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DEVELOPMENT OF CONTINUING EDUCATION TO SUPPORT EVIDENCE BASED NURSING CARE OF PATIENTS WITH VENOUS LEG ULCERS

Minna Ylönen



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To my family

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MINNA YLÖNEN: Development of Continuing Education to Support

Evidence Based Nursing Care of Patients with Venous Leg Ulcers

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ABSTRACT

Venous leg ulcers (VLUs) have extensive impact for patients and cause economic costs to healthcare, and the prevalence of VLUs is increasing as the population ages. Nursing care of a patient with VLU is complex requiring comprehensive knowledge of the patient's unique situation. VLU can persist over a long time and patients report difficulties in living with VLU.

The aim of this two-phase study (2012 - 2014) was to develop an internet-based continuing education (CE) to support evidence-based practice (EBP) in VLU nursing care in home health care (HHC) and to evaluate its' effectiveness. In Phase I integrative literature review was used to collect data about nurses' knowledge of VLU nursing care. In Phases IIa and b knowledge tests, and nurses' CE were firstly reviewed. In Phase IIa instruments to evaluate the effectiveness of CE were developed. In Phase IIb an internet-based learning program of evidence-based VLU nursing care (eVLU) was developed and in Phase IIc it was implemented in a quasi-experimental design. Cognitive, clinical and economic outcomes were evaluated three times during the study.

Gaps in VLU nursing care were identified in nurses' knowledge and skills in VLU pathophysiology and etiology, assessment, healing process, infection, topical care and compression treatment. eVLU had a positive effect on nurses' cognitive outcomes. Nurses' perceived and theoretical knowledge increased as did congruence between them. The effect on clinical and economic outcomes could not be statistically evaluated due to low number of participants.

The results of this study suggest that eVLU has potential in improving EBP in VLU nursing care. Further studies are needed to determine whether the effects can be produced in diverse nursing care environments. In addition, the clinical and economic outcomes need to be studied further.

The maintenance of EBP in VLU nursing care requires continuous effort from nurses and nursing managers. This includes awareness of existing gaps in knowledge and skills. Utilizing eVLU can be one option for them to ensure EBP in VLU nursing care.

KEYWORDS: Venous leg ulcer, Home health care, Nursing care, Continuing education, Internet-based education

TURUN YLIOPISTO

Lääketieteellinen tiedekunta

Hoitotiede

MINNA YLÖNEN: Terveysongelmana laskimohaava – Näyttöön perustuvan hoitotyön kehittäminen täydennyskoulutuksen avulla

Väitöskirja, 217 s.

Elokuu 2020

TIIVISTELMÄ

Laskimohaava aiheuttaa monenlaisia ongelmia potilaalle ja merkittäviä kustannuksia terveydenhuollolle. Se on yleensä pitkäaikainen terveysongelma, joka aiheuttaa potilaalle sosiaalisen elämän ongelmia ja elämänlaadun heikkenemistä.

Tämän kaksivaiheisen tutkimuksen (2012–2014) tavoitteena oli kehittää internet-perustainen täydennyskoulutus (eVLU), jonka avulla voidaan tukea näyttöön perustuvaa toimintaa (NPT) laskimohaavan hoidossa kotihoidossa. Lisäksi tavoitteena oli arvioida koulutuksen vaikuttavuutta. Tutkimuksen ensimmäisessä vaiheessa kartoitettiin kirjallisuuskatsauksen avulla hoitajien tietoja laskimohaavan hoidosta. Toisessa vaiheessa kirjallisuuskatsauksen avulla selvitettiin hoitajien tietotestejä ja täydennyskoulutuksia. Saadun tiedon avulla kehitettiin internet-perustainen täydennyskoulutusohjelma laskimohaavan hoidosta (eVLU), jonka vaikuttavuutta testattiin kvasikokeellisessa asetelmassa tutkimuksen viimeisessä vaiheessa. eVLU:n kognitiivisia, kliinisiä ja taloudellisia vaikutuksia arvioitiin kolme kertaa tutkimuksen aikana.

Kirjallisuuskatsauksen perusteella hoitajilla on puutteita sekä laskimohaavaan liittyvissä tiedoissa että taidoissa. Nämä liittyivät laskimohaavan patofysiologiaan ja etiologiaan, arviointiin, paranemisprosessiin, infektiin, paikallishoitoon ja kompressiohoitoon. eVLU paransi hoitajien kognitiivisia tuloksia. Heidän itsearvioitu ja todellinen tietonsa lisääntyivät, samoin niiden välinen yhdenmukaisuus. Vaikutuksia kliinisiin ja taloudellisiin tuloksiin ei pystytty arvioimaan tilastollisesti vähäisen osallistujamäärän takia. Tulosten perusteella eVLU on potentiaalinen vaihtoehto kehitettäessä laskimohaavan NPT:aa. Jatkotutkimuksissa tulisi arvioida sen vaikutuksia erilaisissa hoitoympäristöissä. Lisäksi tulisi arvioida kliinisiä ja taloudellisia vaikutuksia.

NPT:n ylläpitäminen vaatii sekä hoitajilta että hoitotyön johtajilta jatkuvaa panostusta. Tähän sisältyy tietoisuus olemassa olevista tiedon ja taidon puutteista. eVLU on yksi hyödynnettävä vaihtoehto NPT:n tukemisessa.

AVAINSANAT: Laskimohaava, Kotisairaanhoito, Hoitotyö, Täydennyskoulutus, Internet-pohjainen koulutus

Table of Contents

List of figures and tables	8
List of Original Publications	12
1 Introduction	13
2 Review of the Literature	17
2.1 Literature reviews	17
2.2 Evidence-based venous leg ulcer nursing care in home health care	20
2.3 Evidence-based guidelines in VLU nursing care	23
2.4 Evidence-based education in VLU nursing care	27
2.5 Knowledge tests in evaluating nurses' knowledge	29
2.6 Nurses' continuing education and its outcomes	30
2.6.1 Cognitive outcomes	42
2.6.2 Clinical outcomes	45
2.6.3 Economic outcomes	48
2.7 Summary of the literature review	51
3 Aims and research questions	52
4 Materials and Methods	53
4.1 Study design, setting, sampling and samples	54
4.2 The eVLU intervention and its implementation	63
4.3 Data collection instruments and procedures	73
4.4 Data analysis	85
4.5 Ethical considerations	90
5 Results	94
5.1 Nurses' knowledge about VLU nursing care	94
5.2 Nurses' continuing education and its' outcomes	94
5.3 Results from empirical study	95
5.3.1 Description of study participants	95
5.3.2 Use of eVLU by nurses	96
5.3.3 The outcomes of eVLU	99
5.3.3.1 Cognitive outcomes of eVLU	99
5.3.3.2 Clinical outcomes of eVLU	117
5.3.3.3 Economic outcomes of eVLU	121
5.4 Summary of the main results of the study	122

6	Discussion	125
6.1	Discussion of the results.....	125
6.2	Feasibility of eVLU	128
6.3	Validity and reliability of the study.....	131
6.3.1	Validity and reliability of the intervention.....	131
6.3.2	Validity and reliability of the instruments.....	133
6.3.3	Validity and reliability of data-collection	135
6.3.4	Validity and reliability of the results.....	138
6.4	Implications for future research	139
6.5	Implications for clinical practice	140
6.6	Implications for nursing management.....	142
7	Conclusions.....	143
	Acknowledgements	144
	References	146
	Original Publications	165

List of figures and tables

Figures

Figure 1.	Study phases	16
Figure 2.	Materials and methods of the study.....	53
Figure 3.	Participant flowchart through the study.....	58
Figure 4.	Participant flowchart through the observations	61
Figure 5.	The instructions in eVLU	65
Figure 6.	The eVLU case-description	66
Figure 7.	An example of the purpose and goals of the second week in eVLU	71
Figure 8.	Data collection	75
Figure 9.	Nurses' individual loggings into the eVLU (n) for six weeks eVLU.....	96
Figure 10.	Means of perceived knowledge in pathophysiology and etiology	102
Figure 11.	Means of theoretical knowledge in pathophysiology and etiology	102
Figure 12.	Percentages of answers on perceived knowledge in pathophysiology and etiology	103
Figure 13.	The percentages of answers on theoretical knowledge in pathophysiology and etiology	104
Figure 14.	Means of perceived knowledge in assessment	104
Figure 15.	Means of theoretical knowledge in assessment	105
Figure 16.	Percentages of answers on perceived knowledge in assessment.....	105
Figure 17.	Percentages of answers on theoretical knowledge in assessment.....	106
Figure 18.	Means of perceived knowledge in healing.....	106
Figure 19.	Means of theoretical knowledge in healing	107
Figure 20.	Percentages of answers on perceived knowledge in healing	107
Figure 21.	Percentages of answers on theoretical knowledge in healing	108
Figure 22.	Means of perceived knowledge in infection	108
Figure 23.	Means in theoretical knowledge in infection	109
Figure 24.	Percentages of answers on perceived knowledge in infection	109
Figure 25.	Percentages of answers on theoretical knowledge in infection	110
Figure 26.	Means of perceived knowledge in topical care	110
Figure 27.	Means of theoretical knowledge in topical care	111

Figure 28.	Percentages of answers on perceived knowledge in topical care.....	111
Figure 29.	Percentages of answers on theoretical knowledge in topical care.....	112
Figure 30.	Means of perceived knowledge in compression	112
Figure 31.	Means of theoretical knowledge in compression	113
Figure 32.	Percentages of answers on perceived knowledge in compression.....	113
Figure 33.	Percentages of answers on theoretical knowledge in compression.....	114
Figure 34a.	Comparison of the percentages of answers on perceived and theoretical knowledge during each measurement point	115
Figure 34b.	Comparison of the percentages of answers on perceived and theoretical knowledge during each measurement point	116
Figure 35.	Means of the answers on attitudes	117
Figure 36.	Summary of the main results	124

Tables

Table 1.	Literature reviews	19
Table 2.	International, national and regional level evidence-based guidelines in VLU nursing care	24
Table 3.	Examples of international, national and regional level of evidence-based VLU nursing care education	28
Table 4.	Knowledge tests developed for evaluation of nurses' knowledge.....	29
Table 5.	Studies about nurses' CE in wound care in the order of time	32
Table 6.	Studies about nurses' CE	38
Table 7.	Summary of the definitions and operationalization of the concepts.....	50
Table 8.	Study designs, samples and sampling methods	55
Table 9.	Recruitment of the participants and meetings with the nurses	56
Table 10.	Demographics of the nurses.....	59
Table 11.	Attrition rates of the nurses.....	59
Table 12.	Demographics of the nurses in the observations	62
Table 13.	Demographics and clinical situation (PCS) of the patients in the observations	62
Table 14.	The eVLU content; themes and materials.....	67
Table 15.	The eVLU themes, purposes and weekly tasks	70
Table 16.	Nurses' feedback on eVLU in pilot test.....	72
Table 17.	Background variables and instruments in the study Phase IIc	74
Table 18.	Ulcer characteristics; clinical evaluation of the ulcer in the leg	77
Table 19.	Outcome variables and instruments used in study Phase IIc	78
Table 20.	Knowledge test development-process	80

Table 21.	Frequency of right and wrong response options in the knowledge test.....	82
Table 22.	The structure of the observation checklist	84
Table 23.	Data analysis methods	89
Table 24.	Permissions to use the instruments and materials.....	91
Table 25.	Variation of eVLU weeks logged by individual nurse	97
Table 26.	Number of nurses who logged into eVLU according to HHC districts	98
Table 27.	Number of returned answers weekly	98
Table 28.	Changes in nurses' perceived knowledge and attitudes	101
Table 29.	Changes in nurses' theoretical knowledge	101
Table 30a.	The sizes (cm) and areas (cm ²) of VLUs in the intervention group	119
Table 30b.	The sizes (cm) and areas (cm ²) of VLUs in the comparison group	119
Table 31.	The results of skills observations.....	121
Table 32.	The knowledge test results of the nurses who were observed; percentages of correct answers	121
Table 33.	Treatment times of VLU (minutes).....	122
Table 34.	The costs of nursing care of VLUs	122
Table 35.	Use of eVLU and the reasons for no use.....	128
Table 36.	Nurses' feedback of eVLU.....	130
Table 37.	Cronbach's alphas for perceived and theoretical knowledge subscales	134
Table 38.	Cronbach's alphas for RPPE.....	135

Abbreviations

CE	Continuing Education
CG	Comparison group
DFU	Diabetic Foot Ulcer
eVLU	Internet-based education of VLU Nursing Care
EWMA	European Wound Management Association
EB	Evidence based
EBP	Evidence based Practice
ECTS	European Credit Transfer and Accumulation System
FWCS	Finnish Wound Care Society
CPG	Clinical Practice Guidelines
HHC	Home health care
IG	Intervention group
LPN	Licensed Practical Nurse
MNA	Mini Nutritional Assessment
MSAH	Ministry of Social Affairs and Health
NCSS	Number Cruncher Statistical System
NPUPAP	National Pressure Ulcer Advisory Panel
NRF	Nursing Research Foundation
OC	Observation Checklist
PBL	Problem-Based Learning
PCS	Patient Clinical Situation
PKAK	Perceived Knowledge, Attitudes and Knowledge evaluation instrument
PU	Pressure Ulcer
PUSH	Pressure Ulcer Scale for Healing
PHN	Public Health Nurse
RN	Registered Nurse
RPPE	The Professional Practice Environment -scale
TVN	Tissue Viability Nurse
UK	United Kingdom
VLU	Venous leg ulcer
WUWHS	World Union of Wound Healing Societies

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 Ylönen M., Stolt M., Leino-Kilpi H. & Suhonen R. 2014. Nurses' knowledge about venous leg ulcer care: a literature review. *International Nursing Review* 61 (2), 194–202. doi: 10.1111/inr.12088.
- II Ylönen M., Viljamaa J., Isoaho H., Junttila K., Leino-Kilpi H. & Suhonen R. 2015. Effectiveness of an internet-based learning program on venous leg ulcer nursing care in home health care – study protocol. *Journal of Advanced Nursing* 71 (10), 2413–2425. doi: 10.1111/jan.12683.
- III Ylönen M., Viljamaa J., Isoaho H., Junttila K., Leino-Kilpi H. & Suhonen R. 2017. Internet-based learning program to increase nurses' knowledge level about venous leg ulcer nursing care in home health care. *Journal of Clinical Nursing* 26 (21–22), 3646–3657. doi: 10.1111/jocn.13736.
- IV Ylönen M., Viljamaa J., Isoaho H., Junttila K., Leino-Kilpi H. & Suhonen R. 2019. Congruence between perceived and theoretical knowledge before and after an internet-based continuing education about venous leg ulcer nursing care. *Nurse Education Today* 83:104195. doi: 10.1016/j.nedt.2019.08.013.

The original publications have been reproduced with the permission of the copyright holders. The summary also contains unpublished materials.

1 Introduction

Nursing care of patients with venous leg ulcer (VLU), hereafter venous leg ulcer nursing care, is complex, requiring nurses to have comprehensive knowledge and skills of patients' unique situations, ulcer assessment and nursing care. Many VLUs persist over a long time and patients with VLU may have reduced quality of life (Posnett & Franks 2008, Adey *et al.* 2009, International Consensus 2012, Hopman *et al.* 2014, Mooij & Huisman 2016, Young *et al.* 2017). Many patients with VLU report difficulties, for example in social life and taking care of hygiene (Herber *et al.* 2007, Fagervik-Morton & Price 2009, Hopman *et al.* 2014, Salomé *et al.* 2016, Young *et al.* 2017) and sleep disturbances (Hellström *et al.* 2016). The patients themselves and their careers have an important role in VLU self-care and health care professionals should support them to enhance self-care activities (Franks *et al.* 2016).

VLU is not a disease in itself, it is a symptom of a disease. It is an open wound of venous origin in the ankle or lower leg, and it is the result of venous insufficiency associated with venous hypertension. (Chronic Leg Ulcers: Current Care Guidelines 2014, Mooij & Huisman 2016.) VLU is one of the most predominant medical disorders worldwide; in the Western countries, it affects around 1.5% of the general population (Graham *et al.* 2003, Etufugh & Phillips 2007), and 1–2% of the adult population either have or have had a VLU, and this number seems to remain stable over time (Moffat *et al.* 2004, Herber *et al.* 2007, Nelzén 2007). An ulcer is 2 to 3 times more common in women of all ages (Chase *et al.* 1997, Thomas 1997). VLU healing occurs at normal core body temperature and it usually requires on average 24 weeks to heal, while approximately 15% never heal. (Heit 2002, Posnett & Franks 2007.)

The prevalence of VLUs increases as the population ages (Moffat *et al.* 2004) and the population in Europe is aging (European Commission 2013). It has been estimated that by year 2025 more than 20% of all Europeans will be 65 years or older, and the number of people aged 80 years and above will increase in coming decades, by 167% over the period 2010 to 2060 (European Commission 2012, 2013). It is estimated that 8% of the population over 80 years will suffer from VLU (Moffat *et al.* 2004). VLUs also often recurs and about 1.7% of persons over 60 years develop a new VLU within two years (Takahashi *et al.* 2010).

VLUs have a high impact not only for patients but also on economic costs to healthcare systems (Franks *et al.* 2016, Nussbaum *et al.* 2018, Barnsbee *et al.* 2019). In Europe, the care of foot and leg ulcers accounts for 2%-4% of health care budgets (Gottrup *et al.* 2010), and district nurses in United Kingdom (UK) are estimated to spend 22% of their time treating leg ulcers (Hampton 2003). The average cost of treatment of VLU in Sweden is €814–10.800 per patient (Ragnarson *et al.* 2005). In the USA the costs have been estimated to be about \$14.9 billion annually (Rice *et al.* 2014). In the UK, the cost of ulcer care over 12 months has been estimated to be £7600 per VLU. In the UK, the costs of unhealed VLUs were 4 to 5 times more than the costs for healed VLUs; £3000/healed VLU and £13500/unhealed VLU. (Guest *et al.* 2017.) However, the costs may be underestimated as many patients having an ulcer in the lower leg (420.000 patients in the UK) do not have a diagnosis of the ulcer (Guest *et al.* 2015). Early diagnosis and treatment choices could reduce the costs of VLU nursing care (Vowden & Vowden 2016) and decrease the risk for admission to hospital care, as ulcer duration over 6 months is a risk factor for admission (Ousey *et al.* 2013). Nursing care of patients with VLU extends beyond the use of dressings and includes interventions to detect the cause of the ulcer (Norris *et al.* 2012, Franks *et al.* 2016, Pokorná *et al.* 2017). It requires comprehensive evidence based (EB) knowledge and skills. However, gaps in nurses' knowledge and skill in VLU nursing care have been identified in VLU pathophysiology and etiology, assessment, healing process, infection, topical care and compression treatment (Paper I).

Most older patients with VLU live in their own homes (Probst *et al.* 2014). In Finland, home health care (HHC) is regulated by law which states that every municipality must arrange HHC for its inhabitants (MSHA 2010). The balance of older people care is shifting towards home-based care in most European countries (Lipszyk *et al.* 2012, Tarricone & Tsouros 2012, WHO 2017), and this is also the case in Finland (MSHA 2012), as the goal in older people care is to decrease institutional care and to increase the number of patients cared for HHC. This requires many actions, such as ensuring the amount of competent nursing staff in HHC. (MSHA 2017.) There is also a need to ensure that nurses in HHC have sufficient education on wound and ulcer care (Probst *et al.* 2014).

Using evidence in clinical practice is important for safe, transparent, effective and efficient nursing care and for meeting the expectations of patients, families and society (Strandberg *et al.* 2014, Curtis *et al.* 2016, Holopainen *et al.* 2019.) Updating the knowledge and skills needed in professional practice is the obligation of every member of the health care staff and they must take part in sufficient continuing education (CE) and orientate themselves to instructions considering their professional work (MSHA 1994, 2010). Maintenance of professional knowledge and skills is also nurses' ethical duty (ETENE 2001, 2011, 2012, The Finnish Nurses

Association 1996, The Finnish Union of Practical Nurses 2015, The Finnish Association of Public Health Nurses). However, it is still unclear what is the best way to organize CE for nurses so that it transfers into practice as well (Grimshaw *et al.* 2012, Vaona *et al.* 2018), even though a lot of research has been conducted during the last 20 years to find a way to encourage nurses to use EB knowledge in their clinical practice (e.g. Johnson & May 2015, Curtis *et al.* 2016). Nevertheless, CE has been shown to improve nurses' knowledge (Czurylo *et al.* 1999, Peterson *et al.* 1999, Tsai *et al.* 2010, De Gagne *et al.* 2015), skills (Peterson *et al.* 1999, Clarke-Moloney *et al.* 2008, Duff *et al.* 2014), and attitudes (Duff *et al.* 2014, Yoshika *et al.* 2014).

One of the most important forms of support for nurses' evidence-based practice (EBP) in nursing care is management and leadership (Mortenijs *et al.* 2013, Govranos & Newton 2014, Gunawan & Aunguroch 2017, Traav *et al.* 2018). Managers need to follow up nurses' professional development. They must also create conditions for them to participate in CE needed and to support their professional development, knowledge, and skills to help them perform their professional duties safely and appropriately. (MSAH 2010.) Care shifting towards HCC demands CE efforts targeted at educating nurses working in HCC (MSAH 2017). However, educating nurses working in HCC is challenging due to large number of nurses and because they work in various locations within cities (Gjevjon *et al.* 2014, Probst *et al.* 2016). E-learning provides learning opportunities that are not dependent on the location of the nurses. It can also provide opportunities for active learning and full participation. It is increasingly used to replace or supplement traditional forms of CE (Cobb 2004, Belcher & Vonderhaar 2005, Yu *et al.* 2007, Durkin 2008, Vaona *et al.* 2018.) However, there is no one standardized definition of e-learning and many different terms are used to describe e-learning, such as online learning, web-based learning/education, multimedia learning and technology-enhanced learning (Vaona *et al.* 2015, 2018). In this study, internet-based education based on cognitive-constructivism (Dewey 1938, Vygotsky 1978) was utilized. The aim was to develop internet-based CE to support EBP in VLU nursing care in HHC and to evaluate its effectiveness. Effectiveness was defined as "the ability to be successful and produce the intended results" (Cambridge Dictionary 2019). In this study an internet-based learning program about VLU nursing care (eVLU) was developed for nurses working in HHC and its effectiveness was evaluated with cognitive, clinical and economic outcomes. This study is situated at the interface of clinical nursing, gerontological nursing, and nursing education research. It focuses on nurses' CE about VLU nursing care and its cognitive, clinical and economic outcomes, which are important in delivering high-quality nursing care for patients with VLU.

This study produces new knowledge about EBP in VLU nursing care in HHC which has previously only been studied in a few studies (Haram *et al.* 2003, Ribu *et al.*

al. 2003, Barrett *et al.* 2009, Walsh & Gethin 2009, Franks *et al.* 2016, Freeman & Norris 2016, Lagerin *et al.* 2017). The results of this study also provide new knowledge of the effectiveness of CE among nurses working in HHC. Previous studies of CE effectiveness have mainly focused on institutional or hospital care (Lyons & Kasker 2012, Zhang & Hsu 2013, Yacoub *et al.* 2015, Russell *et al.* 2017). In addition to this, internet-based CE about VLU nursing care as well as an instrument to evaluate nurses' theoretical knowledge of VLU nursing care seem to be lacking according to the literature reviews conducted during this study. (Figure 1)

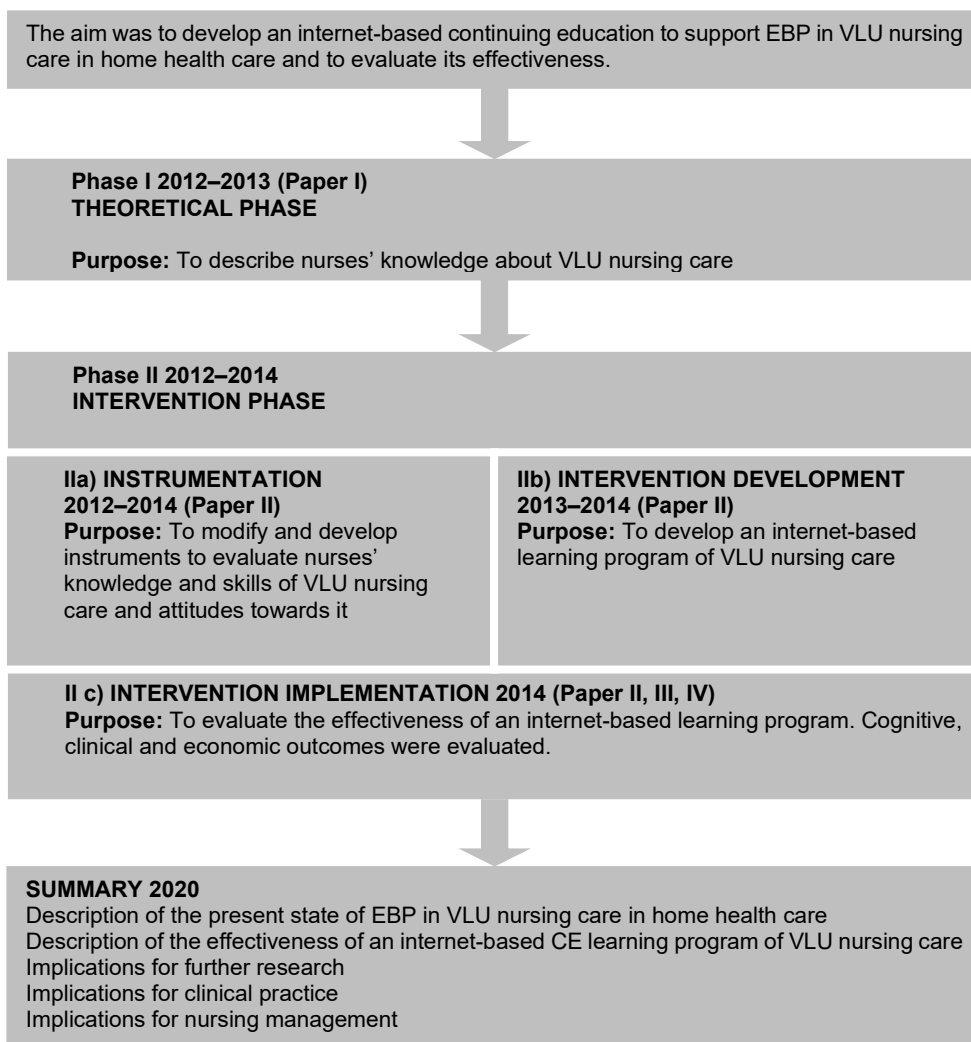


Figure 1. Study phases.

2 Review of the Literature

In this chapter existing literature about EBP in VLU nursing care and HHC is described. Also, previous research of nurses' knowledge tests, nurses' CE, and evaluation of its effectiveness is described. A total of *four literature reviews* were carried out. The first literature review was conducted using the MEDLINE, CINAHL and the COCHRANE LIBRARY databases (Paper I). Literature reviews 2, 3 and 4 were conducted using only MEDLINE. It is a comprehensive database and covers most literature around nursing care and healthcare treatments (Brazier & Beglesy 1996, Subirana *et al.* 2005). Searches in relevant organizations web pages, national guidelines and legislation were also carried out. All literature reviews were updated in May 2019.

2.1 Literature reviews

The literature review 1 was conducted to identify research evidence about VLU nursing care (Phase I, research question 1) (Table 1). To be included in the review, a study had to be published in a scientific journal, be empirically based (including reviews), describe nurses' knowledge in VLU nursing care and use the English language. The exclusion criteria were the study should not describe patients', student nurses' or physicians' knowledge of VLU nursing care, be an editorial, expert opinion, case report, or clinical care description. A computerized search strategy was used to identify relevant studies from three electronic databases: MEDLINE from 1966, CINAHL from 1982 and COCHRANE LIBRARY from 1972 to the end of 2012. (Paper I) The results of this review were used for instrument content and structure as well as the content and structure of eVLU. (Table 1) The literature search was updated on 17. July 2018 and 15. May 2019.

The literature review 2 was conducted to identify knowledge tests for nurses (Phase IIa, research question 2) for this study to evaluate nurses' knowledge in VLU nursing care (Table 1). The search term knowledge test was used in MEDLINE from 1966 to the end of 2012. The limits for the literature review were English language and Nursing Journals. The inclusion criterion was that the knowledge test was intended to measure nurses' actual knowledge which can be objectively measured with a knowledge test in clinical nursing care. The exclusion criteria were as follows:

the study should not describe knowledge tests used in evaluating patients' or student nurses' or physicians' knowledge, be an editorial, expert opinion, case report or clinical care description. The results of this review were utilized in knowledge test development. Literature review was updated in 17. July 2018 and 15. May 2019.

The literature review 3 was conducted to identify research evidence about nurses' CE in wound care and its effectiveness (Phase IIb, research question 2) (Table 1). Data were collected from MEDLINE from 1966 to end of 2012. The limits for the literature review were English language and Nursing Journals. Inclusion criteria were: CE about wound care CE was implemented in nurses' workplaces in adult nursing care and evaluation of CE effectiveness was carried out. The exclusion criteria were that the study should not describe patients' or student nurses' or physicians' CE, be an editorial, expert opinion, case report, or clinical care description. In addition, those CE studies in which participants were advanced clinical nurses were excluded, as those studies in which evaluation of outcomes was conducted during or after conferences (Table 1.). Literature review was updated in 17. July 2018 and 15. May 2019. The results of this review were utilized in eVLU development.

The literature review 4 was conducted to find research evidence about nurses' CE and its effectiveness (Phase IIb, research question 2) (Table 1). The search was conducted in MEDLINE from 1966 to the end of 2012. This literature review was conducted because the results of the previous search about CE interventions in wound care did not reveal any CE interventions about VLU nursing care. The limits for the literature review were English language and Nursing Journals. Inclusion criteria were the CE should have been implemented in nurses' workplaces in adult nursing care in clinical nursing practice and evaluation of CE effectiveness was carried out. The exclusion criteria were as follows: the study should not describe patients' or student nurses' or physicians' CE, be an editorial, expert opinion, case report, or clinical care description. In addition, those CE studies in which participants were advanced clinical nurses were excluded as were those studies in which evaluation was conducted during or after conferences. Literature review was updated in 17. July 2018 and 15. May 2019. The results of this review were utilized in eVLU development.

Table 1. Literature reviews.

Study Phases	Purpose of the literature search	Databases	Search Period	Search terms	Number of records	Full texts included
Phase I 2012–2013	1. To find research evidence about VLU nursing care	MEDLINE	From 1966 to the end of 2012	Leg ulcer AND nursing AND knowledge, Leg ulcer AND nurse AND knowledge Leg ulcer AND nurses and knowledge	MEDLINE 92	21 (16*)
		CINAHL	From 1982 to the end of 2012		CINAHL 92	
		COCHRANE LIBRARY	From 1972 to the end of 2012		COCHRANE LIBRARY 16	
			Updated in 17. July 2018 and 15. May 2019			
Phase IIa 2012–2014	2. To identify knowledge tests for nurses	MEDLINE	From 1966 to the end of 2012 Updated in 17. July 2018 and 15. May 2019	Knowledge-test	928	52
Phase IIb 2013–2014	3. To find studies evaluating effectiveness of CE about wound care	MEDLINE	From 1966 to the end of 2012 Updated in 17. July 2018 and 15. May 2019	Wound care AND Continuing education	142	7
Phase IIb 2013–2014	4. To find studies evaluating effectiveness of CE	MEDLINE	From 1966 to the end of 2012 Updated in 17. July and 15. May 2019	Continuing education	551	13

*16 studies were included in the original review

2.2 Evidence-based venous leg ulcer nursing care in home health care

In this chapter, the EB nursing care and VLU are first described. Second, HHC as the context of VLU nursing care is described.

EB nursing care denotes the use of current best evidence in making clinical decisions about patient care. Evidence can come from various sources although there is an extensive consensus that results from rigorous studies provide the strongest evidence for nursing care. (Polit & Beck 2010, Craig et al. 2013, Richards 2015, Holopainen et al. 2019.)

VLU is an open wound of venous origin in the ankle or lower leg. It is the result of venous insufficiency associated with venous hypertension. VLUs are usually shallow and irregular in shape and they often occur on the medial aspect of the lower third of the leg, around the ankle (WOCN 2011, Chronic Leg Ulcers: Current Care Guidelines 2014, Mooij & Huisman 2016). Venous insufficiency causes leg swelling, and elimination of swelling is essential for VLU healing and for other treatments and medications to take effect (Barwell et al. 2004, Nelson & Adderley 2016). VLUs are a significant clinical challenge in health care because their prevalence is increasing due to the aging of the population (Moffat et al. 2004, Posnett et al. 2008). VLU accounts for about 50% to 60% of all leg ulcers, and around 1% to 1.5% of the general population (Graham et al. 2003, Etufugh & Phillips 2007, Posnett et al. 2008) and 3% to 8% of population over 80 years in Western countries is affected by VLU (Moffat et al. 2004, Posnett et al. 2008). However, the precise global prevalence of VLUs is difficult to estimate due to the various methodologies used in the studies and the variation in reporting the results (Franks et al. 2016). VLUs often recur and can only be prevented by treating the underlying cause (Takahashi et al. 2010, Mooij & Huisman 2016). Almost half of the patients with VLU have multiple comorbidities and living with VLU requires on going adjustment on the part of the patients (Posnett et al. 2009). VLU impacts patients' physical, mental and social life and wellbeing and it also affects patients' family and careers. VLU can lead to depression and social isolation. Pain is one of the major problems of patients with VLU. (Posnett & Franks 2008, Harding et al. 2015, Miller & Kapp 2015, Young et al. 2017, Phillips et al. 2018.) In this study VLU was defined as an open ulcer in the lower leg caused by venous insufficiency (Chronic Leg Ulcers: Current Care Guidelines 2014) (Table 7).

Nurses' role in VLU nursing care has been defined as the "registered nurse who assesses, screens, treats and educates all ages of patients and members of the community" (Franks et al. 2016). "The unique function of the nurse is to assist the individual, sick or well, in the performance of those activities contributing to health or its recovery that he would perform unaided if he had the necessary strength, will or knowledge. And to do this in such way as to help him gain independence as rapidly

as possible” (Henderson 1966, p. 15). To achieve this in VLU nursing care nurses must have knowledge and skills in identification of VLU etiology and pathophysiology, assessment of patient with VLU, identification of VLU healing and assessment of the healing process, assessment of VLU infection, topical care principles, dressings and compression treatment (Chronic Leg Ulcers: Current Care Guidelines 2014, Ylönen et al. 2014). Skills include those needed before, during and after VLU nursing care (Ribu et al. 2003). Positive attitudes promote VLU healing (Flanagan 2005). Patients’ trust in nurses is central to VLU nursing care adherence (van Hecke et al. 2011). It is also important to give patients opportunity to be involved in their treatment and take responsibility for it, if possible (Moore et al. 2014, Franks et al. 2016, Moore et al. 2016). In this study, EBP in VLU nursing care was defined as VLU nursing care by Registered Nurses (RNs) Licensed Practical Nurses (LPNs) and Public Health Nurses (PHNs) which is conducted in patients’ home according to EB guidelines (Table 7).

Home health care (HHC) is defined very differently across European countries and it is mainly publicly funded (OECD 2005, Genet et al. 2013). In Europe, the care of patients with VLUs in HHC is usually delivered by nursing staff (Probst et al. 2014), and the nurse is often the first health care professional who detects the patient with VLU (Franks et al. 2016). However, nurses rarely specialize in working in HHC, and the shortage of qualified HHC professionals is a significant problem across Europe (Genet et al. 2013). At the time of this study in 2014, the mean age of staff working in municipalities was 45.7 years and most of this staff worked in social and health care (Local government employers in Finland 2019.) The mean age of patients receiving HHC at least once a week was 81 years and 43% of them were 85 years or older. Most (70%) of the patients were female. The average duration of HHC was 3.4 years. Over half of the patients (55%) were assessed to need very much or much services. (Noro et al. 2014.) In November 2018, the number of patients in Finland receiving HHC at least once a week was 73.563. Most (77%/56.357) of the them were 75 years or older (=11% of those aged 75 years or older in Finland). Most (65%) of the patients were female. (Finnish Institute for Health and Welfare 2019.)

At the time when this study was conducted in 2014, most of the nurses (68%/n=11.538) working in HHC in Finland were LPNs, 12% (n=2075) were RNs, 10% (n=1838) home aides and 20% were other professionals (Physiotherapists or Occupational therapists, PHNs, Bachelor of Social Services) (Finnish Institute for Health and Welfare 2019.) LPNs are educated in vocational upper secondary schools and they are both health care and social care professionals with a protected occupational title. The curriculum qualification is 180 competence points. (Finnish National Agency for Education 2020, Finnish Union of Practical Nurses 2020.) RNs and PHNs are educated in Universities of Applied Sciences and the education consists of 210 European Credit Transfer and Accumulation System (ECTS) credits

and lasts 3.5 years. PHN education consists of 240 ECTS credits and lasts 4 years. RNs have theoretical knowledge of nursing and other relevant sciences, and they are educated to apply this knowledge to their work in practice. (Finnish Nurses Association 2020, Ministry of Education and Culture 2020).

