-studies of this dissertation was voluntary, and the participants received information relating to the study. After receiving the information and having the opportunity to ask questions, participants signed an informed consent form. The participants remained anonymous and they were free to leave the study at any point, without having to give a reason for leaving. Students' participation did not have any impact on their grades or studies in any way.

An application for permission to conduct the research was made to all participating organizations before data collection and permission was granted; ethical approval (TENK 2019) was requested and obtained from the Ethics Committee for Human Sciences in the University of Turku for the second phase (Phases 2a & 2b) of the study (4/2018). In the final sub-study (Phase 2b), participants were also informed about data processing and protection according to the EU general data privacy regulation (EU 2016/679) which became valid in 2018. Permission to use, translate and edit the Documentation of Various Wounds questionnaire (Huff 2011) was granted in January 2016 by the Journal of Wound Ostomy & Continence Nursing, which holds the copyright for the instrument.

Any possible harm caused by the studies was related to the time required for participation. The items and questions of the instruments were written as clearly as possible in order to save participants' time (DeVellis 2017, p.114-116), and the data collection was organized so that it had as little impact as possible on the participants' study or working time. The subject of this study was not particularly sensitive and all participants were adults. However, observing one's own actions is personal (Bloomer et al. 2013), therefore, it is possible that the final sub-study may have had a slightly negative effect on the self-esteem or confidence of certain students or professionals when providing wound care, if they felt that they had not succeeded in the competence assessment. However, it is likely that such an effect was temporary. Participants in the focus group interviews represented their own experiences, opinions and thoughts, not those of their employers, and they were informed of this.

The data management plan was conducted according to the Data Policy of the University of Turku (University of Turku 2016). Data were stored carefully; electronic data were stored in the university server and paper forms in a locked repository. Only the researcher and the statisticians who were analysing the data had

access to the data. Core practices of publication ethics were followed when publishing the processes and results of the sub-studies (COPE 2020). This study was justified in order to generate new knowledge in relation to the wound care competence of graduating SNs at their graduation stage. The knowledge gained can be used when planning wound care education in bachelor level studies, in order to meet the competence requirements to ensure the best quality care for patients with wounds.

5 Results

The results of the study are presented in this summary in accordance with the research questions of the study. The first two sub-chapters (5.1–5.2) present the findings of the theoretical and descriptive phase (Papers I-II), and the following three sub-chapters (5.3–5.5) present the findings of the instrumentation and evaluation phase (Papers III-IV). These results represent the main findings of the study, and more detailed results are presented in the original Papers I-IV.

5.1 The wound care competence of graduating student nurses and competence assessment methods

According to the literature review (Data 1, Paper I and summary), the wound care competence of graduating SNs was limited. Students' knowledge of wound care was primarily focused on their knowledge of PU care and prevention, which was not optimal. However, the students showed positive attitudes towards wound care and wound prevention according to the findings (Paper I). Yet, one new study identified in the latter stages of the literature review for this summary, suggested that students had diverse attitudes towards wound care. According to the literature review (Paper I and summary), students also had somewhat diverse opinions in relation to their preparedness to care for wounds. In most of the studies, students stated that they did not feel prepared to care for wounds but there were also more optimistic views in which students stated that they felt confident with regard to the majority of wound care procedures. According to the findings (Paper I), students also stated that they did not receive sufficient wound care education during their studies. In addition, those students who participated in extra-curricular activities or sought more information about wounds independently, had better knowledge of wounds. Studies relating to the wound care competence of graduating SPs were also sought, but no studies assessing the wound care competence of SPs were found.

In this summary, methods used to measure the wound care competence of SNs were also identified. In this section, all studies addressing the wound care competence of students regardless of students' study stage were included. The method used most to assess competence was the knowledge test; those validated

measured students' PU knowledge. Self-evaluation and attitude instruments were also popular. Other methods to assess students' wound care competence were interviews, photographs and simulation. Only one instrument was found that did not focus on any specific type of wound: The Documentation of Various Wounds questionnaire by Huff (2011). This instrument, however, was short which meant that it did not suit the study purposes of this study alone, but was included in Phase 1b in the general wound care competence instrument that was developed.

5.2 The theoretical and perceived wound care competence of graduating student nurses and the factors related to their competence

According to the results (Data 2, Paper II), the wound care competence of students was limited. The average percentage of correct answers was 48% (minimum 10%, maximum 79%). The average percentage of correct answers provided by graduating SNs across the whole test was 46% and for SPs, 60% demonstrating that the competence of graduating SPs was statistically significantly higher than that of SNs ($p < 0.0001$). Graduating SPs also scored better in the patient case than SNs (Table 12). Student nurses recorded the highest scores in PU risk factors (94%), debridement (88%), pain management (85%), silver dressings (83%) and surgical wounds (80%). The lowest scores were recorded in PU risk management (10%), wound infection (10%), DFUs (11%), healing process (11%) and burn injuries (16%). (Figure 8).

Students self-evaluated their wound care competence to be primarily poor (Paper II). Almost half (40%) of the students claimed that they were relatively poor in caring for chronic wounds and some (12%) maintained that they could not care for chronic wounds at all. However, almost half (48%) of the SNs regarded themselves as being quite good at caring for surgical wounds, and some (5%) considered themselves very good. However, their self-evaluated competence in relation to burn injuries was lower compared to surgical wound care, as one third (34%) believed they were quite poor at caring for burn injuries and some (16%) claimed that they could not take care of burn injuries at all. Wound care products were also found to be demanding. Almost half (42%) of the students said they had limited knowledge of wound products and some (7%) believed that they had minimal knowledge (Figure 9). The qualitative data of the study (Data 2, Paper II) supported these findings, as many students wrote that their knowledge of wounds was insufficient and they had limited practical experience of wound care.

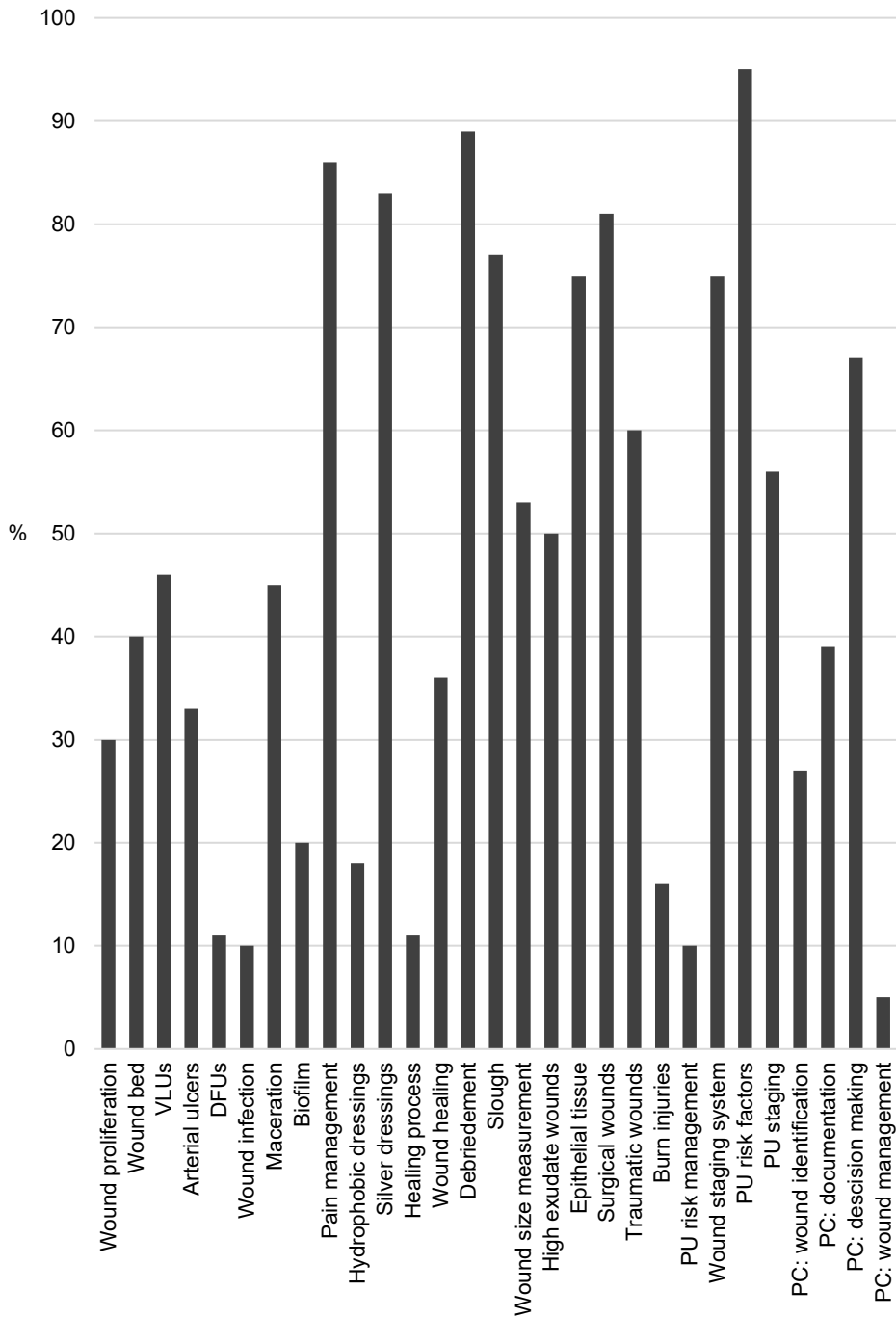


Figure 8. Student nurses' correct answers in general wound care competence assessment (adapted from paper II) (PC=Patient case)

Table 12. Students' correct answers on the knowledge test

Participants	The whole test mean (range)	Patient case mean (range)	Identical part of the test (first 22 items) mean (range)
SNs (n=194)			
Score	14 (0-29)	1.5 (0-4)	10 (0-22)
%	46 (0-100)	37 (0-100)	43 (0-100)
SPs (n=19)			
Score	13 (0-22)	2.8 (0-4)	13 (0-22)
%	60 (0-100)	71 (0-100)	60 (0-100)

Students, however, demonstrated positive attitudes towards wound care (Paper II) because the majority (78%) of students were interested in wound care, and almost all (99%) stated that nurses and podiatrists should be competent in wound care. Yet, most of the students stated that they received little (50%) or very little (18%) theoretical wound care education during their studies, and most of the students estimated that they received little (45%) or very little (42%) practical wound care education at UAS. The qualitative data support these findings because many students wrote in the open-ended question that they were not satisfied with the wound care education they received. However, the level of wound care training received during practical training varied. A third (34%) considered they had received much training, but less than one third (29%) maintained they had received little training and around the same number (27%) reported neither little nor much of training. Data also highlighted that those students who received more wound care training during their practical training in clinical settings received statistically significantly higher scores in the knowledge test ($p=0.0007$). However, those students who had a prior health care degree did not succeed any better in the knowledge test than those who did not have a prior degree in health care.