In this study, HHC was defined as nursing care of older people (age 65 and over) with open VLU in their homes by RNs, PHNs or LPNs (Table 7). LPNs were included as participants in this study as they constitute the main profession taking care of patients with VLU in HHC. In HHC, VLU nursing care is conducted in the patient's home, usually by the nurse alone, without colleague present. This requires proper communication and a good relationship between health care professionals and the patient, as well as comprehensive documentation in assessing the patient and making decisions (Gjevjon & Hellesø 2010, Gjevjon et al. 2014, Probst et al. 2016.) All nurses do not have all the desired competences for nursing care of patients with VLU (Franks et al. 2016). Obstacles to delivering EBP in VLU nursing care in HHC include patients' undernutrition, poor concordance, inadequate resources, lack of up-to-date education, and inadequate communication between health care professionals. Home environments can be physically and psychically demanding and lack adequate ergonomics and lightning. Sometimes nurses must work in unhygienic conditions in patients' homes. (Ribu et al. 2003, Barrett et al. 2009, Walsh & Gethin 2009, Friman et al. 2011, Lagerin et al. 2017.)

Nurses in HHC are uncertain about VLU assessment (Franks et al. 2016) and they perceive their knowledge of VLUs to be insufficient (Haram et al. 2003). Colleagues and daily practice may be nurses' main knowledge sources (Haram et al. 2003, McIntosh & Ousey 2008, Lagerin et al. 2017), and VLU nursing care is not documented as well as it should be (Ribu et al. 2003, Lagerin et al. 2017.) The treatment choices of HHC nurses were not always in accordance with current evidence (Franks et al. 2016). Errors in dressing application have been identified in nurses' failure to fill the wound cavity two-thirds full, removing the cover sheet from the dressing, and overloading the wound by placing the whole dressing up to the wound bed (Kent 2010). Although nurses may have knowledge in wound care, it seems that they lack knowledge and understanding in pain management (Downe 2012) and for example hand washing was not always performed by HHC nurses (Ribu et al. 2003). The most important issue to be further developed in wound care in HHC in the Nordic countries is the need to strengthen nurses' knowledge with education. Based on the literature review (Phase I) nurses have gaps in knowledge and skills in VLU nursing care (Ylönen et al. 2014). These gaps in knowledge were also found in the updated literature review in 15. May 2019 (Adderley & Thompson 2015, Freeman & Norris 2016, Nazarko 2016, Mitchell 2017).

2.3 Evidence-based guidelines in VLU nursing care

EB guidelines for VLU nursing care are published at three levels: international, national and regional. Guidelines from all these levels were utilized in this study. However, in the eVLU intervention the focus was on national EB guidelines.

At the *international level* the World Union of Wound Healing Societies (WUWHS) is a worldwide association for wound care professionals whose purpose is to encourage a global approach to education, research and health care delivery to achieve optimal outcomes for patients with wounds. WUWHS arranges conferences, education and publishes EB consensus documents and journal about wound care. WUWHS provides EB materials online free of charge (WUWHS 2019.) Wound Ostomy and Continence Nurses Society (WOCN) is a professional community for advancing the care of patients with wound, ostomy, and continence. WOCN arranges conferences, education and publishes EB guidelines and journal about wound care. Most of the materials of WOCN are available for paying members. (WOCN 2019.) The European Wound Management Association (EWMA) arranges conferences, education and publishes EB guidelines and a journal about wound care. EWMA co-operates with national and international organizations in Europe, aiming at increased data collection and quality of evidence, implementation of knowledge, and development of education of wound care. EWMA provides EB resources online free of charge (EWMA 2019). (Table 2)

At the *national level*, the Finnish Wound Care Society (FWCS) publishes EB instructions and a journal about wound care. FWCS provides EB material online free of charge. (FWCS 2019.) Clinical care guidelines especially for nursing care are drawn up by the Finnish Nursing Research Foundation (NRF). These are available online free of charge. The aim is to develop EB nursing so that nursing interventions are effective, appropriate, feasible, and/or meaningful. NRF has published clinical guidelines for PU prevention and identification in adult patient care. (NRF 2019.) The Finnish Medical Society Duodecim also publishes EB guidelines for health care professionals. These guidelines are made to improve and standardize chronic ulcer diagnosis, treatment and grading of care and they are intended for all health care professionals taking care of patients with leg ulcers in primary and special health care. The guidelines are available online free of charge. (Finnish Medical Society Duodecim 2019.) (Table 2)

At the *regional level* Hospital Districts, together with primary health care professionals, have developed care chains for chronic leg ulcer care. These are intended for all health care professionals in the prevention, diagnostics, treatment and rehabilitation of patients with chronic leg ulcers. The care chains are based on the international and national EB guidelines which are applied in Finnish health care. The roles of primary health care and specialized health care as well as the roles of different health care professionals are described. Mostly these care chains are available online. (e.g. Hospital District of Southwest Finland 2014, Oulu University Hospital 2019.) (Table 2)

Table 2. International, national and regional level evidence-based guidelines in VLU nursing care.

	Guidelines, consensus and position documents:	Purpose
International	World Union of Wound Healing Societies (WUWHS) Consensus Document. 2019. Wound exudate: effective assessment and management.	Provides practical guidance helping clinicians to effectively assess and manage exudate to prevent exudate-related complications and to improve outcomes for patients.
	World Union of Wound Healing Societies (WUWHS), Florence Congress, Position Document. 2016. Advances in wound care: The Triangle of Wound Assessment.	Provides a framework to include peri wound skin into wound assessment. Explains how the Triangle of Wound Assessment can be used to assess all wound types and examples in management of venous leg ulcers and diabetic foot ulcers are presented.
	Wound, Ostomy and Continence Nurses Society. (2017). Venous, arterial, and neuropathic lower-extremity wounds: Clinical resource guide.	Updates the previous document, A Quick Reference Guide for Lower-Extremity Wounds: Venous, Arterial, and Neuropathic, which was developed by the Wound Committee of the Wound, Ostomy and Continence Nurses Society™ (WOCN®, 2013).
	Franks <i>et al.</i> 2016. Management of patients with Venous Leg Ulcers – Challenges and Current Best Practice.	Aims to highlight barriers and facilitators in implementation of VLU guidelines and provides clinical practice statements in VLU care. Developed by EWMA and Wounds Australia.
	Price <i>et al.</i> 2014. EWMA Study Recommendations – For clinical investigation in leg ulcers and wound care.	The aim is to provide a document to assist new wound care researchers. Another aim is to support more studies that will improve understanding of clinical wound healing and raise the level of evidence. Developed with discussions in the EWMA Patient Outcome Group.
	Probst <i>et al.</i> 2014. EWMA Home Care-Wound Care – Overview. Challenges. Perspectives.	An overview of wound care in home care across Europe. The importance of skills needed in high-quality wound care in home care. Also, recommendations for interdisciplinary work are emphasized in wound care in home care.
	Moore <i>et al.</i> 2014. Managing Wound as a Team.	Provides a model for team approach to wound care. Developed by EWMA in collaboration with Association for the Advancement for Wound Care (AAWC, USA), Australian Wound Management Association (AWMA) in collaboration with the International Working Group on the Diabetic Foot (IWGDF).

	Guidelines, consensus and position documents:	Purpose
	Strohal <i>et al.</i> 2013. <i>EWMA</i> Document: Debridement.	An overview of the importance and options of debridement in wound management.
	European Wound Management Association (EWMA) 2008. Hard-to-heal wounds: a holistic approach.	Provides evidence about hard-to-heal wounds. Three articles: 1. Wound complexity and healing 2. Psychosocial factors and delayed healing and 3. Economic burden of hard-to-heal wounds.
	European Wound Management Association (EWMA) 2006. Management of Wound Infection.	Provides evidence about wound infection. Four articles: 1. An integrated approach to managing wound infection, 2. Demystifying silver, 3. Topical management of infected grade 3 and 4 pressure ulcers and 4. Topical antimicrobials and surgical site infection.
	European Wound Management Association (EWMA) 2005. Identifying Criteria for Wound Infection.	Provides evidence about wound infection. Four articles: 1. Understanding wound infection 2. Clinical identification of wound infection: a Delphi approach, 3. Identifying criteria for pressure ulcer infection, 4. Identifying surgical site infection in wounds healing by primary intention.
	European Wound Management Association (EWMA) 2004. Wound Bed Preparation in Practice.	Three articles: 1. Wound bed preparation: science applied to practice, 2. Wound bed preparation for diabetic foot ulcers, 3. Wound bed preparation for venous leg ulcers.
	European Wound Management Association (EWMA). 2003. Understanding Compression therapy.	Four articles: 1. Understanding the pathophysiology of compression, 2. Compression bandages: principles and definitions, 3. Cost-effectiveness of compression therapy, 4. Compression therapy: a guide to safe practice.
	European Wound Management Association (EWMA). 2002. Pain at Wound Dressing Changes.	Three articles: 1. Understanding wound pain and trauma: an international perspective, 2. The theory of pain, 3. Pain at wound dressing changes: a guide to management.
National	Finnish Wound Care Society: Treatment Guides for compression 2018. Prevention and treatment of low extremity edema 2010, Color classification of open wound 2010. Finnish Translations of EWMA -documents.	The purpose is to share the tried and tested and commonly used instructions to all professionals working with patients with wounds.

	Guidelines, consensus and position documents:	Purpose
	<p>The Finnish Medical Society Duodecim: Chronic Leg Ulcer: Current Guideline 2014. Venous insufficiency of the lower limb: Current Care Guideline 2016</p>	<p>The aim is to improve and standardize diagnosis, treatment and grading of leg ulcers. The aims are to give a general view of modern diagnostics and treatment of venous insufficiency standardize treatment present different treatment options and how they are technically implemented as well as compare the results between different treatment options present the meaning of compression treatment in venous insufficiency present cost-effectiveness point of view</p>
Regional	Care chains for chronic leg ulcer care (Hospital District of Southwest Finland 2014, Oulu University Hospital 2019)	Care chains are intended for all health care professionals in the prevention, diagnostics, treatment and rehabilitation of patients with chronic leg ulcers. They are based on the international and national guidelines which are applied in the Finnish health care. The roles of primary healthcare and specialized healthcare as well as the roles of different healthcare professionals are described.

2.4 Evidence-based education in VLU nursing care

Evidence-based (EB) education is arranged at three levels: international, national and regional. In the following chapters, examples of European and Finnish opportunities for education are presented. In Finland, the first national e-learning education about wound care for health care professionals was published in 2014 by the Finnish Medical Society Duodecim.

In Europe, EWMA has arranged wound care education during conferences and e-learning modules. EWMA published the first curriculum for post-registration qualification in wound care in 2017. This curriculum summarizes a comprehensive nursing intervention such as assessment, planning, interventions and evaluation of individuals with an acute or chronic wound. The topics include: role of prevention in wound care, EBP, patient education and promoting self-care, patient-centered care, wounds and wound healing, nutrition and wound healing, microbiology and wounds, antimicrobial agents, hygiene and wounds, debridement and wounds, moist wound healing, alternative or unconventional treatment options for wounds, pressure ulcers, diabetic foot syndrome, lower leg ulcers, health care delivery and health economics and documentation. A total of 100 hours of lectures, 50 hours of self-directed learning, 50 hours of practical work patient cases, and 50 hours of exams and preparation are needed to complete the curriculum. (Pokorná *et al.* 2017.) In January 2019 EWMA published a new set of e-learning modules of wound management targeted to health care professionals who do not have specialist education in wound management (EWMA 2019). (Table 3)

In national level, the Finnish Medical Society Duodecim offers online courses and electronic textbooks as well as traditional printed products for wound care CE. The usage of this material is chargeable for health care organizations. (The Finnish Medical Society Duodecim 2019.) There are three online courses about wound care. ABC of Wound Care (from 2014) provides knowledge about different kinds of wounds and their nursing care. The Topical Care of the Open Wound course (from 2016) provides information about wound assessment, how to choose treatment and dressings, and how to educate patients. The Prevention of Pressure Ulcer course (from 2016) provides understanding about the factors and diseases in pressure ulcer (PU) development. Participants learn to identify patients at risk for PU and how to use risk assessment tools. (Duodecim Oppiortti 2019.) FWCS arranges national conferences for health care professionals and education for Tissue Viability Nurses (TVN). Universities of Applied Sciences arrange postgraduate Expert in Wound Care –education comprising 30 credits. After finishing this education nurses can apply for authorization in wound care from the FWCS. (Table 3)

In regional level, wound care education is organized by the FWCS. Wound care education for health care professionals is also arranged by hospital districts and primary health care organizations (e.g. Oulu University Hospital, Turku University Hospital.) (Table 3)

Table 3. Examples of international, national and regional level of evidence-based VLU nursing care education.

International level	National level	Regional level
World Union of Wound Healing Societies (WUWHS): conferences and education	The Finnish Medical Society Duodecim: Online learning environment, Electronic textbooks, Traditional printed products	Finnish Wound Care Society, Hospital Districts, Social and health care organizations
Wound, Ostomy and Continence Nurses Society: conferences and education	Finnish Wound Care Society; conferences	
European Wound Management Association (EWMA): conferences and e-learning modules	Universities of Applied Sciences: Postgraduate Expert in Wound Care –education of 30 credits	
EWMA: Wound Curriculum for Nurses: Post-registration Qualification Wound Management. European Qualification Framework Level 5. October 2017.		
EWMA: a set of e-learning modules of wound management targeted to health care professionals who do not have specialist education in wound management. January 2019.		

2.5 Knowledge tests in evaluating nurses' knowledge

Knowledge test can be defined in terms of “measuring device intended to describe numerically the degree or amount of learning under uniform, standardized conditions” (Haladyna 2011, p. 4). In this study knowledge test was defined as an instrument to numerically evaluate nurses' theoretical knowledge about VLU nursing care.

Literature review 2 resulted in several knowledge tests evaluating nurses' knowledge in many clinical nursing care topics in 52 studies. Of these, 9 were about diabetes knowledge and 15 about pressure ulcer (PU) knowledge. In total the literature review yielded knowledge tests in 27 clinical nursing care topics. The previous knowledge tests were screened against the aims and research questions of this study. The knowledge needed in PU nursing care differs from the knowledge needed in VLU nursing care which is why none of the knowledge tests found in literature review 2 were chosen for further development. However, an instrument to be further developed was found in literature review 1 (Paper I, II, III, IV, Table 4).

Table 4. Knowledge tests developed for evaluation of nurses' knowledge.

Research topic	Authors
Pressure ulcer	Pieper & Mattern 1997, Sinclair <i>et al.</i> 2004, Chianca <i>et al.</i> 2010, Miyazaki <i>et al.</i> 2010, Cox <i>et al.</i> 2011, Ilesanmi <i>et al.</i> 2012, Iranmanesh <i>et al.</i> 2013, Pieper & Zulkowski 2014, Lawrence <i>et al.</i> 2015, Gul <i>et al.</i> 2017, Miller <i>et al.</i> 2017, Barakat-Johnson <i>et al.</i> 2018, Delmore <i>et al.</i> 2018, Charalambous <i>et al.</i> 2019, Fulbrook <i>et al.</i> 2019
Diabetes	Moriarty & Stephens 1990, Adams & Cook 1994, Legget-Frazier <i>et al.</i> 1994, Parker <i>et al.</i> 1995, Baxley <i>et al.</i> 1997, el-Deirawi & Zuirakat 2001, el-Deirawi & Zuirakat 2001, Modic <i>et al.</i> 2009, Yacoub <i>et al.</i> 2014
Evidence-based practice	Jansson <i>et al.</i> 2013, Allen <i>et al.</i> 2015
Physical restraints	Trepanier <i>et al.</i> 1996, Karlsson <i>et al.</i> 1998, Kor <i>et al.</i> 2018
Breast cancer	Alkhasawneh 2007, Kataoka <i>et al.</i> 2015
Delirium protocol	Marino <i>et al.</i> 2015
Nurses foot care	Stolt <i>et al.</i> 2015
Breast feeding	Fonseca-Machado <i>et al.</i> 2014
Oral health	George <i>et al.</i> 2014
Glycemic control	Hargraves <i>et al.</i> 2014
Catheter-assisted hemodialysis	Pun <i>et al.</i> 2016
High fidelity patient simulation	O'Leary <i>et al.</i> 2016
Pediatric care	Burka <i>et al.</i> 2014
Heart failure	Mahramus <i>et al.</i> 2013
Anti-tuberculosis treatment	Yukselturk & Dinc 2013
Electrocardiogram	Pickham <i>et al.</i> 2012
Patient legal rights	Iltanen <i>et al.</i> 2012
Vaccination	Nikula <i>et al.</i> 2011

Research topic	Authors
Patient safety	Van Gaal <i>et al.</i> 2010
Epidural treatment	Bird <i>et al.</i> 2009
Resuscitation	Marzooq & Lyneham 2009
Fall prevention	Krauss <i>et al.</i> 2008
Wound care	Zulkowski <i>et al.</i> 2007
Tuberculosis	Messmer <i>et al.</i> 1998
Restraint use	Terpstra <i>et al.</i> 1998
Cancer pain	Vortherms <i>et al.</i> 1992

2.6 Nurses' continuing education and its outcomes

In this chapter, firstly, nurses' continuing education (CE) is described and results from literature reviews about nurses' CE in wound care and other CEs are presented. Secondly, the outcomes studied in this study as CE outcomes are presented.

The purpose of CE is to maintain, update or increase nurses' knowledge and skills in clinical nursing care (MSHA 2004). CE is recommended to be evaluated at the level of practice and patient outcomes (ANCC 2014). E-learning is one way to offer CE. The term e-learning (electronic learning) was developed in the middle of the 1990s when the use of the internet expanded (Garrison 2013). Internet-based education and learning, e-learning, web-based learning and education are used to describe education and learning via internet. It can consist of existing internet-based material or educators can develop specific educational material accessible on the internet. (Billings 2000, Billings & Rowles 2001, Cobb 2004, Wutoh *et al.* 2004, Durkin 2008, Vaona *et al.* 2015, Vaona *et al.* 2018). E-learning requires learners to be responsible for their learning and provides access to CE that is not dependent of time and place (Cheng *et al.* 2007, Chen *et al.* 2008, McVeigh 2009, Clark & Mayer 2016, Vaona *et al.* 2018). E-learning and face-to-face education have been shown to deliver equivalent results in knowledge and skills (Lahti *et al.* 2014, Vaona *et al.* 2015, Vaona *et al.* 2018). However, when used together, e-learning and traditional teaching methods seem to produce better outcomes (McDonald *et al.* 2018). Nurses' attitudes towards e-learning are usually positive (Yu & Yang 2006, Chong *et al.* 2016). When courses are delivered fully on-line, learners can miss the opportunity for face-to-face interaction with other learners and the instructor, and this can be an obstacle to learning (Haigh 2004, Sit *et al.* 2005, Cook 2007, So 2009). Because of this, discussion forums are often offered in e-learning programs (Billings 2000, Billings & Rowles 2001, Wutoh *et al.* 2004, Vaona *et al.* 2018). In this study, CE was defined as internet-based CE about VLU nursing care for HHC nurses. Distance learning was conducted with the 6-week module Electronic Learning of Venous Leg Ulcer Care (eVLU) in University Moodle which is a virtual web-based learning environment (Moodle 2019). (Table 7)

In literature review 3 about nurses' CE of wound care, the inclusion criteria were met by 7 studies, and only one of them focused on CE about leg ulcer nursing care; it consisted of 1-day education (half a day of theory and half a day of practice of Doppler measurement) for nurses setting up a community-based leg ulcer clinic or who were already working in such a clinic. (Clarke-Moloney et al. 2008.) Three studies focused on CE about PU nursing care. One PU CE combined lecture-based CE and experiential learning opportunities (Price et al. 2017). One PU CE consisted of four 8-hour sessions over 4 months including self-studies between sessions (Tully & Ganson 2007). In another PU CE study, the aim was to determine whether there is a difference in retention of knowledge about PU with traditional lecture versus computer instructions and control without any instructions (Cox et al. 2011). One study focused on CE about appropriate dressing usage, and "just-in-time" education was used, meaning that the education was provided with appropriate dressing usage instructions attached to the dressing package (Kent 2010). Two studies focused widely on CE about wound and ulcer care. One of them contained 4 months of education with elementary lectures (10 h), intermediate (30 h), technical (18 h), introduction to wound dressings (2 h), discussion (2 h), written and technical test (4 h) and clinical practice (5 days) including lectures, discussions and clinical demonstrations. In addition to these, the participants completed a case report after a 2-month follow-up period. (Tsai et al. 2010.) The other was arranged with workshops for nurses about management of chronic wounds (Goudy-Egger & Dunn 2018). (Table 5)

Improvement in wound care knowledge scores after CE was found in five studies (Tully & Ganson 2007, Tsai et al. 2010, Cox et al. 2011, Price et al. 2017, Goudy-Egger & Dunn 2018). When comparing traditional lectures and computer-based instructions, the mean knowledge scores improved more in the lecture group. This difference remained statistically significant between post-test and three months post-test. However, significant differences between the groups were not found between three months and six months post-tests. The most significant loss of PU knowledge, regardless of the CE model, occurred within the first three months. (Cox et al. 2011.) Improvement in picture test scores after CE was found in one study (Tully & Ganson 2007) reflecting improvement in PU identification and staging. In two studies (Tsai et al. 2010, Price et al. 2017), nurses' technical skills and clinical practice scores improved after CE. In the study by Kent (2010) CE improved statistically significantly ($p < 0.0001$) nurses' confidence in dressing application of an unfamiliar dressing. In one study (Clarke-Moloney et al. 2008), leg ulcer practices improved significantly over an 18-month period; in an audit in 2007, more patients ($p = 0.001$) received high compression compared to 2005. (Table 5) The results are encouraging; however, statistical significance of the changes before and after CE was reported only in some studies. More rigorous studies about wound care CE effectiveness are needed.

Table 5. Studies about nurses' CE in wound care in the order of time.

Researches and country	Aim	Method	CE intervention	Participants	Measurement of CE effectiveness in learning outcomes	Main results
Goudy-Egger & Dunn 2018, USA	To determine whether nurses' knowledge regarding chronic wound care management would differ after attending an educational workshop.	Comparative study; pre-test-post-test design	Educational workshops	31 RNs	Knowledge test.	A statistically significant increase in nurses' knowledge from pre-test to post-test ($p < .05$).
Price <i>et al.</i> 2017, Australia	To determine the changes in staff knowledge, time spent on healing and wound prevention and proportion of wounds	One group pre-test/post-test design	Lectures and practical training.	11 RNs 10 Enrolled nurses (ENs) 17 Personal care workers	The PU knowledge test	RNs and ENs showed significant increase in mean knowledge scores ($p < 0.001$). Improvement in pressure injury prevalence ($p = 0.01$) and faster development of wound management plans ($p = 0.03$) were also results.
Cox <i>et al.</i> 2011, USA	To determine whether there is a difference in retention of knowledge about PUs with traditional lecture versus computer-based instruction and control without any instructions.	Three groups quasi-experimental , pre-test/post-test	Traditional classroom learning; 1-hour lecture with Power-Point slides). Two-weeks computer-based self-learning module with Power Point slides; completion time one hour or less.	60 RNs	The PU Knowledge test, pre-test, post-test, follow-ups at 3 and 6 months.	The greatest improvement in mean knowledge scores between pre- and post-test was gained in lecture group. Between post-test and three months post-test these differences remained statistically significant. Between three months post-test and 6 months post-test statistically significant differences were not found between the groups. The most significant loss of PU knowledge, regardless of the model, occurred within the first three months.

Researches and country	Aim	Method	CE intervention	Participants	Measurement of CE effectiveness in learning outcomes	Main results
Kent 2010, USA	To compare the effects of a just-in-time educational intervention to traditional wound care education on reported confidence and dressing application in a simulated model.	Randomized controlled trial	“Just-in-time” education; appropriate dressing usage instructions were attached to manufacturer’s dressing package.	59 LPNs and 21 RNs in the CG and 71 LPNs and 22 RNs in the IG	Dressing confidence assessment questionnaire in wound dressing application and observation of nurses applying the dressing to a wound model.	Statistically significantly ($p < .0001$) more nurses in the IG reported agreeing that they felt confident in dressing application of an unfamiliar dressing. In the IG 88% of the nurses were able to apply dressings correctly to a simulated model compared to none of the nurses in the CG.
Tsai <i>et al.</i> 2010, Taiwan	To develop, implement, and evaluate the first professional wound care training program in Taiwan	One group pre- and post-test	Four months training; lectures (10 h elementary, 30 h intermediate, 2 h discussion and 4 h written and technical tests), clinical practice for 5 days (lectures, discussions, clinical demonstrations and practical experiences).	45 RNs	Knowledge test, wound discretion (4 pictures), technical test (manipulation of negative pressure wound therapy), ABPI, how to choose, apply and change wound dressing. Clinical practice evaluation: integration of dressings, case-reports after 2-month follow-up period.	Statistically significant improvement in knowledge-test scores ($p = .001$) between pre- and post-test. Technical test: mean passing score was 81.6 of 100 points (60 points were needed to pass). Clinical practice: mean passing score was 84.77 of 100 points. Case report: average score was 82.2 of 100 points.
Clarke-Moloney <i>et al.</i> 2008, Ireland	To identify regional changes in leg ulcer management following leg ulcer training for community-based nurses which incorporated Doppler ankle brachial pressure	One group pre- and post-audit	One day-education; half a day of theory and half a day of practice. Implemented two times: the first time in 2005 and the	30 PHNs (participated in education) 98 PHNs and RGNs (community health nurses) participated in	Audit in 2005 gathering details on all leg ulcer patients treated in the community in one week, including patient demographics, ulcer etiology, assessment	Leg ulcer practices improved significantly in the 18-month period. In audit results in 2007 more patients ($p = 0.001$) received high compression compared to 2005. The number of leg ulcers treated once a week

Researches and country	Aim	Method	CE intervention	Participants	Measurement of CE effectiveness in learning outcomes	Main results
	index (ABPI) assessment.		second time in 2006.	follow-up audit in 2007	and treatment. The first audit was carried out before the training course for community-based nurses in leg ulcer assessment and management.	increased from 36.6% in 2005 to 46.7% in 2007. Those patients who had ABI assessment were likely to require only weekly dressing changes.
Tully & Ganson 2007, Canada	To support a collaborative atmosphere among nurses by promoting best practice and increasing knowledge and expertise in the prevention and management of Stage I and Stage II PUs and to develop a peer resource system.	One group pre- and post-tests	Wound Care Resource Nurse Program; four 8-hour education sessions over 4 months. Between the sessions, participants' self-study with assignments and readings.	65 RNs	Knowledge test, picture test (30 photographs of chronic wounds) and each participant was required to either stage the photographed PU or to identify the type of chronic wound.	Knowledge test results showed an average knowledge improvement from 10.5% to 12.7% of skin breakdown and management of stage I and stage II PUs. Average scores in picture test improved 26.5% from pre-test to post-test reflecting knowledge improvement in identification and staging of PUs.

Literature review 4 yielded 13 studies meeting the inclusion criteria. CE was implemented in various ways. Lectures were utilized in 5 studies: a CE program with seminars about pain management (Czurylo et al. 1999) and 8 days CE about gerontological nursing (Langlan & Farrah 1990). Lectures were also used in CE about end-of-life nursing care consisting of 5 lectures over 2 months (Yoshioka et al. 2014), 1-hour CE about diabetes care (Yacoub et al. 2015) and CE about patients with behavioral and substance abuse disorders consisting of 12 one-hour classes over 3 months (Russell et al. 2017). (Table 6)

Various kinds of educational methods were combined in three studies. In CE about aged care, 15-day problem-based (PBL) learning, lectures, small group discussions, reflection and journals were used (Peterson et al. 1999). In CE about EBP in oncology nursing, interactive staff meetings with EBP poster presentations in units lasting 20 minutes, one day with lectures, posters and projects and an online EBP educational module were used (Underhill et al. 2015) Lectures and a self-learning handbook was utilized in one study about interpretation of 12-lead electrocardiogram with lecture-based CE (5 hours of lectures and self-learning handbook) (Zhang & Hsu 2013). Practical training was utilized in two studies. One was CE in which lectures and practical training were combined into a one-day course in IV catheter insertion (Lyons & Kasker 2012). The second one was a one-day lecture and three months of practical training about respiratory skills by educators and clinical coaches (Duff et al. 2014). E-learning in CE was utilized in a 120-hours CE about mental health care including reading tasks, a discussion forum, reflective journals and assignments after each unit. (Lahti et al. 2014.) E-learning was also used in a self-paced three-weeks CE about continence care with three hours of recorded video lectures and supplementary materials (literature, websites, video clips and documents) (De Gagne et al. 2015). Portable video media was compared to standard verbal communication (Kam et al. 2016), and 5 weeks (total 15 hours) of PBL and lecture-based CE was compared to CE that only comprised conventional lectures (Hung et al. 2015). (Table 6)

The effectiveness of CE has been evaluated with assessment of nurses' knowledge scores (Czurylo et al. 1999, Peterson et al. 1999, Lyons & Kasker 2012, Zhang & Hsu 2013, Duff et al. 2014, Yoshioka et al. 2014, De Gagne et al. 2015, Yacoub et al. 2015, Kam et al. 2016), self-rated knowledge (Langlan & Farrah 1990), self-efficacy (Yoshioka et al. 2014), perceived competence (Russell et al. 2017), attitudes (Duff et al. 2014, Yoshioka et al. 2014, De Gagne et al. 2015), beliefs (Duff et al. 2014, Underhill et al. 2015), observation of nurses' skills (Peterson et al. 1999, Lyons & Kasker 2012), self-reported skills (Duff et al. 2014), perceived improvement (Czurylo et al. 1999) and description of transfer of knowledge (Lahti et al. 2014). (Table 6) CE has usually shown improvement of evaluated outcomes

which have been evaluated either immediately after CE or after a longer time span. These are described in more detail in the following chapters.

Immediately after CE, a statistically significant ($p < 0.001$) improvement in nurses' perceived knowledge about aged care (Peterson et al. 1999) has been noted, as well as an increase in nurses' perceived competency of knowledge of resource availability in substance abuse care (Russell et al. 2017). A significant improvement ($p < 0.001$) has been noted in nurses' knowledge test scores in IV catheter insertion (Lyons & Kasker 2012), interpretation of electrocardiogram (Zhang & Hsu 2013), end-of-life nursing care (Yoshioka et al. 2014), continence care (De Gagne et al. 2015) and diabetes knowledge (Yacoub et al. 2015.) In the study of Czurylo et al. (1999), almost all (94%) of nurses' knowledge test scores about pain management improved after CE. When comparing knowledge acquisition between portable video media and standard verbal communication, knowledge acquisition was statistically significantly ($p = 0.001$) higher with portable video media (Kam et al. 2016). In some studies, knowledge test was conducted again after some time span. Statistically significant ($p = 0.00018$) knowledge improvement in IV catheter insertion was shown at 8 and 12 weeks after CE (Lyons & Kasker 2012). In the study of Yoshioka et al. (2014), knowledge improvement continued statistically significantly ($p < 0.005$) at two months after CE, and in Zhang & Hsu (2013) there were significant differences ($p = 0.000$) between the pre-test and the last knowledge score of electrocardiograms interpretation at 5 months. (Table 6)

Nurses' skills about pain management improved after CE: almost all (91%) of the nurses stated that they had opportunity to use the new information and 98% stated that the use of the new information had improved patient care (Czurylo et al. 1999). Statistically significant differences ($p < 0.001$ to $p < 0.005$ depending on the subscale) between IG and CG were noted regarding self-reported use of respiratory skills, three months after CE (Duff et al. 2014). In the study about CE in aged care (Peterson et al. 1999), observations during case scenarios showed that nurses developed a holistic approach to aged care, reflected on their practices in the journals, developed an understanding of the current guidelines, and acquired the skills, strategies, and motivation to make changes in their workplaces as the result of CE. Nurses' willingness and ability to transfer what they had learned into their daily practice, communication and co-operation among staff members, understanding of preventive and alternative treatment methods and critical thinking regarding ones' own work were noted in the study of Lahti et al. (2014) as results of e-learning CE about mental health care. (Table 6)

Nurses' beliefs and attitudes about respiratory care improved statistically significantly ($p < 0.001$ to 0.005 , depending on the subscale) in the IG compared to nurses in the CG immediately after CE (Duff et al. 2014). Also, in the study by De

Gagne et al. (2015), statistically significant ($p = 0.001$) improvement in attitudes towards continence care was noted after CE. A statistically significant ($p < 0.001$) increase in perceived competency related to self-confidence in substance abuse care and attitudes towards it was also noted in the study of Russell et al. (2017). However, no significant differences were noted in beliefs and implementation after the EBP initiative, but nurses reported valuing EBP (Underhill 2015). (Table 6) Based on the previous studies, CE seems to improve nurses' knowledge immediately afterwards and over a longer time span. Studies evaluating CE effectiveness on patient outcomes were not found.

Table 6. Studies about nurses' CE.

Researchers and country	Aim	Design	CE intervention	Participants	Measurement of CE outcomes	Main results
Russell <i>et al.</i> 2017, USA	To determine the effects of an CE intervention on the perceived competency of nurses who care for patients with behavioral and substance abuse disorders.	Quasi-experimental one group pre-class and post-class design.	12 hours of live classes over 3 months	57 RNs	Perceived Competence - questionnaire	Immediately after the CE, a statistically significant increase was found in perceived competency related to self-confidence, attitudes, communication, and knowledge of resource availability among participating nurses.
Kam <i>et al.</i> 2016, USA	To compare portable video media (PVM) to standard verbal communication (SVC) for surgical information delivery and CE training for nurses and evaluate its impact on knowledge acquisition and participant satisfaction.	Prospective multicenter (two hospitals), randomized controlled crossover trial.	Information delivery via PVM- 7-minute video compared to information delivered via SVC.	36+36 nursing staff	Knowledge questionnaire	Knowledge acquisition and participant satisfaction were higher via PVM compared to SVC.
Yacoub <i>et al.</i> 2015, Jordan	To evaluate the effectiveness of a diabetes education program for RNs.	One group pretest-post-test design.	One-hour lecture with Power Point presentation	129 RNs	Knowledge test	Significant improvement was noted basic knowledge mean test scores before and after implementation ($p < 0.001$).
De Gagne <i>et al.</i> 2015, South Korea	To develop an online CE course on continence care for community health nurses and to examine its effectiveness.	One group pretest-post-test design.	1-month module course: 3 hours of video lectures, literature, websites, videos, documents	24 RNs	Knowledge test and Attitudes questionnaire	A significant improvement in knowledge and attitudes toward continence care was noted.

Researchers and country	Aim	Design	CE intervention	Participants	Measurement of CE outcomes	Main results
Underhill <i>et al.</i> 2015, USA	To compare and describe oncology nurse beliefs and perceived implementation of EBP and explore beliefs and implementation before and after implementing an institutional EBP initiative	One group pre- and post-design.	20 -minute interactive staff meeting with poster and Nursing Scholarship day with lectures and Online EBP module.	112 RNs	The Evidence-Based Practice Beliefs (EBP-B) and Implementation (EBP-I) scales.	No significant differences were noted in beliefs and implementation after the EBP initiative, but nurses reported valuing EBP.
Lahti <i>et al.</i> 2014, Finland	To describe the transfer of knowledge gained from an e-learning course to daily practice in mental health care.	Qualitative study design.	129 -hour e-learning program with reading tasks, discussion forum, reflective journals. Virtual patient for clinical decision making.	35 RNs	Inductive analysis of nurses' writings. Comparison of nurses' reflective writing during the e-learning course and course evaluation forms completed after the course.	Nurses were willing and able to transfer what they had learned into their daily practice including the course themes, communication and co-operation among staff members, understanding of preventive and alternative treatment methods and critical thinking regarding one's own work.
Duff <i>et al.</i> 2014, Australia	To evaluate the effectiveness of implementing a Respiratory Skills Update (ReSKU) CE program, in the context of organizational utility, on improving surgical nurses' practice in the area of respiratory assessment	A quasi-experimental pre- post-test nonequivalent control group design	3 months program with self-directed learning module, a 1-day education program and supported clinical practice.	90 RNs	Self-reported skills, attitudes and beliefs, knowledge questionnaires	Statistically significant differences between groups regarding reported use of respiratory skills, three months after CE. Between-group data analysis indicated that the IG's reported beliefs and attitudes pertaining to subscale descriptors showed statistically significant differences in three of the six subscales.

Researchers and country	Aim	Design	CE intervention	Participants	Measurement of CE outcomes	Main results
Yoshioka <i>et al.</i> 2014, Japan	To examine the effectiveness of the End-of-life nursing care CE program for general ward nurses	One group nonrandomized before after trial	5 lecture sessions over 2 months	22 RNs	Self-efficacy, attitudes, knowledge questionnaire	Implementation ability of end-of-life nursing care was significantly improved after the program; improvements continued even at 2 months after.
Zhang & Hsu 2013, China	To evaluate the effectiveness of a CE program on nurses' knowledge of interpretation of 12-lead electrocardiograms (ECGs).	One group quasi-experimental pre- post-test design	5 hours of lectures and self-learning handbook	52 RNs	Knowledge questionnaire	The post-test total and domain scores at 2 weeks, and 4 months after the lecture-based learning and 1 month after a self-learning ECG handbook was presented were higher than the pretest scores.
Lyons & Kasker 2012, USA	To assess the success of an IV catheter insertion CE class aimed at improving experienced nurses' skills levels, confidence, and knowledge	One group pre-and post-measurement design	One-day course with lectures and practice	33 RNs	Skills level (observation checklist), and knowledge questionnaire	Knowledge and skills improved after the CE. Improvement in knowledge was shown immediately after the course and 8 to 12 weeks later.
Czurylo <i>et al.</i> 1999, USA	To assess the effect of CE in pain management.	One group pre-and post-measurement design	Continuing education program	50 RNs	Knowledge test, perceived improvement in patient care	94% had improved scores on the post-test. 91% stated they had an opportunity to use the new information and 98% stated the use of this information had improved patient care.

Researchers and country	Aim	Design	CE intervention	Participants	Measurement of CE outcomes	Main results
Peterson <i>et al.</i> 1999, Australia	To evaluate the effectiveness of the problem-based education about aged care.	One group pre- and post-measurement design	15 day of lectures, small group discussions and reflection and journals	4 RNs, 11 Enrolled Nurses	Observation nurses when working on case scenario, perception of knowledge - questionnaire	Participants developed a holistic approach to aged care, reflected on their practice in the journals, developed an understanding of the current aged care guidelines, and acquired the skills, strategies, and motivation to make changes in their workplaces.
Langlan & Farrah 1990, USA	To evaluate gerontological nursing CE outcomes.	One group pre- and posttests.	Lectures and discussions	517 RNs	Self-rated knowledge questionnaire.	Significant increase in perceived knowledge scores from pre- to post-test ($p < .0001$). Increase in both perceived knowledge of theory-based gerontological nursing and theory-based practice.

2.6.1 Cognitive outcomes

In this study the cognitive outcomes used were nurses perceived and theoretical knowledge about 6 areas of VLU nursing care. Congruence between nurses perceived and theoretical knowledge was evaluated. In addition, nurses' attitudes towards VLU nursing care were evaluated.

Knowledge has been defined in several ways. It can be defined as “the fact or condition of knowing something with familiarity gained through experience or association” (Merriam-Webster dictionary 2019) or as “understanding of or information about a subject that you get by experience or study, either known by one person or by people generally” (Cambridge Dictionary 2019). Defining nursing knowledge is complex because it is often “embedded in practice” (Benner et al. 2009, p. 234). In nursing, “knowledge is the form of knowledge that has been judged by standards that are shared by nurses and that is taken to be valid and accurate understanding of elements and features that comprise nursing care.” (Chinn & Cramer 2011, p 20). “Know that” knowledge comes from theory and research and it can be verbally communicated. “Know-how” knowledge is learned in practice through personal experience and equates with art of nursing and can be applied in a certain task. It is not easy to verbally communicate “know-how” knowledge. Individuals may learn procedural knowledge without being aware that they are learning. (Ryle 1949, pp. 14–20.)

In this study, perceived knowledge was defined as nurses' own subjective evaluation of their knowledge of VLU nursing care while theoretical knowledge was defined as nurses' actual EB knowledge about nursing care of a patient with VLU (Table 7). The knowledge needed in VLU nursing care consists of 6 areas, that are common to all nursing care environments: physiology and etiology, assessment, healing, infection, topical care and compression treatment (Ylönen *et al.* 2014). These areas of knowledge are described in the following chapters.

Firstly, knowledge about VLU physiology and etiology is essential because nursing care of the underlying cause of VLU is important for it to heal. Therefore, a medical diagnosis of the cause is needed. Most of the patients with VLU have venous insufficiency as underlying cause of VLU. (Lower extremity venous insufficiency: Current Care Guidelines 2010, Chronic Leg Ulcers: Current Care Guidelines 2014, Mooij & Huisman 2016.) However, ulcer etiology and diagnosis has not been determined in all the patients with leg or foot ulcers (O'Brien et al.2002, Weller & Evans 2012, Weller et al. 2013), and about 26% of the patients with such an ulcer do not have definite diagnosis (Drew et al. 2007). The reasons for missing diagnosis may be due to poor documentation (Törnvall et al. 2009, Nichols 2015) difficulties in communication between nurses and physicians, and lack of support for best practices from the primary health care center (Friman et al. 2010).

Secondly, nurses need knowledge about clinical assessment of patients with VLU. It includes patients' medical, nursing care and VLU history, vascular assessment, biochemical investigations, mobility and functional status, pain history, nutritional, psychosocial and cognitive status and quality of life. (International Consensus 2012, Chronic Leg Ulcer: Current Care Guidelines 2014, Probst et al. 2016, Wounds Australia 2016). VLUs are not traditionally thought to be painful (Emflorgo, 1999, King, 2003). However, for example in the study by Hofman et al. (1997), it was found that 69% of patients with VLU reported pain as the worst thing in having a VLU.

Thirdly, nurses need knowledge about VLU healing. It occurs at normal core body temperature (Dini et al. 2015, Wounds UK 2016). VLUs require a long time to heal; usually, an average of 24 weeks is needed for the VLU to heal (Heit 2002, Posnett & Franks 2007). However, complete healing can take as long as 6 to 12 months. Only 50% of VLUs heal within 4 months, 20% will heal within two years, and 8% will not heal after 5 years. About 70% of VLUs will recur within 5 years from closure. (Browse & Burnand 1982, Posnett & Franks 2007.) Many factors may have an impact on VLU healing, and these can be associated with the patient (e.g. nutritional status), VLU (e.g. VLU size and duration), competence of the health care professionals or various biophysiological factors (Vowden 2011, Dowsett 2015).

Fourthly, nurses need knowledge about the signs of VLU infection and how to assess it. The signs of an ulcer infection include one or more of the following: new, or increased ulcer-related pain, delayed healing, hypergranulation tissue, increased heat, increased exudate, green/purulent exudate, increased odor, fever, increased erythema and increased swelling or edema of the lower limb. Infection delays the healing process. Bacteria are present on the skin as natural flora and they migrate to a VLU; this means that all VLUs are contaminated with micro-organisms, but this does not mean that all VLUs are infected. (Chronic Leg Ulcer: Current Care Guidelines 2014, Franks et al. 2016, Wounds Australia 2016.)

Fifthly, nurses need knowledge about topical care dressings which are used to prepare the VLU bed for granulation tissue leading to ulcer closure (Schultz et al. 2003, Nichols 2015). When selecting an appropriate dressing, nurses must consider several factors including VLU size and location, ulcer bed and tissue, wear time, the ulcer stage (inflammation, granulation or re-epithelialization phase), amount and type of exudate, bacteria level or topical infection, pain and odor, peri-ulcer and surrounding skin, patient tolerance and preference, ease of application and removal, cost and availability (Australian and New Zealand Clinical Practice Guideline for Prevention and Management of Venous Leg Ulcers 2011, Broussard & Powers et al. 2013, Adkins 2013).

Sixthly, nurses need knowledge about compression treatment, which is the cornerstone of VLU treatment. Increased healing rates of VLU have been shown in

patients with compression compared to patients with no compression. (O'Meara et al. 2013.) Compression treatment is based on applying an external pressure to the limb. It improves venous hemodynamics, controls edema, reduces inflammatory mediators, and improves microcirculation, arterial inflow and lymphatic drainage. (Nelzén 2007, O'Meara et al. 2013, Chronic Leg Ulcers: Current Care Guidelines 2014, Nelson & Adderley 2016.)

In this study congruence was studied by determining the congruence between nurses' self-assessments (perceived knowledge) and their actual knowledge (theoretical knowledge). Congruence describes the degree to which individual's ideal self and actual self are similar and consistent. Complete state of congruence is rarely achieved, and all individuals experience some amount of incongruence. However, the view that individuals have of themselves is important in directing their behaviors. (Rogers 1959, p. 206.) Congruence can be defined as the level of agreement between two or more individuals in their perceptions, assessments, or beliefs. Congruence can also be defined as "the quality of being similar to or in agreement with something" (Cambridge Dictionary 2019). Congruence between perceived and actual knowledge has seldom been studied (Baxley 1997, El-Deirawi 2001, Iltanen et al. 2012, Yacoub et al. 2014, Markström & Bjersa 2015), and they are not always congruent. However, in VLU nursing care there are no such studies. It is important to determine if nurses who take care of patients with VLUs have greater perceived knowledge than actual knowledge because discrepancy between these can potentially influence the probability that nurses will seek further training. In this study, the congruence was defined as correspondence between nurse's perceived and actual knowledge of EBP in VLU nursing care (Table 7).

Attitudes can be defined as "a feeling or opinion about something or someone" (Cambridge Dictionary 2019). They are learned evaluations of an object (person, place or issue) that influence actions. Attitudes are a relatively enduring evaluative reaction to situations and other persons or objects, which can be either negative or positive. Attitudes are based on how people feel and think about an object. Attitudes influence behaviors, they guide actions; people holding a certain attitude are inclined to behave in a way consistent with that attitude (Perloff 2003, DeLamater et al. 2015.) However, there are studies that have resulted in only modest correlation between attitudes and behavior (Dawes & Smith 1985, Glasman & Albarracin 2006). In this study, attitudes were defined as some degree of positive or negative orientation towards VLU nursing care (Table 7). Overall, previous literature about VLU nursing care and nurses' attitudes is very limited. However, nurses' attitudes towards patients with VLU have been found to be positive (Graham et al. 2001) and it has been shown, that negative attitudes can be a barrier to ulcer healing (Flanagan 2005).

2.6.2 Clinical outcomes

In this study clinical outcomes used were nurses' skills, VLU infection and VLU size. Clinical outcomes can be care-related, patient-related or performance-related. Care-related clinical outcomes refer to results from nurses' interventions in nursing care. Patient-related outcomes refer to outcomes from nurses' interventions in clinical care and affecting patients' perceptions, preferences and knowledge. Performance-related outcomes refer to nurses' interventions in nursing care and reflecting the quality of care. (Kleinpell 2013.) In this study clinical outcomes were related to care-related and performance-related outcomes in VLU nursing care.

Nurses have different levels of skills in different areas of practices based on their experience, background and knowledge (Benner 2009). Skills also refer to art of nursing which refers to nurses' ability to form a sense of the patient's situation, understand what needs to be done and act on the patients' behalf in the nursing situation. The art of nursing contains holism and compassion and it is supported by technical functions in nursing practice. (Chinn & Kramer 2011 p.125-150.) In this study, nurses' skills in VLU nursing care were defined as nurses' bedside skills in VLU nursing care (Table 7). Skills were organized according to VLU nursing care process: 1) skills needed before VLU nursing care: preparation in VLU nursing care 2) skills needed during VLU nursing care: VLU assessment, hygiene, cleansing the VLU, dressings used, protective agent used to protect the skin around the VLU, compression bandages, pain medication 3) skills needed after VLU nursing care: documentation, hygiene and taking care of the waste (Ribu et al. 2003, Paper I, III).

Preparation in VLU nursing care consists of ensuring the correct room temperature, making sure that necessary supplies are available, covering (gloves, apron etc.), taking care of the patient's good position, and taking care of ergonomics and lightning. Ensuring the room temperature is important because VLU healing occurs at normal core body temperature and body surface temperature above 33 Celsius. Below this or when the temperature is over 42 Celsius, VLU healing is delayed (Dini et al. 2015, Wounds UK 2016). Patient's good position is important to ensure patient's comfort during VLU nursing care and nurse's ergonomic working position (Ribu et al. 2003).

VLU assessment skills are important for deciding the proper nursing care options for VLU. Effective nursing care of patients with VLU is based on full assessment of the patient (WOCN 2011, Chronic Leg Ulcers: Current Care Guidelines 2014) and in many cases, clinical assessment is enough for diagnosis or to clarify if more examinations are needed (Franks et al. 2016). Assessment skills, including skills to assess patients' medical, nursing care and VLU history, mobility, functional and cognitive status and quality of life and physical examination skills in palpation of pedal pulses, are needed (Fagervik-Morton & Price 2009, Management of Chronic Venous Leg Ulcer 2010, Australian and New Zealand Clinical Practice Guideline

for Prevention and Management of Venous Leg Ulcers 2011, Chronic Leg Ulcer: Current Care Guidelines 2014, Franks et al. 2016).

Skills are also needed to assess VLU healing progression, and VLU must be protected from further deterioration. A moist VLU bed supports healing. (Palfreyman et al. 2006, The Wound Healing Society 2007, WOCN 2011.) The VLU healing progress can be monitored by recording ulcer size (length, width and depth) with a disposable ruler (e.g. Management of chronic venous leg ulcers 2010). The amount of exudate must also be recorded as accurately as possible. The type of exudate includes a description of its color, consistency and amount. Descriptions of VLU exudate can be for example serous (yellow fluid), hemoserous (blood and serous fluid), sanguineous (old blood), or purulent (green fluid). (e.g. Chronic Leg Ulcer: Current Care Guidelines 2014.) Assessment of patients' nutritional status is recommended (The Wound Healing Society 2007, WOCN 2011, Probst et al. 2016). There is no nutritional assessment tool that has been validated specifically with patients with VLU. However, generic tools are suitable for these patients (Finnish Food Safety Authority 2010), and Mini Nutritional Assessment (MNA) (Vellas et al. 2006) is recommended for nutritional assessment with older patients (age ≥ 65) (Nutritional Recommendations for Elderly 2010). Nurses need skills in pain assessment, which is recommended to be conducted with a valid and reliable assessment tool (WUWHS 2004, Fagervik-Morton & Price 2009, Australian and New Zealand Clinical Practice Guideline for Prevention and Management of Venous Leg Ulcers 2011). Nursing care must be performed so that pain is minimized, especially during ulcer dressing changes (WUWHS 2004, Posnett & Franks 2008, Mooij & Huisman 2016, Young et al. 2017).

Nurses need skills in hygiene and in-home environment, clean technique can be used in VLU nursing care. It requires the use of non-sterile gloves, clean disposable aprons and clean disinfected scissors. This technique involves hand washing, using hand disinfection, maintaining a clean environment (including garbage collection), using clean gloves and sterile instruments, and preventing direct contamination of supplies and other materials. (Hospital District of Southwest Finland 2014, Sims 2018, Weir & Swanson 2019.)

Nurses need skills in cleansing the VLU. Cleansing establishes a VLU environment conducive to healing. It is important to remember that cleansing may cause trauma to the VLU bed and therefore it must be performed in the right way (Magson-Roberts 2006, Main 2008, Strohal et al. 2013.) In VLU nursing care, using tap water is recommended (Bucknote 1996, Watret & Armitage 2002, Lindsay 2007, Strohal et al. 2013). Saline, irrigation solution, honey or different kinds of dressings (autolytic, enzymatic or absorptive dressings) could also be used in cleansing the VLU (Ribu et al. 2003, Bousa et al. 2005, Jull et al. 2008, Gray et al. 2011, Strohal et al. 2013). When using water, saline or irrigation solution, it is important to warm

it before using. Dressing changes should be done avoiding ulcer bed cooling as it delays healing. (Rippon et al. 2012, Weir & Swanson 2019.)

In selecting dressing, nurses must consider several factors including VLU size and location, ulcer bed and tissue, the VLU phase (inflammation, granulation or re-epithelialization phase), amount and type of exudate, bacteria level or topical infection, pain and odor, patient tolerance and preferences, ease of application and removal, cost and availability. (Moffat et al. 2002, Broussard & Powers 2013, Franks et al. 2016)

Dressing changes must be performed so that pain is minimized (Ribu et al. 2003, WUWHS 2004, Australian and New Zealand Clinical Practice Guideline for Prevention and Management of Venous Leg Ulcers 2011, Adkins 2013, Broussard & Powers et al. 2013) as dressing changes is the most painful time for the patient (Briggs & Torra 2002, EWMA 2002, Moffat et al. 2002, WUWHS 2004). Assessment of VLU edges is important as they can be raised or rolled, and this can delay healing. Assessment of surrounding skin (dryness, maceration, erythema, pruritus, edema, contact dermatitis) is important because a lot of exudate can cause maceration of the surrounding skin. Topical barrier can be used to reduce erythema and maceration. In choosing dressings, patient's possible hypersensitivity to the product must be recognized. Antimicrobial therapy (silver or honey) can be used when there are signs of infection in VLU. However, there is no need to take a bacterial swab unless there are clinical signs of infection present in the VLU. (Chronic Leg Ulcer: Current Care Guidelines 2014, Franks et al. 2016, Wounds Australia 2016.)

Nurses need skills in using protective agents to protect the skin around the VLU. VLUs usually exudate heavily, and this can cause maceration of the skin around the VLU. There can also be erythema, pruritus or edema in the skin around the VLU. VLU edges can be rolled, and this can cause delayed healing. Protective agents can be used to reduce erythema and maceration. For example, skin creams, hydrocortisone or zinc paste can be used to protect the skin around the VLU (Ribu et al. 2003, Chronic Leg Ulcers: Current Care Guidelines 2014.)

Nurses need skills in applying compression correctly for it to be effective (Management of Chronic Venous Leg Ulcers 2010, WOCN 2011). High-pressure bandages are effective in achieving VLU healing because of their ability to maintain pressure and stiffness. They shorten the treatment time, and therefore they are also cost-effective. (Meara et al. 2012, Franks et al. 2016, Nelson & Adderley 2016.) However, high-pressure compression can cause discomfort to patients and because of this they may not use them (Franks et al. 2016). Patient adherence improves VLU healing rates and it seems to be more important than pressure itself. Because of this, for example pressure stockings with lower pressure can be used to improve adherence. (Weller et al. 2013, Clarke-Moloney et al. 2014, Franks et al. 2016.)

Nurses seem to have a lack of understanding in pain management of patients with VLU (Downe 2012). Based on previous studies, 20%–67% of patients with VLU are not prescribed pain medication and of those who had, only about 50% were taking them regularly. Patients also reported that pain medication was not effective (Douglas 2001, Nemeth et al. 2003, Heinen et al. 2007.) When treating a VLU, pain medication (e.g. Paracetamol) can be taken before VLU treatment or/and used locally (e.g. Lidocaine-gel) during the treatment. It is always important to assess patient's pain with a validated assessment instrument. (EWMA 2002, Ribu et al. 2003, WUWHS 2004.)

VLU size is recommended to be recorded, and the best way for size measurement is to use the clock face measure. This means that when measuring the length, the head is at 12 o'clock and the feet are at 6 o'clock and when measuring the width, it is conducted from 3 o'clock to 9 o'clock. The length and width must be multiplied to calculate the surface area of the VLU. (Management of chronic venous leg ulcers 2010, Strohal et al. 2013). Change in VLU area of 30% or more over a four-week period has been defined as a good predictor of healing (Kantor & Margolis 2000, Sheehan et al. 2003). In this study, VLU healing was defined as decreased ulcer area during the study. (Table 7) VLU sizes were recorded to follow up the progress of VLU healing over time by measuring the maximum length and maximum width using a disposable ruler (Gethin 2006, Management of chronic venous leg ulcers 2010).

2.6.3 Economic outcomes

In this study the economic outcomes used were supply costs (dressings) and costs of labor (nurses' time used to take care of the patient with VLU).

The economic outcomes of VLU nursing care include the cost of health care professionals, dressings and bandages and other possible therapies and overhead costs (e.g. electricity, rent, administration) (Posnett et al. 2009, Probst et al. 2014, Franks et al. 2016). Nursing care of patient with VLU in HHC is long-lasting and time-consuming. It can take on average 10 – 12 nursing visits for four weeks to take care of the patient with an ulcer in HHC and the time needed for one ulcer is 20 to 30 minutes (Friedberg et al. 2001, Ribu et al. 2003, Gottrup 2004, Gottrup et al. 2010). In health care organizations, it is important to consider that the best nursing care for patients with VLUs is delivered within the financial frame of the organization. However, the level and quality of nursing care is dependent on the total resources available, and their usage must be based on best available evidence. (Franks et al. 2016.) When considering the costs of topical treatment, dressing reimbursement is an important aspect to be considered; in Europe, there are differences in ulcer dressing reimbursement in HHC. In Finland, it depends on the

municipality; in some ulcer care products are delivered to patients by HHC whereas in others, patients need to pay for some of the products themselves. In Denmark and Sweden, patients do not pay for ulcer care products. In Finland, most of the ulcer care products and dressings do not require a prescription and therefore the national reimbursement system does not cover them. (Probst et al. 2014.) In this study the economic outcomes were defined as direct costs of VLU nursing care to the organization (Table 7). These included supply costs (dressings) and costs of labor. Supply costs were calculated from prices (€) to the organization, not the compression bandages included. The cost of labor was defined as nurse's time (minutes) spent to take care of a patient with VLU. Nurses' monthly salary was divided by hourly salary divider (163) to find out the cost of labor (KVTES 2018). The costs of developing and running eVLU were not calculated.

Table 7. Summary of the definitions and operationalization of the concepts.

Concept	Definition	Operationalization
Venous leg ulcer (VLU)	Open ulcer in the lower leg caused by venous insufficiency.	Patient's clinical assessment (PCS), patient's ulcer assessment during observations
EBP in VLU nursing care	Nursing care by RNs, LPNs and PHNs which is conducted according to evidence-based guidelines.	Nursing care according to Chronic Leg Ulcer: Current Care Guidelines (2014)
Home health care (HHC)	Nursing care of elderly (age 65 and over) patients with open VLU in their homes by RNs, PHNs or LPNs.	Nursing care of elderly (age 65 and over) in two Finnish cities.
Continuing education (CE)	Internet-based education about VLU nursing care to RNs, PHNs and LPNs working in HHC.	eVLU to nurses in the IG
Internet-based education	Using the Moodle –platform to deliver education to HHC nurses.	Using the Moodle –platform to provide existing evidence-based material on the internet
Cognitive outcomes	Nurses' knowledge about VLU nursing care and attitudes towards VLU nursing care. Knowledge was defined as nurses perceived and theoretical knowledge about VLU nursing care. Theoretical knowledge was defined as nurses' actual EBP knowledge about nursing care of patients with VLUs. Perceived knowledge was defined as nurses' own subjective evaluation of their knowledge of VLU nursing care. The congruence was defined as correspondence between nurse's perceived and actual knowledge of EBP in VLU nursing care. Attitudes were defined as some degree of positive or negative orientation towards VLU nursing care.	Perceived and theoretical knowledge and attitudes evaluation with PKAK –instrument.
Clinical outcomes	Nurses' bedside skills in VLU nursing care. VLU size (area) Supplies used in topical care	Nurses' skills evaluation with structured observation checklist (OC) during video-recorded observations. VLU width and length measurement with a paper ruler Supplies according to patient's individual situation
Economic outcomes	Direct costs of VLU nursing care to the organization	The costs of topical treatment supplies (€) and minutes (€) used in nursing care of patient with VLU were evaluated with a structured observation checklist (OC) during video-recorded observations.

2.7 Summary of the literature review

The aim of the literature review was to gain a comprehensive understanding of EBP in VLU nursing care, nurses' knowledge tests, nurses' CE and HHC as a context in VLU nursing care.

There are EB guidelines about VLU nursing care available in defining the content of EBP in VLU nursing care. However, based on previous studies, nurses have gaps in knowledge and skills in VLU nursing care. Most patients with VLU are cared for in home environments and mostly taken care of LPNs. The nurse is usually the first person to detect the patient's ulcer in HHC. Therefore RNs, PHNs and LPNs need comprehensive knowledge and skills in VLU nursing care and more attention needs to be paid to their CE.

The results of previous studies about nurses' CE are encouraging, showing an improvement in nurses' knowledge and skills as well as their attitudes immediately after CE and over a longer time span. However, the statistical significance of the changes in outcomes was not reported in all of these studies. Despite finding a total of 13 CEs in adult clinical nursing care and 5 on wound care in literature reviews 3 and 4, only one study of CE on leg ulcer nursing care was found. It was conducted with face-to-face lectures and practical training sessions. This calls for more attention to CE about VLU nursing care as well as more rigorous designs in evaluating the outcomes. VLUs have a high impact on patients and economic costs to health care organizations, and it is therefore important to pay more attention to EBP in VLU nursing care in HHC.

Knowledge tests to evaluate nurses' knowledge in clinical nursing care have been developed on many nursing care topics. Most of them are about PU nursing care or diabetes care. Knowledge tests of VLU nursing care were not found for the purposes of this study. Therefore, there is a need to develop such test.

HHC as the context of VLU nursing care is demanding because nurses are working alone in patients' homes and there are no on-the-spot possibilities for consultation with other nurses, VLU nursing care experts or physicians. Educating HHC nurses is challenging due to their timetables and the large number of nursing staff. One possible answer to the need to strengthen HHC nurses' knowledge and skills in EBP in VLU nursing care is to utilize internet-based education to provide nurses opportunities for learning in their own workplaces.

3 Aims and research questions

The aim of this two-phased study was to develop an internet-based continuing education to support EBP in VLU nursing care in home health care and to evaluate its effectiveness.

The following main research questions were addressed:

Phase I

1. What is the research evidence about VLU nursing care? (Paper I, Summary)
2. What is the research evidence about nurses' CE and its outcomes? (Summary)

Phase II

3. What is the effectiveness of eVLU in improving cognitive, clinical and economic outcomes?

Detailed research questions for phase II were addressed:

- a) What are the cognitive outcomes of eVLU? (Paper II, Paper III, Summary)
The following hypothesis was tested: The eVLU statistically significantly improves cognitive outcomes in the IG compared to the CG.
- b) What is the congruence between nurses perceived and actual knowledge? (Paper IV, Summary)
The following hypothesis was tested: The eVLU improves the congruence.
- c) What are the clinical outcomes of eVLU? (Paper II, Summary)
The following hypothesis was tested: The eVLU improves clinical outcomes in the IG compared to the CG.
- d) What are the economic outcomes of eVLU? (Paper II, Summary)
The following hypothesis was tested: The eVLU lowers the economic expenditure in the IG compared to the CG.

4 Materials and Methods

This was a two-phased intervention study consisting of a theoretical and an intervention phase. In this chapter the study phases, study design, setting, samples, data-collection, intervention, instruments and data-analysis are described. (Figure 2)

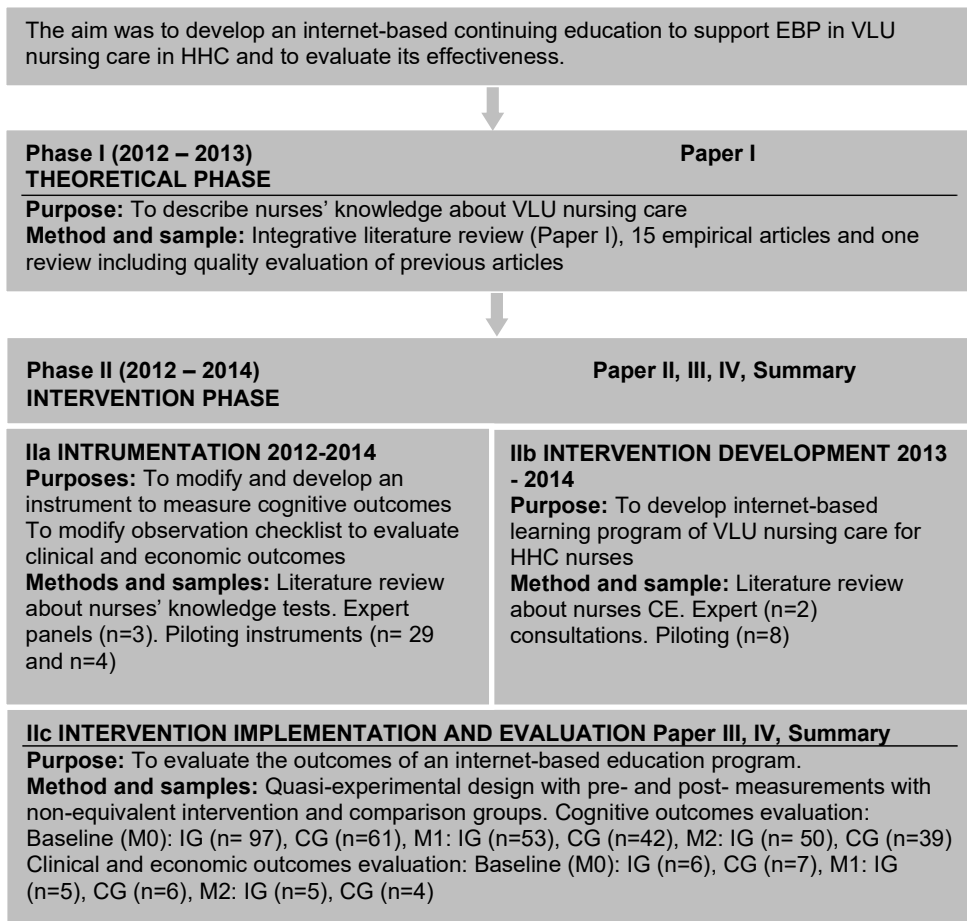


Figure 2. Materials and methods of the study.

4.1 Study design, setting, sampling and samples

In this study a descriptive, methodological, one-group cross-sectional, quasi-experimental design and one-group post-test designs were utilized. Sampling methods consisted of systematic, purposive and cluster and total samplings. (Grove et al. 2013.) (Table 8)

In Phase I, a descriptive design with systematized integrative literature review (Kirkevold 1997) was used to synthesize existing research to describe the evidence about VLU nursing care. (Paper I). Because no previous reviews were found about the topic of interest, an integrative review was chosen to provide understanding of VLU nursing care. Integrative review design is flexible in allowing the combination of results from studies with diverse methodologies. (Kirkevold 1997, Grant & Booth 2009.) A total of 16 studies with various study designs were included in the original review. (Paper I) The literature review was updated in 17. July 2018 and 15. May resulting 5 additional studies. (Table 8)

In Phase IIa descriptive design with narrative literature review (Grove et al. 2013) was used to find out relevant instruments to evaluate nurses' knowledge and skills in VLU nursing care. A total of 52 studies meeting the inclusion criteria were included. (Table 1). Methodological study design with purposive sampling was used in expert panels to evaluate the knowledge test items. One-group cross-sectional study design with purposive sampling was used in pilot testing the instruments evaluating nurses' knowledge, attitudes and skills developed in this study. (Table 8)

In Phase IIb descriptive design with narrative literature review was used to find out studies in which CE interventions' effectiveness was evaluated to direct the development and implementation of the study (Grove et al. 2013 p. 115). A total of 7 studies meeting the inclusion criteria in wound care CE and 13 meeting the inclusion criteria of CE were included. (Table 1) One-group cross-sectional design with purposive sampling was used in expert panels to evaluate the intervention developed in this study. One-group cross-sectional design was also used to pilot-test the intervention. (Table 8)

In Phase IIc quasi-experimental design with IG and CG (Shadish et al. 2002) was used to evaluate the effectiveness of eVLU. Cognitive, clinical, and economic outcomes were evaluated. In addition, one-group post-test design was used to find out the feasibility of eVLU (Richards 2015). (Paper II, Summary, Table 8)

Table 8. Study designs, samples and sampling methods.

Phase	Design	Data-collection method	Sample	Sampling method
I	Descriptive, integrative literature review	Computerized literature search	n= 21 (16*)	Systematic
IIa	Descriptive, narrative literature review	Computerized literature search	n= 52	Systematic
IIa	Methodological design	Expert panels, three rounds	n= 6	Purposive
IIa	One-group cross-sectional pilot	Survey	n=29	Purposive
IIb	Descriptive, narrative literature review	Computerized literature search	n = 13	Systematic
IIb	Descriptive, narrative literature review	Computerized literature search	n = 7	Systematic
IIb	One-group cross-sectional	Discussions	n = 2	Purposive
IIb	One-group cross-sectional pilot	Survey	n=8	Purposive
IIb	One-group cross-sectional	Discussions	n = 4	Purposive
IIc	Quasi-experimental with pre-test and post-test with a comparison group	Survey with follow-ups Observation with follow-ups	IG n= 239 CG n= 229 IG n= 5 CG n= 5	Cluster (organizations), Total (nurses)
IIc	One group post-test design	Survey	n=18	Purposive (eVLU users)

*16 studies were included in the original review

IG = Intervention Group, CG = Comparison Group

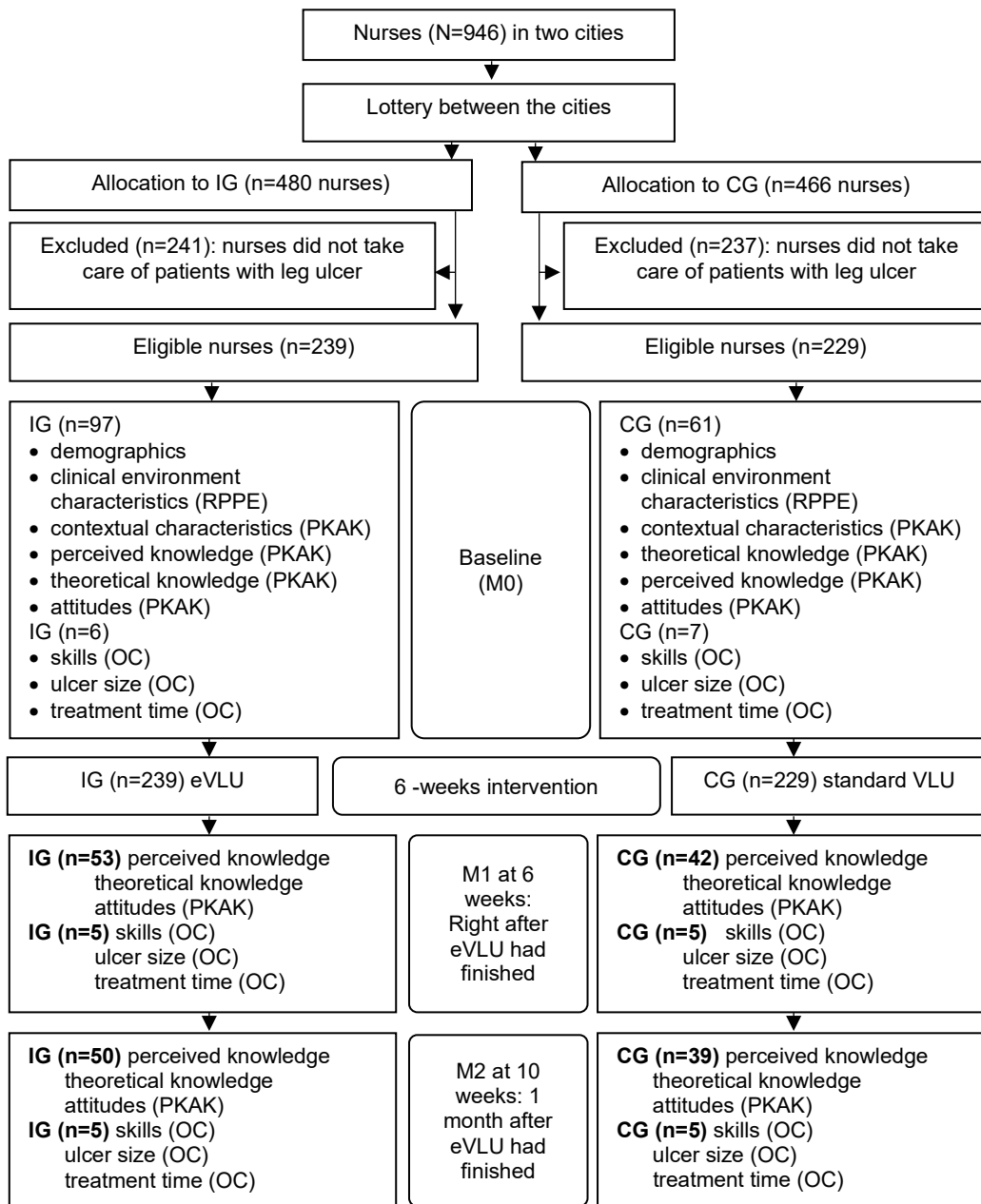
Recruitment of nurses started in 2013 with first contact with HHC directors in both cities. Directors approved the preliminary plan, and recruitment was continued in 2014 with detailed presentations to directors, managers and coordinators. Information briefings to RNs, PHNs, and HHC team managers were arranged in summer 2014. A total of 55 meetings were arranged with nurses during the study when data was collected. (Table 9)

Table 9. Recruitment of the participants and meetings with the nurses.

Level	Contacts and meetings	Intervention Group (IG)	Comparison group (CG)
Organizational level	First contact with HHC director	19. Sep 2013 (discussion)	1. Oct 2013 (e-mail)
	Presentation to executive committee		8. Apr 2014
	Meeting with HHC coordinator		29. Apr 2014
	Meeting with HHC director and coordinator	11. Apr 2014	
Unit level	Information briefing HHC team managers, RNs and PHNs	10. Jun 2014	5. Jun 2014
	Information to HHC team managers, RNs and PHNs by e-mail	11. Jun 2014	7. Jun 2014
Individual level	Meeting nurses in the cities during data collection in autumn 2014	Evaluation of perceived knowledge, theoretical knowledge and attitudes: Baseline 9 x 1 hour M1 8 x 1 hour M2 8 x 1 hour Evaluation of skills, ulcer size and treatment-time: Baseline 5 times M1 5 times M2 5 times	Evaluation of perceived knowledge, theoretical knowledge and attitudes: Baseline 9 x 1 hour M1 8 x 1 hour M2 8 x 1 hour Evaluation of skills, ulcer size and treatment-time: Baseline 5 times M1 5 times M2 5 times

In *Phase IIc*, this study was conducted in HHC in two large Finnish cities with similar size and staffing; the sample consisted of RNs, PHNs and LPNs. The nurses were divided into two groups according to the city with lottery between the cities. The first city in the lottery served as intervention group (IG) and the other city was comparison group (CG). The population consisted of all nurses working in HHC in both cities (n=946) who were assessed for eligibility to participate; 480 nurses in the IG and 466 nurses in the CG. Sampling criteria for eligibility to participate were that nurses had to have permanent employment relationship or a temporary post of at least 3 months' duration in the same HHC district and they had to be taking care of

patients with a chronic leg ulcer. The target population was those nurses who were working in a HHC district where patients with chronic leg ulcer were taken care of when this study began. The target population consisted of 239 nurses in the IG and 229 nurses in the CG, who met the inclusion criteria (Figure 3.). The sampling criterion for observations was that nurses were working in HHC district where patients with VLU were cared for. A total of 5 VLU nursing care situations were observed three times (total of 15 observations in both groups). (Figure 4)



OC = Observation checklist, PKAK = Perceived Knowledge, Attitudes and Knowledge evaluation instrument

Figure 3. Participant flowchart through the study (Paper III, IV modified).