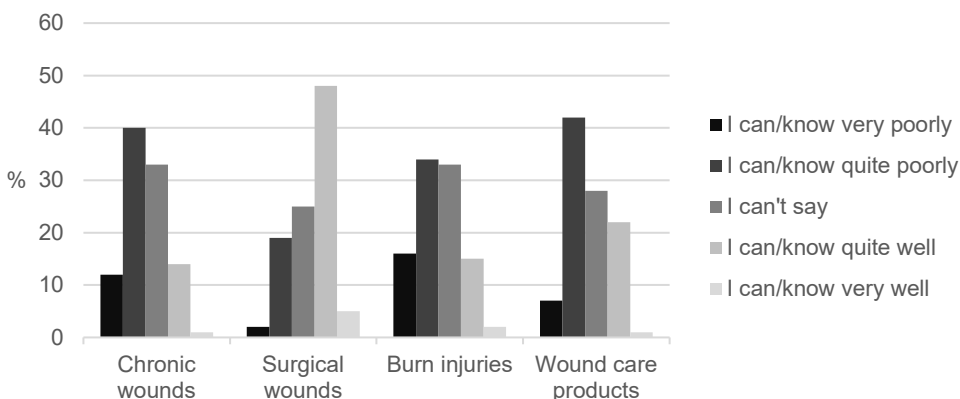


Figure 9. Students' perceived wound care competence (adapted from paper II)

5.3 Required competence areas in chronic wound care

According to the results (Data 3, Paper III), the chronic wound care competence areas of RNs (and podiatrists) were categorized as knowledge, skills and performance in wound care and as values and attitudes in wound care in accordance with Cowan et al. (2005). Knowledge, skills and performance were divided into theoretical and practical competences in i) anatomy and physiology, ii) aetiology, care and prevention and iii) wound management and assessment. Values and attitudes in wound care were divided into i) wound care, ii) wound prevention, iii) EBP, iv) holistic care, v) respect and vii) economics. The key areas of theoretical and practical wound care competence were divided into more specific competences (Figure 10). The competence areas were identical for both RNs and podiatrists. However, certain areas were highlighted for nurses and others for podiatrists. Theoretical knowledge was expected from both groups in all competence areas, but practical skills and performance varied between the groups in certain competences.

In anatomy and physiology, RNs were expected to have knowledge of skin and tissue viability, including skin layers and tissue types. They were also expected to have both theoretical knowledge of understanding the circulation, and skills to recognize possible venous or arterial insufficiency. In the wound healing process, they were expected to have knowledge of the healing stages and factors affecting wound healing (Figure 10).

In aetiology, care and prevention competence, RNs were expected to have knowledge of the most common chronic wounds, including aetiology of the wound, and wound care and prevention procedures relating to each common chronic wound. In VLU care, RNs were expected to have skills to perform compression therapy but for podiatrists, this was only expected at a theoretical level, as podiatrists' work usually focuses on the feet, not the legs. In relation to arterial leg ulcer care, both nurses and podiatrists were expected to have knowledge of arterial insufficiency and the skills to perform circulation assessment to recognize potential problems in the arterial circulation. It was highlighted in the interviews that in Finland, neither nurses nor podiatrists are expected to fix a patient's decreased arterial perfusion, but it is essential that they recognize the potential problems or ischaemia as quickly as possible, and consult a physician for further assessments. In DFU care, RNs were expected to have an understanding of the aetiology of DFUs and to understand the principles of offloading. Nurses need to understand the importance of offloading and should consult podiatrists if they are not familiar with offloading and footwear. Lastly, in the case of PUs, both nurses and podiatrists were expected to have knowledge of what causes PUs, how PUs are treated and how they may be avoided. For nurses, it was also expected that they have the skills to perform pressure-relieving procedures (Figure 10).

In wound management and assessment, RNs were expected to have knowledge of asepsis and the environment, including skills and performance in aseptic working and the correct procedure preparation before wound management. They were also expected to have knowledge of open wounds and the wound bed, including the recognition of different tissue types, and an understanding as to why an open wound should be kept moist and warm. With regard to infections, RNs were expected to recognize the signs of a wound infection and to be able to take a bacteria sample. In wound cleaning, they were expected to have knowledge of different debridement techniques, to be able perform a proper debridement, and to know when and when not to perform it. Moreover, RNs were expected to know the generic groups of wound care products, and to understand the use and function of these different generic groups. Registered nurses should also have knowledge about nutrition and its role in wound management. Both nurses and podiatrists were expected to have basic knowledge of nutrition assessment and nutrients affecting wound healing. Registered nurses were also expected to be able to perform basic nutrition assessment and to promote wound healing with the correct nutrition. Pain management was also mentioned as an important part of wound management and nurses and podiatrists are expected to assess patient's pain. Pain management is an essential element of every nurse's competence and podiatrists are expected to consult other health care professionals if needed. Documentation skills are also grouped under wound care competence and professionals are expected to document a description of the wound and the procedure. Registered nurses were also expected to educate the patient, including motivating the patient and supporting the patient for self-care. They were also expected to inform the patient about their care. Finally, cooperation with other health care professionals was deemed to be essential, including the ability to consult other health care professionals if needed, and to understand the significance of multi-professional team working (Figure 10).

Furthermore, RNs were also expected to have certain values and positive attitudes towards wound care. They were requested to have positive attitudes towards wound care and wound prevention, as well as evidence-based practice. They were also expected to perform holistic care, respect patients' autonomy and privacy, and take account of the economic aspects of wound care from the perspective of the patient and society (Figure 10).

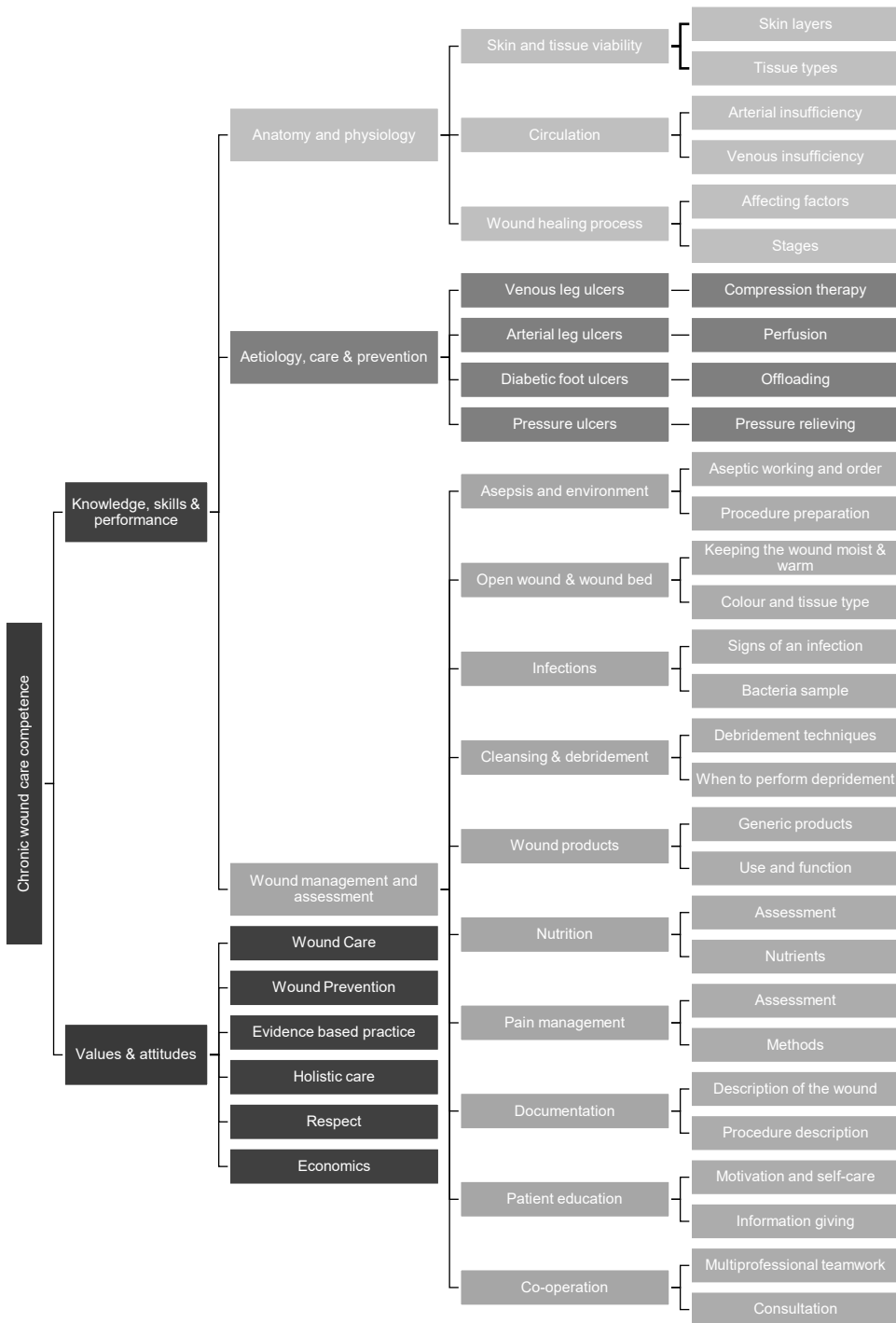


Figure 10. Competence areas in chronic wound care for registered nurses (Modified by combining figures from paper III)

5.4 The chronic wound care competence of student nurses compared to registered nurses

According to the results (Data 4, Paper IV), participants' mean score in terms of correct answers in the knowledge test was 28/38 (73%); the SNs' mean score was 25/38 (65%) and that of RNs was 31/38 (81%) (Table 13). The RNs' mean score was statistically significantly higher than that of the SNs ($p < 0.0001$). In addition, SPs scored significantly higher in the knowledge test than SNs ($p = 0.0220$). The highest mean scores for graduating SNs came from signs of a wound infection (100%), venous insufficiency (98%) and nutrients (98%). The lowest mean scores were related to pain assessment (0%), pressure ulcer prevention (16%) and dressings (generic names) (16%) (Figure 11).

The participants' mean score in the simulation was 9/14 (60%); the SN's mean score was 7/14 (52%) and that of the RNs was 10/14 (70%) (Table 13). The RNs' mean scores were again statistically significantly higher than those of SNs ($p = 0.0005$). However, no statistically significant difference was found between SNs and SPs in the simulation ($p = 0.5981$). Graduating SNs received the highest scores in relation to colour and tissue type (100%), debridement (95%) pain management (74%) and consultation (74%). The lowest scores were related to DFU care (11%), procedure description (16%) and bacterial sample (21%). (Figure 12).

Table 13. Participants' mean scores in the knowledge test and in the simulation (adapted from paper IV)

Knowledge test						
	Mean score (%)	SD	Min	Max	CI (95%)	p*
All (n=135)	27.8 (73%)	4.43	12	36	27.1-28.6	<0.0001
SN (n=44)	24.5 (65%)	4.24	12	31	23.5-25.6	
SP (n= 28)	26.5 (70%)	3.66	18	33	25.2-27.7	
RN (n=54)	30.8 (81%)	2.74	24	36	29.9-31.7	
P (n=9)	30.2 (80%)	2.28	25	32	27.9-32.5	
Simulation						
All (n=135)	8.4 (60%)	2.53	3	13	7.7-9.2	0.0009
SN (n=44)	7.2 (52%)	2.55	3	12	6.2-8.2	
SP (n= 28)	6.7 (48%)	1.86	5	10	4.9-8.5	
RN (n=54)	9.9 (70%)	1.93	6	13	8.9-10.8	
P (n=9)	9.6 (69%)	1.95	7	12	7.6-11.5	

SN=student nurses, SP=student podiatrists, RN=registered nurses, P=podiatrists, *=ANOVA

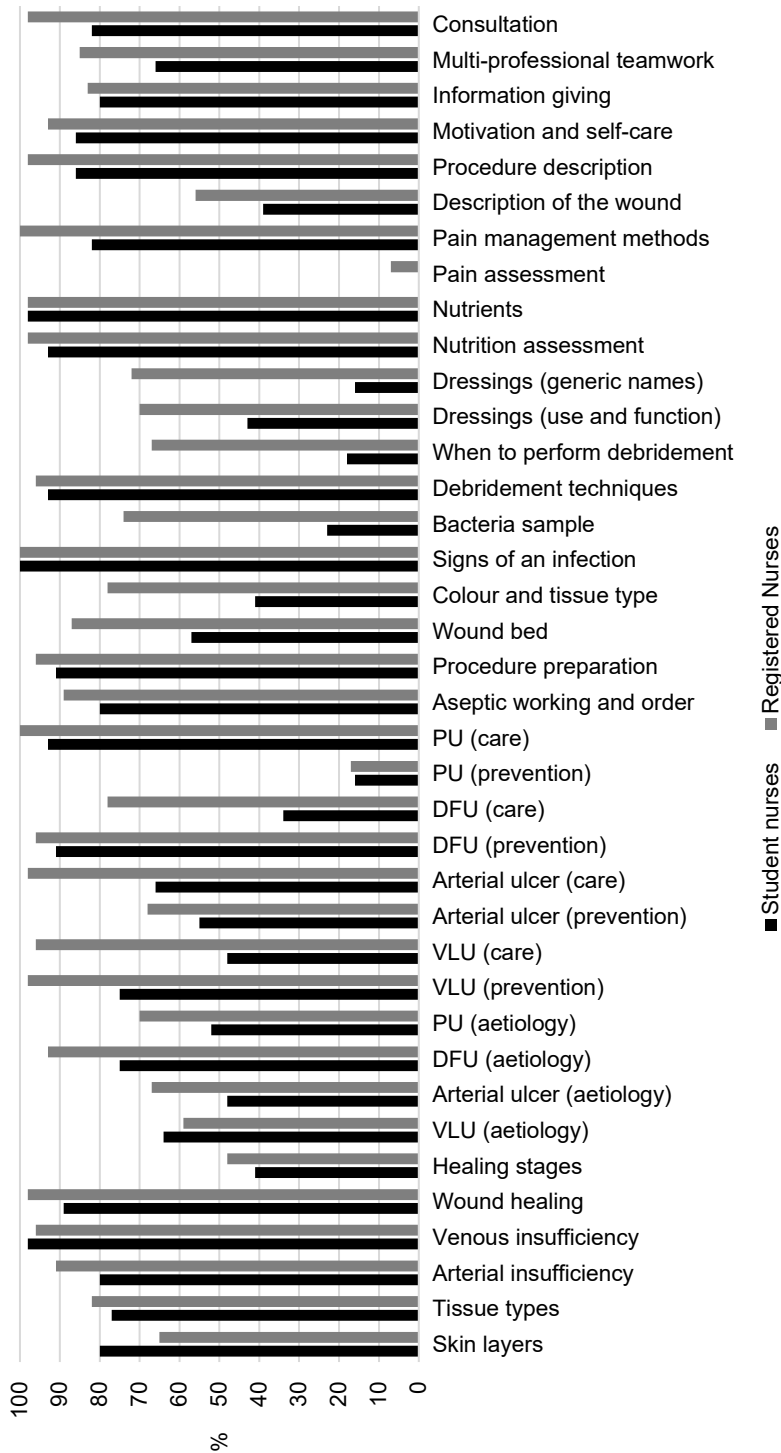


Figure 11. Student nurses' and registered nurses' correct answers in the knowledge test of the C/WoundComp (adapted from paper IV)

After combining the theoretical and practical parts of the instrument, the SNs' mean score was 32/52 (62%) and the RNs' mean score was 40/52 (77%), indicating that the RNs' mean score was statistically higher than that of the SNs ($p < 0.0001$) across the whole instrument. No statistically significant difference between the student groups was found ($p = 0.6736$).

Lastly, participants' attitudes towards chronic wound care were measured. Graduating SNs demonstrated positive attitudes towards wound care, wound prevention, evidence-based practice, holistic care and respect, but there was more variation between the SNs with regard to economics. Professionals' attitudes were more positive than those of students in general (all items) ($p = 0.0117$).

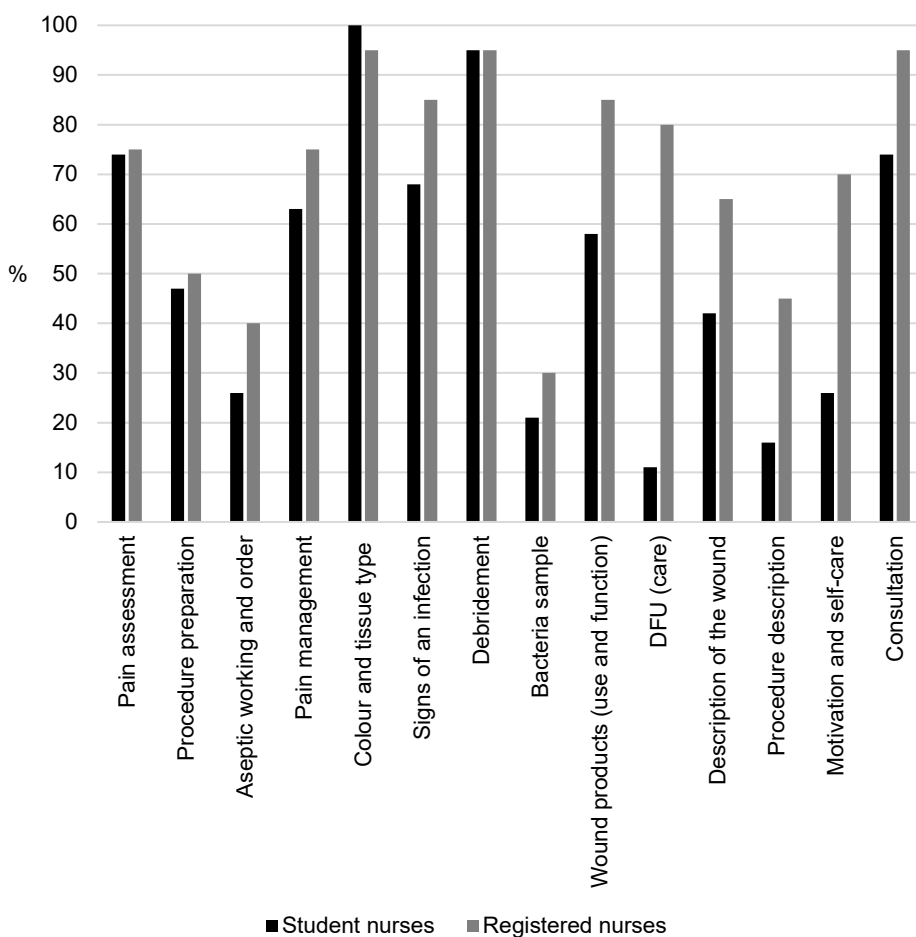


Figure 12. Student nurses' and registered nurses' correct actions in the simulation of the C/WoundComp (adapted from paper IV)

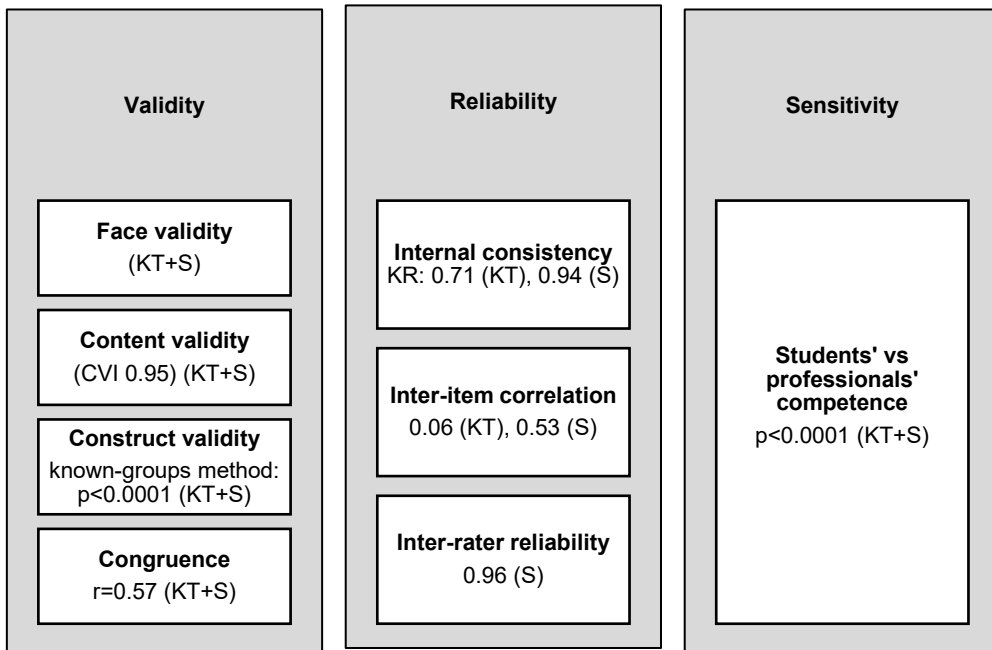
5.5 Validity, reliability and sensitivity of the C/WoundComp instrument

The validity, reliability and sensitivity of the developed C/WoundComp instrument was tested in the final sub-phase of this study (Data 4, Phase 2b, Paper IV) (Figure 13). According to the psychometric testing, the instrument demonstrated sensitivity, as the instrument was able to segregate students' and professionals' competence levels in both the theoretical and practical part of the instrument. The statistically significant difference ($p < 0.0001$) between the students and professionals also indicated a proper construct validity for the instrument, using a known-groups method, as the professionals in this data set were considered as the gold standard for the expected competence level.

The reliability of the instrument was assessed using Kuder-Richardson (KR) formula to assess the internal consistency of both the theoretical part and the practical part of the instrument. The KR coefficient for the knowledge test was 0.71 and for the simulation, 0.94, indicating acceptable levels of internal consistency. In addition, inter-item correlations were assigned to the knowledge test and the simulation separately, as well as to each subscale of the knowledge test. The inter-item correlation with the whole knowledge test was 0.06 and with the simulation, 0.53. The inter-item correlations with the subscales of the knowledge test were 0.0 (anatomy and physiology), 0.21 (aetiology, care and prevention) and 0.17 (wound assessment and management), meaning that the inter-item reliability of the knowledge test was low but was optimal for the simulation. The reliability of the simulations was strengthened with the inter-rater reliability assessment, since there were two observers who watched the videotaped simulations. The agreement between the observers according to Cohen's Kappa was 0.96, demonstrating that the inter-rater agreement of the simulations was excellent.