There were some differences between the groups in nurses' demographics at M0. There were more RNs in the IG participating in the measurements than in the CG; 25.5% (n= 25) of the nurses in the IG and 9.7% (n=6) in the CG were RNs. (Table 10) The effects of profession and age on the outcomes were checked. Their impact was not statistically significant and therefore they are not included in the main modeling. (Paper III)

Table 10. Demographics of the nurses (Paper III, IV modified).

Item	IG (n= 95-98) Mean (SD)	CG (n= 54-61) Mean (SD)	P-value*
Age (years)	39.0 (11.9)	44.3 (12.9)	0.009
Work experience in social and health care	9.4 (8.5)	13.7 (10.3)	0.007
Work experience in HHC	7.6 (7.5)	11.1 (9.9)	0.011
Experience in VLU nursing care	5.7 (7.2)	8.3 (8.1)	0.095

*Analysis of variance, p-value is statistically significant at the <0.05 level

Sample attrition rate (= number of subjects withdrawing/sample size x 100) (Grove *et al.* p. 372) was high in both groups during the PKAK measurements (Figure 3). In IG it varied from 59.4 (baseline) to 79.1 (M2); in CG the variation was between 73.4 (baseline) and 83.0 (M2) (Table 11).

Table 11. Attrition rates of the nurses.

	IG potential subjects n = 239 Attrition rate %	CG potential subjects n = 229 Attrition rate %
Baseline IG (n = 97) CG (n = 61)	59.4 (n = 142)	73.4 (n = 168)
M1 IG (n = 53) CG (n = 42)	77.8 (n = 186)	81.7 (n = 187)
M2 IG (n = 50) CG (n = 39)	79.1 (n = 189)	83.0 (n = 190)

In *Phase IIc* the target population for observation consisted of those nurses who were working in HHC and took care of patients with VLU. The target population consisted of 239 nurses and 24 patients in the IG and 229 nurses and 16 patients in the CG who met the inclusion criteria. Consent for observations was received from 9 nurses and patients in the IG and from 7 nurses and patients in the CG. In the IG three VLUs healed before M0. During M0, all ulcers were screened, and one ulcer from both

groups was excluded during M0 because it was not VLU. This left 5 VLU nursing care situations for observation at M1 and M2 (Figure 4.). Nurses in the IG were 27 to 45 years and they had 4 months to 8.5 years' experience in social and health care. Working experience in HHC was 3 months to 8.5 years while experience in VLU nursing care ranged from 3 months to 6 years. None of the nurses in the IG had updating education in VLU nursing care. Nurses in the CG were 25 to 56 years old and they had 2.5 years to 30 years' experience in social and health care. Working experience in HHC ranged from 2 years to 30 years and experience in VLU nursing care 2 years to 19 years. All the nurses in the CG had updating education in VLU nursing care. (Table 12)

Patients in the IG weighed from 48 kg to 103 kg, the ulcer diagnosis was known in one patient, and first occurrence of VLU in two. Topical care decision was made by a physician in the case of two VLUs, and the costs of three VLU topical care supplies were paid by the health care organization. Patients in the CG weighed from 48 kg to 90.6 kg, ulcer diagnosis was known in three patients and first occurrence in two. Topical care decision was made by a physician in the case of one VLU, and the costs of all five VLU topical care supplies were paid by the patient. MNA -scores varied from 9 to 11 in the IG and from 8 to 10 in the CG. (Table 13)

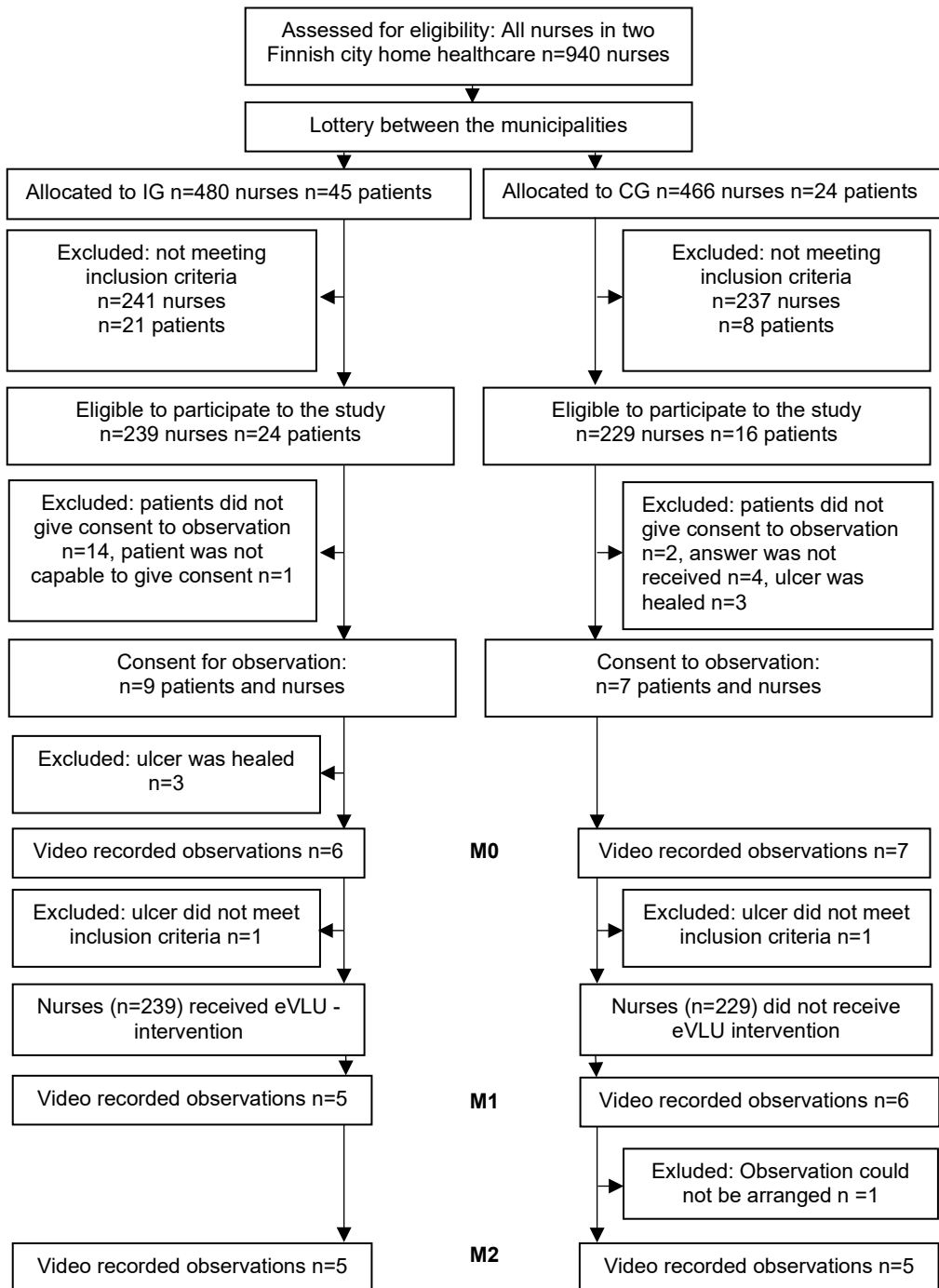


Figure 4. Participant flowchart through the observations.

Table 12. Demographics of the nurses in the observations.

	Intervention group					Comparison group				
	1	2	3	4	5	1	2	3	4	5
Age	27	37	45	20	28	25	50	56	55	38
Profession	RN	LPN	LPN	LPN	LPN	PHN	LPN	LPN	LPN	LPN
Graduation year	2009	2014	2006	2013	2005	2012	2003	2000	1993	2008
Total working experience in social and health care	4 y	4 m	8 y	1.5 y	8.5 y	2.5 y	28 y	30 y	6 y	6 y
Working experience in HHC	2.5 y	3 y	5 y	1.5 y	8.5 y	2.5 y	28 y	30 y	2 y	2.5 y
Experience in treating patients with VLU	3 y	3 m	5 y	1 y	6 y	2.5 y	19 y	10 y	2 y	6 y
Updating education about VLU nursing care	No	No	No	No	No	Yes	Yes	Yes	No	Yes

RN =Registered Nurse, LPN = Licensed Practical Nurse, PHN = Public Health Nurse, y = years, m = months

Table 13. Demographics and clinical situation (PCS) of the patients in the observations.

	Intervention group					Comparison group				
	1	2	3	4	5	1	2	3	4	5
Gender	F	M	F	F	F	F	M	F	F	F
Weight	55	87	63	103	48	60	90.6	78	48	64
Height	160	190	Na	164	161	164	180	172	159	166
Ulcer diagnosis	Yes	No	No	No	No	No	Yes	Yes	No	Yes
Ulcer location	Leg	Leg	Leg	Leg	Leg	Leg	Leg	Leg	Leg	Leg
Ulcer duration	4-6 m	7-12 m	1-3 m	na	1-3 m	> 5 y	1- 2 y	> 5 y	1-3 m	1-3 m
Ulcer first occurrence	na	na	11.7.-14	na	7.7.-14	na	na	04/14	na	04/-14
Topical treatment decision	PH	LPN	PH	TVN	RN	PH	PHN	PHN	PHN	RN
Supply cost payment	O	O	P	O	P	P	P	P	P	P
MNA -score	10	9	na	na	10	na	10	9	8	na

F = Female, M= Male, y = years, m = months, Na = not available, RN = Registered Nurse, LPN = Licensed Practical Nurse, PHN = Public Health Nurse, PH=Physician, TVN= Tissue Viability Nurse, P = Patient, O = Organization

4.2 The eVLU intervention and its implementation

In this chapter the eVLU intervention development, its content and content evaluation, piloting and implementation are described. The intervention development was carried out to fulfill the criteria for reporting, development and evaluation of complex interventions in health care (CReDECI) (Möhler et al. 2012).

eVLU was based on cognitive-constructive learning theory which declares that each individual constructs his own meaning out of new information. Communication with others is needed as learning is seen as social activity. Environmental conditions influence learning and teacher's instructions and feedback are needed to promote learning. New learning is built upon previously learned knowledge. Learning is recommended to be divided into smaller parts which can be easily understood. (Dewey 1938, Neisser 1967, Dewey 1970). The assistance of experts in information systems, TVN and a physician specialized in VLU care was utilized in eVLU development. In the literature review, no previously published CE programs about VLU nursing care nor any other field close to it that could be used were found.

Development of eVLU started by assessing learning needs, which were understood as gaps in knowledge and skills in VLU nursing care found in the integrative literature review 1. Gaps were identified in VLU pathophysiology and etiology, assessment, healing process, infection, topical care, dressings and compression treatment (Paper I). These gaps constituted the structure of the eVLU (Paper III). eVLU comprised face-to-face and e-learning activities (Whitelock & Jelfs 2003, Graham 2013, Richards 2015) and it started with a one-hour face-to-face briefing for RNs, PHNs and HHC district managers. The briefing was designed to educate participants on how to use eVLU. After the briefing, internet-based learning with group discussions in HHC teams was utilized for 6 weeks. It was based on case description of an HHC patient with VLU (Figure 6.) which was constructed based on a real-life HHC patient case. The case description was completed with a TVN and nurses working in HHC.

The objectives for e-learning in eVLU were that nurses know: the etiology and physiology of the VLU and the effects of the VLU for patients and their lives, the principles of VLU healing, the factors affecting VLU healing and how to carry out assessment of the ulcer and its healing, when ulcer is infected, when to take a bacterial sample from the ulcer and how to do it correctly, the principles of topical care of the VLU, and the use appropriate tools and ulcer care products in nursing care and the principles of compression treatment and its correct use. (Figure 5)

The eVLU included 6 weekly themes with learning goals and tasks to achieve them. WWW-links to the EB material were included in the eVLU. (Table 14 and 15, Figure 7) Each weekly module opened on Monday and weekly tasks were returned at the end of each week (Figure 5). Once each weekly theme opened, nurses could study the content until the end of the 6th week. The instruction was that one answer

should be returned by every HHC team studying in eVLU each week. There were two to four teams in every HHC district. Nurses answered the weekly tasks in teams of 8 – 12 nurses, depending on the HHC district. One member from each team posted the answer in Moodle at the end of each week. The researcher downloaded all the eVLU material to Moodle before the eVLU was implemented, including model answers to each week's tasks. The model answers were opened after the nurses had returned their answers. Nurses were guided to compare their answer to the model answer and ask for more guidance if needed. The researcher also gave common feedback to nurses after each week.

The content of the eVLU included EB material already available on the internet (Table 14). eVLU also included the Pressure Ulcer Scale for Healing (PUSH -Tool 3.0) instrument (National Pressure Ulcer Advisory Panel (NPUAP) 1997, Thomas et al. 1997) for nurses to help learning to assess VLU healing (Paper II). PUSH Tool 3.0 is a generic instrument that provides an evidence based, consistent and quick method for tracking and reporting ulcer healing progression over time. Commonly used clinical parameters for ulcer healing (length, width, amount of exudate and tissue type) are used to monitor it. PUSH Tool 3.0 has been found to be responsive to PUs, VLUs and diabetic foot ulcers (DFUs) (Thomas et al. 1997, Santos et al. 2007, Hon et al. 2010). NPUAP holds the copyright to PUSH Tool 3.0, but it is free to use for research, practice and education purposes. "Version Number" of the tool and NPUAP as the reference must be mentioned. NPUAP invites users to fill the PUSH Tool Users Registration Form and send it to NPUAP; this helps them monitor the use of the PUSH Tool and observe the needs of PUSH Tool users. (NPUAP 2014.) Permission to use and translate PUSH Tool 3.0 into Finnish for this study was obtained from NPUAP (Table 24.). In eVLU nurses were taught to use PUSH Tool 3.0 in VLU assessment. It was possible, and permitted, to download and print the instrument.



Tarkoitus:

Kurssin aikana on tarkoitus oppia potilaan hoidon kokonaisuus tapauskuvauksen ja siihen liittyvien viikoittaisten kysymysten ratkaisemisen avulla. Kurssin materiaali perustuu Internetissä olevaan ennalta määriteltyyn materiaaliin ja kaikkien materiaalien käyttöluupa on asianmukaisesti hankittu.

Tavoitteet:

Oppijat tietävät:

1. laskimohaavan etiologian ja fysiologian ja haavan vaikutukset potilaaseen ja hänen elämäänsä
2. laskimohaavan paranemisen periaatteet
3. paranemiseen vaikuttavat tekijät ja osaavat arvioida haavaa ja sen paranemista
4. milloin haava on infektoitunut
5. miten haavasta otetaan bakteeriviljelynäyte ja he osaavat ottaa sen oikein
6. laskimohaavan paikallishoidon periaatteet ja käyttävät työssään asianmukaisia välineitä ja haavanhoitotuotteita
7. kompressiohoidon periaatteet ja osaavat käyttää kompressiohoitoa oikein työssään

Toteutus:

Kurssi etenee siten, että kurssin kokonaisuudet 1 - 3 ovat avoimna helmi-huhtikuun ajan ja kokonaisuudet 4 - 6 ovat avoimna maaliskuu-huhtikuun ajan 30.4.2015 saakka.

Kurssin jokaisella viikolla on omat kysymykset, joihin vastataan lähdemateriaalin avulla. Vastaukset tallennetaan tänne Moodleen kysymysten yhteydessä avautuvaan palautusosioon.

Tarkoituksena on, että työskentelette ryhmässä. Oma kotihoidon tiimisi on se ryhmä, johon kuulut. Sopikaa ryhmässä, kuka tallentaa viikoittaiset vastaukset kullakin viikolla. Muistakaa merkitä lähde, johon ryhmänne vastaus perustuu. Pyrkikää tiiviisiin, yhden/kahden sivun mittaisiin vastauksiin. Miettikää, mikä on oleellisinta ja tärkeintä kunkin viikon teemassa ja kysymyksiin vastaamisessa.

- Kun aloitatte työskentelyn, niin huomioikaa, että materiaalin käyttö on ohjeistettu erikseen tekstissä ennen varsinaista materiaalia; esimerkiksi Käypä hoito -suosituksista ohjeistetaan tutustumaan eri kappaleisiin eri viikoilla.
- Haavan arviointiin käytettävä PUSH-Tool 3.0:n käytön opetteleminen on osa kurssia, joten tulostakaa lomakkeita ja käyttäkää sitä arviointivälineenä hoitaessanne potilaita, joilla on haava. Tämä työväline soveltuu painehaavojen, diabeettisten haavojen ja laskimohaavojen paranemisen arviointiin.
- Voitte lisäksi käyttää Avoimen haavan VPKM -väriluokituskomaketta kurssin aikana haavan tilan arvioinnissa ja päätettäessä hoitoperiaatteista. Lähde: Suomen haavanhoitoyhdistys ry.

Arviointi:

Ohjaaja tallentaa mallivastauksen kunkin viikon kysymyksiin Moodleen. Voitte verrata omaa vastaustanne mallivastaukseen.

Figure 5. The instructions in eVLU.

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Martan haavan hoito

Martan haava hoidetaan kotihoidon hoitajan toimesta kaksi kertaa viikossa. Martan luona käyvät hoitajat vaihtuvat usein. Aamuisin kotihoidon hoitaja huolehtii Martan lääkityksestä (Paratabs, Orloc, Furesis).

Martan haavanhoidossa käytettävät tuotteet on valittu kotihoidon hoitajan arvioinnin perusteella ja Marta on kuullut, että ohjeet on kirjattu hänen potilastietoihinsa. Martan kotona ei ole haavanhoito-ohjetta. Usein on käynyt niin, että Marta on kertonut hoitajille, miten haavaa hoidettiin edellisellä kerralla.

Haavan paikallishoitoon käytettävät tuotteet säilytetään Martan kotona. Tuotekoriin on kerääntynyt erilaisia haavanhoitotuotteita ja hoitaja saattaa käyttää viikon ensimmäisellä kerralla yhtä tuotetta ja toisella kertaa toista. Marta on huomannut, että toinen tuote imee eritettä paremmin ja kertonut sen hoitajalle ja toivonut, että juuri sitä tuotetta käytettäisiin.


Marta oppi omassa työssään aseptica työskentelyä ja tottui käyttämään käsidesinfektioainetta ja tarvittaessa suojaimia. Tästä syystä hän ihmetellyt sitä, ettei hänen kotiinsa ei ole tuotu käsidesinfektiopulloa, mutta kertakäyttöisiä suojaesiliinoja hoitaja toi heti kun sovittiin, että kotihoidon hoitajat hoitavat haavaa.

Haava hoidetaan siten, että Marta lepää vuoteessaan. Haavan hoitamisen jälkeen on käynyt niin, että Marta joutuu vaihtamaan lakanat; vuode on soikeutunut haavan eritteestä tai haavan puhdistusaineesta.

Haavan puhdistaminen on hoidon kivuliain vaihe ja Marta on usein pyytänyt kipulääkettä ennen haavanhoitoa, mutta hoitajalla on yleensä ollut niin kiire, että kipulääke ei ole ehtinyt vaikuttaa ennen kuin haavaa on alettu puhdistamaan. Jotkut hoitajat laittavat kipua lievittävää voidetta haavaan ja Marta kokee, että se on paras keino kivunlievityksessä. Haavaa ympäröivä ihon kutinaan Marta toivoisi jotain apua.

Haavanhoitopäivinä Marta jännittää aina kovasti haavanhoitoa ja koko päivä menee joko hoitajan odottamiseen tai sitten haavanhoidosta aiheutuvasta kivusta selviämiseen. Martan molemmat jalat ovat erittäin turvonneet ja Marta on jo pitkään miettinyt sitä, miten saisi apua turvotukseen. Marta oli työpaikassaan huomannut, että niille potilaille, joilla oli turvotusta jaloissa, puettiin jonkinlaiset sidokset. Sen tarkemmin Marta ei sidoksista tiedä, mutta huomasi, että sidosten avulla potilaiden liikkuminen helpottui. Marta oli kysynyt aikaisemmin kotihoidon hoitajalta mahdollisuutta "sellaisiin sidoksiin" ja hoitaja oli luvannut selvittää asiaa, mutta asiaan ei enää pelattu. Marta ajatteli, ettei halua vaivata kiireistä hoitohenkilökuntaa enempää ja päätti olla kyselemättä asiasta lisää.

[+ Lisää aktiviteettiä tai aineisto](#)

[+](#) **Laskimohaavan fysiologia ja etiologia**  Muokkaa ▼

Rajoitettu Ei saatavilla, jollei:

- 1 helmikuu 2015, 07:00 jälkeen (muuten piilotettu)
- Ennen 30 huhtikuu 2015, 23:00 (muuten piilotettu)

Tarkoitus:

Kurssin ensimmäisen viikon aikana opitaan:

- minkälainen on ihon normaali rakenne
- miten ikääntyminen vaikuttaa ihoon
- miten laskimohaava syntyy (etiologia ja fysiologia)
- miten laskimohaava vaikuttaa potilaan elämään.

Tavoitteet:

Oppijat tietävät:

Figure 6. The eVLU case-description.

Table 14. The eVLU content; themes and materials

	Theme	Material
week 1	VLU recognition and pathophysiology	<ul style="list-style-type: none"> • Chronic Leg Ulcers: Current Care Guidelines (2014). Definition, Incidence, Clinical examination of the patient with ulcer. • Ellonen (2010). Evidence-based Medicine Guidelines: How to use Doppler device and how to carry out ABPI measurement. • Hospital District of Southwest Finland (2014): Care Chain for chronic ulcer; pictures of VLUs. • Lower extremity venous insufficiency: Current Care Guidelines (2010): Incidence and Pathophysiology. • Skin Federation (2014): the structure of healthy skin, ageing skin guidance book. • Viljamaa (2014): Evidence-based Medicine Guideline: Calculating ABPI.
week 2	VLU healing and assessment of healing process	<ul style="list-style-type: none"> • Chronic Leg Ulcers: Current Care Guidelines (2014). Pain treatment. • Finnish Medical Society Duodecim (2014). ABC-Online course about wounds: the process of wound healing. • EWMA (2008). Hard-to-heal wounds: a holistic approach. EWMA Position Document. Finnish translation by Finnish Wound Care Society (FWCS). • WUWHS (2004). Minimizing Pain at Wound Dressing-related Procedures. A European Consensus Document. Finnish translation by FWCS. • Siljamäki-Ojansuu (2014). Evidence-based Medicine Guideline: Evaluation of Energy, Nutrients and Nutrition among Patients with Chronic Leg Ulcer. • The National Nutrition Council (2010). Nutrition Recommendations for Elderly People: Special questions about elderly nutrition. • Vainio (2009). Evidence-based Medicine Guideline. Can pain be measured?
week 3	Assessment of VLU infection	<ul style="list-style-type: none"> • Chronic Leg Ulcers: Current Care Guidelines (2014). Bacterial sample, using antibiotics in wound care. • EWMA (2006). Management of Wound Infection: criteria for wound infection, what is a wound infection, taking care of a wound infection. Finnish translation by FWS. • Finnish Medical Society Duodecim (2014). ABC-Online course about wounds: video about how to take a bacterial sample and pictures of infected and non-infected wounds • Finnish Medical Society (2012). Basics about infection control. • Hospital District of Southwest Finland (2014a). Taking a bacterial sample from the wound.

	Theme	Material
week 4	Principles of VLU topical care	<ul style="list-style-type: none"> • Chronic Leg Ulcers: Current Care Guidelines (2014). Topical care, removal of necrotic tissue, cleansing the wound. • Finnish Medical Society Duodecim (2007). Principles of infection prevention. • Hospital District of Southwest Finland (2014a). Video about cleansing the wound. Topical care. • Tiitinen & Terho (2012). Secretion disinfection. Handbook for Nurses. Finnish Medical Society.
week 5	VLU topical care products and dressings	<ul style="list-style-type: none"> • Chronic Leg Ulcers: Current Care Guidelines (2014). Classification of topical care products based on the appearance of the wound, pictures and table of principles of choosing the products and dressings. • EWMA (2006). Management of Wound Infection: using silver –dressings. • Hietanen (2012 a, b). Conservative care of leg ulcers. Topical care of leg ulcers. Handbook for Nurses. Finnish Medical Society. • Hospital District of Southwest Finland (2014 a). Classification of wound care products and choosing products and dressings.
week 6	Compression treatment	<ul style="list-style-type: none"> • Chronic Leg Ulcers: Current Care Guidelines (2014). Prevention of edema, compression techniques, compression stockings. • EWMA (2005). Understanding compression therapy. Position Document. Finnish translation by FWS. • Society Duodecim (2014). ABC-Online course about wounds: video about compression treatment. • FWCS (2012a, b). How to use light elasticity compression bandages. How to use high or moderate compression bandages. • Hospital District of Southwest Finland (2014b.) Instruction for light elasticity compression bandages. Instruction for high or moderate compression bandages. • Lower extremity venous insufficiency: Current Care Guidelines (2010). Compression stockings.

The material used in eVLU was available to all nurses before and after the eVLU was implemented. Some of the material is freely available on the internet and some of it is available to health care organizations for a fee (Online courses, Handbook for nurses). Permissions to use eVLU materials were obtained from the owners or publishers (Table 24). The first week of eVLU was the basis of VLU nursing care. However, each of the six weeks could be considered as independent entities.

The pilot test of the eVLU was conducted in one municipality HHC (n=8 nurses) on 3. Apr 2014 over three hours from 1 pm to 4 pm (Feeley & Cossette 2015). The researcher informed the managers of the pilot municipality at a ward nurses’ meeting

24. Feb 2014. Nurses signed consent forms. The population in the pilot test was representative of the target population in terms of educational level and organization. In pilot test, nurses completed eVLU in pairs; two pairs completed weeks 1 and 2, one pair completed weeks 3 and 4 and one pair completed weeks 5 and 6. All the nurses were told to familiarize themselves with the instructions in eVLU before starting to study. The pilot test included asking nurses' opinions about eVLU feasibility and possible needs for changes in any of its components. Nurses' opinions were asked with a paper format questionnaire developed by the researcher. Based on the feedback nurses considered the eVLU easy to use and that it would help them in their daily VLU nursing care (Table 16).

Three of the 8 nurses gave comments in the open space at the end of the questionnaire:

- “It was sometimes difficult to open the links because you had to check the instructions on how to find them. “
- “An interesting entity, a lot of good references.”
- “There was a lot of information. Studying on the internet is not familiar, finding the answers was challenging. The education is interesting and clear.”

eVLU was evaluated based on the pilot test results and changes were not needed.

Table 15. The eVLU themes, purposes and weekly tasks.

	Theme	Purpose	Aim: nurses know:	Tasks (questions)
WEEK 1	VLU recognition and pathophysiology	To learn: the normal skin structures how does aging affect the skin how VLU develops and affects patient's life	what is the normal skin structure, what is the cause of VLU, how to palpate pedal pulses and measure ABPI	What would you do to find out the cause of Martta's ulcer? Why is it important to find out the cause of the ulcer? What can you figure out about the cause of the wound based on the picture and clinical description?
WEEK 2	VLU healing and assessment of healing process	To learn: VLU healing principles what affects VLU healing how to evaluate VLU healing	how VLU affects the patient, what affects VLU healing, how to evaluate VLU healing and they know to implement these in their work	How can you evaluate the effects of Martta's nutrition on VLU healing? How and with what tools would you estimate the healing of the VLU?
WEEK 3	Assessment of VLU infection	To learn: to evaluate an infected ulcer to take a bacterial sample form the ulcer	when the ulcer is infected, when to take a bacterial sample from the ulcer, how to take a bacterial sample and how to implement these in their work	What can you figure out from changes in Martta's ulcer; increased pain and exudate, that smells bad? What do these symptoms mean for ulcer healing? What actions does this change in Martta's ulcer require from you? When will you take a bacterial sample from Martta's ulcer? How do you take the bacterial sample?
WEEK 4	Principles of VLU topical care	To learn: the principles of VLU topical care	how to work aseptically during VLU nursing care, how to cleanse VLU and how to implement these in their work	Explain what aseptic working means during VLU care. Martta's infection has healed and it is in the same condition as it was during the first week. Describe how you would cleanse the VLU.
WEEK 5	VLU topical care products and dressings	To learn: the principles of VLU topical care	the principles of how to choose topical care supplies and they can choose the right supplies for each patient and justify their choices	Describe what information nurses need to decide about topical care of Martta's VLU. What would be the best choice for topical care in Martta's VLU? Please, justify your choice.
WEEK 6	Compression treatment	To learn: the principles of compression treatment	the principles of compression treatment, how to carry out compression treatment and they know how to implement this in their work	How would you treat Martta's swollen legs? Describe the principles of compression treatment.

+ Laskimohaavan paraneminen ja paranemisen arviointi ✎

Muokkaa ▾

Rajoitettu Ei saatavilla, jollei:

- 1 helmikuu 2015, 07:00 jälkeen (muuten piilotettu)
- Ennen 30 huhtikuu 2015, 23:00 (muuten piilotettu)

Tarkoitus:

Tällä viikolla opitaan

- laskimohaavan paranemisen periaatteita
- mitkä asiat vaikuttavat haavan paranemiseen
- miten voidaan arvioida laskimohaavan paranemista.

Tavoitteet:

Oppijat tietävät:

1. miten laskimohaava vaikuttaa potilaaseen (kipu, haju, erityis) ja huomioivat ne työssään
2. laskimohaavan paranemisen periaatteet
3. mitkä asiat vaikuttavat haavan paranemiseen
4. miten haava paranemista arvioidaan ja osaavat käyttää arviointimenetelmiä työssään

LÄHTEET:

- **Haavan paraneminen** -linkin kautta pääset Duodecim oppiportti -pääsivulle, minkä kautta löydät Haavojen ABC-verkkokurssin, missä on kuvattuna tiivistetyssä muodossa haavan paranemisen vaiheet ja paranemiseen vaikuttavat tekijät. Lähde: Duodecim, oppiportti 2014.
- **Huonosti paranevat haavat - holistinen näkökulma - dokumentista** voit opiskella paranemiseen vaikuttavista tekijöistä. Lisäksi selviää minkälaisia psykososiaalisia tekijöitä ja liittyy hitaasti paraneviin haavoihin ja miten paljon ne aiheuttavat kustannuksia. Lähde: Suomen haavanhoitoyhdistys ry 2008. Suomen haavanhoitoyhdistyksen asiantuntijat ovat kääntäneet dokumentin European Wound Management Associationin luvalla.
- **Ikääntyneiden ravitsemussuosituksista** selviää ikääntyneen ravitsemuksen keskeiset huomioitavat asiat. Haavan vaikutuksia ikääntyneen ravitsemukseen käsitellään kappaleessa ikääntyneen ravitsemuksen erityiskysymykset. Lähde: Valtion ravitsemusneuvottelukunta 2010.
- **Energian, ravintoainneiden ja ravinnonsaannin tarpeen arviointi potilaalla, jolla on krooninen alaraajahaava** -linkin kautta avautuu artikkeli, missä käsitellään potilaan ravitsemuksen osalta keskeisimpiä asioita. Lähde: Siljamäki-Ojansuu 2014, Duodecim Käypä Hoito, artikkeli nix02036
- **Krooninen alaraajahaava** -linkin kautta tällä viikolla tutustutaan kappaleeseen Alaraajahaavapotilaan muu hoito, kivun hoito. Lähde: Duodecim, Käypä hoito -suositus 2014, artikkeli hoi50058
- **Kivun vähentäminen haavanhoidossa** - linkin kautta avautuu kivun hoitoon keskittyvä Haava-lehti, missä käsitellään parhaita hoitokäytäntöjä kivun minimoinnissa haavanhoitotoimenpiteiden yhteydessä. Lähde: Suomen Haavanhoitoyhdistys ry 2004.
- **Voiko kipua mitata** -linkin kautta avautuu kivun mittaamista käsittelevä artikkeli. Lähde: Vainio 2009, Duodecim artikkeli kha00025.

Figure 7. An example of the purpose and goals of the second week in eVLU.

Table 16. Nurses' (n=8) feedback on eVLU in pilot test.

Items	Totally disagree n (%)	Somewhat disagree n (%)	Neither disagree nor agree n (%)	Somewhat agree n (%)	Totally agree n (%)	Mean
1. The model answer from educator is a good way to give feedback	0 (0)	0 (0)	0 (0)	0 (0)	8 (100)	5.00
2. Working on the internet advanced my learning of VLU nursing care	0 (0)	0 (0)	0 (0)	1 (12.5)	7 (87.5)	4.87
3. The weekly tasks made it possible to deepen my knowledge and skills in VLU nursing care	0 (0)	0 (0)	0 (0)	2 (25.0)	6 (75.0)	4.75
4. I can utilize eVLU studies in developing my expertise in VLU nursing care	0 (0)	0 (0)	1 (12.5)	1 (12.5)	6 (75.0)	4.62
5. The content of eVLU was adequately challenging	0 (0)	0 (0)	0 (0)	3 (37.5)	5 (62.5)	4.62
6. The content in the eVLU was professionally interesting	0 (0)	0 (0)	0 (0)	2 (25.0)	6 (75.0)	4.50
7. Returning tasks to eVLU was easy	0 (0)	0 (0)	0 (0)	4 (50.0)	4 (50.0)	4.50
8. The timetable of the eVLU was suitable	0 (0)	0 (0)	3 (37.5)	2 (25.0)	3 (37.5)	4.00
9. eVLU worked technically well	0 (0)	0 (0)	1 (12.5)	3 (36.5)	4 (50.0)	4.37
10. Information about eVLU timetable was easy to find	0 (0)	0 (0)	2 (25.0)	1 (12.5)	5 (62.5)	4.37
11. I found the needed information through eVLU	0 (0)	0 (0)	1 (12.5)	4 (50.0)	3 (37.5)	4.25
12. The layout of the eVLU was clear	0 (0)	2 (25.0)	0 (0)	3 (37.5)	3 (37.5)	3.87
Mean						4.47
13. I would have needed more guidance	0 (0)	5 (62.5)	1 (12.5)	2 (25.0)	0 (0)	2.62

Scale 1 = Totally disagree, 2 = Somewhat disagree, 3 = Neither disagree nor agree, 4 =Somewhat agree, 5= Totally agree

4.3 Data collection instruments and procedures

In Phase I, data were collected with a systematic and comprehensive electronic literature search in September 2013. Three electronic databases Medline, CINAHL and COCHRANE were used. (Table 1) Inclusion and exclusion criteria were systematically applied in evaluating the literature. No limitations on study design or time were made. (Paper I) The search was updated for the summary with a search covering the period 2013 – May 2019.

In Phases IIa and IIb, data were collected systematically applying inclusion and exclusion criteria in the literature review from Medline database in spring 2013. In Phase IIa literature review data was used for outcome data collection instrument development and in Phase IIb, it was used for eVLU intervention development. Literature searches were updated in 15. May 2019 for the summary. (Table 1)

In Phase IIc, 6 different instruments were used in this study according to the research questions: 1) instrument for sample determination including MNA screening, 2) instrument for nurses' demographic information 3) instrument for contextual factors in VLU nursing care, 4) instrument for professional practice environment 5) instrument for assessment of ulcer characteristics, and 6) two instruments measuring the outcomes of eVLU intervention (Figure 8).

At M0, background data were collected for sample determination including patients' clinical situation and nutritional status. In addition to this, data about for nurses' demographics, contextual factors in VLU nursing care and professional practice environment and ulcer characteristics were collected. (Table 17)

Table 17. Background variables and instruments in the study Phase IIc.

Variable	Purpose	Instrument	Number of items	Scale
Patients' clinical situation and demographics	Sample determination	PCS	12	Different scales according to the item
Patients' nutritional status	To compare the patients' nutritional status between IG and CG	MNA -screening	6	Normal nutritional status (12-14), At risk of malnutrition (8-11), Malnourished (0-7)
Nurses' demographics	To compare the nurses' demographics between IG and CG	Items at M0 in the first pages of PKAK	8	Different scales according to the item
Contextual factors in VLU nursing care	To compare the contextual factors in VLU nursing care between IG and CG	Items at M0 in the first pages of PKAK	15	Totally disagree (1) – Totally agree (4)
Professional Practice Environment	To compare the contextual factors between IG and CG	RPPE	39	Strongly disagree (1) – Strongly agree (4)
Ulcer characteristics	To monitor ulcer status at M0	Ulcer analysis	7	Different scales according to the item

PCS = Patients Clinical Situation instrument, MNA = Mini Nutritional Assessment PKAK = Perceived Knowledge, Attitudes and Knowledge evaluation - instrument, RPPE = Professional Practice Environment Scale

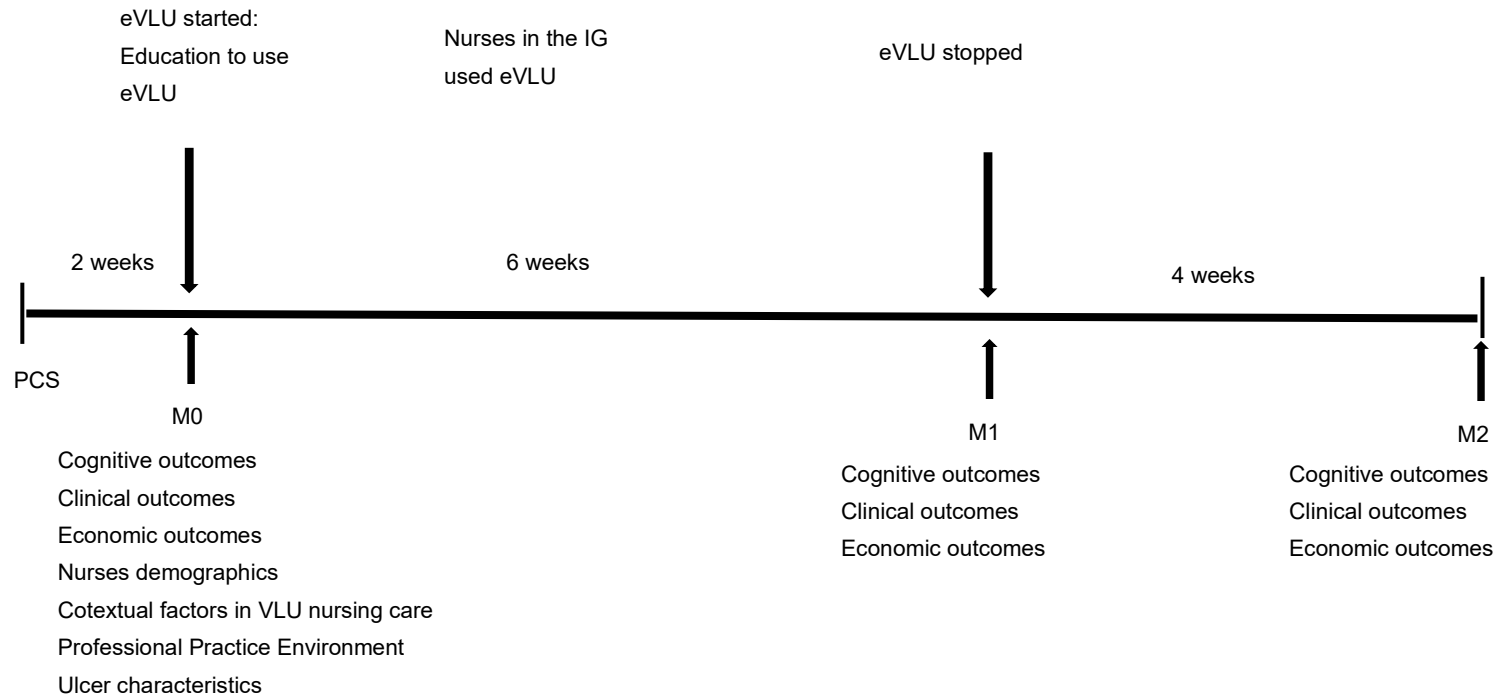


Figure 8. Data collection.