The congruence of the instrument was assessed by counting the correlation between the knowledge test and the simulation results to establish whether these different parts are able to measure the same phenomena. According to Spearman's correlation coefficient, the correlation between participants' theoretical and practical competence was 0.57 ($p < 0.0001$), indicating that there was a moderate correlation between these two parts of the instrument, providing the co-directional results of one's competence.

Lastly, the cut-off score for an acceptable competence level was assessed using a contrasting-groups method by Azzarello (2003). According to the analysis, the intersection point of professionals' and students' competence (initial cut-off score) with regard to the knowledge test was 76% and for the simulation, 57%. However, the final cut-off score could be set higher in order to avoid false, positive results.



KT=knowledge test, S=simulation, KR=Kuder-Richardson formula

Figure 13. Validity, reliability and sensitivity testing of the C/WoundComp

5.6 Summary of the results

According to the results of this two-phased study, the wound care competence of graduating SNs was found to be limited. Students also stated that they received minimal wound care education during their studies, and they did not feel prepared to care for wounds as health care professionals. However, students showed positive attitudes towards wound care. Three main competence areas regarding the chronic wound care knowledge, skills and performance of RNs were found, as well as six competence areas relating to the values and attitudes in chronic wound care. The developed C/WoundComp instrument demonstrated preliminary validity, reliability and sensitivity (Table 14).

Table 14. Summary of the main results

The wound care competence of graduating SNs
<ul style="list-style-type: none"> • Both theoretical and practical wound care competences were limited • Students showed positive attitudes towards wound care • Students self-evaluated their wound care competence as being low • Students received minimal wound care education during their studies • Higher theoretical competence was associated with a greater level of practical training in wound care
Competence areas in chronic wound care
<ul style="list-style-type: none"> • Knowledge, skills and performance in wound care <ul style="list-style-type: none"> ○ anatomy and physiology ○ aetiology, care and prevention ○ wound management and assessment • Values and attitudes towards wound care <ul style="list-style-type: none"> ○ wound care, wound prevention, EBP, holistic care, respect and economics
Instrument development and testing
<ul style="list-style-type: none"> • Competence assessment instruments were developed, focused on general and chronic wound care • The instrument development processes were systematic • The C/WoundComp instrument demonstrated preliminary validity, reliability and sensitivity • The C/WoundComp can be used to assess both theoretical and practical competence or just one of these • The C/WoundComp can be used to assess the chronic wound care competence of graduating SNs, SPs, RNs or podiatrists

6 Discussion

In this discussion chapter, the main findings of the study are discussed in the light of previous literature. In addition, the validity and reliability of the study are discussed, as well as suggestions for further research and the practical implications of the results for nursing education, clinical practice and administration.

6.1 Discussion of the results

This study was conducted in two phases. The first phase promoted knowledge relating to the wound care competence of graduating SNs following a literature review and a cross-sectional study. The first phase also provided information on the competence assessment methods used in previous literature, as well as students' self-evaluated wound care competence. The second phase consisted of the instrument development and evaluation. At first, the competence requirements for chronic wound care were identified to build the construct for the chronic wound care competence instrument, and finally the instrument was systematically developed and tested.

According to the results, the wound care competence of graduating SNs was found to be limited in terms of both theoretical and practical competence. Still, the students showed positive attitudes towards wound care. The main competence areas in chronic wound care consisted of anatomy and physiology, aetiology, care and prevention, and wound management and assessment, including certain values and attitudes towards wound care. The chronic wound care instrument developed, demonstrated preliminary validity and reliability.

According to the literature review (Paper I and summary), the wound care competence of graduating SNs was found to be limited. Previous research focused primarily on students' wound care knowledge, especially on PU care and prevention. The other main findings were that students' attitudes towards wound prevention were mostly positive, but they often felt unprepared in caring for wounds.

Previous research relating to the wound care competence of RNs has also focused mainly on nurses' PU knowledge and their attitudes towards PU prevention, indicating comparable results with the students. Studies have also shown that RNs' knowledge of PU care and prevention has been found to be at an inadequate level in

various studies (Miyazaki et al. 2010, Ilesanmi et al. 2012, Qaddumi & Khawaldeh 2014, Dalvand et al. 2018). In addition, limited knowledge among nurses has also been found in relation to leg ulcers (Van Hecke et al. 2009, Ylönen et al. 2017) and DFU knowledge (Bilal et al. 2018, Kumarasinghe et al. 2018), as well as in their knowledge of caring for surgical wounds (Labeau et al. 2010).

According to previous literature (Paper I and summary), graduating SNs often felt unprepared in terms of caring for wounds. However, there were some diversity in students' answers within the studies. Self-evaluation has also been used to assess the perceived wound care competence of RNs, and in one study, of podiatrists. According to a study by McIntosh and Ousey (2008), both nurses and podiatrists assessed that their wound care competence was either satisfactory or poor, and in a study by Gillespie et al. (2014), two thirds of the RNs assessed that their knowledge of wound products were either satisfactory or inadequate. Diversities in subjects' self-evaluations may be explained by the difficulty in assessing one's own competence. In addition, certain wounds and wound care procedures have been found to be more demanding than others.

Insufficient competence and confidence among students and professionals might indicate that wound care education does not correspond with competence requirements. According to the previous literature (Paper I and summary), students argued that they did not receive enough wound care education during their studies. Studies also suggested that additional wound care education had positive effects on participants' competence. For example, in a study by Beeckman et al. (2008), SNs' PU classification skills improved after an e-learning programme, and in a study by Larcher Caliri et al. (2003), SNs who had participated in extra-curricular activities or sought information about wound care independently, had better knowledge of PU care.

Further education and courses in wound care among professionals have also showed promising results. According to a study by Ylönen et al. (2017), an internet-based learning programme in VLU care, had a positive impact on nurses' VLU knowledge in the home care setting, and a study by Henry (2019), indicated that a multimedia educational intervention in PU prevention, increased nurses' knowledge in critical care setting. These results indicate that more education and modern teaching methods in wound care are needed in nursing education but also in further education for health care professionals.

Despite the limited knowledge and education, graduating SNs primarily showed positive attitudes towards PU prevention, according to previous studies (Paper I and summary). However, in one study (Garrigues et al. (2017) summary), students' attitudes were not at all positive. Comparable findings have also been found in previous studies conducted with RNs, indicating primarily positive attitudes towards PU prevention among nurses (Källman & Suserud 2009, Strand & Lindgren

2010, Aslan & Yavuz van Giersbergen 2016). However, certain controversial results were also found in nurses' attitudes (Etafa et al. 2018), and in a study by Florin et al. (2016), students thought that they had a more important task in PU prevention compared to RNs. Students' enthusiasm and assumptions might explain students' more positive attitudes in some perspectives, but the reality is often more complex.

According to the literature review (summary), several evaluation methods were used to assess the wound care competence of SNs in previous literature. The method used most was that of instruments, especially knowledge tests. Instruments were also used for self-evaluation and for the evaluation of one's attitudes towards wound care. Other evaluation methods were interviews, photographs and simulation.

Most of the knowledge tests were developed to measure individuals' knowledge of a specific wound such as a PU, and most of these instruments were validated. These types of instruments give information about a person's knowledge and they are easy to use for research and clinical purposes in either paper or in electronic form. However, their weakness relates to the fact that participants can guess the correct answer and the ability of participants to apply their knowledge cannot be quantified (Hunt 2003). Neither do they provide information relating to one's practical competence and skills.

Self-evaluation measures one's own beliefs of their competence. Studies using self-evaluated competence have been popular in nursing research. For example, Meretoja et al. (2004) studied and developed an instrument – *Nurse Competence Scale* – to measure nurses' self-evaluated general competence, and Kajander-Unkuri et al. (2016) used the instrument to measure the self-evaluated general competence of graduating SNs. Self-evaluation gives information relating to one's own perception of one's competence, but the weakness is the potential Dunning-Kruger effect, according to which a subject might over- or underestimate their competence; overestimating is common especially among those who are less experienced (Kruger & Dunning 1999, Dunning 2011). Due to the appeal of competences and clinical responsibilities, subjects might also pretend that they are better or worse at something than they really are (Streiner et al. 2015, p.106-111).

Measuring one's attitudes has also been much studied in nursing research. For example, nurses' attitudes towards patients with mental illnesses or substance use disorders, have been studied globally (e.g., Chambers et al. 2010, Chu & Galang 2013, Al-Awadhi et al. 2017). In wound care, attitudes are closely related to attitudes towards PU prevention. The reason why research is so focused on attitudes towards PU prevention is obvious; most of the PUs can be prevented with the correct nursing interventions (Black et al. 2011, NICE 2014), and nurses' attitudes towards PU prevention play a key role. However, research about nurses' or SNs' attitudes towards other wounds or wound care in general, is scarce.

Interviewing was used as an evaluation method in only two studies. Interviewing was not a common method either when evaluating RNs' perceptions of their wound care competence in previous studies. In one new study (Blackburn et al. 2019), tissue viability nurses felt that they had gaps in their competence and confidence in relation to wound care and especially in dressing selection. The weakness of interviewing is the same as that of self-evaluation. Still, compared to self-evaluation questionnaires, interviewing provides more in-depth information about one's competence and factors related to it (Denzin & Lincoln 2005, p.687-698).

Photographs were used in three previous studies to assess SNs' PU classification and staging skills. According to previous studies, photographs have been used in clinical nursing, nursing education and in nursing research (Riley & Manias 2004, Lapum & St-Amant 2016), for example in documentation, nursing interventions and in performance evaluation (Riley & Manias 2004). Photographs of authentic wounds can be useful when real wounds cannot be used in education or in a competence assessment. However, photographs are two-dimensional pictures of wounds meaning that photographs are not fully comparable with reality.

Simulation was used in only one study to assess SNs' competence. Simulation has been used a great deal in nursing education in different contexts (Kim et al. 2016) for example, in emergency care (Small et al. 2018) and in patient education (Virtanen et al. 2015). The strength of simulation is that it also takes into account participants' practical skills and performance, not just their knowledge of something (Schreiber et al. 2010, Kiernan 2018). However, a successful simulation requires an environment and equipment as close as possible to the real world and a proper debriefing in educational situations (Fanning & Gaba 2007, Durham & Alden 2008, p.3-233-3-234).