At M0, patients' clinical situation was evaluated with the *Patient Clinical Situation* (PCS) instrument developed for this study (Figure 8). PCS included items about patients' demographics. Development of the instrument was needed because information about all patients with VLU could not be obtained from patient records, for example. The reason for this is that VLU is not a diagnosis; it is a manifestation of venous insufficiency (Chronic leg ulcers: Current Care Guidelines 2014, Mooij & Huisman *et al.* 2016). However, not every patient with venous insufficiency diagnosis has a VLU and not every VLU has a definitive diagnosis (Guest *et al.* 2017). The PCS was based on EB guidelines of VLU nursing care (Chronic Leg Ulcers: Current Care Guidelines 2014) and experts on VLU nursing care were consulted during the development. The PCS consisted of information about patients: 1) weight, 2) length, 3) ulcer location 4) ulcer diagnosis, 5) ulcer duration, 6) first occurrence of the ulcer, whether it is known 7) who has decided what products are used in topical care 9) who pays for the topical care products, and 10) MNA scores. PCS included *MNA® screening* (Mini Nutritional Assessment) (Guigoz 2006, Vellas *et al.* 2006) at M0 because nutritional status has an important impact on ulcer healing (Chronic leg ulcers: Current Care Guidelines 2014) (Paper II). The MNA® was originally developed in 1989 and it has been used in hundreds of studies in many settings and countries. MNA® has been translated into more than 20 languages. An MNA® screening score 12-14 identifies patients with a normal nutritional status while scores 8-11 identify patients at risk of malnutrition, and scores 0-7 identify malnourished patients (Guigoz 2006, Vellas *et al.* 2006.) (Table 17)

RNs in HHC were asked to complete the PCS including MNA for all their patients who had an ulcer in the leg. Nurses were given a paper-format PCS and envelope with the researcher's home address and stamp. PCSs were returned to the researcher by post. All nurses who took care of patients with a chronic ulcer in the lower leg according to the PCS were included in the study. For observations researcher checked the PCS data and contacted nurses if the patient had an ulcer in the lower leg. Nurses were asked to deliver the research handout and consent form for observations to these patients.

At M0 *nurses' demographics* were requested including: 1) profession, 2) year of graduation, 3) age, 4) length of work experience in social and health care, 5) work experience in HHC, 6) experience in taking care of patients with VLU, 7) CE about VLU nursing care. At M0, 9 items of *contextual factors* (Graham *et al.* 2001, Van Hecke *et al.* 2009) about communication and involvement in VLU nursing care were included in the first pages of the PKAK instrument to find out possible differences in VLU nursing care between IG and CG. These included nurses' experience of their education about VLU nursing care, communication and involvement and work organization. (Paper III)

At M0, the *Professional Practice Environment* (RPPE) -scale was used to find out possible differences in professional practice environments between IG and CG. With RPPE it is possible to measure nurses' perception of their professional clinical practice environment and it can be used in many health care settings. In RPPE, professional practice environment is defined as an organizational culture that advances nurses' and other health care professionals' clinical practice. Collaborative decision-making is the theoretical foundation of professional practice environment meaning that all stakeholders could participate in changes. The RPPE includes 8 subscales with 39 items. The 8 subscales are: 1. Leadership and autonomy over practice, 2. Staff relationship with physicians, 3. Control over practice, 4. Communication about patients, 5. Teamwork, 6. Handling disagreement and conflict, 7. Internal work motivation and 8. Cultural sensitivity. Results from psychometric evaluation show the subscales to be reliable and construct valid for use as independent dimensions of professional practice environments. It takes about 10 minutes to complete RPPE. (Ives Erickson *et al.* 2009, Yvonne and Munn Center for Nursing Research 2011.) The RPPE has been translated into Finnish by Suhonen (Reported in Charalambous *et al.* 2010). (Paper III, Table 17)

At M0 observation, *ulcer characteristics* were evaluated (Table 18). The instrument was developed for the purposes of this study with experts in VLU nursing care (a TVN and vascular surgeon). This information was needed to ensure that the observed ulcers were VLUs.

Table 18. Ulcer characteristics; clinical evaluation of the ulcer in the leg.

Item	Answer options
1. The location of the ulcer	1. Lower leg, 2. Somewhere else, where?
2. Ulcer bed	1. Dry, 2. Wet, secretion
3. Ulcer appearance	1. Epithelial, 2. Granulation, Fibrin, 2. Necrotic
4. Stasis eczema	1. Yes, 2. No
5. Varicose veins	1. Yes, 2. No
6. Surrounding skin	1. Lipodermatosclerosis (hard skin), 2. Pigmentation, 3. Atrophie blanche, 4. Something else, what?
7. Ulcer size	1. Length, 2. Width, 3. Depth

In *Phase IIc*, data for evaluating the effectiveness of eVLU were collected from September 2014 to December 2014 (Figure 8). The data comprised cognitive, clinical and economic outcomes. Nurses' perceived and theoretical knowledge were primary cognitive outcomes. All other outcomes were secondary. Outcome data were collected three times during the study: at baseline (M0) before eVLU implementation, at six weeks (M1) and at 10 weeks (M2) with the PKAK instrument

(Graham *et al.* 2001, Van Hecke *et al.* 2009) and the observation checklist (OC) (Ribu *et al.* 2003) partly modified and developed for this study. (Table 19)

Table 19. Outcome variables and instruments used in study Phase IIc

Outcome		Variable	Instrument	Number of items	Scale
Primary	Cognitive	Perceived knowledge	PKAK	28	Totally disagree (1) - Totally agree (5)
Primary	Cognitive	Theoretical knowledge	PKAK	65	Wrong (1) - Right (2) - Don't know (3)
Secondary	Cognitive	Attitudes	PKAK	4	Totally disagree (1) - Totally agree (5)
Secondary	Clinical	Skills	OC	13	Right - Wrong
Secondary	Clinical	VLU size	Paper ruler	1	Centimeter - Millimeter
Secondary	Economic	Cost	OC	4	Euro
Secondary	Economic	Cost	Clock	1	Minutes

PKAK = Perceived knowledge, Attitudes and Knowledge evaluation -instrument

OC = Observation checklist

Data about *cognitive outcomes* were collected with the Perceived Knowledge, Attitudes and Knowledge -instrument (PKAK) partly developed for this study. Data collection was conducted in a quiet environment with either the researcher or research assistant present. Nurses completed and returned the paper version of PKAK.

The PKAK instrument was based on the instrument of Graham *et al.* (2001) also used by Van Hecke *et al.* (2009) in terms of nurses' perceived knowledge and attitudes. The knowledge test items were developed for this study in 2012-2013 according to EB guidelines (Chronic Leg Ulcers: Current Care Guidelines 2014) and the Phase I literature review. (Table 1) Permission to use and revise the original instruments was obtained (Table 24) and they were translated and back translated from Flemish (Van Hecke *et al.* 2009) and English (Graham *et al.* 2001) into Finnish (Sousa & Rojjanasrirat 2010). Additional items in perceived knowledge were added to ensure that the items in the knowledge test have corresponding items in the perceived knowledge section. The scale in perceived knowledge and attitudes was a five-point Likert -scale; 1 = totally disagree, 2 = somewhat disagree, 3 = neither disagree, nor agree, 4 = somewhat agree, 5 = totally agree. (Paper II)

The knowledge test items were developed considering the 12-step process of Downing & Haladyna (2006). During development, experts of VLU nursing care were consulted several times. The aim was to avoid over-specific and over-general items (Haladyna 2011, p. 103). In this study the items reflected the valid Finnish guidelines for venous leg ulcer care (Venous Leg Ulcer: Current Care Guidelines

2014). Opinion-based as well as trick-based items were avoided. (Haladyna 2011, pp. 97-126.) (Table 20)

The PKAK items were edited for clarity, grammar, punctuation, and spelling. However, professional editing of the items was not carried out. (Downing & Haladyna 2006.) Vocabulary was planned to be as simple as possible so that reading the items would not interfere with testing the content intended. Negative words were avoided in the items because using negative words can have a negative impact on answers. Options that give hints as to the right answers were also avoided. Each item in the knowledge test was either right or wrong, so two response options would have been the natural limit of answer options. (Haladyna 2011, pp. 97-126.) However, three answer options (right – wrong – don't know) were used in the knowledge test because we also wanted to allow the nurses to express that they did not know the answer.

Finally, the researcher was responsible for the final selection of the items. The pilot test of the PKAK was conducted in a sample of 29 HHC nurses on the 4th, 13th and 25th of March 2014 to refine the instrument and to give the researcher experience with the subjects, the setting, and methods of measurement. In the pilot test nurses completed the knowledge test in format (Webropol®) in computer class and gave feedback with an electronic questionnaire (Webropol®). Two items were omitted based on the pilot test. The time spent to complete the PKAK varied from 25 minutes to one electronic hour. The layout of the paper version of PKAK was formatted vertically to minimize additional cognitive burden and to maximize the ease of reading the items and answering. (Haladyna 2011, pp. 97-126). The final knowledge test included 65 items divided into 6 subscales: pathophysiology and etiology, assessment, healing, infection, topical care and compression. The scale was: 1 = wrong, 2 = right and 3 = do not know. One of the 65 items was an item with four pictures of ulcers, one of which was correct (picture of VLU) and others wrong. The answers were coded for analysis: correct answers = 1 point, wrong and do not know answers = 0 points. Higher scores indicated higher knowledge and the maximum score was 65. (Paper III) Passing scores were not established. (Table 21)

Table 20. Knowledge test development-process.

Steps	Description
1. Overall plan	<p>Purpose: to assess nurses' theoretical knowledge about VLU nursing care before and after CE.</p> <p>Construct to be measured: nurse' theoretical knowledge about VLU nursing care</p> <p>Desired test format: selected responses, wrong, right</p> <p>Test administration: paper and pencil</p> <p>Major source of validity evidence: Chronic Leg Ulcers: Current Care Guidelines (2014)</p> <p>Desired inferences: nurses' knowledge before and after CE</p> <p>Timeline: 2013 – 2014</p> <p>Security: All test materials were stored by the researcher.</p>
2. Definition of test content	<p>Test content was based on Phase I literature review results (Paper I) screened according to Chronic Leg Ulcers: Current Care Guidelines (2014); 6 subscales: Pathophysiology and etiology, Assessment, Healing, Infection, Topical care, Compression</p>
3. Test blueprint	<p>Test format: three response options: wrong, right, don't know</p> <p>Visual stimuli contained: Four pictures of ulcers, from which nurses must choose the right picture of VLU</p> <p>The total number of items: 78 in the original test</p> <p>Expected item scoring rules: 1 point for correct answer, 0 point for incorrect and 0 points for don't know</p>
4. Item development	<p>Test developer is a nurse with experience in VLU nursing care. Experts of VLU nursing care were consulted several times during item development.</p> <p>Knowledge test items were evaluated three times by national expert panels for item relevancy, clarity and difficulty (Papers II, III and IV). Panels were conducted with an electronic questionnaire (Webropol®). Experts were not selected from cities where the research was planned to be conducted. Paper versions of the test were not sent or given to anyone. During expert panels number of items decreased to 66 items, one of which was the same picture as in the test blueprint.</p> <p>Pilot testing of the knowledge test was carried out with electronic format of the knowledge test in computer class. Feedback from knowledge test was requested in electronic format. Only two items were omitted at this stage (Paper III).</p> <p>Finally, the researcher was responsible for the final selection of test items.</p> <p>The final number of items was 65 divided into 6 subscales: pathophysiology and etiology, assessment, healing, infection, topical care and compression. The scale in was 1 = wrong, 2 = right and 3 = do not know. (Papers II, III and IV).</p>
5. Test design and assembly planning	<p>Paper and pencil mode. Layout of the items was formatted to minimize additional cognitive burden and to maximize the ease of reading the items and answering.</p>

Steps	Description
6. Test production	The paper format instrument was checked by the researcher and research assistant several times before printing. The paper format of the instrument was delivered to the printing house and the researcher herself. All paper format instruments were stored by the researcher.
7. Test administration	Nurses completed the paper-pencil test in quiet environments with either researcher or research assistant present. Nurses returned the paper after they had completed the test. Nurses had a standard time of one hour to complete the total of PKAK, including 28 items about nurses' perceived knowledge, 4 items about attitudes and 65 knowledge test items.
8. Scoring the test responses	The answers were coded for analysis; correct answers = 1 point, wrong and do not know answers = 0 points. Higher scores indicated higher knowledge. The maximum score was 65.
9. Establishing passing scores	Passing scores were not established. This is the first version of the knowledge test and further studies are needed for establishing passing scores.
10. Reporting the results	Papers III and IV and summary
11. Banking	Paper versions were not given to anyone during the study. The knowledge test and nurses' answers are stored by the researcher.
12. Technical report	Summary

Response options were placed in the same numerical order throughout the knowledge test (Haladyna 2011, pp. 97-126): the first answer option from the left was wrong, the second right and the third I don't know. Item developers and test participants usually have a bias toward the middle position, and they tend to place the correct answer in the middle position (Attali & Bar-Hillel 2003). If nurses had chosen only middle position options, they would have answered that most of the items were right and it was not always the correct answer. The location of correct answer should vary and there should be about equal frequency of right and wrong response options (Haladyna 2011, pp. 97-126). In this study this was not achieved as there were more items where the correct response was wrong. (Table 21)

Table 21. Frequency of right and wrong response options in the knowledge test.

Subscale	Theoretical knowledge Items n	Right n	Wrong n	Perceived knowledge Items n
Pathophysiology and etiology*	15 (*16)	4	11	5
Assessment	14	5	9	5
Healing	7	4	3	5
Infection	5	3	2	4
Topical care	13	4	9	4
Compression	10	3	7	5
Total	64 (^65)	23	41	28

*One item was four pictures of different kind of ulcers, from which one was a picture of VLU, which was a right answer

^Total number of the items when item with pictures was included

In the PKAK there was a lot of variation in the amount of theoretical knowledge items according to the subscale. This variation is based on knowledge gaps found in the literature review in which the gaps were organized in 4 themes: 1. Knowledge gaps in VLU physiology and healing process, 2. Knowledge gaps in VLU assessment, 3. Knowledge gaps in local VLU nursing care and dressings and 4. Knowledge gaps in compression treatment. (Paper I) During the expert panel rounds it became clear that there was a need to separate the subscales for Healing and Infection into their own entities because experts and additional literature emphasized the importance. After modifications Graham approved all of them in September 2013 and Van Hecke in December 2013. In this study the PKAK was delivered in paper-pencil mode. (Paper II, III, IV)

Clinical outcome data were collected with video-recorded observations at M0, M1 and M2. A semi-structured *observation checklist* (OC) (Ribu *et al.* 2003), a

disposable paper ruler and *clock* were used in data collection. (Figure 8) Nurses and patients were informed about the study and observations with video-recordings and they gave informed consent to participate. Permission to use and revise the OC was obtained (Table 24) and the original OC was translated and back translated from Norwegian into Finnish (Sousa & Rojjanasrirat 2010). OC was screened against valid Finnish guidelines (Chronic Leg Ulcers: Current Care Guidelines 2014) and some revisions were made. The OC included 10 themes reflecting the VLU nursing care situation and there was an open space for comments (Ribu *et al.* 2003). The OC included measuring of VLU size. Width and length were measured from widest and longest point; VLU depth was not measured.

Using OC is dependent on individual patient situation. OC was formatted with the list of nurses' behaviors in VLU nursing care situations in the left side categorized as themes with subthemes (Ribu *et al.* 2003, Polit & Beck 2007). When some behavior described in the themes was noted during observations, the observer ticked these on the OC and entered possible complementary comments in the open spaces (Ribu *et al.* 2003). The researcher and research assistant piloted the OC separately with two video-recorded observations. Based on the pilot test (n=4) in 3rd, 10th, 14th and 17th of March 2014, it was decided to complete the OC right after the observation not during it. No revisions of the OC were needed after piloting. The OC was in paper format. (Summary, Table 22)

OC was not shown to the nurses and they were asked to carry out VLU nursing care normally. Observers avoided influencing the nurses' behavior. However, it was decided that normal everyday discussion between nurses, patients and observer could create a safe environment for observations. The researcher conducted observations in the CG and research assistant in the IG. With video-recorded observations it was possible to return to the issues observed after the home visit. The researcher and research assistant watched all the videos together and based on this, the final decisions completing the OC were made. (Paper II, Summary)

Table 22. The structure of the observation checklist.

Theme	Subthemes
1. Preparation of VLU nursing care	<ol style="list-style-type: none"> 1. Ensuring the room temperature, 2. Hand washing/disinfection 3. Paying attention that necessary supplies are available 4. Covering (gloves, apron etc.) 5. Taking care of patient's good position 6. Taking care of ergonomics and lightning
2. VLU assessment	<ol style="list-style-type: none"> 1. Performing approximate clinical examination of the ulcer 2. Carrying out Doppler-measurement 3. Measuring ABPI 4. Palpating pedal pulses 5. Examining both legs 6. Estimating ulcer pain 7. Evaluating the appearance of the ulcer 8. Evaluating skin around the ulcer
3. Cleansing the VLU	<ol style="list-style-type: none"> 1. Flushing with saline 2. Flushing with tap water or shower 3. Flushing with irrigation solution 4. Taking care of temperature of flushing liquid 5. Wiping the ulcer with cotton wool moistened with tap water or with saline or with irrigation solution
4. Used dressings	<ol style="list-style-type: none"> 1. Hydrogel 2. Other kind of gel 3. Pasta 4. Alginat 5. Antibiotic dressing 6. Silver 7. Silver-alginate 8. Nothing 9. Something else, what?
5. Protective agent used to protect the skin around the VLU	<ol style="list-style-type: none"> 1. Skin cream 2. Hydrocortisone 3. Zinc paste 4. Hydrocolloid 5. Nothing 6. Something else, what?
6. Compression bandages	<ol style="list-style-type: none"> 1. Non-elastic compression bandages 2. Elastic bandages 3. Medical compression stockings made in patient's size 4. Other kinds of compression stockings 5. Four-layer compression bandages 6. Cream socks 7. Nothing 8. Something else, what?
7. Pain medication	<ol style="list-style-type: none"> 1. Pain medication before ulcer treatment

Theme	Subthemes
	<ol style="list-style-type: none"> 2. Pain medication during ulcer treatment, 3. Lidocaine 4. Paracetamol 5. Opiate 6. Alternative method 7. Something else, what?
8. Documentation	<ol style="list-style-type: none"> 1. Nurse documents the ulcer size 2. Nurse documents the treatment with computer or mobile device 3. Treatment diary in patient's home 4. There is a separate diary for ulcer care 5. Ulcer care plan is available 6. Guidelines for patient's ulcer treatment are available in patient's home 7. Nurse does not document ulcer care
9. Hygiene and taking care of the wastes	<ol style="list-style-type: none"> 1. Using gloves when taking care of dirty dressings 2. Putting dirty dressings straight into the waste bag 3. Disinfection/washing hands is done before, during and after the ulcer care 4. There is a waste bag near to treatment place 5. Throwing the waste direct into the waste bag
10. Time spent to take care of the VLU	Minutes

Economic outcomes data were collected with OC. VLU treatment time was measured with a clock (minutes). The cost (€) of supplies used was calculated based on the costs to the IG organization. (Paper II, Table 19)

After all observations were conducted, the IG patients were offered an opportunity to a home visit by a physician to examine their ulcer. One patient agreed to a home visit and it was carried out on 13. Feb 2015. During the home visit, the physician confirmed that the patient had VLU. If more patients in the IG had agreed to the physician home visit, the same opportunity would have been offered also to patients in the CG.

4.4 Data analysis

Several data analysis methods were used in different study phases including inductive thematic analysis of the literature, critical appraisal quality evaluation of the articles, inductive analysis of the literature and statistical analysis (Table 23).

In Phases I, IIa and IIb data analysis methods consisted of inductive content analysis of literature and critical appraisal quality evaluation of the articles included in the literature review. In Phase IIc, data analysis methods consisted of inductive and statistical analysis. Content validity index (I-CVI) was used to analyze the

content validity of PKAK. Cronbach's alpha was used to analyze RPPE and PKAK internal consistency. Percentages were used to analyze congruence between nurses perceived and theoretical knowledge. (Table 23)

In Phase I, the integrative literature review (Kirkevold 1997), the studies included ($n = 16$) were analyzed inductively with thematic analysis to constitute themes of nurses' knowledge gaps in VLU nursing care (Miles & Huberman 1994). Inductive thematic analysis is a flexible way to conduct analysis and it is not tied to any specific theory (Braun & Clarke 2006). Quality evaluation of included studies was carried out independently by two researchers using checklists according to the study design. The checklists used were: STROBE appraisal tool (von Elm et al. 2007), CONSORT 2010 checklist (Moher et al. 2010), PRISMA appraisal tool (Moher et al. 2009) and COREQ appraisal tool (Tong et al. 2007). The researchers discussed their findings reaching a consensus about quality scores for each of the 16 studies. The synthesis of the previous studies was narrative with tabular accompaniment, and themes of nurses' knowledge gaps about VLU nursing care were presented. (Grant & Booth 2009.) (Paper I) (Table 23) The results were used in PKAK and eVLU development. The literature review was updated in 15. May 2019. (Table 1., Table 23)

In Phase IIa, literature ($n = 52$) was analyzed inductively (Miles & Huberman 1994). The results were used in PKAK development. Pilot test data of PKAK was analyzed statistically. In Phase IIb, literature ($n = 13$) was analyzed inductively (Miles & Huberman 1994). (Table 23) The results were used in eVLU development.

In Phase IIc, sample determination data (PCS) was analyzed inductively to find nurses who were taking care of patients with an ulcer in the lower leg. Data were analyzed further to find the patients with VLU for observations. MNA –data analysis was performed according to the instructions: MNA® screening score from 12 to 14 identify patients with a good nutritional status, scores from 8 to 11 patients at risk of malnutrition, and scores 7 or less identify patients with malnutrition (Guigoz 2006, Vellas et al. 2006) (Table 23.). MNA data was aimed to be used in analyzing possible differences between the patients taken care of by nurses in IG and CG. Nurses' background data consisted of their demographics, contextual factors of VLU nursing care and professional practice environment), and these were analyzed statistically to find out possible differences between nurses in the IG and CG. (Table 23)

RPPE data was scored so that higher scores represent higher amount of the measured construct. If more than 10% of the data across 39 items is missing, the case should be dropped from further analysis. If less than 10% of the data is missing, the item means, or median may be substituted for missing data. Average scale scores should be used because there are different numbers of items in each subscale. Mean subscale scores should be composed by adding the subscale items together and then

dividing the sum by the number of items in that subscale (Yvonne L. Munn Center for Nursing Research 2011.) (Table 23)

In Phase IIc, both statistical analysis (Paper II, IV, Summary) and qualitative data analysis (Summary) were conducted in analyzing the outcome data. For statistical analysis, the researcher coded the data, checking two times for possible errors, and the statistician checked the data during analysis. In categorical variables (background variables), Chi-square test and Fisher Exact test were used to compare the IG and CG. There were some differences in demographics between the groups. We checked the effect of differences in age and profession on the results of the study. The impact was not statistically significant. Therefore, age and profession are not included in the main modeling. (Table 23)

Cognitive outcome analysis was conducted with Number Cruncher Statistical System (NCSS) version 10 (2015). Power analysis (for F-test ANOVA, effect size 0.20, $p=0.05$, Power 0.80) was performed to define the sample size needed using statistical package G*POWER version 3.17. (Faul et al. 2007.) Based on the sample calculations 100 nurses were needed in both IG and CG to show a significant difference in the primary outcomes (perceived and theoretical knowledge) within the groups and between the groups. A p -value < 0.05 was considered statistically significant in all the statistical analyses, indicating 5% chance of rejecting the null hypothesis when it is true. Descriptive statistics such as percentages, means, ranges and standard deviations (SD) summarized the data. (Faul et al. 2007, Greenland et al. 2016).

In continuous variables (perceived knowledge, theoretical knowledge and attitudes) the Mixed Models with Repeated Measures (Shadish et al. 2002) allowing repeated measures with Bonferroni multiple comparisons was used to estimate the changes in IG and CG between the measurements. With Mixed Models with Repeated Measures it was possible to include all respondents in the analysis without dropping out those participants who did not participate in every measurement. In the analysis, floor and ceiling effects (Shadish et al. 2002) were considered and based on comparison of SDs between baseline (M0) and second follow-up (M2), there was some ceiling effect in the perceived knowledge measurements due to high M0 scores; the highest ceiling effect was found out in the subscale Compression. In the theoretical knowledge measurements, there were no floor or ceiling effects. (Paper II, III, Table 23)

For the analysis of congruence between perceived and theoretical knowledge, the results in perceived knowledge were combined into two groups: answers 4 and 5 = perceived knowing, answers 1, 2 and 3 = did not perceive knowing. The results of theoretical knowledge were correspondingly combined into two groups: answer 2 = knew the correct answer, answer 1 and 3 = did not know the correct answer. The percentages of those who perceived knowing and knew the correct answers in the

knowledge test are presented in the results. The percentages of congruence were calculated for every measurement-point. The McNemar test was used to find out p-values of change of congruence between measurement points in both groups and reported p-values refer to the same participants in sequential measurements. (Paper IV)

Clinical outcomes were analyzed with descriptive statistics by calculating the total number of correct skill scores from each theme of the OC. Data about observations were coded numerically by both observers separately after each video-recorded observation. The qualitative material in open spaces on the OC was used as additional material to describe the results. The researcher and research assistant viewed every video together and discussed coding and based on this discussion the final codes were decided. The usage of appropriate treatment methods and supplies was evaluated during observations based on supply adequacy for each patient's situation and VLU. VLU sizes (centimeters and areas) were analyzed with descriptive statistics. (Summary, Table 23)

Economic outcomes were analyzed by calculating nurses' salaries and supply costs. The costs of supplies were calculated from prizes to the IG organization. Nurses' salaries were analyzed based on RGNs' and LPNs' hourly salaries; monthly salary was divided by hourly salary distributor (163) (Local government employers 2014). (Summary, Table 23)

Table 23. Data analysis methods.

Phase		Analysis methods	Purpose
Phase I		Inductive thematic analysis (Kirkevold 1997)	To find out research evidence about VLU nursing care and knowledge and skills gaps in VLU nursing care
Phase IIa	Descriptive statistics (PKAK pilot data, RPPE pilot data)	Inductive analysis of the literature (Miles & Huberman 1994)	To identify knowledge tests for nurses in clinical nursing care
		Frequencies, distributions and Cronbach's' alpha	To evaluate internal consistency
Phase IIb		Inductive analysis of the literature (Miles & Huberman 1994)	To identify research evidence measuring effectiveness of nurses' CE
Phase IIc	Statistical analysis	Descriptive statistics	To summarize the data and to find out possible differences between IG and CG
		Frequencies, percentages, means, range, standard deviations, minimum, maximum	
	Statistics for estimation of the differences between the IG and CG and between the measurements		
	Categorical variables	Chi-square test, Fisher Exact test and Analysis of Variance	To compare IG and CG at M0
Continuous variables	Mixed Method Model with Repeated Measures with Bonferroni comparisons, McNemar -test, descriptive statistics	To find out changes in the IG and CG between measurements (M0 to M1, M1 to M2 and M0 to M2) and between the groups	
Psychometrics of PKAK and RPPE			
Phase IIa	PKAK development	I-CVI (three expert panels)	To evaluate item relevancy, clarity and difficulty
	RPPE pilot data	Cronbach's alpha	To evaluate reliability; internal consistency
Phase IIc	PKAK data	Cronbach's alpha	To evaluate PKAK reliability; internal consistency

4.5 Ethical considerations

The study was conducted according to good scientific practice and legislation. Ethical issues were considered in every phase of the study and good scientific practice was followed. (The Finnish Advisory Board on Research Integrity 2012, Allea 2017, World Medical Association 2018.) Confidentiality of the cities, nurses and patients, who participated was guaranteed in the publications. All who substantially contributed to the articles were listed as co-authors. Important work and intellectual contribution of others (e.g. funders) was acknowledged and previous research work was cited correctly. (Committee on Publication Ethics 2018.)

Ethical approval for the study protocol was obtained from the ethics committee of Turku University (10. Feb 2014, Statement 13/2014). Permissions to conduct the study were sought from the participating organization's chief administrators on 23. Apr 2014 and 13. Jun 2014. The research was registered in the International Clinical Trials Registry (identifier NCT02224300) before nurses were recruited (World Medical Association 2018) and the study protocol (Paper II) has been published in a peer-review journal.

Even though the purpose of the research is to generate new knowledge, individual research subject's rights and interests must always come first. In this study, research risks and benefits were evaluated considering the individual patient and nurse, HHC and social and healthcare system (Tarricone & Tsouros 2008). During the risk and benefits evaluation, ethical legitimacy of research questions was evaluated. Patients have the right to get nursing care that is based on best EB knowledge (MSHA 1992 and 2012). Based on the literature review (Paper I) nurses have knowledge gaps in VLU nursing care and because of this they may fail to conduct EBP in VLU nursing care. VLUs can cause suffering and social isolation for patients and supporting nurses' knowledge and skills can help VLUs to heal faster. The economic burden to social and healthcare system consists of nurses' working time and the costs of topical care supplies and compression treatment. These can be reduced by choosing the right treatment options for each patient based on individual patient and VLU situation.

Permission to use the eVLU internet material and instruments was obtained from the copyright owners. Also, permission for instrument modifications as well as approval for modification was requested and received. (Table 24)

Table 24. Permissions to use the instruments and materials.

Instrument/eVLUMaterial	Permission received	Permission received from
Perceived knowledge and attitudes about VLU nursing care	31. Aug 2012	Anna Van Hecke, PhD, professor, Ghent University, Department of Public Health, Nursing Science and Midwifery Unit, Belgium.
Perceived knowledge and attitudes about VLU nursing care	4. Sep 2012	Ian Graham, PhD, Senior Scientist, Center of Practice-Changing Research, The Ottawa Hospital Research Institute, Canada.
Modifications approved	29. Sep 2013 25. Dec 2013	Ian Graham Ann Van Hecke
Observation checklist	28. Aug 2013	Lis Ribu, Associate professor, Oslo and Akerhus University College, Faculty of Health Science, Department of Nursing.
RPPE	29. Jan 2014	Linda Lyster, The Yvonne L. Munn Center for Nursing Research and The Center for Innovations in Care Delivery within the Institute of Patient Care
MNA	29. Apr 2013	Jane Skates, Nestlé Health Sciences Consultant, MNA [®] Mini Nutritional Assessment Application. The usage of MNA does not require permission. However, if MNA is included in a publication, permission for publication is needed.
PUSH –Tool 3.0	Jan 2014	NPUAP holds the copyright to the PUSH Tool, but it is free to use for research, practice and education purposes. “Version Number” of the tool and NPUAP as the reference must be mentioned. NPUAP invites users to fill PUSH Users Registration Form and send it to NPUAP; this helps them to monitor the use of PUSH –Tool and observe the needs of PUSH Tool users. (National Pressure Ulcer Advisory Panel 2014.)
Current Care Guidelines links	24. Nov 2013	Jorma Komulainen, Chief Editor, Finnish Medical Society Duodecim.
Links to Finnish Medical Society articles and online courses and Handbook for Nurses	16. Jan 2014	Minna Pellikka, Editor, Duodecim Medical Publications, Databases for Nurses, Finnish Medical Society
Links to Hospital District of Southwest Finland: Care Chains	20. Jan 2014	Pirjo Immonen-Räihä, Director of Primary Health Care Unit, Hospital District of Southwest Finland and Hospital District of Satakunta
Links to Skin Federation WWW pages	2. Jan 2014	Maija Krappe, Informer, Skin Federation
Links to Finnish Wound Society WWW pages	30. Dec 2013	Heidi Castrén, Chairman of Finnish Wound Society
Link to Nutrition recommendations for elderly	29. Dec 2013	Raija Kara, General Secretary of National Nutrition Council, Finnish Food Safety Authority.

Nurses were the primary sample of the study. The nurses and their managers were informed about the study. Their participation was voluntary and completing the PKAK instrument was considered as consent. (Grove *et al.* 2013.) Informed consent for the observations was obtained from patients and nurses. Information about the study was delivered with information leaflets to nurses and patients. Information to nurses was also given during a briefing at the beginning of the study. Patients were given information leaflets when they were asked to consent to observations. Nurses delivered patient information leaflets and consent forms to patients. Refusal to participate did not influence patients' nursing care.

Nurses and patients were given the researchers contact details alongside the information leaflet, so they had a possibility to ask about the research if they wished. The researcher was contacted several times during the study by nurses in both cities. The contacts concerned arrangements of the study and especially observations required careful planning with nurses.

To ensure confidentiality, all personal data were safeguarded. All PKAK data were coded by numbers (pseudonymized) and names were not used together with the data. All the data collected during the study was stored by the researcher and only she had access to it. Video recordings were conducted by the researcher and research assistant. The research assistant delivered all videos to the researcher; after that she deleted them from her video-recorder. (The National Advisory Board on Social Welfare and Health Care Ethics 2018, MSHA 2018.)

A privacy policy document for person register was written about the study and only the researcher had access to research data. The research assistant and researcher watched the observation videos together and they were not delivered to any others. (MSHA 2018.) Patients' confidentiality was ensured. Real VLU nursing care situations were video-recorded, and patients were informed that the purpose of this was to record nurses' actions during VLU nursing care. Because VLUs are in the leg, recording patients' faces was not needed, for example. However, recording patients' home environments was needed to record, for example, VLU cleansing methods (shower). Recording patients so that they could be identified from the videos was avoided as much as possible, but due to the complexity of nursing care situations, it was not always avoidable. Only the researcher and research assistant viewed the videos during the analysis. (The National Advisory Board on Social Welfare and Health Care Ethics 2018, MSHA 2018.)

This study was partly (IG) carried out in the same organization where the researcher works. This means that the researcher knows the organization and some persons working there, especially the nursing managers. For this reason, researcher collected observational data from CG and research assistant collected it from IG. All misconduct was avoided in data collection, data storage and publishing (Committee on Publication Ethics 2018, The Finnish Advisory Board on Research Integrity

2012). It can be asked, whether it is ethical to exclude nurses in CG access to CE about a work-related topic? (Durkin 2008.) In this study, patients in both groups received standard nursing care according to the organization's instructions which were based on current guidelines. In addition to this, nurses in the IG received the 6-weeks eVLU, which could have improved VLU nursing care in the IG.

Education research can be difficult to conduct among staff nurses because of workflows (Durkin 2008). Data were collected for 10 weeks during nurses' working days, so they had to organize their daily work to complete the PKAK. All data collections were arranged in the afternoons to disturb daily work as little as possible. Also, in the afternoons there are more nurses present as both morning and evening shifts are present. Participating nurses in the IG needed also time to use the eVLU. Filling the PUSH Tool 3.0 form in patients' homes was a new task for nurses during VLU nursing care and this needs to be considered. All this time is their working time, and it was important to discuss this with their managers as well as with all the participating nurses.

5 Results

In this chapter results are presented according to the study phases, research questions and hypotheses. More comprehensive reports of results are presented in the original Papers I, II, III and IV. The summary contains previously unpublished results and they are reported in detail in this chapter.

5.1 Nurses' knowledge about VLU nursing care

A systematic literature review was used to identify previous studies about nurses' knowledge about VLU nursing care. A total of 16 studies from 1966 to the end of July 2012 were included in the original integrative literature review. (Paper I). Updating the original literature review up to 15 May 2019 resulted in 5 additional studies, so the final literature review contains 21 articles. When analyzing the literature, four themes emerged demonstrating nurses' knowledge gaps: VLU physiology and healing process, VLU assessment, VLU topical care and dressings and compression treatment. (Paper I) Results of the literature review were used in eVLU and PKAK development.

5.2 Nurses' continuing education and its' outcomes

Two systematic literature reviews, from 1966 to 30. July 2013 which were updated 15. May 2019 were used to identify previous studies about nurses' CE and its' outcomes. A total of 7 studies met the inclusion criteria in wound care CE. Three of these focused-on CE about PU nursing care, one was about appropriate dressing usage, two focused widely on CE about wound care and one on CE about leg ulcer nursing care. A total of 13 studies met the inclusion criteria of the other CE studies implemented in nurses' working places. These focused on gerontological nursing, aged care, pain management, iv catheter insertion, interpretation of 12-lead electrocardiograms, end-of-life nursing care, respiratory skills, mental health care, oncology nurse's implementation of EBP, continence care, diabetes care, surgical information, behavioral and substance abuse disorders. Face-to-face and video lectures, small-group discussions, reflection, poster presentations, online education, self-learning handbooks and practical learning were utilized in CEs. The

effectiveness of CE was evaluated with knowledge scores, self-rated knowledge, perceived competence, attitudes, beliefs, observation of skills, self-reported skills and description of transfer of knowledge. CE has usually shown to improve of evaluated outcomes. The results of the literature reviews are presented in detail in chapter 2.6.

5.3 Results from empirical study

In this chapter, the results from study Phase IIc are described. Firstly, description of study participants is described. Secondly, the outcomes of eVLU are presented.

5.3.1 Description of study participants

In this chapter, the differences between IG and CG in sample demographics, contextual items about VLU nursing care and RPPE are described.

Samples differed in terms of age, work experience and completion of updating education. Nurses in the CG were older compared to nurses in the IG ($p = 0.009$) and they had longer work experience in social and health care ($p = 0.007$), and longer work experience in HHC ($p = 0.011$) and VLU nursing care ($p = 0.095$). (Table 10) The effects of profession and age on the outcomes were checked. The impact of these was not statistically significant and therefore they are not included in the main modeling. (Paper III, IV) In the observations, nurses in the CG were older (mean 44.8 years) compared to nurses in the IG (mean 31.4 years). In both groups 4 nurses out of 5 were LPNs. All the nurses ($n=5$) in the CG had completed updating education about VLU nursing care, but in the IG ($n=5$) had none done so. (Table 12)

At M0, in contextual items about VLU nursing care there was only one item with a statistically significant difference ($p=0.007$) between the groups: 50% of the nurses in the CG and 30% in the IG felt that they can rely on the physician to have up-to-date information about VLU care. The RPPE results showed only minor differences between IG and CG. A statistically almost significant difference between the groups was found in the subscale about staff relationship with physicians; in IG the mean was 2.8 and in the CG 3.0 ($p = 0.063$). (Paper III)

Five observed VLU nursing care situations were analyzed in both groups. All observed nurses were female, and their ages in the IG were between 20 and 45 years and in the CG between 25 and 56 years. Four nurses in both groups were LPNs. Nurses in the CG had longer working experience in HHC and in taking care of patients with VLU. All ($n=5$) the nurses in the CG and none in the IG had completed updating education in VLU nursing care. (Table 12) Most patients in both groups were female. Ulcer diagnosis was known with three patients in the CG compared to one in the IG. First occurrence of the ulcer was known in two patients in both groups.

Decisions of topical treatment choices were made by a physician for one patient in the CG and two patients in the IG. Supply costs were paid by patients in the CG. MNA scores were received from three patients in both groups and the scores referred a risk of malnutrition; scores varied between 9 – 10 in the IG and 8-10 in the CG. (Table 13)

5.3.2 Use of eVLU by nurses

eVLU was available to 239 nurses in the IG. These nurses worked in 14 HHC districts in teams of 8-12 nurses. The number of individual nurses' loggings into the eVLU varied according to the week; it decreased about 60% during the eVLU. (Figure 9)

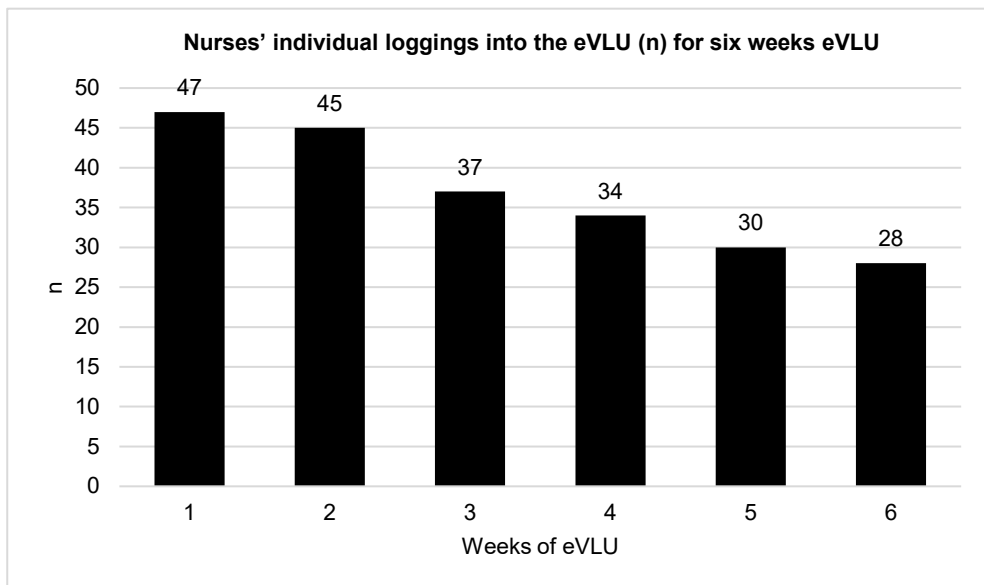


Figure 9. Nurses' individual loggings into the eVLU (n) for six weeks eVLU.

Eighty nurses logged into the eVLU at least once. Six nurses logged in each week of eVLU. There was a lot of variation in the combination of the weeks in which the nurses logged in. (Table 25) At the beginning of eVLU nurses were told to complete eVLU in teams with discussions and to also complete weekly tasks together. One member from each team was asked to post the answer the Moodle weekly. This may have been one reason for the low individual loggings into eVLU.

Table 25. Variation of eVLU weeks logged by individual nurse.

Week studied	Number of nurses
All 6	6
First 5	5
1, 3, 4, 5 and 6	2
1, 2, 3 and 6	1
1, 2, 3 and 4	1
1, 2, 3 and 6	1
1, 2 and 3	2
1, 2 and 4	1
1, 2 and 5	1
1, 3 and 5	1
1, 4 and 5	1
1 and 2	2
1 and 4	2
1 and 6	1
Only 1	18
2, 3, 4, 5 and 6	2
2, 3, 4 and 5	2
2, 3, 4 and 6	1
2, 3, 5 and 6	1
2, 4, 5 and 6	2
2, 3 and 6	2
2, 3 and 4	1
2 and 3	2
2 and 5	1
2 and 6	1
Only 2	10
3, 4 and 5	1
3 and 6	1
Only 3	1
4, 5 and 6	1
4 and 5	1
Only 4	2
Only 5	3
Only 6	0
Total	80

The number of nurses who logged into eVLU varied according to HHC district. There was a total of 221 loggings during eVLU. Nurses in some HHC districts were more active in loggings. Despite the low total number of nurses who logged in during each week of eVLU, nurses from 10 HHC districts out of the 14 included in the study logged in eVLU during each week of eVLU. (Table 26)

Table 26. Number of nurses who logged into eVLU according to HHC districts (n = 14).

Weeks	1	2	3	4	5	6	Total
HHC district							
1	0	1	0	0	0	0	1
2	0	2	2	2	1	0	7
3	2	1	1	1	1	1	7
4	6	5	4	3	2	2	22
5	0	1	1	0	1	1	4
6	5	4	5	4	2	4	24
7	4	4	5	4	3	4	24
8	3	0	0	2	1	1	7
9	7	5	2	3	2	1	20
10	7	6	6	5	8	5	37
11	0	1	0	0	0	0	1
12	6	11	7	7	5	7	43
13	1	1	1	1	2	1	7
14	6	3	3	2	2	1	17
Total	47	45	37	34	30	28	221

The number of returned answers varied weekly. Answers to weekly tasks were received from 7 – 12 HHC districts depending on the week in eVLU. In weeks one, two and four, total of 14 answers were sent to Moodle, but these were sent from 10 – 12 HHC districts; i.e. two or more answers from some districts. The reason for this was that there are one to three teams working in each HHC district. (Table 27).

Table 27. Number of returned answers weekly.

Week	Theme	Number of returned answers	From how many HHC districts
1	VLU recognition, etiology and pathophysiology	14	12
2	VLU healing and assessment of healing process	14	11
3	Assessment of VLU infection	12	8
4	Principles of VLU topical care	14	10
5	VLU topical care products and dressings	10	9
6	Compression treatment	9	7

The researcher had downloaded model answers to Moodle, and they were made available for the nurses at the end of each week. Nurses were instructed to compare their answer to the model answer and ask for clarification in discussion forum if it was needed. The researcher also gave feedback after every week by downloading common feedback to the Moodle discussion forum. Nurses did not use the discussion forum for questions to researcher or discussions with other nurses.

5.3.3 The outcomes of eVLU

In this chapter, the cognitive, clinical and economic outcomes of eVLU are presented. The cognitive outcomes measured were perceived knowledge, theoretical knowledge and attitudes. The clinical outcomes measured were nurses' skills and ulcer size. The economic outcomes measured were treatment time and nurses' salaries. (Paper II)

5.3.3.1 Cognitive outcomes of eVLU

Nurses' perceived and theoretical knowledge about VLU nursing care and attitudes towards it were evaluated at baseline (M0), at the end of eVLU (M1), and one month after eVLU had finished (M2) (Figure 3). The results are presented according to the subscales of perceived and theoretical knowledge of the PKAK instrument. At M0, there were minimal differences between IG and CG in cognitive outcomes (Table 28, Table 29).

In the IG, the level of *perceived knowledge* in all subscales, except for Infection and Topical care, were significantly higher at M1 compared to M0. There were no significant changes between M1 and M2 in any subscale. The perceived knowledge level in all subscales, except for Infection, was significantly higher at M2 compared to the M0. The level of *theoretical knowledge* was significantly higher in all subscales, except for Healing, at M1 compared to M0. There were no statistically significant changes between M1 and M2. The level in the subscales Assessment and Compression were significantly (both $p < 0.001$) higher at M2 compared to M0. There were no significant changes in *Attitudes* during the study. (Paper III, Table 28, Table 29)

In the CG, the level of *perceived knowledge* remained unchanged between M0 and M1. The level in the subscale Compression was significantly higher ($p < 0.001$) at M2 compared to M0. There were no statistically significant changes in the levels of *theoretical knowledge* and *attitudes* between the measurements. (Paper III, Table 28, Table 29)

There were no significant differences in *perceived knowledge* levels and *attitudes* between the IG and CG at any measurement points. The *theoretical*

knowledge levels were statistically significantly higher at M1 in the IG in the subscales Pathophysiology and etiology ($p = 0.016$), Healing ($p = 0.002$), and Topical care ($p = 0.043$) compared to CG. At M2 there was a significant difference between IG and CG only in subscale Infection ($p = 0.024$). (Paper III, Table 28, Table 29)

Table 28. Changes in nurses' perceived knowledge and attitudes (Paper III, modified).

	IG						CG					
	M0 (n=97) Mean	M1 (n= 53) Mean	p* M0 – M1	M2 (n=49-50) Mean	p* M1-M2	p* M0-M2	M0 (n=59-62) Mean	M1 (n=41-42) Mean	p* M0-M1	M2 (n=39-40) Mean	p* M1-M2	p* M0-M2
Pathophysiology and etiology	3.6	4.0	<0.001	4.1	0.959	<0.001	3.8	4.0	1.000	4.0	1.000	1.000
Assessment	3.5	3.8	< 0.001	3.9	0.156	<0.001	3.4	3.6	1.000	3.7	0.170	0.064
Healing	3.7	4.0	<0.001	4.1	1.000	<0.001	3.9	4.0	1.000	4.1	1.000	1.000
Infection	4.0	4.1	0.207	4.1	1.000	0.775	4.1	4.1	1.000	4.1	1.000	1.000
Topical care	4.1	4.2	1.000	4.4	0.132	0.003	4,2	4.3	1.000	4.3	1.000	1.000
Compression	4.0	4.5	<0.001	4.5	1.000	0.006	3.7	4.0	0.427	4.2	0.377	0.001
Attitudes	3.9	3.8	1.000	3.9	1.000	1.000	3.8	3.9	1.000	3.9	1.000	1.000

*Mixed models with repeated measurements and Bonferroni multiple comparisons, p-value is statistically significant at <0.05 level

Scale: 1= Totally disagree, 2 = Somewhat disagree, 3 = Neither agree, nor disagree, 4 = Somewhat agree, 5 = Totally agree

Table 29. Changes in nurses' theoretical knowledge (Paper III, modified).

	IG						CG					
	M0 (n=79-95) Mean	M1 (n=46-52) Mean	p* M0-M1	M2 (n=42-49) Mean	p* M1-M2	p* M0-M2	M0 (n=47-58) Mean	M1 (n=37-42) Mean	p* M0-M1	M2 (n=35-40) Mean	p* M1-M2	p* M0-M2
Pathophysiology and etiology	0.47	0.56	<0.001	0.53	0.924	0.113	0.46	0.47	1.000	0.49	1.000	1.000
Assessment	0.52	0.61	<0.001	0.61	1.000	<0.001	0.52	0.57	1.000	0.58	1.000	1.000
Healing	0.59	0.63	0.233	0.60	1.000	1.000	0.54	0.52	1.000	0.54	1.000	1.000
Infection	0.59	0.69	<0.001	0.67	1.000	0.092	0.56	0.57	1.000	0.56	1.000	1.000
Topical care	0.61	0.64	0.014	0.64	1.000	0.099	0.57	0.62	1.000	0.59	1.000	1.000
Compression	0.41	0.53	<0.001	0.52	1.000	<0.001	0.43	0.49	0.793	0.50	1.000	0.316

*Mixed models with repeated measurements and Bonferroni multiple comparisons, p-value is statistically significant at <0.05 level

Scale: 1 = Right, 2 = Wrong, 3 = I don't know

In the subscale *Pathophysiology and etiology* at M0, the mean in nurses' *perceived knowledge* in the IG was 3.6 (SD 0.9) compared to 3.8 (SD 0.9) in the CG ($p = 0.297$). At M1 the mean was 4 in both groups ($p=1.000$) and at M2 it was a 4.1 in the IG compared to 4 in the CG ($p=0.554$). (Paper III, Figure 10)

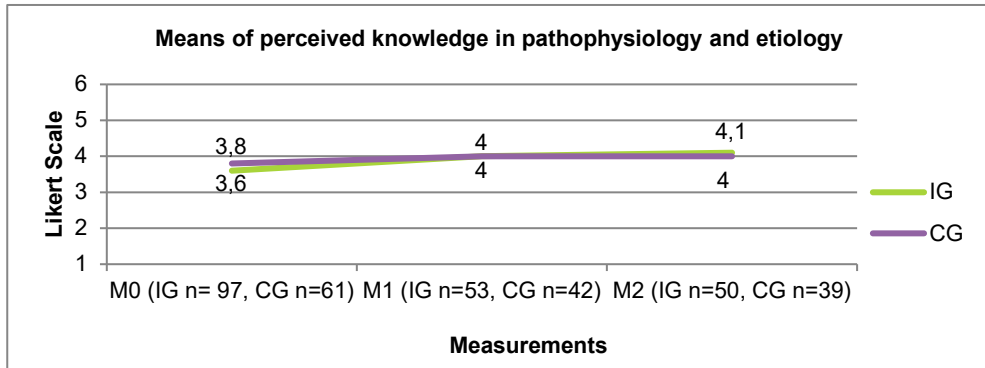


Figure 10. Means of perceived knowledge in pathophysiology and etiology.

In the *theoretical knowledge* at M0 the mean was 0.47 (SD 0.2) in the IG and 0.46 (SD 0.2) in the CG ($p = 1.000$). At M1 the difference between IG and CG was statistically significant ($p=0.016$); however, at M2 there was no statistically significant difference between the groups ($p = 0.423$). In the IG, the increase of theoretical knowledge was statistically significant from M0 to M1 ($p < 0.001$); however, between M1 and M2 there were no statistically significant changes ($p=0.924$), and this was also the case between M0 and M2 ($p=0.113$). In the CG, the changes between any of the measurements were not statistically significant ($p=1.000$). (Paper III, Figure 11)

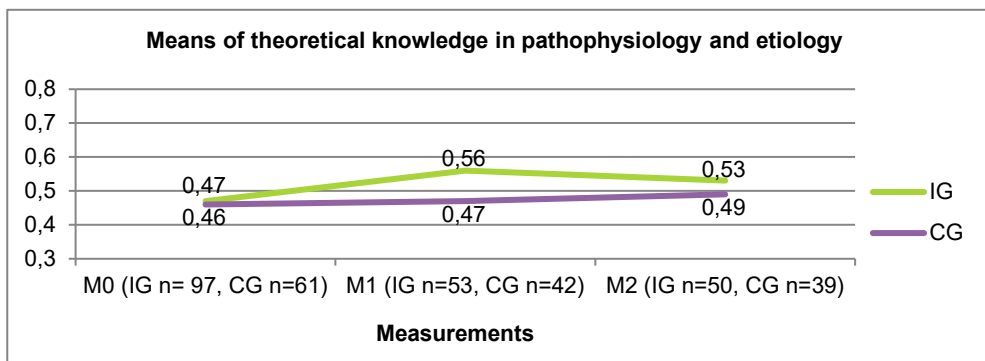


Figure 11. Means of theoretical knowledge in pathophysiology and etiology.

In *perceived knowledge* measurement at M0, in the IG 66.5% and in the CG 62.3% of the nurses either agreed or somewhat agreed that they know VLU pathophysiology and etiology. The percentages of these nurses increased in both groups between M0 and M1 and between M1 and M2. (Figure 12)

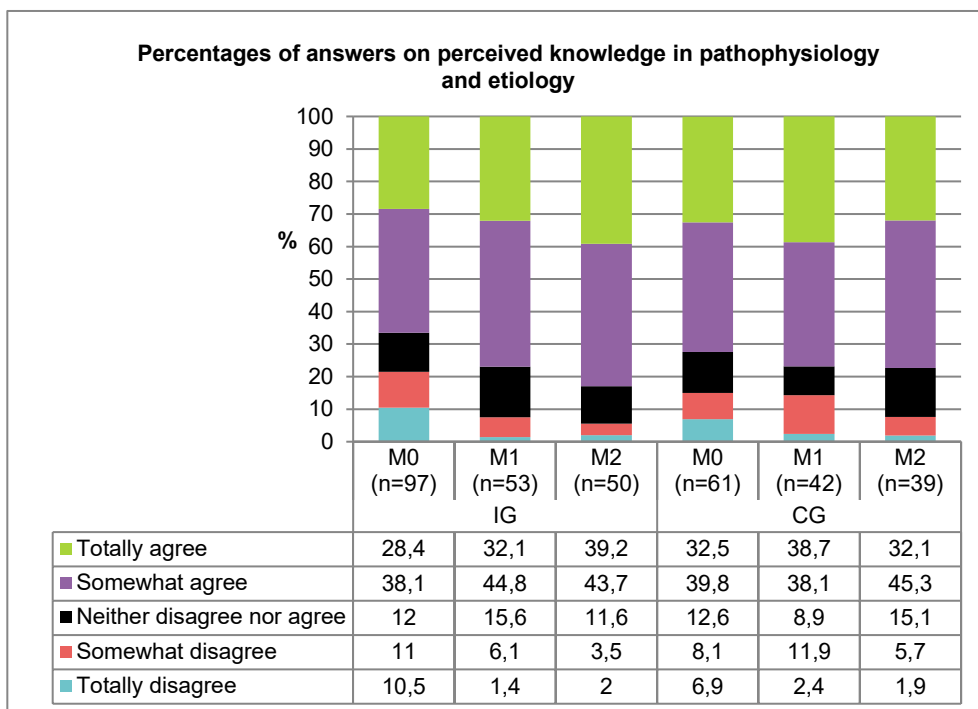


Figure 12. Percentages of answers on perceived knowledge in pathophysiology and etiology.

In *theoretical knowledge* measurement 47.5% in the IG and 45.5% the CG knew the correct answers at M0. The percentages of nurses knowing the correct answers increased during the study in both groups. The best percentage of correct answers was 53.7% in the IG at M1. (Figure 13)

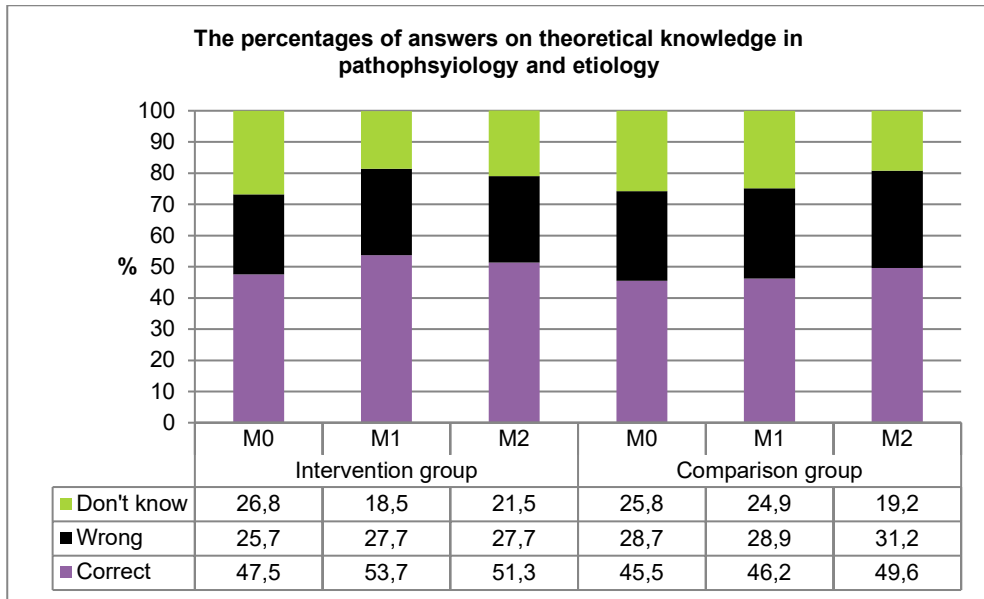


Figure 13. The percentages of answers on theoretical knowledge in pathophysiology and etiology.

In the subscale *Assessment* at M0, the mean of nurses' perceived knowledge in the IG was 3.5 (SD 0.9) compared to 3.4 (SD 0.9) in the CG ($p=1.000$). At M1 the mean was 3.8 in the IG and 3.6 in the CG ($p=0.270$) and at M2 it was 3.9 in the IG and 3.7 in the CG ($p=0.441$). (Figure 14)

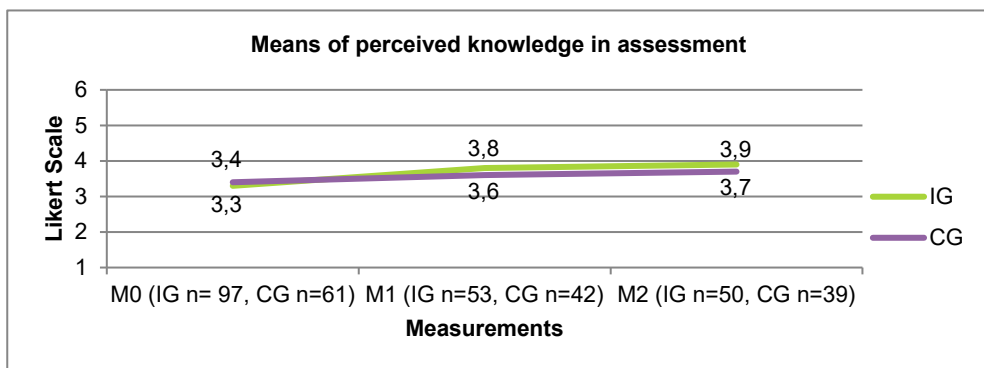


Figure 14. Means of perceived knowledge in assessment.

In theoretical knowledge at M0, the mean in the IG was 0.52 (SD 0.2) and 0.53 (SD 0.2) in the CG ($p=1.000$). At M1, the mean in the IG was 0.61 and, in the CG, it was 0.57 ($p=0.270$) and at M2, the mean was in the IG 0.61 and 0.58 in the CG ($p=0.441$). (Paper III, Figure 15)

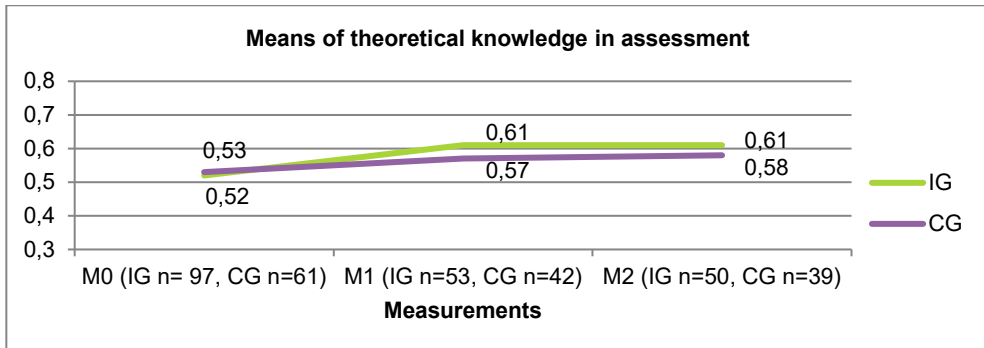


Figure 15. Means of theoretical knowledge in assessment.

In perceived knowledge at M0, in the IG 57.7% and in the CG 55.1% of the nurses either agreed or somewhat agreed that they know how to assess patient with VLU. The percentages of nurses who perceived knowing increased in both groups between M0 and M1 and between M0 and M2. (Figure 16)

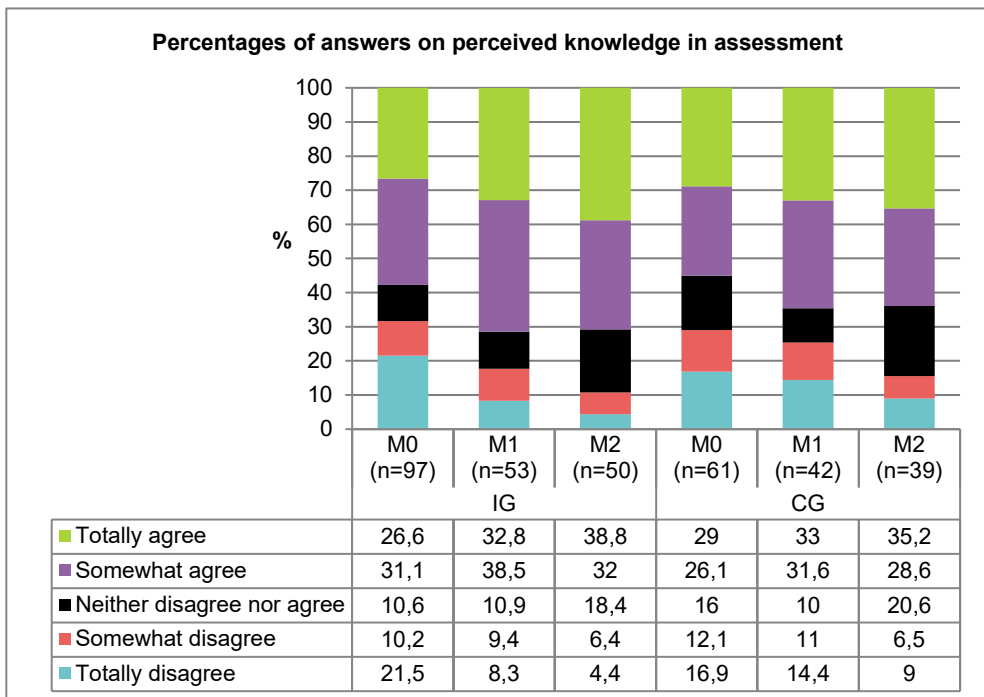


Figure 16. Percentages of answers on perceived knowledge in assessment.

In theoretical knowledge, 52.5% in the IG and 52.3% in the CG knew the correct answers at M0. The percentage of nurses knowing the right answers increased in both groups. The best percentage of correct answers was 60,6% in the IG at M2. (Figure 17)

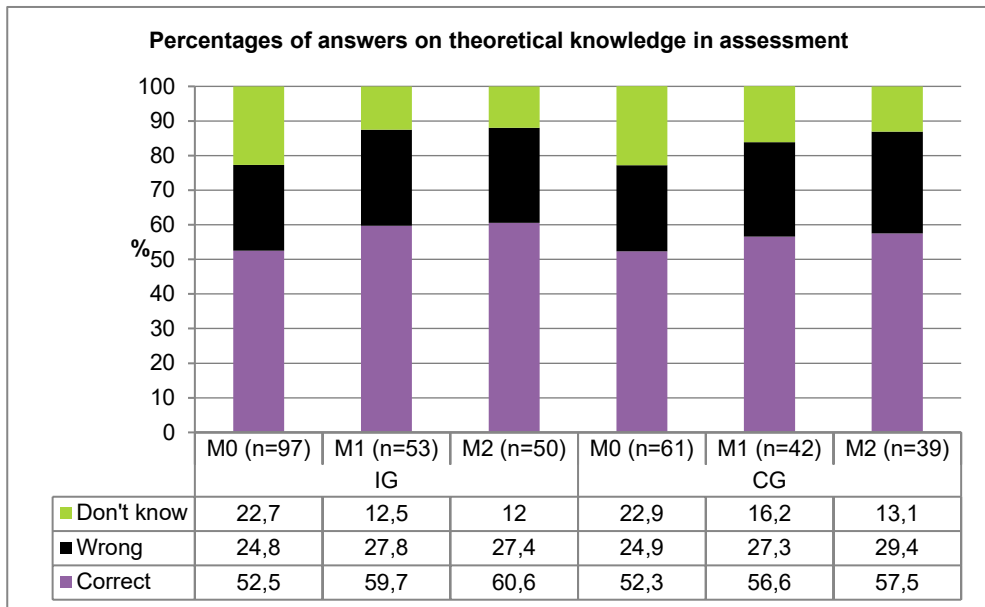


Figure 17. Percentages of answers on theoretical knowledge in assessment.

In the subscale *Healing* at M0, the mean in *perceived knowledge* in the IG was 3.7 (SD 0.8) compared to 3.9 (SD 0.8) in the CG ($p = 0.220$). At M1 the mean was 4 in both groups ($p=1.000$) and at M2, 4.1 in both groups ($p=1.000$). (Paper III, Figure 18)

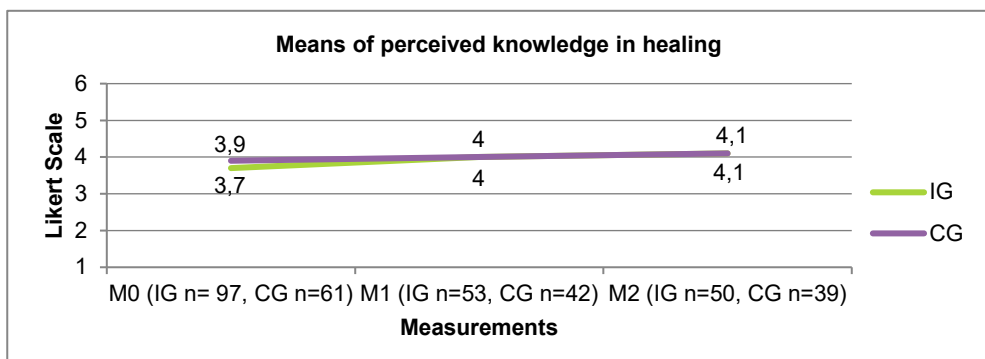


Figure 18. Means of perceived knowledge in healing.

In *theoretical knowledge* at M0, the mean was 0.59 (SD 0.2) in the IG and 0.54 (0.2) in the CG ($p = 0.323$). At M1, the difference between IG and CG was statistically significant ($p = 0.002$); however, at M2 there was no statistically significant difference between the groups ($p = 0.127$). (Paper III, Figure 19)

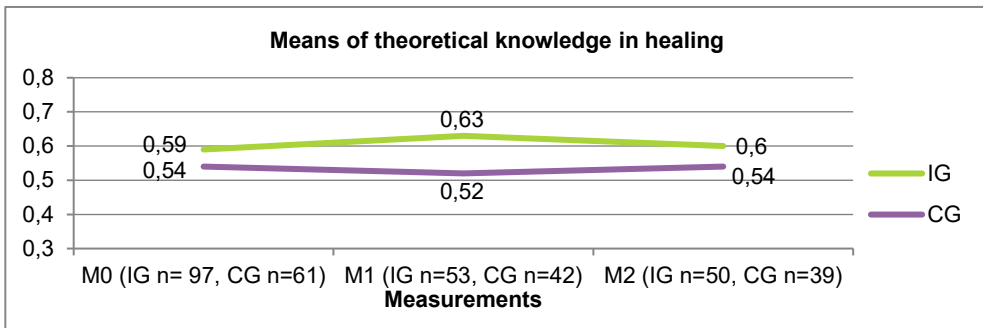


Figure 19. Means of theoretical knowledge in healing.

In *perceived knowledge* at M0, 71.6% in the IG and 77.2% in the CG either agreed or somewhat agreed that they know the signs of VLU healing. The percentage of these nurses increased between in both groups between M0 and M1 as well as between M1 and M2. (Figure 20)

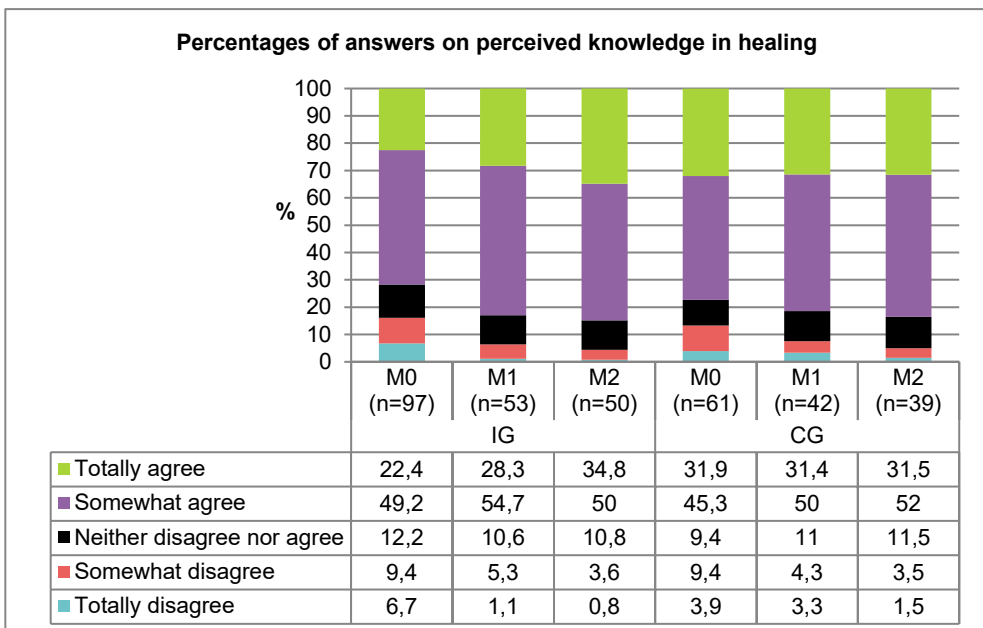


Figure 20. Percentages of answers on perceived knowledge in healing.

In *theoretical knowledge*, 58.9% in the IG and 54.3% in the CG knew the correct answers at M0. The percentage of nurses knowing the correct answers increased during the study in both groups. The best percentage of correct answers was 63.2% in the IG at M1. (Figure 21)

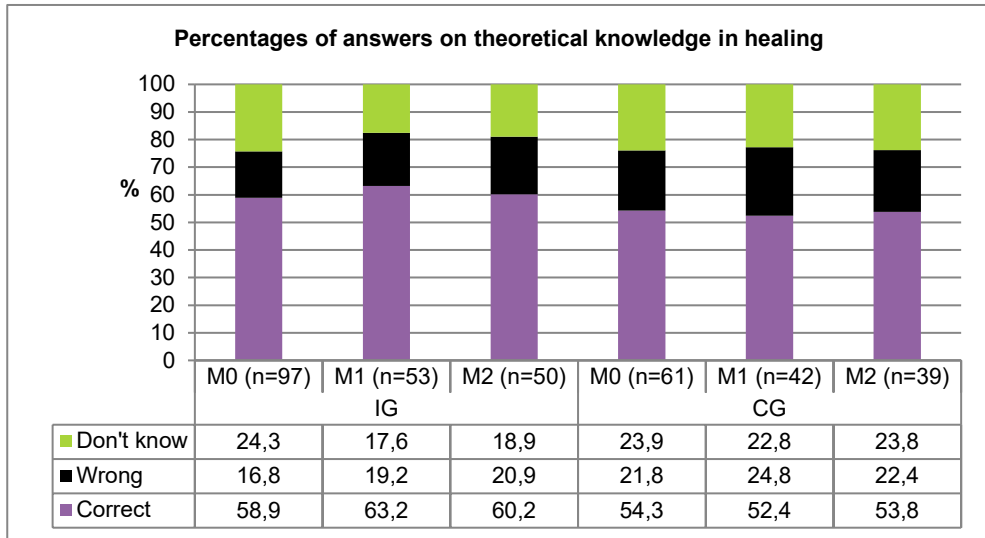


Figure 21. Percentages of answers on theoretical knowledge in healing.