According to the Part b of the theoretical and descriptive phase (Paper II), the theoretical wound care competence of graduating SNs was limited. The mean percentage of students' correct answers in the knowledge test was less than 50%. However, graduating SPs scored significantly higher in the test competing with graduating SNs. Previous studies (Paper I and summary) relating to the wound care competence of graduating SNs support these findings indicating that the competence is not at a sufficient level before graduation. The final exams for graduating SNs such as the exams of the National Council of Licensure for Examination-Registered Nurse (NCLEX-RN) in the USA, are not yet included in the nursing curriculum in Finland. However, a national final exam for graduating SNs has been planned and is already being pilot tested in some of the Finnish UAS. The final exam aims to measure the general competence of graduating SNs in all areas and it is planned to be launched in 2021 at all Finnish UAS (Silén-Lipponen et al. 2019). The Finnish final exam for graduating SNs also includes items of students' wound care

competence (Silén-Lipponen 2019) that could enable national comparisons of students' wound care competence in the future. The final exams in certain countries also include an evaluation of students' practical skills (Mårtensson & Löfmark 2013).

According to the results (Paper II), students also self-evaluated their wound care competence as being low and claimed that they did not receive sufficient wound care education during their studies. The problem with self-evaluation is that students tend to grade their competence higher than would teachers. In addition, those who are less experienced usually assess their competence more optimistically than those who are more experienced (Ross 2006). A previous study conducted in Finland, showed that graduating SNs assessed their general competence higher than did their mentors during their final practical training period (Kajander-Unkuri et al. 2016). However, in this study, students' self-evaluations were mostly in line with the objective competence. This may be explained by the fact that the students first answered the knowledge test which could have helped them evaluate their knowledge. Students probably believed themselves to be either confident or uncertain when answering the knowledge test questions, helping them to evaluate their competence more truthfully. In addition, when they had an opportunity to say that they did not receive enough education relating to wounds during their studies, they could have demonstrated that they were unconfident, owing to the fact that they did not have a sufficient level of education.

Finally, as stated in the results (Paper II), those students, who had practiced more wound care during their practical training periods, received statistically significantly higher scores in the knowledge test. The variation in the training received may vary a lot because there are more patients with wounds in some placements than in the others. In Finland, students choose their practical training placements, using an internet-based software called *Jobiili* (previously JobStep). However, *Jobiili* works on a first come first served basis, meaning that not all students get the placement they hoped for, therefore, in the worst-case scenario, a student has not seen many real wounds, especially chronic wounds, during their studies. A lack of learning opportunities and direct experience among SNs during their practical training periods have also been pointed out in previous literature (Baraz et al. 2015, Egilsdottir et al. 2019). A solution for this could be student exchanges in hospitals and other clinical training placements which students could visit, for example, local wound centres or polyclinics.

According to the results of the instrumentation and evaluation phase (Paper III), the competence areas of RNs in relation to chronic wound care can be divided into competences such as anatomy and physiology, aetiology, care and prevention, and wound management and assessment. These competence areas cover both theoretical and practical competences in wound care. In addition, certain attitudes

and values can also be requested from nurses working with patients with wounds including attitudes and values surrounding wound care, wound prevention, EBP, holistic care, respect and economics.

According to the results concerning RNs' theoretical competence in wound care, nurses should know and understand the anatomy and physiology of the skin, circulation and wound healing process. The knowledge and understanding of the basics of the anatomy and physiology related to wounds, is crucial in wound management. If the caregiver does not understand, for example, the physiology of the circulation and differences in venous and arterial circulation, this can delay the wound healing and cause harm for the patient. An understanding of the circulation was highlighted among health care professionals because if a nurse does not recognize or react to potential problems in a patient's arterial perfusion, this may even lead to an amputation in the worst case (Marston et al. 2006). In addition, if the importance of compression therapy in VLU care is not understood, this may lead to delayed wound healing, causing prolonged suffering for the patients (O'Meara et al. 2012). Studies investigating RNs or SNs' competence in anatomy and physiology are scarce (Jensen et al. 2018) indicating that more research should be conducted to ascertain whether nurses' and SN's competence in human anatomy and physiology is at a sufficient level.

Alongside the sufficient knowledge on anatomy and physiology, RNs are also expected to have an understanding of the aetiologies of the most common chronic wounds and the basic principles of care and prevention of these wounds. The competence requirements in this area are closely related to the anatomy and physiology category and were also highlighted in the interviews. If a nurse does not understand the aetiology of the wound and the possible underlying causes of the delayed healing process, then wound care basically consists of changing the dressings. If the underlying cause is not treated, the wound might never heal (Atkin et al. 2019). For example, if the pressure is not relieved from the wound area, the wound will not get enough oxygen and nutrients needed for the healing process (IDF 2017, EPUPAP/NPIAP/PPPIA 2019). These basic care and prevention procedures create the foundation for chronic wound care, and there is up-to-date information in several international care guidelines and working group documents, supporting these interventions as part of an evidence-based wound care.

Competence in wound management and assessment consisted of multiple main and sub-categories related to the wound care situation according to the results (Paper III). This competence area covers the skills and knowledge required to perform evidence-based and high-quality wound care. The competence areas in this category could also be generalized to encompass the care of other chronic wounds, as well as acute wound care. Debridement and infections were highlighted among the health care professionals in this area. Correct debridement is important for

supporting re-epithelialization and preventing infections (Strohal et al. 2013). However, practicing wound debridement is difficult without real wounds, and the skills are usually learned through practice. Identification of an acute wound infection is also important because an infection can lead to sepsis or even death without the correct treatment (WHO 2020b). However, it is important to remember that there are always certain bacteria and other microbes on chronic wounds and unnecessary antibiotics may lead to bacterial resistance (Schultz et al. 2003). Along with debridement and infection control, a moist wound environment and management of the wound edge are important factors in wound bed preparation, as part of evidence-based wound care (Ligresti & Bo 2007).

The definition of competence in this dissertation includes also the values and attitudes. As reported in the results (Paper III), RNs are expected to have positive attitudes towards wound care and wound prevention as well as towards EBP. Registered nurses should also see the patient as a whole and respect patients' autonomy and privacy, as well as take into account the economics of care. Previous literature has suggested that nurses' attitudes towards wound care and wound prevention are somewhat controversial, as previously stated. Similar findings have also been found regarding nurses' attitudes towards EBP (Mehrdad et al. 2012, White-Williams et al. 2013, Stokke et al. 2014). Student nurses' attitudes towards EBP are suggested as being mostly positive but the lack of experience, support and gaps between theory and practice might hinder the implementation of new knowledge into practice (Ryan 2016).

Holistic wound care was highlighted in the results (Paper III). It is known that chronic wounds might limit patients' every-day lives and decrease their quality of life (e.g., Green et al. 2014, Phillips et al. 2018). In addition, a poor quality of life can lead to delayed wound healing (Finlayson et al. 2017). Wound care is not just changing the dressings; a holistic and person-centred wound care has been highlighted in the wound care literature (e.g., Lindsay et al. 2017, Smith & Sharp 2019, Gethin et al. 2020). In person-centred wound care, the patient is at the centre of the care, and this care is tailored to respond to the patient's needs in co-operation and in agreement with the patient. Holistic and person-centred care are related to the values of wound care, such as respect and dignity. Studies evaluating the effectiveness of patient-centred interventions in wound care, are scarce. However, patients' active involvement might lead to better outcomes and improved satisfaction in terms of care (Lindsay et al. 2017).

Finally, according to the second phase of the instrumentation and evaluation phase (Paper IV), the competence of graduating SNs in chronic wound care was statistically significantly lower compared with RNs. The difference between students' and professionals' competence was expected, as the recruited RNs were working with wounds and many of them had years of experience in wound care.

Previous studies comparing the wound care competence of SNs and RNs are limited. However, a few studies have compared SNs' PU knowledge compared to RNs' knowledge with controversial results (Beeckman et al. 2010a, Gunningberg et al. 2015). Comparing students' and professionals' competence may seem futile since professionals' competence is assumed to be higher. However, this kind of comparison can provide valuable information relating to the validity and sensitivity of the instrument (Kirkwood & Sterne 2003, p.430, Zwakhalen et al. 2006). In other words, this comparison aims to establish whether the instrument is able to segregate the less experienced from the more experienced.

In this study, a less used competence assessment method – observation with simulation – was used to measure SNs' practical competence in chronic wound care, with promising results. According to the literature review (summary), simulation has only been used in one previous study for SNs (Moura & Lercher Caliri 2013), where simulated situations were used to assess the PU risk assessment competence of SNs. A lack of studies using simulation as an assessment method, especially in wound care might be caused by the complexity of study procedures (Doolen et al. 2016). In addition, simulation is never a real situation (Krishnan et al. 2017), and it cannot provide a completely accurate account of one's competence. However, when using real equipment and actual situations in a realistic environment, it can provide information about an individual's skills and performance in a safe environment (WHO 2018) and it gives more information with regard to competence compared with subjective or self-evaluated competence (Ryall et al. 2016).

Furthermore, attitudes towards wound care among graduating SNs were also studied in the final sub-study (Paper IV). In this fourth sub-study, there were more items in the instrument to measure attitudes than in the second sub-study (Paper II), and the items were focused on chronic wound care. According to the results (Paper IV), SNs demonstrated primarily positive attitudes towards chronic wound care but their attitudes were less positive than those of RNs. The more positive attitudes of professionals can be explained by their working experience because professionals have a more realistic picture of actual wound care and wound prevention compared to students. Previous studies comparing the attitudes of SNs and RNs towards wound care are also limited. In the study by Beeckman et al. (2010b), similar results were found since RNs displayed more positive attitudes towards PU prevention than SNs. However, in the study by Florin et al. (2016), the attitude scores of RNs and SNs were equal in general. Comparisons of the results of this study with these two studies are not very reliable, because the two previous studies focused on PU prevention attitudes and the items in the C/WoundComp focused on chronic wound care in general. More studies on SNs' and RNs' attitudes towards wound care in general are needed. In addition, the instrument lacked the assessment of individual values in wound care even though the values belonged to the definition of competence used in

this study. The reason is that values are difficult to operationalize in general, as participants might fake socially desirable values in their answers (Van de Mortel 2008, Streiner et al. 2015, p.106-107). However, values guide attitudes (Albaraccin & Shavitt 2018) meaning that assessing one's attitudes can give an insight into one's values too.

Lastly, the developed C/WoundComp instrument was psychometrically tested to evaluate the validity, sensitivity and reliability of the instrument. The face- and content validity were evaluated before the psychometric testing, and were deemed acceptable, indicating that the instrument was suitable for psychometric testing. According to the psychometric testing, both construct and criterion validity were found to be at an acceptable level (DeVon et al. 2007), indicating that the instrument was able to measure its intended matter (Cook & Beckman 2006, Kimberlin & Winterstein 2008). In addition, the reliability tests showed acceptable internal consistency (Kimberlin & Winterstein 2008, Streiner et al. 2015, p.87) and an excellent inter-rater reliability with regard to the practical part of the instrument (McHugh 2012). However, the inter-item reliability of the instrument was too low (Ferketich 1991), indicating that certain modifications could be made to the instrument, especially to the knowledge test items in future to ensure that the items are not too easy or too demanding or unclear.