In the subscale *Infection* at M0 in *perceived knowledge* the mean in the IG was 4.0 (SD 0.8) compared to 4.1 (SD 0.8) in the CG ($p=0.823$). At M1, the mean was 4.1 in both groups (SD 0.7 in IG and 0.8 in CG) ($p=1.000$). At M2, the mean was 4.1 in both groups (SD 0.7 in both groups) ($p=1.000$). (Paper III, Figure 22)

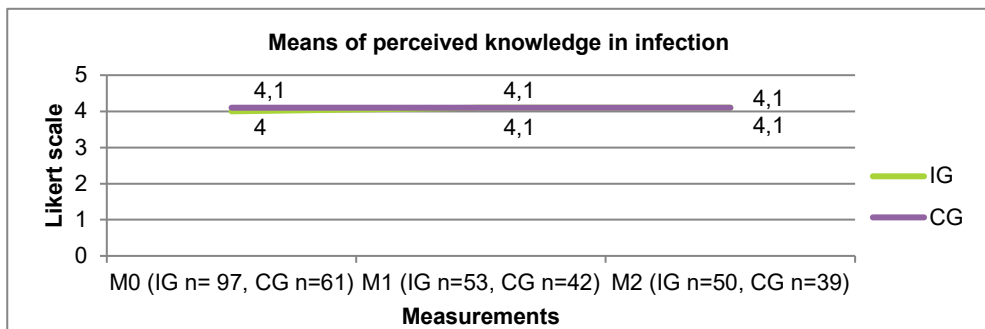


Figure 22. Means of perceived knowledge in infection.

In *theoretical knowledge* at M0 the mean was 0.59 (SD 0.2) in the IG and 0.56 (SD 0.2) in the CG ($p = 1.000$). At M1, the mean was 0.69 (SD 0.2) in the IG and 0.57

(SD 0.2) in the CG ($p < 0.001$). At M2, the mean was 0.67 (SD 0.2) in the IG and 0.56 (SD 0.2) in the CG ($p = 0.024$). (Paper III, Figure 23)

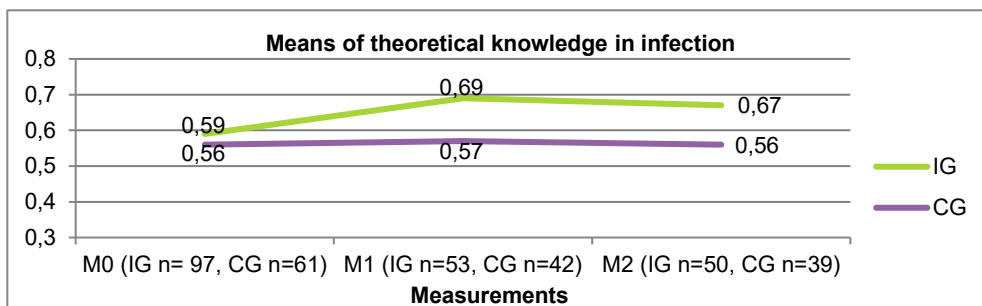


Figure 23. Means in theoretical knowledge in infection.

In *perceived knowledge* at M0, 75.8 % of the nurses in the IG and 80.5% in the CG either agreed or somewhat agreed that they know the signs of VLU infection and how it should be analyzed and treated. The percentages of these nurses increased in the IG and decreased in the CG between M0 and M1. In both groups the percentage of these nurses increased between M1 and M2. (Figure 24)

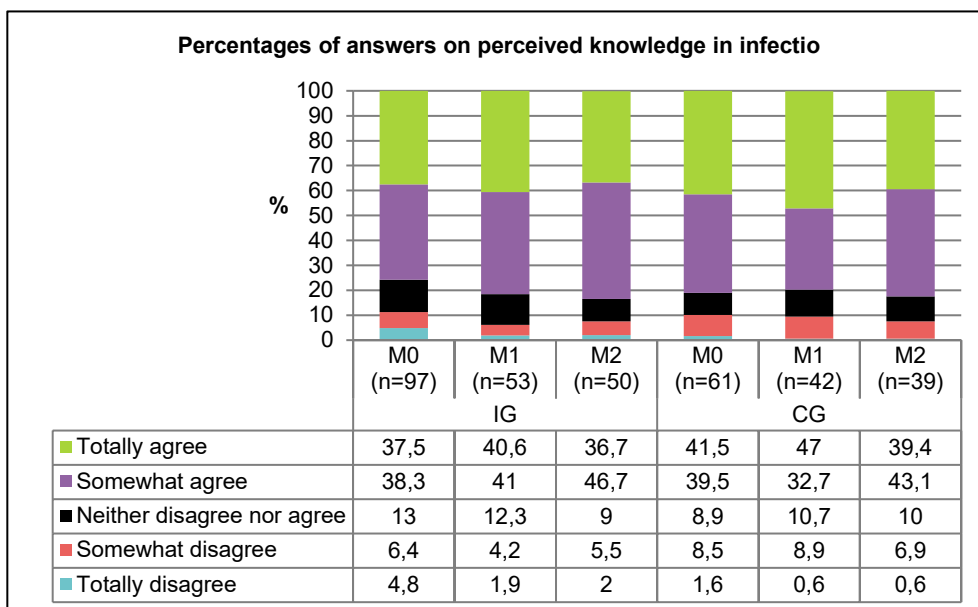


Figure 24. Percentages of answers on perceived knowledge in infection.

In *theoretical knowledge*, 59.7% of the nurses in the IG and 56.8% in the CG knew the correct answers at M0. The percentage of nurses knowing the correct answers

increased during the study in the IG. The best percentage of correct answers was 67.5% in the IG at M2. (Figure 25)

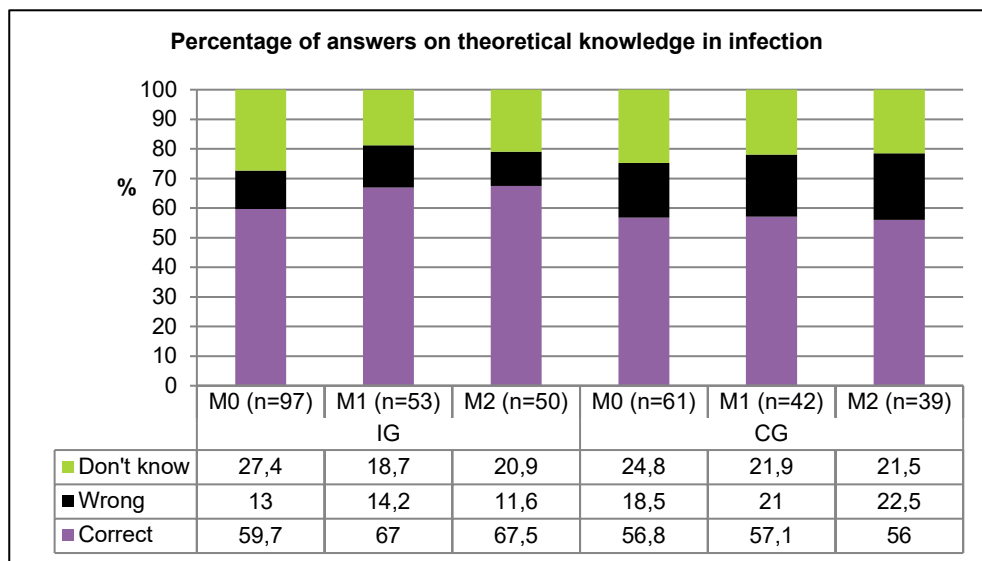


Figure 25. Percentages of answers on theoretical knowledge in infection

In the subscale *Topical care* at M0 in *perceived knowledge* the mean was 4.1 (SD 0.6) in the IG and 4.2 (SD 0.6) in the CG ($p=0.417$). At M1, the mean was 4.2 (SD 0.6) in the IG and 4.3 (SD 0.6) in the CG ($p=1.000$). At M2, the mean was 4.4 in the IG (SD0.5) and 4.3 in the CG ($p=1.000$). (Paper III, Figure 26)

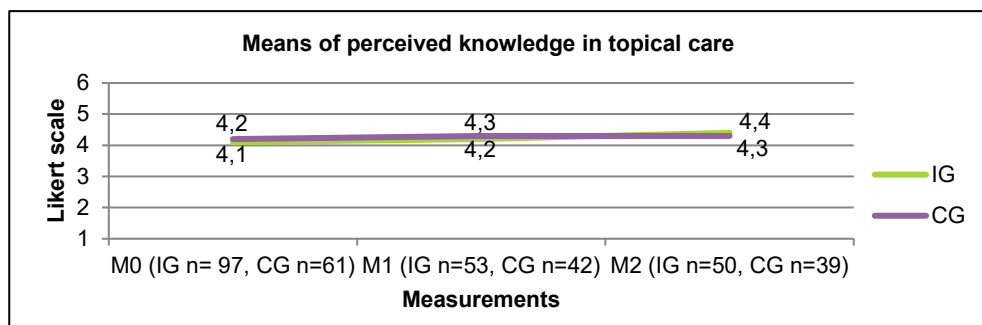


Figure 26. Means of perceived knowledge in topical care.

In *theoretical knowledge* at M0, the mean was 0.61 (SD 0.2) in the IG and 0.57 (SD 0.2) in the CG ($p = 0.439$). At M1, the mean was 0.64 (SD 0.2) in the IG and 0.62 (SD 0.2) in the CG ($p = 0.043$). At M2, the mean was 0.64 (SD 0.2) in the IG and 0.6 (SD 0.2) in the CG ($p=0.066$). (Paper III) (Figure 27)

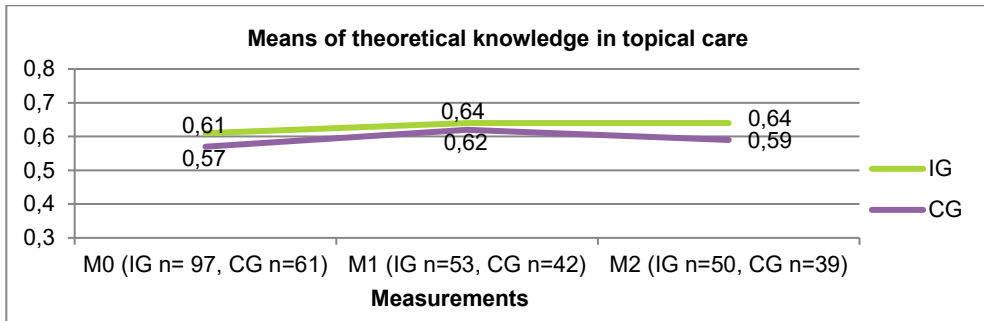


Figure 27. Means of theoretical knowledge in topical care.

In *perceived knowledge* at M0, 81.1% of the nurses in the IG and 85.9 % in the CG either agreed or somewhat agreed that they know how and why VLU topical care should be conducted. The percentage of these nurses increased in both groups between M0 and M1. In the IG the percentage increased also between M1 and M2, while in the CG the percentage decreased. (Figure 28)

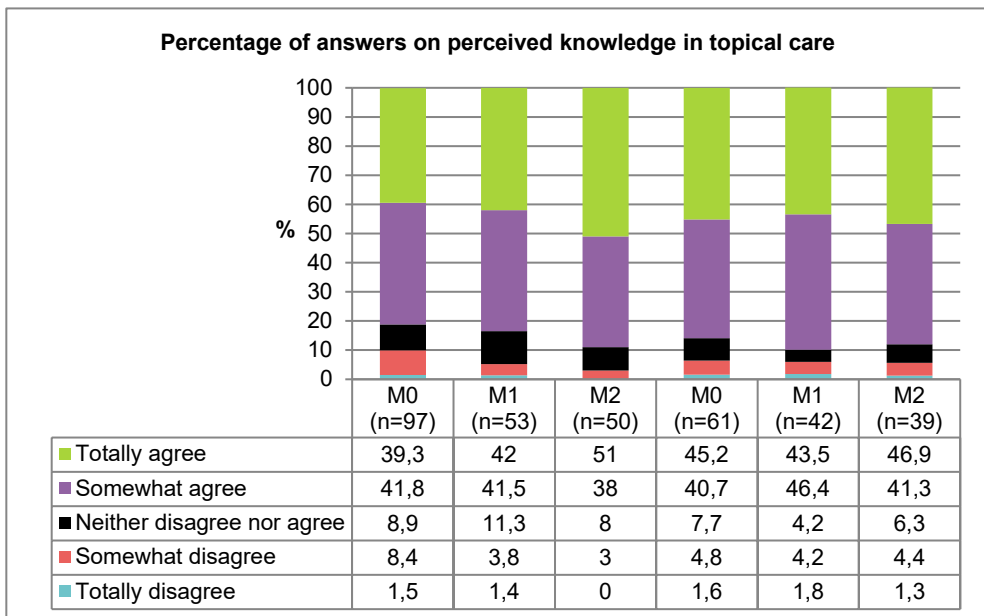


Figure 28. Percentages of answers on perceived knowledge in topical care.

In *theoretical knowledge*, 60.5% of the nurses in the IG and 55.8% in the CG knew the correct answers at M0. The percentage of nurses knowing the correct answers increased between M0 and M1 in both groups but also decreased between M1 and M2 in both groups. The best percentage of correct answers was 64.1% at M1 in the IG (Figure 29)

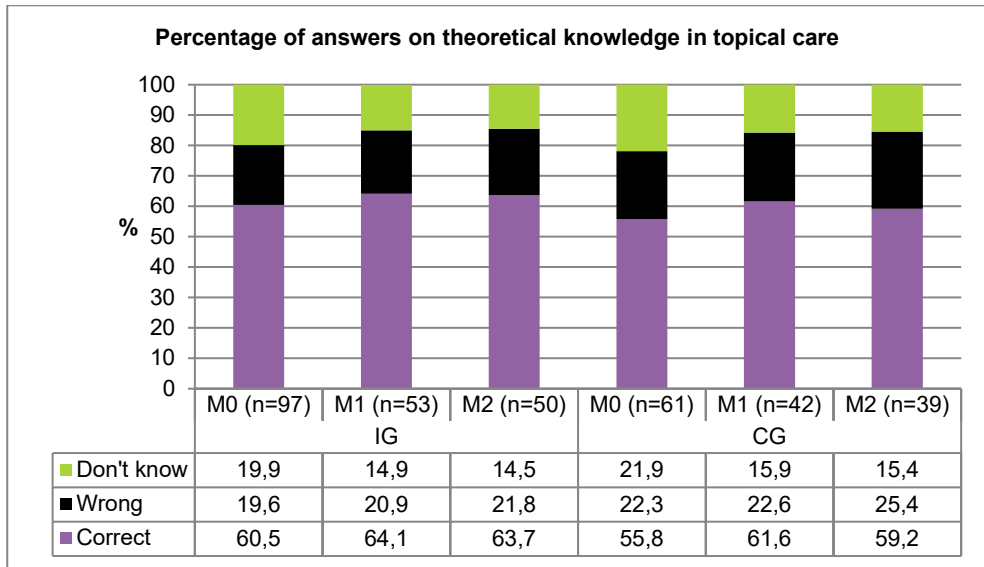


Figure 29. Percentages of answers on theoretical knowledge in topical care.

In the subscale *Compression* at M0 in *perceived knowledge* the mean was 4.0 (SD 1.3) in the IG and 3.7 (SD 1.2) in the CG ($p= 0.312$). At M1, the mean was 4.5 (SD 0.5) in the IG and 4.0 (SD 0.9) in the CG ($p=0.039$). At M2, the mean was 4.5 (SD 0.6) in the IG and 4.2 (SD 0.9) in the CG ($p=1.000$). (Figure 30)

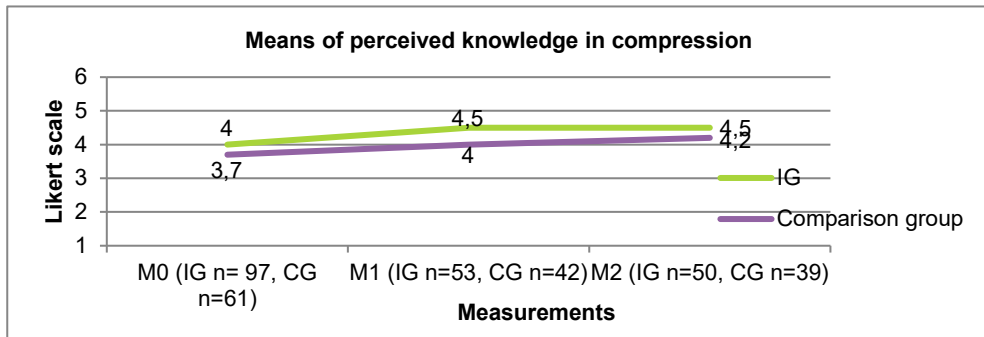


Figure 30. Means of perceived knowledge in compression.

In *theoretical knowledge* at M0, the mean was 0.41 (SD 0.2) in the IG and 0.43 (SD 0.2) in the CG ($p=1.000$). At M1, the mean in the IG was 0.53 (SD 0.2) and in the CG it was 0.49 (SD 0.2) ($p=0.289$). At M2, the mean was 0.52 (SD 0.2) in the IG and 0.5 (SD 0.2) in the CG ($p=0.900$). (Paper III, Figure 31)

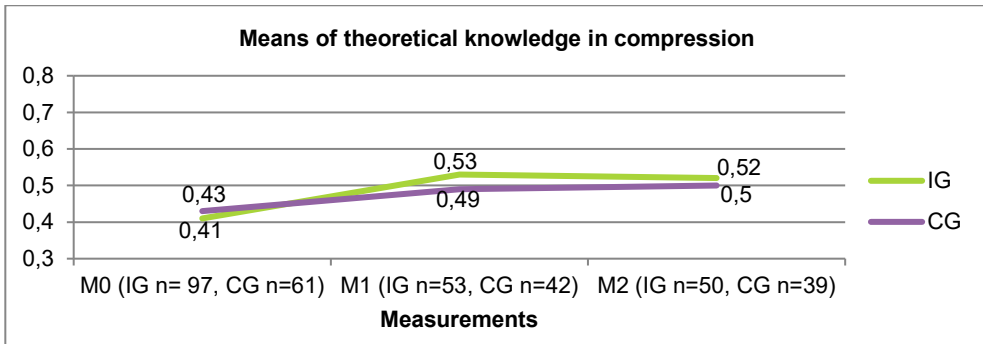


Figure 31. Means of theoretical knowledge in compression.

In perceived knowledge at M0, 78.6 % of the nurses in the IG and 64.5% in the CG either agreed or somewhat agreed that they know how, why, and when compression treatment should be used. The percentage of these nurses increased in both groups between M0 and M1. In the CG the percentage increased between M1 and M2, but in the IG the percentage decreased. (Figure 32)

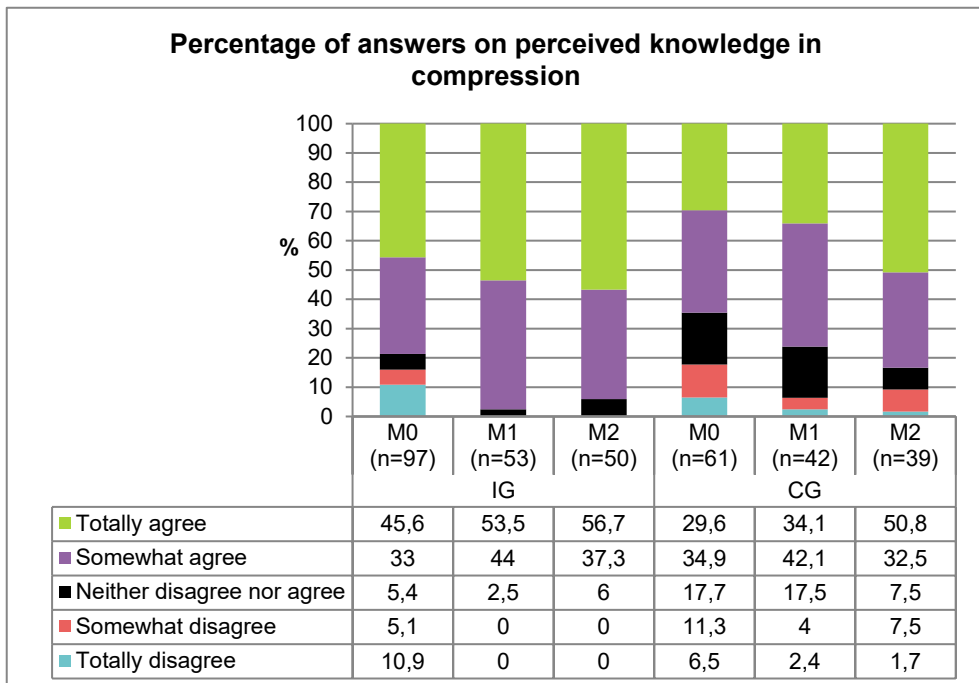


Figure 32. Percentages of answers on perceived knowledge in compression.

In theoretical knowledge at M0, 41.8% of the nurses in the IG and 42.6% in the CG knew the correct answers. The percentage of nurses knowing the correct answers increased between M0 and M1 in both groups. However, in the IG the percentage of correct answers decreased between M1 and M2 and in the CG it continued to increase. (Figure 33)

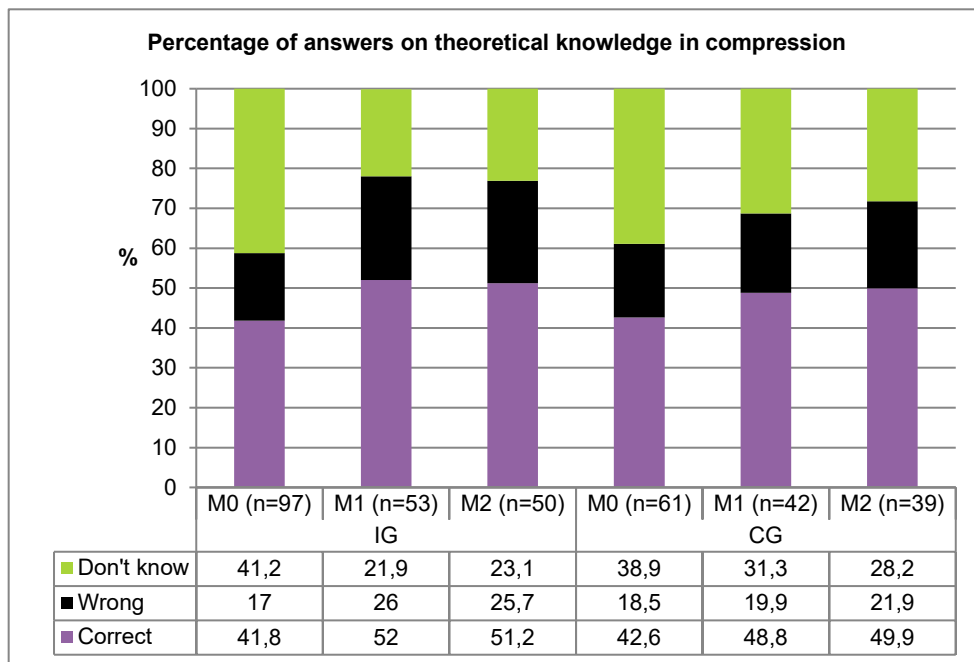


Figure 33. Percentages of answers on theoretical knowledge in compression.

In the following figures comparison of percentages in perceived and theoretical knowledge in IG and CG is presented (Figure 34a, Figure 34b).

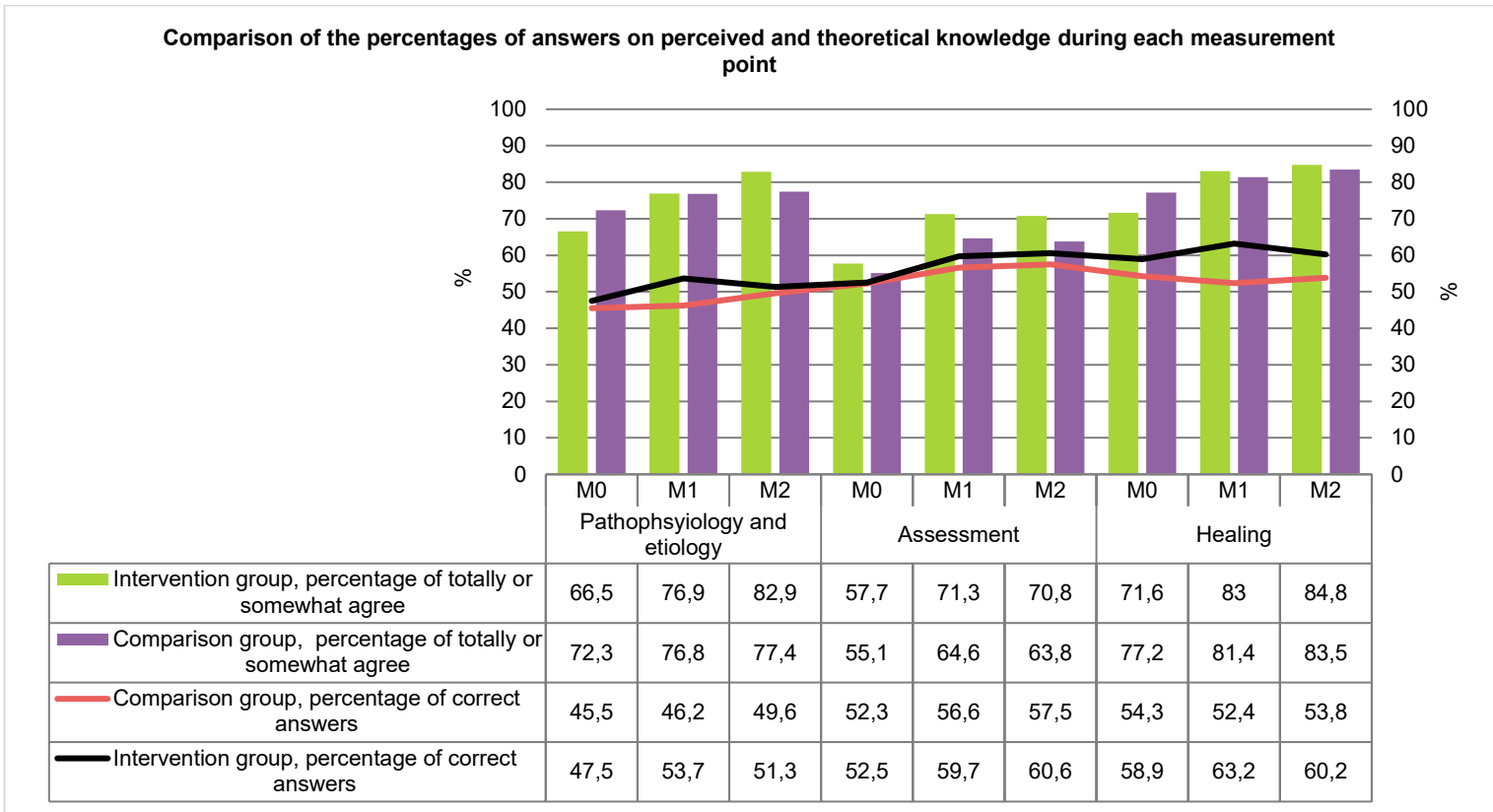


Figure 34a. Comparison of the percentages of answers on perceived and theoretical knowledge during each measurement point.

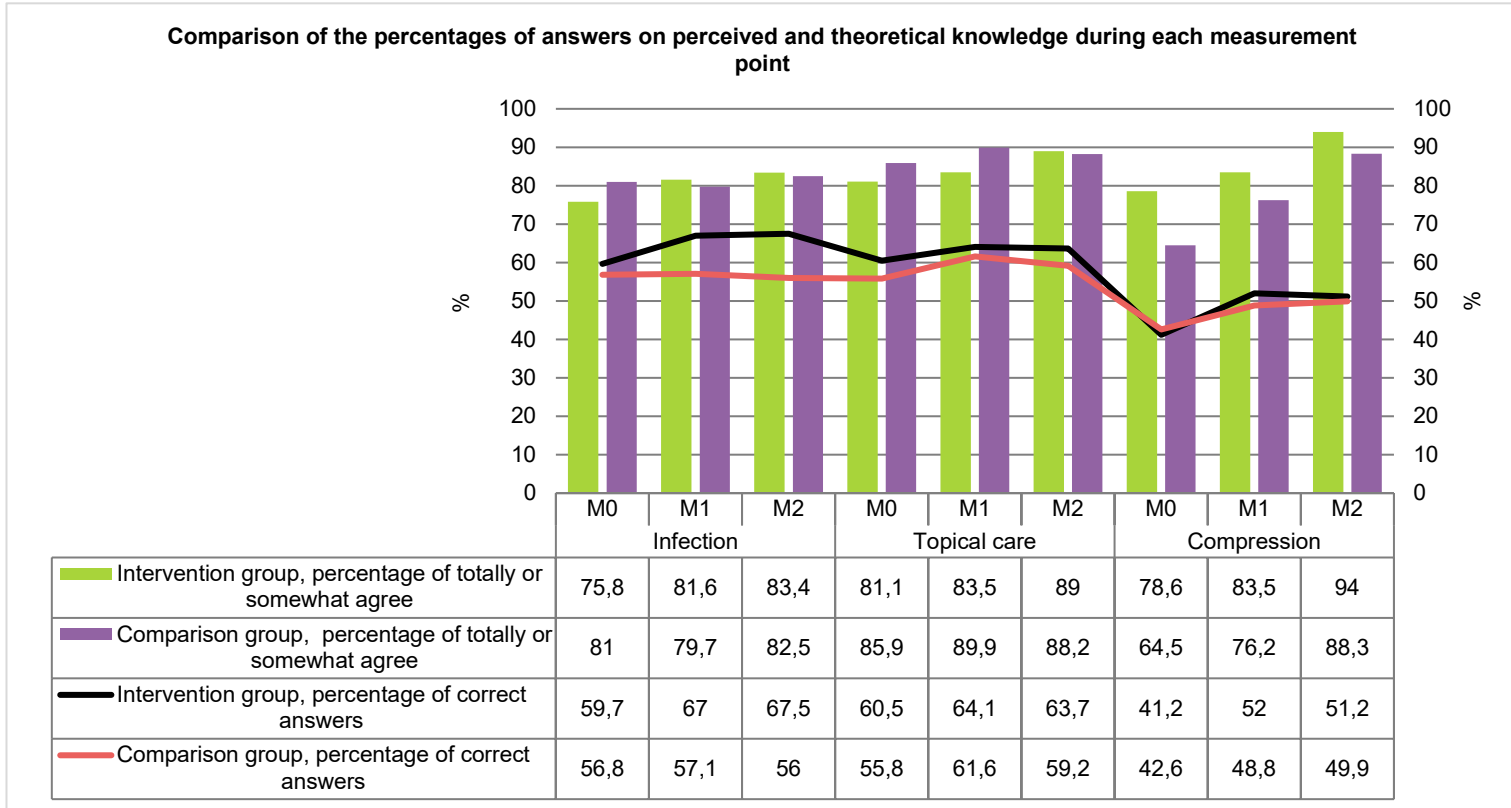


Figure 34b. Comparison of the percentages of answers on perceived and theoretical knowledge during each measurement point.

In this study one hypothesis was that the percentage of congruence between perceived and theoretical knowledge would be higher among nurses in the IG using eVLU than nurses in the CG following standard care without eVLU. There were some differences in the congruence at M0 between the groups in all perceived and theoretical knowledge subscales. The congruence increased in both groups, but the increase was statistically significant in more items in the IG. In the IG the increase stabilized between M1 and M2 while in the CG it continued to increase also between M1 and M2. (Paper IV)

In the subscale *Attitudes*, the mean at M0 in IG was 3.9 (SD 0.7) and in the CG it was 3.8 (SD 0.8) ($p=0.499$). At M1, the mean was 3.8 (SD 0.7) in the IG and 3.9 (SD 0.8) in the CG ($p = 0.858$). At M2, the mean in the IG was 3.9 (SD 0.7) while in the CG it was 3.9 (SD 0.7) ($p=0.799$). (Figure 35)

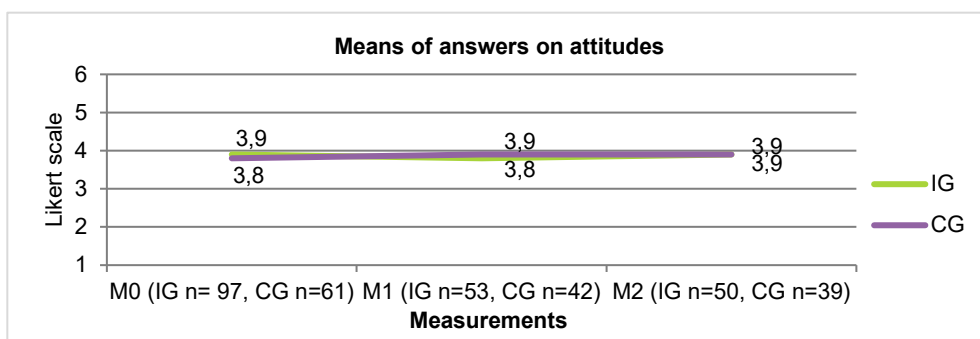


Figure 35. Means of the answers on attitudes.

5.3.3.2 Clinical outcomes of eVLU

Clinical outcomes were evaluated with OC (Ribu et al. 2003) in the same timeline as cognitive outcomes.

VLU sizes (cm²) decreased in the IG between M0 and M1 as well as between M1 and M2 and between M0 and M2. The mean decreases in the IG between M0 and M1 was 57.5% and between M1 and M2 it was 64.41. Between M0 and M2 the mean decrease was 85.0%. (Table 30a) In the CG the sizes (cm²) of four VLUs decreased between M0 and M1. The size of one VLU increased. Between M1 and M2 the sizes (cm²) of two VLUs decreased, two VLUs remained at same level and one VLU increased. The mean decreases in the CG between M0 and M1 was 59.52% and between M1 and M2 it was 23.88%. Between M0 and M2 the mean decrease was 69.18%. (Table 30b) There were no infected VLUs in either of the groups.

At M0, the observed skills ($n = 5$ nurses in both groups) in the IG were better than in the CG. In the IG, there was improvement in skills during the study. In the CG, the skills remained at the same level. (Table 31) When comparing the skills and

knowledge test results of the nurses who were observed in the study, the results in the knowledge test were higher in the CG (Table 32). However, skills were better in the IG at every measurement time (Table 31).

Preparation for VLU nursing care was better organized in the IG at every measurement time. At M0, three nurses in the IG and one nurse in the CG completed preparations according to the guidelines. At M2, there were three nurses in the IG and two in the CG who completed these according to the guidelines. In both groups, nurses usually did not pay any attention to lightning. (Table 31)

VLU assessment was not completely performed by nurses in either of the groups. It seems that nurses are not used to assessing VLU, even if it is an essential part of VLU nursing care. At M0, patient's both legs were assessed by none of the nurses in the IG and by two nurses in the CG. At M1, none of the nurses in the IG and three nurses in the CG assessed patient's both legs. At M2, one nurse in both groups assessed patient's both legs. Palpation of pedal pulses was conducted by one nurse in the IG at M2. Nurses in both groups assessed VLU appearance in various ways and words; mainly they communicated it by analyzing the size of the VLU or the amount of secretion. The assessments of skin around the VLU and VLU edges were mostly approximate in both groups. The VLUs were also analyzed by the researcher and research assistant; most (2-4-3) of the VLUs in the IG had a fine edge, but in the CG, there were more macerated (4-2-3) edges. Nurses did not assess VLU infection signs at any measurement time in either of the groups. (Table 31)

Table 30a. The sizes (cm) and areas (cm²) of VLUs in the intervention group.

Intervention group												
P	M0			M1			M0 - M1	M2			M1 - M2	M0 - M2
	L	W	cm ²	L	W	cm ²	%	L	W	cm ²	%	%
1	3.0	1.5	4.5	2.5	1.5	3.5	D 22.2	2.5	1.0	2.5	D 28.57	D 44.44
2	3.8	3.4	12.9	1.5	1.5	2.2	D 82.9	0.5	1.0	0.5	D 77.27	D 96.12
3	4.0	3.0	12.0	2.3	3.0	6.9	D 42.5	2.0	2.5	5.0	D 27.54	D 58.33
4	1.0	1.5	1.5	0.8	1.0	0.8	D 46.7	0.5	1.0	0.5	D 37.5	D 66.67
5	4.0	3.0	12.0	1.0	3.5	3.5	D 70.8	0	0	0	D 100	D 100
M	3.2	2.5	8.0	1.6	2.1	3.4	D 57.5	1.1	1.1	1.2	D 64.41	D 85.0

P = Patient, L = Length (cm), W = Width (cm), D = % of decrease of cm², I = % of increase of cm², M= Mean

Table 30b. The sizes (cm) and areas (cm²) of VLUs in the comparison group.