Finally, the instrument demonstrated sensitivity, as it was able to segregate the students and the professionals (Larson 1986). However, the cut-off scores for both the knowledge test and the simulation were relatively low according to the analysis, meaning that the cut-off scores could be set higher, for example, to the level of professionals' mean scores, avoiding false positive results (Azzarello 2003). In addition, some of the items were considered more important than others according to the expert panel, indicating that the items could be prioritized for future use to ensure that graduating nurses have sufficient competence in dealing with the most crucial issues. Furthermore, a difficulty analysis and a further discrimination validation could be conducted to assess the difficulty of the items among more and less competent participants (Streiner et al. 2015, p.275-276). In addition, the timeliness and accuracy of the items need to be checked before using the instrument in the future. Instrument development is a continuing process (Streiner & Kottner 2014) and this process will be continued.

6.2 Validity and reliability of the study

The validity and reliability of this study have been ensured throughout the research process from different aspects. In this section, the validity and reliability as well as the generalizability of the research in its two main phases and four sub-phases are discussed and critically appraised. The strengths, limitations and generalizations of

the study are gathered in Table 15. The more detailed validity and reliability discussions of each sub-study are presented in the original papers (I–IV).

In the first sub-study (Phase 1a, Paper I), the literature search was conducted systematically using five international electronic databases (Medline/PubMed, CINAHL, Cochrane Library, Web of Science, Scopus) which have been found to be comprehensive in health sciences (Subirana et al. 2005, Higgins et al. 2019) increasing the validity of the study. In addition, a national electronic data base called Medic was used to complete the literature retrieval, which increases the coverage of the literature review. Also, the literature search was updated in this summary in order to find more recent publications in this field. Finally, the quality of the reporting of previous studies was assessed, using the critical appraisal tool by Hawker et al. (2002) in order to find out how well the previous studies could be generalized and utilized in the sub-phases. The data (Data 1) were analysed using inductive content analysis in accordance with Elo and Kyngäs (2008). However, the literature retrieval process was conducted by a single researcher, which might decrease the validity of the literature review process (Higgins et al. 2019). In addition, publication languages were restricted to English and Finnish only.

In the second sub-study (Phase 2b, Paper II), the data (Data 2) were collected from five Finnish UAS using cluster and convenience sampling, which might decrease the validity and reliability of the study (Hammer et al. 2009) because the sampling was not randomized. However, the cluster sampling was found to be suitable because the sample represented five UAS in different cities and geographical areas in Finland, making the sample more heterogenous as it would have been, if the data had been collected in one area only. In addition, the data were collected during classes limiting the possibility of students searching for the correct answers to the knowledge test on the internet. However, part of the data was collected by the teachers, not by the researcher, meaning that some variation in the data collection methods might have existed (Grimes & Schulz 2002), if for example the data collector did not monitor the students and the students were trying to find the correct answers elsewhere. The estimated sample size was achieved, and the response rate was high, increasing the validity of the study (Nulty 2008). However, there were some missing data in the patient case. Finally, the general wound care competence assessment instrument was developed in this phase, including a face validity and a content validity evaluation by the wound care experts (DeVon et al. 2007), as well as the pilot testing of the instrument (Grove et al. 2013, p.46). Still, the instrument did not undergo a psychometric testing in this phase, decreasing the validity and reliability of the study. The data were analysed using both qualitative and statistical analysis. The qualitative analysis was conducted by the researcher using an inductive-deductive content analysis (Elo et al. 2014). The statistical analysis was conducted in co-operation with a statistician, increasing the validity and reliability

of the analysis and the results of the study. The data were collected in Finland only, limiting the possibilities to generalize the results to other countries. However, Finnish nursing education is based on the EU directive (2013/55/EU) demonstrating that the results could be utilized to some extent to other EU countries too.

In the third sub-study (Phase 2a, Paper III), the semi-structured focus-group interviews focused on chronic wounds, as the new version of the instrument was aimed at highlighting chronic wound care only, based on the previous competence gaps related to chronic wound care, and also minimizing the respondent burden. In addition, the number of people suffering from chronic wounds is increasing, highlighting the need for more focused competence assessment. In total, six interviews were carried out, four of which discussed the wound care competence areas of RNs. The participants of the interview groups represented different health care professions from various type of organizations, making the data (Data 3) more heterogenous, which increases the validity and reliability of the study, even though the focus-groups were relatively small (Jayasekara 2012). In addition, purposeful sampling of the study participants was used, which might decrease the validity and reliability of the study, although the sampling method is common in qualitative research designs, as qualitative studies focus more on understanding the phenomena rather than generalizing the results (Holloway & Wheeler 2010, p.138). The trustworthiness of the interviews was carried out by means of member checking, negative case searching, peer review and reflexivity (Holloway & Wheeler 2010, p.305-311). Furthermore, the data-analysis was conducted by a single researcher with the help of a qualitative analysis software NVivo. The use of NVivo might have increased the validity and reliability of the study, as the computer-based analysis, together with the qualitative analysis might bring more objectivity to the data analysing process (Leech & Onwuegbuzie 2011). The qualitative design and varying competence requirements in other countries limit the generalization of the results. However, the qualitative approach enabled a deeper understanding of the topic than would a quantitative design.

Finally, in the fourth sub-study (Phase 2b, Paper IV), all study participants took part in the theoretical competence assessment, but only some of them also participated in the practical competence assessment for practical and economic reasons. The study participants were recruited using a cluster sampling, which might decrease the validity and reliability of the study as the sample was not randomized (Hammer et al. 2009). However, the randomization would have been prohibitive in terms of economics and time allocation (Grove et al. 2013, p.360). In addition, the target sample was reached, and again, the study participants were recruited from various organizations, including two UAS and primary and specialized care units, making the sample more heterogenous. In addition, the majority of the data for the theoretical competence assessment, and the whole data for the practical competence

assessment, were collected by the researcher, increasing the validity and reliability of the study, as the data (Data 4) were collected in a similar way. The sample was not particularly large, and the groups varied in size, which may decrease the validity of the study, as the sample was small in terms of a dependable instrument examination. However, the sample represented both students and professionals, making competence comparisons possible in order to assess the sensitivity of the instrument (Streiner et al. 2015, p.268-259). The instrument development was conducted systematically, and the process was adapted from DeVellis (2017). The instrument went through face- and content validity testing (DeVon et al. 2007), pilot testing (Grove et al. 2013, p.46), and psychometric testing (Streiner et al. 2015, p.351-352). The psychometric testing of the C/WoundComp included the validity, reliability and sensitivity assessments of the instrument. The results of the psychometric testing were mainly acceptable, indicating proper construct validity, as the instrument was able to segregate the students and the professionals (Larson 1986). The internal consistency was also close to 1 (Kimberlin & Winterstein 2008) increasing the validity and reliability of the instrument. However, the inter-item correlations of the theoretical part of the instrument were not optimal (Ferketich 1991) decreasing the reliability of the instrument. That may be explained by the fact that certain knowledge test items were either too easy, too demanding or unclear. In addition, the cut-off scores calculated in accordance with Azzarello (2003) were relatively low (76% and 57%). However, the cut-off scores should be evaluated by professionals in future to avoid false positive results. Furthermore, the practical competence assessment was conducted using a simulated situation, which might decrease the validity and reliability of the study, as the situation was not real (Krishnan et al. 2017). On the other hand, simulation is a useful method for competence assessment and learning in a safe environment, and it enables the standardization of the situation (Ryall et al. 2016). In addition, a real situation would have not been possible for practical and ethical reasons. Furthermore, there was a congruence between participants' theoretical and practical competence, increasing the validity of the instrument. Finally, the data were analysed using statistical analysis and the analysis was conducted with co-operation between two statisticians, increasing the validity and reliability of the analysis process and thus the whole study. The same generalization limitations apply to this sub-study as was the case in the second sub-study. However, this study provided a multidimensional picture of individual competence as both theoretical and practical competences were assessed.

Table 15. Strengths, limitations and generalisations of the study

	Strengths	Limitations	Generalisation
Phase 1a	<ul style="list-style-type: none"> • Systematic literature retrieval • Six databases • Search updated 	<ul style="list-style-type: none"> • One researcher selected the studies • Language restrictions 	<ul style="list-style-type: none"> • Limited number of studies (-) • Poor to fair quality of original studies (-)
Phase 1b	<ul style="list-style-type: none"> • Heterogenous and sufficient sample • Observed data collection • Systematic instrument development • Analysis with a statistician • High response rate 	<ul style="list-style-type: none"> • Cross-sectional design • Cluster/convenience sampling • The instrument was not psychometrically tested • Many data collectors • Missing data in the patient case 	<ul style="list-style-type: none"> • Conducted in one country (-) • Finnish nursing education is based on the EU directive (+)
Phase 2a	<ul style="list-style-type: none"> • Experienced study participants • Different profession groups • Single researcher collected the data • Member checking, negative case searching, peer review, reflexivity • Systematic analysis with NVivo 	<ul style="list-style-type: none"> • Qualitative design • Purposeful sampling • Small sample size • New interview frame 	<ul style="list-style-type: none"> • Qualitative study, but deeper understanding (-/+) • Focus on chronic wound care (-) • Varying competence requirements internationally (-) • Finnish nursing education is based on the EU directive (+)
Phase 2b	<ul style="list-style-type: none"> • Heterogenous and diverse sample • Simulation data collected by a single researcher • Systematic instrument development process including psychometric testing • Analysis with statisticians 	<ul style="list-style-type: none"> • Descriptive, comparative methodological design • Cluster sampling • Small sample size, inequal groups • Low inter-item correlation • Simulated situation 	<ul style="list-style-type: none"> • Conducted in one country (-) • Finnish nursing education is based on the EU directive (+) • Multidimensional picture of one's competence (+)

- = Generalisation restrictions, + = generalisation advantages

6.3 Suggestions for further research

According to the results of this study, the following suggestions for further research are proposed (Table 16). Wound care requires multi-professional teamwork (Moore et al. 2014), meaning that the wound care competence of graduating SNs as well as other health care students and professionals should be studied in future, including both chronic and acute wound care perspectives. As stated in the definition of wound care, wound care is constantly developing, and new evidence and treatment methods are being provided (Piaggese et al. 2018, Öhnstedt et al. 2019), indicating that the competence of health care professionals should be regularly assessed with validated instruments. In addition, the identification of general competence requirements and learning goals for nursing education could be implemented, as well as educational interventions aiming to improve the wound care competence of students and health care professionals. Furthermore, the developed C/WoundComp instrument could be developed and tested more frequently to include further validity, reliability and sensitivity testing as well as further cut-off point calculations, as no individual study can ever prove the reliability or validity of an instrument (Streiner & Kottner 2014). The instrument should also be updated if new evidence is being generated, and the instrument could be translated and validated in other languages and cultures, ensuring its wider use.

6.4 Practical implications

According to the results of this study, the following practical implications for nursing education, clinical practice and nursing administration can be outlined (Table 17). In nursing education, the information received in relation to students' wound care competence could be used to develop and standardize wound care education for bachelor level studies. A national wound care curriculum could be formulated to ensure that wound care education is provided consistently at the Finnish UAS and covers the required competence areas in wound care. In addition, the developed C/WoundComp instrument should be tested more to increase its validity, and in the future, it could perhaps be used in a competence assessment for SNs at graduation stage, as part of the national final exams. The wound care competence areas could also be utilized in postgraduate nursing education or for specialist education in wound care. Furthermore, the developed wound care simulation presented in Paper IV could be included as part of the wound care education, not just as a competence assessment, but also to improve students' clinical competence (e.g., Lejonqvist et al. 2016) and their psychomotor skills (e.g., Shin et al. 2015) in wound care. The simulation could also be carried out as a means of providing multi-professional

wound care education for SPs, for example. Finally, students could be invited to visit local wound centres and wound wards during their practical training periods to practice wound care.

Table 16. Suggestions for further research

Wound care competence assessment
<ul style="list-style-type: none">• International assessment of the theoretical and practical wound care competence of graduating SNs, including both chronic and acute wound care competencies• Assessment of the wound care competence of other graduating health care students, such as graduating practical nurses or assistant nurses• Assessment of the wound care competence of different health care professionals
Wound care education
<ul style="list-style-type: none">• Identification and implementation of competence areas in acute wound care for RNs• Development and implementation of general competence requirements and learning goals for nursing education at bachelor level• Implementation of wound care simulations in nursing education to increase students' practical competence in wound care
Educational interventions
<ul style="list-style-type: none">• Development and implementation of educational interventions to increase the wound care competence of graduating SNs• Development and implementation of educational interventions for health care professionals caring for patients with wounds• Development of multi-professional, wound care education interventions
Further development and implementation of the C/WoundComp
<ul style="list-style-type: none">• Full instrument validation of the C/WoundComp with a larger sample• Translation and validation of the C/WoundComp to other languages and cultures• Inclusion of acute wound care competence assessment (future A/WoundComp) in the C/WoundComp instrument• Development and testing of the wound care simulation for other types of wounds

In clinical practice, the results of this study could be used in hospitals and other health care units as part of a professional's competence assessment and in bedside wound care education. Registered nurses and podiatrists could, for example, use the C/WoundComp instrument as a checklist tool to assess their own competence and practices in wound care. The instrument and the competence areas developed in this

study could also help the health care professionals recognize their competence gaps and educational needs, as the health care professionals in Finland are responsible for their own professional development (Health Care Professionals Act 559/1994).

Finally, from the nursing administration perspective, the results of this study could be used to help employers and managers allocate educational resources to those employees who need the education most, for example, for newly graduated employees or new employees who have not been working recently with patients with wounds. The health care employers are also required to audit their employees' professional development (Health Care Act 1326/2010), therefore, the C/WoundComp instrument could be used in development discussions at units where wound care is part of everyday nursing care. In addition, the managers could also arrange time and equipment for employees to practice their wound care skills in a safe, simulated setting.

Table 17. Practical implications

Nursing education

- Formulation of a national wound care curriculum
- Further development and testing of the C/WoundComp, and its possible future implementation in the national final exams of nursing education
- Development of postgraduate wound care education module
- Development of ready-to-use simulated patient case for wound care education
- Implementation of multi-professional wound care education
- "Student exchanges" during practical trainings to wound centres or wards

Clinical practice

- Application of the C/WoundComp in the competence assessment for professionals
- Use of the C/WoundComp as a competence checklist
- Implementation of the wound care competence areas to encompass bedside wound care education at health care units

Nursing administration

- The use of C/WoundComp in educational resource allocations
- The application of the C/WoundComp in employees' wound care competence audits
- The use of the C/WoundComp in development discussions
- The use of simulation in professional development and training

7 Conclusions

This study provided new knowledge in three areas: i) wound care competence of graduating SNs, ii) competence areas for RNs providing chronic wound care and iii) instrument development for the chronic wound care competence assessment of graduating SNs. This study also presented different methods of assessing individual competence and provided new knowledge in relation to the wound care competence of graduating SPs as well as RNs and podiatrists.

The main competence areas in the reality where graduating SNs enter after graduation were identified as competencies in anatomy and physiology; aetiology, care and prevention; and wound management and assessment. The competence areas also included certain attitudes and values relating to chronic wound care and patients with chronic wounds. The instrument developed for the assessment of chronic wound care competence was constructed based on these competence areas and named as the *C/WoundComp*. The instrument demonstrated preliminary validity and reliability in psychometric testing, but further testing is needed. The results of this study indicated that the theoretical and practical wound care competence of graduating SNs was limited, but the students showed positive attitudes towards wound care. In addition, students stated that they were provided with too little wound care education during their studies.

This study concludes that if things are described, they can be identified, and if things are measured, they can be changed. The results of this study highlight the reality that more wound care education, together with varying teaching and learning methods are needed in nursing education. With comprehensive wound care education, the competence of future health care professionals and the quality of care can be ensured, because time does not necessarily heal all wounds, care does.

Acknowledgements

This dissertation was conducted at the University of Turku, Department of Nursing Science. During this research process, I received help and encouragement from many people, and I would like to express my profound gratitude to all of them, even though I cannot name them all by their names here.

I wish to express my deepest gratitude to my excellent supervisors PhD, Docent Minna Stolt and PhD, Professor Riitta Suhonen. They helped me during these years by supporting my ideas and giving me valuable knowledge and recommendations to make this dissertation and its sub-studies better. Their knowledge of the research process and methods have been indispensable, and they were always available and willing to help and support me. I would also like to give my deepest gratitude to my follow-up committee member PhD, Professor Leena Salminen, who has been helping me from the beginning of this journey. Her pedagogical knowledge and expertise have been valuable to me during this process.

I want to thank my statistical experts Pauli Puukka, Terhi Kolari and Jouko Katajisto. They helped me with the statistical analysis and gave their best opinions as experts in their field. Furthermore, I would like to thank all professors and teachers at the Department of Nursing Science who have taught me and supported me during my studies. I would also like to thank my official reviewers PhD, Docent Tarja Välimäki from the University of Eastern Finland and PhD, Professor Christa Lohrmann from the Medical University of Graz for their valuable feedback.

I wish to express my gratitude to all others who have been helping me with this study. I would like to thank all the experts in the wound care field who commented on my instruments and helped me to make them better. I would also like to give my special thanks to RN, authorized wound care nurse Maarit Ahtiala of her expertise in wound care and RN, authorized wound care nurse Leena Jalonen who supported me with practical arrangements. I would also give my deepest gratitude to all those who participated in my study in its different phases and made this study possible. Also, I want to thank all the persons in charge of the organisations who helped me to recruit the study participants.

I want to thank my fellow workers and study mates at the Department of Nursing Science. I would like to thank all PhD candidates in my seminar group who

supported me and gave excellent comments to make my research better. I would like to thank also my room-mates Sunna Rannikko and Johanna Wiisak of their help and support when I was working at the department. I would also like to give my special thanks to all my wonderful co-workers at Arcada University of Applied sciences who gave me a lot of support and understanding during these years.

I also want to thank my family and friends. My deepest thanks go to my beloved husband Jaakko, who has been indispensable support to me. He has helped me a lot during this process, encouraged me to believe in myself, and celebrated my achievements with me. Without him, I probably would not have become a wound care researcher in the first place. I would also like to thank my parents Tiina and Timo, my sister Esteriina and brother Eetu, and my grandparents Seija and Jussi of their support. I would also like to thank all my friends supporting me during this process, especially my old course mates and now colleagues Johanna Nieminen and Sanna Kitula of our therapy sessions with coffee and cake.

This study was funded by the Doctoral Programme in Nursing Science at the University of Turku, Finnish Wound Care Society, The Finnish Nursing Education Foundation, The Finnish Nurses Association, Turku University Foundation and The Finnish Vascular Nurse Society, all of which are gratefully acknowledged.

Turku, 7. December
Emilia Kielo-Viljamaa

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Appendices

Appendix 1. Original studies assessing the wound care competence of graduating student nurses (Partially adapted from paper 1)

Authors, Country and Year	Purpose	Design and participants	Instrument or other evaluation method	Main findings
Beeckman et al. Belgium 2008	To detect problems when classifying a PU and to examine whether an e-learning programme can increase the classification skills of qualified nurses and SNs.	An intervention study with a repeated measure design (pre-test and 3 post-tests) N = 212 nurses and 214 final-year SNs	Photographs of pressure ulcers	The PU classification skills were low in both groups in the pre-test. SNs achieved better results when using the e-learning programme. Still, their skills did not become optimal.
Beeckman et al. Belgium 2010a	To develop a valid and reliable instrument to assess knowledge of PU prevention.	A prospective psychometric instrument validation study N = 608 of whom 296 were SNs, and of whom 99 were third-year SNs	Knowledge test: A 26-item instrument with 6 themes (PUKAT)	The third-year SNs' mean score of the PU knowledge test was 12.3/26.
Cullen Gill & Moore Ireland 2013	To determine fourth-year undergraduate SNs' knowledge of and attitudes towards PU prevention.	A quantitative cross-sectional survey N = 46 fourth-year undergraduate SNs	Knowledge test: The Pressure Ulcer Attitude and Knowledge Tool	SNs showed a positive attitude towards PU prevention. The mean score was 40/47 and 59% achieved a score greater than 40. However, students displayed poor knowledge of PU prevention. The mean score was 15/26 and 92% scored less than 18. Inverse relationship between attitude and knowledge scores.

<p>Florin et al. Sweden 2016</p>	<p>To conduct a psychometric evaluation of the APuP instrument in a Swedish context, and to describe and compare attitudes towards PU prevention between RNs assistant nurses and SNs.</p>	<p>An instrument validation study N = 196 of whom 122 last-semester SNs</p>	<p>Attitude assessment instrument: Attitude towards Pressure ulcer Prevention (APuP)</p>	<p>SNs' mean PU attitude score was 46/52. SNs had lower confidence in PU prevention than registered and assistant nurses. SNs also rated their own training to be less rigorous and they found PU prevention to be too difficult. SNs also thought that they had a more important task in PU prevention than registered and assistant nurses.</p>
<p>Garrigues et al. USA 2017</p>	<p>To examine the attitudes of baccalaureate SNs toward their role in PU prevention and describe how clinical experiences influence their attitudes.</p>	<p>Qualitative exploratory descriptive study N = 16 senior SNs</p>	<p>Interviewing: Semi-structured, in-depth, open-ended interviews</p>	<p>Following categories were found: ambivalence, emerging awareness, committed, and passionate. Students had diverse experiences and attitudes towards PU prevention.</p>
<p>Gunningberg et al. Sweden 2015</p>	<p>To describe and compare the knowledge of RNs, assistant nurses and SNs about preventing PUs.</p>	<p>A descriptive, comparative multicenter study N = 415 of whom 122 last-semester SNs</p>	<p>Knowledge test: The Pressure Ulcer Knowledge Assessment Tool (PUKAT)</p>	<p>SNs' mean knowledge score was 61%. The highest scores were in nutrition (92%) and risk assessment (80%). The lowest scores were in reduction in the amount of pressure and shear (49%) and classification and observation (54%).</p>
<p>Larcher Caliri et al. Brazil 2003</p>	<p>To examine Brazilian SNs' knowledge of PUs.</p>	<p>A quantitative study design N = 83 third- or fourth year SNs</p>	<p>Knowledge test: The Pressure Ulcer Knowledge Test (PUKT)</p>	<p>SNs answered correctly to 68% of the knowledge test items. Students who participated in extracurricular activities and used the internet had a significantly higher knowledge level.</p>
<p>Moura & Larcher Caliri Brazil</p>	<p>To analyse the perception of undergraduate SNs of simulation</p>	<p>A descriptive study with qualitative analysis</p>	<p>Interviewing: Focus group discussions with</p>	<p>Students evaluated that they did not apply the presupposed policy</p>

2013	strategies in the teaching-learning process in order to develop competence in risk assessment for PUs.	N = 29 final-year SNs	semi-structured questions	or practices of risk assessment for PUs.
Ousey et al. UK 2013	To explore if pre-registration SNs felt prepared to manage patients' skin integrity effectively on registration.	A quantitative study design with qualitative comments N = 217 pre-registration SNs	Self-evaluation: 10 questions relating to SNs' experience of learning about managing patient's skin integrity needs plus qualitative comments	70% reported that the teaching they received had developed their knowledge and skills to maintain skin integrity for all patients. Most respondents were confident in undertaking the majority of wound care procedures.
Rafiei et al. Iran 2015	To determine the level of SN' knowledge of PU prevention, classification and management.	A cross-sectional descriptive study N = 133 final-year SNs	Knowledge test: (PUKT)	Students answered correctly to 67% of the knowledge test items. Students answered correctly to 50% of the items in the classification/onset section, 78% in PU evaluation and 70% in PU prevention.
Redmond et al. Ireland 2018	To evaluate the educational attributes of the wound care Reusable Learning Objects (RLOs) with third year undergraduate SNs to identify their perceived learning gains in terms of knowledge, performance and attitudes.	Pre-test/post-test cross-sectional survey N = 192 third year SNs	Self-evaluation: 33 item Wound Care Competency Outcomes questionnaire	Students evaluated their ability better in all items in the post-test. The highest change scores were in students' ability to recognize if a wound is infected, to follow infection control policy during wound care, and their ability to assess and treat pain experienced during wound care.
Simonetti et al. Italy 2015	To assess both knowledge and attitudes among SNs on PU prevention evidence-based guidelines.	A multi-center cross-sectional survey N = 742 SNs of whom 191 were third-year students	Knowledge test: PUKAT and attitude assessment instrument: APuP	Third-year SNs' mean PU knowledge score was 14.7/26 (56.5%) and PU attitude score was 41.1/52 (79%). Third-year students' PU knowledge and attitudes towards PUs were significantly higher than first- and second-year students.

<p>Snarska et al. Poland 2005</p>	<p>To assess PU prevention knowledge among SNs and to determine the factors on which their level of knowledge depend.</p>	<p>A quantitative study design N = 50 third-year part-time SNs</p>	<p>Self-evaluation: 37 open questions</p>	<p>SNs' PU prevention knowledge was insufficient. Students knew the main causes of PUs better, but they knew less about the factors related to the patient's state that could cause PUs. 54% of the students evaluated their PU prevention knowledge to be insufficient.</p>
<p>Stephen-Haynes UK 2013</p>	<p>To generate a clearer insight into pre-registration SNs knowledge of the key aspects within tissue viability and capture their views on preregistration tissue viability education.</p>	<p>A quantitative study design N = 170 pre-registration SNs</p>	<p>Self-evaluation: Interactive voting pads at a conference</p>	<p>84% of SNs felt that they were not well prepared in tissue viability and 83% indicated that they did not receive sufficient education in skin anatomy and physiology. 83% of the students believed that they could undertake PU risk assessment.</p>
<p>Van Hecke et al. Belgium 2011</p>	<p>To develop and test the psychometric properties of an instrument to assess VLU lifestyle knowledge.</p>	<p>Instrument development study and psychometric testing N = 350 of whom 240 third year SNs</p>	<p>Knowledge test: 19 item leg ulcer advise instrument</p>	<p>SNs' mean score was 32% in the knowledge test.</p>

Appendix 2. Studies and documents of wound care competence requirements and areas for registered nurses and podiatrists

Authors, Country and Year	Purpose	Design and methods	Main findings
Coleman et al. UK 2017	To establish a generic wound assessment minimum data set to underpin clinical practice.	Literature review and a structured consensus study. N=24 papers / N=17 wound care experts	68 potential assessment items were identified through literature search. Experts agreed that 37 of them should be included in the minimum data set including general health information, wound history/baseline information, wound assessment parameters, wound symptoms, infection, and specialist information.
Cowman et al. Ireland 2012	To incorporate an international and multidisciplinary consensus in the determination of the research and education priorities for wound healing and tissue repair.	Four-round e-Delphi method from 24 countries. N=360 health care professionals	The top educational priorities were: 1) the standardization of all foundation education programmes in wound care, 2) the inclusion of wound care in all professional undergraduate and postgraduate education programmes, 3) selecting dressings, and 4) the prevention of PUs. The top research priorities were: 1) the dressing selection, 2) PU prevention, and 3) wound infection.
Pokorná et al. Czech Republic, UK, Austria, Germany 2017	To support a common approach to post-registration qualification in wound management for nurses across Europe.	Expert working group document/guideline	The curriculum is divided into 16 units: role and prevention in wound care; EBP; patient education and promoting self-care; case management; wounds and wound healing; nutrition and wound healing; microbiology and wounds; antimicrobial agents, hygiene and wounds; debridement and wounds; moist wound healing; alternative treatment options for wounds; PUs; diabetic foot syndrome; lower leg ulcers; health-care delivery and health economics; and documentation.
Redmond et al. Ireland 2016	To develop an educational package for undergraduate SNs that would provide them with the theoretical	Discursive study. Development of an educational package with wound care experts using	The educational package includes lectures on the general physiology of wound healing, the pathophysiology of chronic wounds, the assessment and

	knowledge and clinical judgement skills to care for a patient with a wound.	constructivism learning theory.	management of chronic wounds including pair working. The education also includes demonstration of use of negative pressure dressings and profore dressings, and sessions of the psychosocial aspects of caring for a patient with a wound.
TRIEPoD-UK UK 2012	To produce a competency framework for the advanced level of diabetic foot care.	Expert working group document/guideline using consultation process	The framework includes competences in DFU care for podiatrists. A qualified podiatrist should be competent for example in recognition and classification of active foot ulceration, in debridement and wound bed management, offloading and dressing selection. A qualified podiatrist should also understand psychosocial impacts of active foot ulcer on the patient and understand the healing process of the wound and control infections etc.
Van Acker et al. Belgium, US, Ireland, Kuwait, UK, Spain, Romania 2018	To assist clinicians by pointing them in the direction in which they need to develop services in diabetic foot care.	Expert working group document/guideline	The document includes knowledge, skills and behaviors in wound care which includes for example knowledge of DFU and infections, skills in dressing changing and pressure relieving devises and debridement etc.

Appendix 3. Critical appraisal of the previous literature (Hawker et al. 2002) (Partially adapted from paper I)

Study	1	2	3	4	5	6	7	8	9	Total (36)
	Abstract and title	Introduction and aims	Method and data	Sampling	Data analysis	Ethics and bias	Results	Transferability and generalizability	Implications and usefulness	
Beeckman et al. 2008	4	3	4	3	3	1	3	3	3	27
Beeckman et al. 2010a	4	3	3	2	2	3	4	2	4	27
Cullen Gill & Moore 2013	4	3	4	2	2	2	4	2	3	26
Florin et al. 2016	3	4	4	3	4	3	4	3	4	32
Garrigues et al. 2017	4	3	4	2	4	3	4	2	3	29
Gunningberg et al. 2015	4	3	3	2	3	2	3	2	4	26
Larcher Caliri et al. 2003	3	3	3	4	2	2	3	3	3	26
Moura & Larcher Caliri 2013	3	2	2	2	3	2	2	2	1	19
Ousey et al. 2013	3	3	2	3	2	2	3	3	2	23
Rafiei et al. 2015	4	2	3	2	2	2	3	2	3	23
Redmond et al. 2018	4	3	4	2	3	2	4	2	2	26
Simonetti et al. 2015	4	3	4	3	3	2	4	3	3	29

Snarska et al. 2005	2	2	2	2	1	1	2	2	2	16
Stephen-Haynes et al. 2013	2	4	4	3	2	2	3	4	3	27
Van Hecke et al. 2011	4	4	3	3	4	2	4	1	3	28
Average scores	3.5	3	3.3	2.5	2.7	2.1	3.3	2.4	2.9	26
Coleman et al. 2017	4	3	3	2	3	2	4	2	4	27
Cowman et al. 2012	4	3	3	2	3	2	3	2	3	25
Pokorná et al. 2017*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-
Redmond et al. 2016	4	3	2	2	2	1	3	1	3	21
TRIEPoD-UK 2012*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-
Van Acker et al. 2018*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-
Average scores	4	4	2.7	2	2.7	1.7	3.3	1.7	3.3	24

*not a research paper

Appendix 4. Semi-structured interview frame used in focus-group interviews (Adapted from paper III)

Knowledge	What should registered nurses/podiatrists know about wounds in general? Chronic leg ulcers (venous, arterial, diabetic foot ulcers) Pressure ulcers Wound healing process
Performance	What should registered nurses/podiatrists know about wound management? Wound care products Asepsis and environment Cleansing and debridement Pain management
Skills	How should registered nurses/podiatrists care for wounds? Open wounds Documentation Infections Circulation Nutrition
Values	How should registered nurses/podiatrists act when caring wounds? Ethics in wound care Holistic care
Attitudes	How should registered nurses/podiatrists deal with wounds and patients with wounds? Attitudes towards wound care and prevention

Appendix 5. Equipment used in the wound care simulation (Pictures of the equipment in the Picture 1, page 54, according to the superscripts)

Equipment

Hand sanitiser¹

Gloves¹

Aprons¹

Masks¹

Scissors²

Curettes²

Scalpel²

Pincers²

Saline (NaCl 0,9%)³

Wound gel and cleaning solution (Prontosan®)³

Hydrogen peroxide³

Barrier film (Cavilon®)³

Local anaesthetic (Xylocain®)³

Cotton swabs⁴

Pain scale⁴

Bacterial swabs⁴

Wound size measuring rulers⁴

Wound model⁵

Protective barrier⁵

Tape⁶

Felt pad⁶

Wound dressings and products⁶:

- Hydrophobic gauze (Sorbact®)
- Medical honey (MediHoney®)
- Silver dressings (Aquacel Ag®)
- Hydrocolloid dressings (Aquacel®)
- Foam dressings (adherent and non-adherent) (Mepilex Border Lite®, Kendall®, Mesorb®, Sorbact®)
- Fabric tape (Mefix®)



**UNIVERSITY
OF TURKU**

ISBN 978-951-29-8329-2 (PRINT)
ISBN 978-951-29-8330-8 (PDF)
ISSN 0355-9483 (Print)
ISSN 2343-3213 (Online)