Comparison group												
P	M0			M1			M0 - M1	M2			M1 - M2	M0 - M2
	L	W	cm ²	L	W	cm ²	%	L	W	cm ²	%	%
1	4.0	5.0	20.0	3.0	4.0	12.0	D 85.0	3.0	4.0	12.0	D 0	D 40.0
2	19.0	16.0	304.0	12.0	6.5	78.0	D 74.34	9.0	4.5	40.5	D 58.08	D 86.68
3	4.5	2.3	9.0	4.0	1.5	6.0	D 33.33	4.0	1.5	6.0	D 0	D 33.33
4	1.0	0.5	0.5	2.4	1.1	2.6	I 420	1.4	1.5	2.1	D 19.23	I 320.0
5	3.0	2.5	7.5	2.4	1.0	2.4	D 68.0	2.2	1.5	3.3	I 37.5	D 56.0
M	6.3	5.3	33.1	4.8	2.8	13.4	D 59.52	3.9	2.6	10.2	D 23.88	D 69.18

P = Patient, L = Length (cm), W = Width (cm), D = % of decrease of cm², I = % of increase of cm², M= Mean

Cleansing the VLU was usually carried out with tap water, saline or irrigation solution in both groups. In all cases, the bottle of saline was open and used multiple times. The bottles were sealed with tape after cleansing the VLU. Mechanical debridement was used by the nurses, but the usage of equipment was not always according to instructions. *Dressings* were selected and used more appropriately in the IG at every measurement point. The selection of methods and materials improved during the study in the IG. The use of *protective skin agent around the VLU* was not performed sufficiently in either of the groups at any measurement point. The nurses usually used normal skin creams, which are not protective enough to block moisture around the VLU. Only one nurse in the CG used adequate protective skin agent at M1. (Table 31)

Compression bandage usage improved in the IG. At M0, two nurses in both groups completed the compression according to the guidelines. At M1 and M2, four nurses in the IG and two nurses in the CG completed the compression according to the guidelines. In the CG, compression was not used with one patient and the nurse did not know the reason for this. (Table 31)

Pain medication (pain relieving gel) during nursing care was used more in the CG. However, the usage of pain relieving gel was not carried out according to instructions; nurses either used it too much, did not wait until it had taken effect or applied the gel so that it ran off the VLU (the leg was not in horizontal position when the gel was applied). Gel applicators were afterwards sealed with tape. Gel application was not based on systematic evaluation of patient's pain. (Table 31)

Nurses in both groups had mobile devices allowing the *documentation* into patient records to be done in patient's home. However, documentation of VLU nursing care into patient record system was completed in patient's home only by one nurse in both groups at M2. Nurses told that they document nursing care in the HHC office after the home visit. eVLU included PUSH -Tool 3.0 to help with VLU assessment and documentation, but only one nurse in the IG used it at M1 and M2. She also measured the VLU with a paper ruler without asking at M1 and M2. (Table 31)

In *hygiene and taking care of waste*, the main difference between IG and CG was in hand washing and disinfection, as all the nurses in the IG disinfected their hands at every measurement point while four nurses in the CG used disinfection at M0 and three at M1 and M2. The other difference between the groups was in using gloves and plastic apron. In the IG at M0 one nurse used both gloves and plastic aprons, while at M1 and M2 three nurses in the IG used them. In the CG, none of the nurses used both plastic apron and gloves during any measurement point; they used only gloves. (Table 31)

Table 31. The results of skills observations.

	IG (n=5)			CG (n=5)		
	M0 *	M1*	M2*	M0*	M1*	M2*
1. Preparation of VLU nursing care	3	2	3	1	1	2
2. VLU assessment	0	1	1	1	1	1
3. Cleansing the VLU	3	3	4	2	3	2
4. Used dressings	3	4	4	2	2	2
5. Protective agent to protect the skin around the VLU	0	0	0	0	1	0
6. Compression bandages	2	4	4	2	2	2
7. Pain medication	1	2	1	1	4	3
8. Documentation	0	1	0	0	0	1
9. Hygiene and taking care of wastes	2	3	4	1	2	2

* The number of nurses who completed all tasks correctly included in each subscale

Table 32. The knowledge test results of the nurses (n=5) who were observed; percentages of correct answers.

Subscale	IG			CG		
	M0 % (n=5)	M1 % (n=3) *	M2 % (n=4) *	M0 % (n=5)	M1 % (n=4) *	M2 % (n=5)
Pathophysiology and etiology	46.25	60.42	50.00	51.25	60.94	60.00
Assessment	65.72	52.38	57.15	68.57	60.72	68.57
Healing	65.71	71.42	64.28	45.71	53.57	45.71
Infection	60.00	66.67	65.00	68.00	65.00	52.00
Topical care	66.15	78.59	59.54	67.92	75.00	69.23
Compression	64.00	66.67	47.50	64.00	65.00	58.00

* all nurses, whose VLU nursing care was observed did not participate knowledge test measurements

5.3.3.3 Economic outcomes of eVLU

Nurses' VLU treatment time was measured with a clock (minutes) and the supplies used were recorded and costs (€) calculated.

Treatment times were longer in the IG, and this was the main reason for higher costs in the IG. At M0, there were less VLU showering in the CG, and this was one reason for shorter treatment times in the CG. (Table 33)

The costs of topical treatment supplies were higher in the IG during the whole study, as were nurses' salaries (Table 34).

Table 33. Treatment times of VLU (minutes).

Nurse	IG		CG			
	M0	M1	M2	M0	M1	M2
1	60	90	90	30	40	40
2	25	20	20	25	20	15
3	30	30	30	10	35	30
4	30	30	60	30	30	15
5	30	30	30	15	25	20
Mean	35	40	46	22	30	24
Total time	2 h 55 min	3 h 40 min	3 h 58 min	1 h 50 min	2 h 30 min	2 h

Table 34. The costs of nursing care of VLUs.

Nurse	IG €			CG €		
	M0	M1	M2	M0	M1	M2
1	13.01	18.98	18.98	9.10	9.10	9.10
2	7.89	5.90	5.90	8.02	5.33	3.03
3	10.39	10.39	6.95	7.23	9.05	8.73
4	31.21	31.21	28.35	5.11	9.60	5.59
5	12.05	10.34	9.72	6.33	4.26	7.05
Mean	14.91	15.36	13.98	7.16	7.47	6.70

(Nurses' salaries and costs of topical treatment supplies)

5.4 Summary of the main results of the study

In this chapter, a summary of the main results of the study is presented according to the study phases and research questions.

There are EB guidelines and education available for nurses, but nurses still have gaps in knowledge and skills about VLU nursing care. However, nurses' attitudes towards patients with VLUs seem to be positive. There are knowledge tests available to measure nurses' knowledge in clinical nursing care available, most of them are focused on PU or diabetes care. A knowledge test to measure nurses' knowledge in VLU nursing care is lacking. There are many kinds of CE programs available for nurses to utilize in clinical nursing care; however, CE specifically about VLU nursing care is lacking. According to previous studies, it is possible to increase nurses' knowledge and skills as well as improve their attitudes with CE. (Figure 36)

In this study, the PKAK and OC instruments were partly modified and partly further developed. They were used to evaluate the effectiveness of eVLU intervention developed in this study. The effectiveness of eVLU was evaluated three times during the study. Based on the results eVLU improved nurses perceived and

theoretical knowledge in the IG but did not influence nurses' attitudes. The improvement in knowledge seems to be short-lived. The congruence between perceived and theoretical EB knowledge increased in both groups during the study, but the increase was statistically significant in more items in the IG compared to the CG. (Figure 36)

Although only 6 nurses logged in to eVLU during each week of the eVLU, answers to weekly tasks were received from almost all HHC districts each week. The organization of work in HHC and the large number of nurses can be challenging for arranging common CE. In this study, nurses in the HHC teams were instructed to complete the weekly tasks together, and this was considered to relieve nurses' individual burden to complete the whole eVLU alone.

Nurses' attrition rates in cognitive outcome measurements were high in both groups. In addition to this, only 5 VLU nursing care situations were observed in both groups and because of this the results are mostly indicative. Despite the low participation, it was possible to get information about eVLUs effectiveness on cognitive outcomes and how it needs to be developed in the future. This complies with the aim of the study, which was to develop internet-based CE to support EBP in VLU nursing care in HHC.

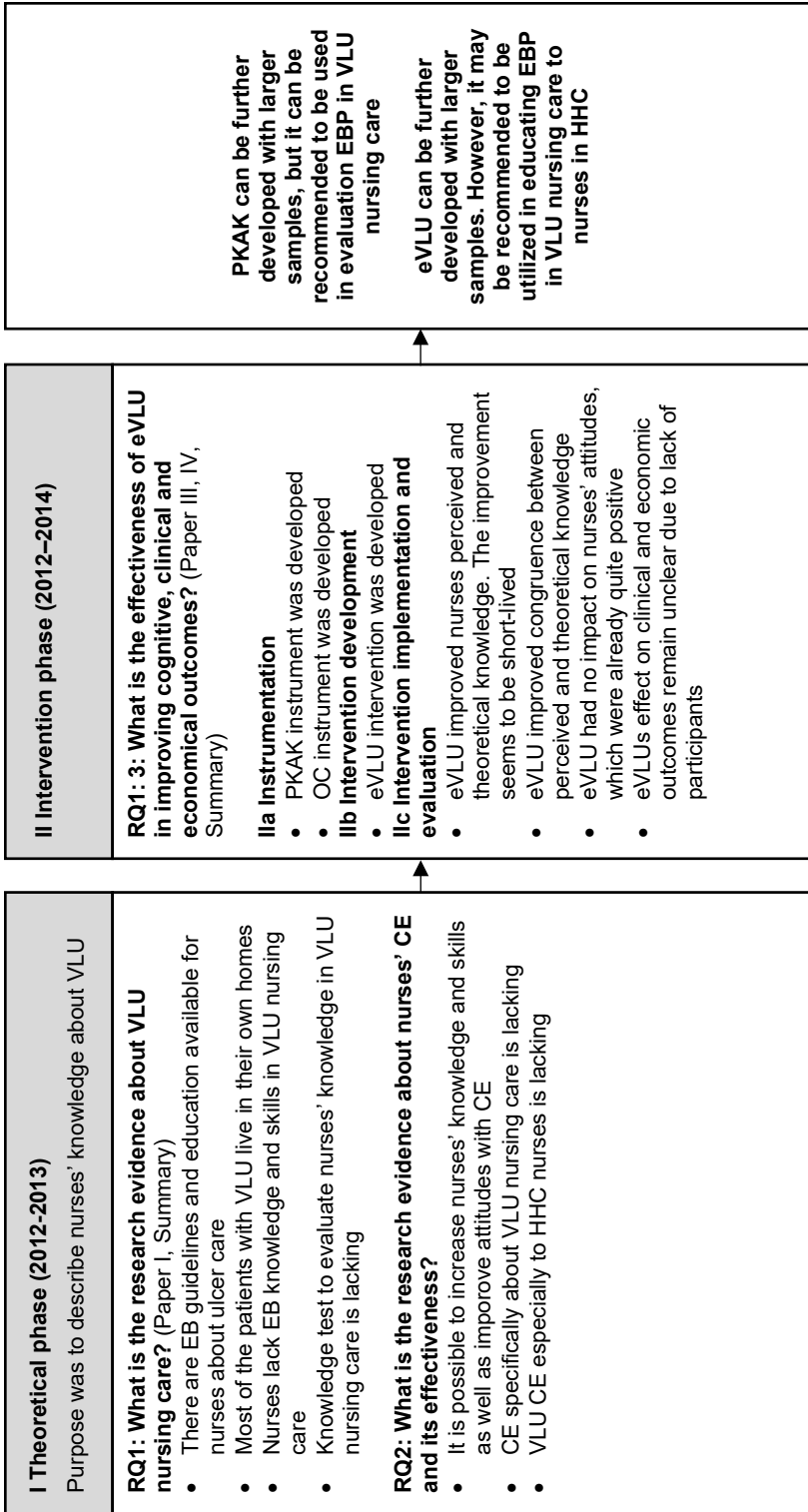


Figure 36. Summary of the main results.

6 Discussion

In this chapter, first, the main results of this study are discussed. Second, the validity and reliability of the study are discussed. Finally, implications for future research, clinical practice and management are stated.

6.1 Discussion of the results

In this study the aim was to develop internet-based CE to support EBP in VLU nursing care in HHC. Internet-based education about VLU nursing care (eVLU) was developed for HHC nurses and its effectiveness was evaluated. For effectiveness evaluation, the PKAK instrument was partly modified from previous instruments (Graham et al. 2001, Van Hecke et al. 2009) and a knowledge test of VLU nursing care was developed. In addition to this, a previously developed OC (Ribu et al. 2003) was modified. The cognitive, clinical and economic outcomes of eVLU were evaluated in a quasi-experimental study at three time points during the study: at baseline (M0) before the eVLU, at first follow-up (M1) right after the 6-week eVLU, and at second follow-up (M2) one month later at 10 weeks. Next the results of this study are discussed according to the study phases.

The results of the original and updated literature review (Phase I) revealed nurses' knowledge gaps in VLU nursing care. Nurses may not use the EB knowledge sufficiently well to support VLU healing and patient well-being. (Paper I)

Nurses acquire most of their knowledge about VLU nursing care from their own experience, practice and from colleagues, and decision-making on VLU nursing care can be driven by experiential knowledge (Haram et al. 2003, Gillespie et al. 2014), which were also the findings in this study. (Paper III) This can cause implementation of out-of-date practices and possible delay in ulcer healing. CE about VLU nursing care is needed. The results of the literature review about nurses' knowledge tests yielded several knowledge tests, but none about VLU nursing care. The literature review about nurses' CE and its' effectiveness resulted in many CEs, but none about VLU nursing care. The effectiveness of CE has been evaluated with many methods and instruments, and CE has been proven to be effective in improving nurses' knowledge, skills and attitudes. (Summary)

Cognitive outcomes included nurses' perceived knowledge, theoretical knowledge, attitudes and congruence between perceived and theoretical knowledge. The hypothesis was supported as both perceived and theoretical knowledge levels increased statistically significantly in the IG. However, eVLU had no effect on nurses' attitudes.

In the CG, the knowledge levels remained at the same level during the study. The increases in the IG were detected between M0 and M1 as well as between M0 and M2. (Paper III) This is in line with the results of previous studies reporting knowledge increase immediately after CE (Maylor & Torrance, 1999, Pieper & Mott 1995, Zulkowski et al. 2007). However, the length of time that knowledge is retained varies in previous studies. For example, in the study of Tweed & Tweed (2008), knowledge increased right after the CE but returned to baseline after 5 months. In the study by Cox et al. (2011), the most significant loss of knowledge, regardless of CE method (lecture or computer-based instruction), became apparent during the first three months. In the study by Sinclair et al. (2004) it was found that knowledge increased significantly both right after the CE and 3 months later. The congruence between perceived and theoretical knowledge increased statistically more significantly in more items in the IG than in the CG. This result supported the hypothesis.

In both groups, nurses' attitudes towards VLU nursing care were positive at M0 and remained at the same level during the study. Result did not support the hypothesis. Positive attitudes towards VLU nursing care are important as negative attitudes can be a barrier to ulcer healing (Flanagan 2005).

Clinical outcomes included VLU size measurement, VLU infections and nurses' skills and they were evaluated with observations. Nurses' participation rate was very low and only 5 nurses participated in the observations in both groups. Due to this, the real success of eVLUs effect in changing VLU sizes and VLU nursing care skills remains unclear. In addition to this, VLU infections were not identified in either of the groups.

Improvement in nurses (n=5) skills was detected more often in the IG. VLU areas (cm²) decreased more in the IG and hypothesis was supported. Based on the guidelines measuring and recording the VLU area should be a routine part of patient assessment in VLU nursing care in predicting ulcer healing (Gethin 2006, Chronic Leg Ulcer: Current Care Guidelines 2014). However, the researcher and research assistant had to remind nurses in both groups about measurement, which showed that measuring was not a routine part of VLU nursing care. Ulcer area decrease 30% or more over 4-weeks period has been defined as good predictor of ulcer healing (Kantor & Margolis 2000, Sheehan et al. 2003) and this was achieved with four VLUs in both groups between M0 and M1. Between M1 and M2 it was achieved

with three VLUs in the IG and one in the CG. Between M0 and M2 the area decreases 30% or more was achieved with all 5 VLUs in the IG and four VLUs in the CG.

Economic outcomes included the costs (€) of topical care supplies and nurses' salaries (€). VLU nursing care times were longer and the costs of topical care supplies higher in the IG at every measurement point. The mean of the costs was approximately twice as high in the IG compared to CG at every measurement. These results did not support the hypothesis.

Nursing care outcomes in VLU nursing care are dependent on many factors besides practices used to deliver care, including patient health status, well-being and adherence to recommendation and guidance, and contextual or environmental factors (Upton & Solowiej 2010, Hopman et al. 2014, Upton et al. 2014, Skolarus et al. 2015, Dudfield et al. 2019). Education is likely to change the practice. However, education cannot provide readymade answers to all practical problems. Learners must be able to adapt knowledge to similar kinds of problems as were discussed in education. Nurses' personal interest in a topic can bring learning to life and bring about real change in nursing practice (Rogers 1959, Andrew & Theiss 2015).

The time between the publication of evidence and its integration into daily work can be a quarter of a century. Therefore, organizations need to assess supportive mechanisms to shorten this time. (Eskes et al. 2012, Eskes et al. 2014.) Education alone does not bridge the gap between evidence and practice; nursing managers and opinion leaders should be involved as they are important in promoting EBP in nursing care. EB guidelines are useful decision aids in VLU nursing care but nurses must at all times pay attention to patients' individual situation. (Eskes et al. 2012, Chronic Leg Ulcers: Current Care Guidelines 2014.)

It must also be kept in mind that barriers to CE and knowledge transition can exist at various levels of health care, many of which operate beyond the control of an individual nurse, for example organizational barriers (e.g. inappropriate skill mix, lack of equipment), peer group barriers (e.g. local standards of care are not in line with desired practice), professional (e.g. knowledge, attitudes and skills) and nurse-patient interaction barriers (e.g. communication issues). (Shadish et al. 2002, Griscti & Jacono 2005, Grimshaw et al. 2012, Dogherty & Eastbrooks 2015.) Organizational leadership plays an important role in supporting attendance in CE as an investment for the future (Coventry et al. 2015). In this study, managers were informed about the study and they were asked to enable nurses' participation in eVLU and study measurements during working hours. In the future, more systematic follow-up in CE participation from managers is needed, because they are leading the developmental actions in social and health care organizations. eVLU would have been a free-of-charge opportunity for them to utilize in VLU nursing care development.

Based on previous studies, nurses can perceive e-learning disconnected and isolated, while socialization and interaction are considered as essential parts in

learning (Haigh 2004, Hyde & Murray 2005). In this study, nurses were instructed to collaborate and discuss in HHC teams and compose answers to weekly questions collectively. It is not possible to find out how much nurses discussed and worked together on the topics in eVLU. Also, there was no communication in the eVLU discussion forum except for the researcher's weekly feedback. Any social interaction involves making oneself vulnerable, facing the risk of rejection and misunderstanding (Pallof & Pratt 2007), and this may have been one reason for not participating in the discussion forum. It may be that nurses are not committed to participate in this kind of study even when the topic is exactly in the focus of their work, and even though the eVLU would have given them an excellent opportunity to test their knowledge and skills.

6.2 Feasibility of eVLU

Feasibility of the eVLU was analyzed with the electronic (Webropol ®) feedback questionnaire developed for this study. The questionnaire link was sent to all the nurses (n=239) in the IG one month after the eVLU had finished. It consisted of 23 items considering the use of eVLU and its benefits. The scale was 1 = Totally disagree, 2 = Somewhat disagree, 3 = Neither disagree nor agree, 4 = Totally agree. A total of 80 (33.5%) of the nurses logged to on the eVLU at least once, and answers were expected especially from them. A total of 18 nurses (7.53% of 239) answered, and 14 nurses who had used eVLU themselves continued answering the remaining 21 questions. (Table 35, Table 36)

Table 35. Use of eVLU and the reasons for no use (n = 18).

Item	Yes n (%)	No n (%)	Why not
1. We used eVLU in our team	16 (89)	2 (11)	1. We did not find the material. 2. The use of the material was advised but working with clients won over it.
2. I used eVLU myself	14 (78)	4 (22)	1. Sick leave 2. I did not have a password 3. Too little time

Out of 14 nurses, 6 (42.86%) agreed that working with internet advanced their learning of VLU nursing care and 10 (71.43%) found the needed information through eVLU. Over half (57.14%) of the nurses disagreed that eVLU operated technically well. Over half (57.14%) of the nurses agreed that the layout of eVLU was clear. Most (85.71%) of the nurses agreed that the content of eVLU was professionally interesting. Over half (57.14%) agreed that returning tasks to eVLU was easy and

most (78.57%) agreed that they can utilize eVLU in developing their expertise. Most (78.57%) agreed that the content of eVLU was adequately challenging and over half (56.57%) agreed that the weekly tasks made it possible to deepen their knowledge and skills in VLU nursing care. (Table 36)

Only one (7.14%) nurse agreed that all members of the HHC team took part in answering the weekly tasks. However, most (71.43%) of the nurses agreed that answering the weekly tasks in teams with other nurses is a development-promoting way to study. Half (50%) of the nurses agreed that the PUSH Tool 3.0 was a useful tool for VLU assessment; over half (57.14%) of them would like to use this instrument also in the future. Most (71.43%) agreed that the model answer from the educator is a good way to give feedback. Over half (57.15%) agreed that the information about eVLU timetable was easy to find; however, only 40% agreed that the information about eVLU content was easy to find. Only 28.57% agreed that the duration of the eVLU was suitable and 7.14% agreed that the timetable was suitable. About one fifth (21.43%) of the nurses agreed that they would have needed more guidance during the eVLU. (Table 36)

Table 36. Nurses' feedback of eVLU (n=14).

Items	Totally disagree	Somewhat disagree	Neither disagree nor agree	Somewhat agree	Totally agree	Mean
	n (%)	n (%)	n (%)	n (%)	n (%)	
1. The content in the eVLU were professionally interesting	0 (0)	0 (0)	2 (14.29)	8 (57.14)	4 (28.57)	4.13
2. The content of eVLU was adequately challenging	0 (0)	0 (0)	3 (21.43)	9 (64.28)	2 (14.29)	3.93
3. The model answer from the educator is a good way to give feedback	0 (0)	0 (0)	4 (28.57)	7 (50.0)	3 (21.43)	3.93
4. I can utilize eVLU studies in developing my expertise in VLU nursing care	0 (0)	3 (21.43)	4 (28.57)	7 (50)	3 (21.43)	3.93
5. I would like to use PUSH Tool 3.0 -instrument also in the future in ulcer assessment	0 (0)	1 (7.14)	5 (35.72)	4 (28.57)	4 (28.57)	3.79
6. PUSH Tool 3.0 -instrument was a useful tool for ulcer assessment	0 (0)	1 (7.14)	6 (42.86)	3 (21.43)	4 (28.57)	3.71
7. Information about eVLU timetable was easy to find	0 (0)	1 (7.14)	5 (35.71)	6 (42.86)	2 (14.29)	3.64
8. Information about eVLU content was easy to find	0 (0)	1 (7.14)	6 (42.86)	4 (18.57)	3 (21.43)	3.64
9. Answering the weekly tasks in teams is a development-promoting way to study	1 (7.14)	1 (7.14)	2 (14.29)	8 (57.14)	2 (14.29)	3.64
10. I found the needed information through eVLU	0 (0)	3 (21.43)	1 (7.14)	9 (64.29)	1 (7.14)	3.57
11. Working with the internet advanced my learning of VLU nursing care	0 (0)	1 (7.14)	7 (50.0)	4 (28.57)	2 (12.29)	3.50
12. The layout of the eVLU was clear	0 (0)	3 (21.43)	3 (21.43)	7 (50.0)	1 (7.14)	3.43
13. Returning tasks to eVLU was easy	1 (7.14)	3 (21.43)	2 (14.57)	5 (35.71)	3 (21.43)	3.43
14. The weekly tasks made it possible to deepen my knowledge and skills in VLU nursing care	1 (7.14)	2 (14.28)	3 (21.43)	6 (42.86)	2 (14.29)	3.43
15. eVLU operated technically well	0 (0)	8 (57.14)	3 (21.43)	2 (14.29)	1 (7.14)	2.71
16. The duration of the eVLU was suitable	3 (21.43)	4 (28.57)	3 (21.43)	3 (21.43)	1 (7.14)	2.64
17. The timetable of the eVU was suitable	3 (21.43)	7 (50.0)	3 (21.43)	0 (0)	1 (7.14)	2.21
18. All members of my team took part of answering the weekly tasks	10 (71.43)	2 (14.29)	1 (71.14)	1 (7.14)	0 (0)	1.50
Mean						3.38
19. I would have needed more guidance during the eVLU	1 (7.14)	3 (21.43)	7 (50)	2 (14.29)	1 (7.14)	3.43

Scale: 1 = Totally disagree, 2 = Somewhat disagree, 3 = Neither disagree nor agree, 4 = Somewhat agree, 5 = Totally agree

6.3 Validity and reliability of the study

The validity and reliability will be discussed in terms of intervention, instruments, data collection and results.

6.3.1 Validity and reliability of the intervention

In Phase II, in planning of the study protocol CONSORT 2010 Statement (Moher et al. 2010) was followed to ensure the quality of the protocol. Also, criteria for reporting the development and evaluation for complex interventions in health care (CReDECI) (Möhler et al. 2012) were used in reporting the intervention. (Paper II) The planned protocol was followed accurately to ensure rigor in implementation and performance bias (Borglin & Richards 2010, Lamb & Altman 2015). The intervention was delivered by the researcher, and before implementation, RNs, PHNs and team managers were educated with a lecture. LPNs received information from managers and it was also included in the eVLU.

eVLU was developed in this study. Intervention development was needed because there was no internet-based CE available specifically about VLU nursing care. The first European post-registration wound curriculum was published in 2017 and one unit of this concerns lower leg ulcers with different kind of etiologies (EWMA 2017). In this study, the EB guidelines (Chronic Leg Ulcers: Current Care Guidelines 2014) were used as golden standard of VLU nursing care as they have been developed for health care professionals to understand the principles of ulcer care. In the eVLU, skills were disseminated with pictures and videos. Hands-on-training was lacking, and due to this, learning technical skills may have been difficult. (Degon 2010.) However, due to the large number of nurses working in HHC, educating every nurse with hands-on-training demands a lot of time and resources and therefore e-learning was chosen in this study. E-learning and face-to-face education have been shown to deliver equal results in knowledge and skills (Chumley-Jones et al. 2002, Chen et al. 2008, Mc Veigh 2009, Koch 2014, Vaona et al. 2018).

During eVLU development, experts of VLU nursing care were consulted several times to reach consensus on the content and timetable (Lodewijckx et al. 2012, Sermeus 2015). Assessing nurses' learning needs was conducted with integrative literature review (Kirkevold 1997) in Phase I identifying nurses' knowledge gaps in VLU nursing care. (Paper I) eVLU components were described in detail (Paper II). In eVLU the goals for learning were established for each week (Braungart & Braungart 2008). The material to solve weekly tasks was available on the internet and in the eVLU, nurses were guided to find the answers to weekly tasks. EB guidelines are usually quite long and in eVLU, nurses were told exactly in which chapter in the guidelines they could find the answer. HHC as the context (Skolarus

& Sales 2015) of the education was considered especially when composing the patient case-description for the eVLU which the weekly tasks were targeted at. All the nurses from whom eVLU was planned to be implemented were adults, and they usually do better with self-directed problem-oriented learning with possibilities to use their experiences and skills to help each other (Tennant 2006, Bastable & Dart 2008). Adults are eager to learn when the subject taught is relevant and applicable to their everyday concerns. However, adults often need or want structure as well as clear and concise specific and direct guidance in learning (Kitchie 2008, Bastable & Dart 2008, Govranos & Newton 2014); in addition, learning is always a cognitive process for achieving knowledge, and technology can be used to enable the learning process.

The eVLU was delivered in the same way to all the nurses ($n = 239$) in the IG (Skolarus & Sales 2015). On individual level, the use of eVLU was very low as only 6 nurses logged in during each week of eVLU. A total of 80 nurses logged in at least for one week and there were over 200 loggings into the eVLU over 6 weeks. According to the pilot test, the timing and dosing of eVLU was acceptable and the content was professionally interesting to nurses (Feeley & Cossette 2015). However, based on nurses' feedback on the study, the timing of eVLU was too rapid in view of the nurses' heavy workload. Low participation in leg ulcer education was found also in the study of Clarke-Moloney et al. (2008), in which only 30 nurses out of 98 participated in the education but improved practices were found in audits. The improved practices may be attributed to the dissemination of knowledge and skills. In learning, the need to recognize and relate the new information to the learners' past experiences is important; for example, old habits and culture. The control over learning lies within the learner (Dewey 1938, Braungart & Braungart 2008.) Based on the results of this study, nurses perceived their knowledge on VLU nursing care to be rather good and this may have been one reason for the low participation. As a result of low participation and the possibility that only the more committed nurses participated it is possible that the results cannot be generalized to all nurses working in HHC. In addition to this, nurses' beliefs of their knowledge are not sufficient indications of EB knowledge use in practice. National and international comparisons of nurses' knowledge levels are needed to ensure homogeneous nursing care of patients of VLUs.

Evaluation of the eVLU implementation process was carried out when participants returned the weekly answers to Moodle. The educator (researcher) sent common feedback to all nurses after each week of eVLU. Nurses were advised to compare their answer to this model answer. Implementation was also evaluated with a feedback questionnaire after the eVLU. Barriers and facilitators to the delivery of the intervention's components could have been analyzed more, e.g. with focus group interviews with nurses actively involved in eVLU. (Möhler et al. 2012.)

Some technical problems were reported to the researcher; mostly difficulties in logging on the Moodle. The internet links in eVLU seemed to function well because nurses did not report any problems with them. The researcher checked every link before the weekly material was made available to the nurses. The eVLU was free of charge, but one hour of nurses' working time was estimated to be needed during each week of eVLU. E-learning is usually described as a low-cost way to educate professionals because nurses can learn in their own workplaces at their own pace. However, from the teacher's point of view, e-learning can be more time-consuming than, for example, face-to-face lectures according to a standardized curriculum. (Koch 2014.) It would have been useful to calculate the costs of developing and running eVLU, and this should be considered when developing the eVLU further. (Booth et al. 2009, Liu et al. 2014, Serrat 2017.)

6.3.2 Validity and reliability of the instruments

Validity describes the extent to which the instrument measures what it is intended to measure. Validity can be considered in terms of content and construct validity. Reliability refers to the quality of the measurement's consistency, stability, and repeatability (Lynn 1986, Ferketich 1990, Shadish et al. 2002, DeVon 2007.)

The face validity of PKAK was first evaluated by experts of VLU care (one physician and TVN). They provided information on how the HHC nurses might interpret the items and whether the PKAK measures the perceived and theoretical knowledge of VLU nursing care and attitudes towards it. (DeVon et al. 2007.)

The content validity of PKAK was evaluated by three expert panels (Schulz & Whitney 2005) in electronic format (Webropol®). It is recommended that there should be at least 5 experts to provide a sufficient level of agreement (Lynn 1986). In this study, the number of experts varied from 6 to 4, but their contribution was important to base the items to reflect the specific important content to be learned. The first expert panel was conducted in 2012. In it 6 experts (one physician specialized in ulcer care and 5 nurses who had completed expert education in wound care) from different health care organizations around Finland evaluated and scored each item from two perspectives, relevancy and clarity using a 4 –point Likert scale. For relevance the scale was: 1= not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant. For clarity the scale was 1 = not clear at all, 2 = only somewhat clear, 3 = rather clear, 5 = very clear. In the case of no relevance or clarity, a written explanation as to why was asked. Item content validity (I-CVI) (Polit et al. 2007, Polit & Beck 2010) was calculated for every item; the mean I-CVI for relevancy was 0.90 and for clarity 0.84, which can be considered to be adequate (Lynn 1986). However, revisions in item clarity were made based on the experts' opinions.

The second expert panel was conducted in April 2013; the same expert panel evaluated item clarity, and the mean I-CVI for clarity was 0.93. (Paper II) The third expert panel, arranged in June – August 2013 with four experts (one physician specialized in ulcer care and three nurses who had completed expert education in wound care) from different health care organizations around Finland, evaluated the level of difficulty of the knowledge test items using the scale 1= too difficult 2 = suitable, and 3 = too easy. Most items were rated as suitable; however, 5 items were rated as too difficult by two experts and 12 items by one expert. Revisions were made based on experts’ opinions, and the total knowledge test items were developed further based on EB guidelines (Chronic Leg Ulcers: Current Care Guidelines 2014), the content was evaluated by a TVN and a physician specialized in VLU care.

Cronbach's alpha was used to evaluate the PKAK’s internal consistency, which denotes how well the items fit together conceptually. In the IG, it varied between 0.72 and 0.96 for perceived knowledge subscales, and between 0.49 and 0.80 for theoretical knowledge subscales. In the CG, it varied between 0.66 and 0.97 and between 0.47 and 0.83, respectively. An alpha of at least 0.70 is considered to be adequate for an instrument in its early stages and an alpha of 0.80 for a more highly developed. In PKAK, subscales Healing and Infection had low alphas. The reason for this may be that there were only from 5 to 7 items in these subscales. (Ferketich 1990, DeVellis 2003, DeVon et al. 2007.) (Paper III, Table 37)

Table 37. Cronbach’s alphas for perceived and theoretical knowledge subscales (Paper III, modified).

Subscale	Perceived knowledge level			Theoretical knowledge level		
	IG (n=97-98)	CG (n=59-62)	CG (n=59-62)	IG (n=97-98)	CG (n=59-62)	CG (n=59-62)
	Items	Cronbach’s alpha	Cronbach’s alpha	Items	Cronbach’s alpha	Cronbach’s alpha
Pathophysiology and etiology	4	0.76	0.66	16	0.77	0.82
Assessment	5	0.78	0.80	14	0.70	0.79
Healing	5	0.79	0.77	7	0.49	0.51
Infection	4	0.79	0.83	5	0.54	0.47
Topical care	4	0.72	0.75	13	0.72	0.83
Compression treatment	3	0.96	0.97	10	0.80	0.72

In PKAK reliability assessment, floor and ceiling effects (Streiner & Norman 2008) were considered and based on comparison of SDs between M0 and M2, there was some ceiling effect in the perceived knowledge measurements due to high M0 scores, with the highest ceiling effect found out in the subscale Compression. In the

theoretical knowledge measurements, no floor or ceiling effects were detected. (Paper III)

Passing scores were not established for the knowledge test. This is the first version of the knowledge test and further studies are needed to establish passing scores. It could also be useful to assess the item content using professional judgment about the relative importance of the items/subscales, giving more weight to some of them. Item formatting should also be examined more. (Downing & Haladyna 2006, Steiner & Norman 2008.) In the future, national and international comparative data is needed. Test-retest data should be collected to test the stability and reliability of PKAK over time. Sensitivity and specificity for nursing practice needs to be examined further to develop, and possibly shorten, the PKAK scale.

The OC (Ribu et al. 2003) and rating scale were carefully constructed, and pilot tested by both observers. The observers discussed the underlying dimensions in the rating scale to reach consensus about the behaviors to be observed (Polit & Beck 2010). National and international comparative data is needed in further studies.

Reliability of RPPE internal consistency was evaluated with Cronbach's alpha with pilot-test data (n = 29) and Cronbach's alpha was also evaluated in the study (n =150). (Table 38)

Table 38. Cronbach's alphas for RPPE.

Subscale	Pilot test (n=29)	Study (n=150)
1. Handling disagreement and conflict (9 items)	0.65	0.63
2. Leadership and autonomy in clinical practice (5 items)	0.56	0.76
3. Internal work motivation (8 items)	0.71	0.72
4. Control over practice (5 items)	0.68	0.59
5. Teamwork (4 items)	0.54	0.27
6. Communication about patients (3 items)	0.39	0.59
7. Cultural sensitivity (3 items)	0.61	0.65
8. Staff relationship with physicians (2 items)	0.64	0.51

6.3.3 Validity and reliability of data-collection

The sample criteria were developed to make the target population in the IG and CG as homogeneous as possible and to maximize the effects of the independent variable (Grove et al. 2013). The researcher conducted data collection in Phase I in cooperation with another researcher to ensure reliability. In Phases IIa and IIb, the researcher conducted the data-collection herself, and experts of VLU nursing care and HHC were consulted during data analysis. In Phase IIc, the researcher collected the PKAK data from IG and CG. Phase IIc observational data was collected by the researcher in the CG and by the research assistant in the IG.

In Phase I and Summary, the integrative review method (Kirkevold 1997) of empirical studies was used to analyze nurses' knowledge about VLU nursing care. The aim was to integrate separate study findings into a comprehensive and logical description of nurses' knowledge in VLU nursing care. Three scientific databases (MEDLINE, CINAHL and COCHRANE LIBRARY) were chosen for the review because they are mostly concerned with nursing care and healthcare treatments (Brazier & Begley 1996, Subirana et al. 2005). The search covered a period from 1966 to the end of 2012 and was updated in 15. May 2019 for the summary.

In Phase I, the keyword "leg ulcer" was chosen instead of using the search term "venous leg ulcer" because nurses' knowledge about VLU nursing care is usually reported as part of a larger study about chronic leg ulcers. The literature search was limited to English language; this may have led to missing some studies in other languages that would have been worthy of analysis. Two researchers selected the included studies, and quality appraisal of data was conducted independently by two researchers according to appropriate appraisal instruments. Of the 16 studies included in the review, three experimental studies were assessed with the CONSORT appraisal tool (Begg et al. 1996, Schultz et al. 2010). One literature review was assessed with the PRISMA appraisal tool (Moher et al. 2009) and 11 other studies were assessed with the STROBE appraisal tool (von Elm et al. 2007) for cohort, case-control and cross-sectional studies. One qualitative study was assessed with the COREQ appraisal tool (Tong et al. 2007). The first limitation of the literature search was that a manual search of non-electronic material was not conducted, which might have uncovered some beneficial additional literature. Secondly, there may have been studies in languages other than English that could have been worthy of analysis. Thirdly, the validity of the review was reduced due to small sample sizes in the included studies. This makes it difficult to generalize the findings. Finally, most of the studies were conducted in Europe. However, the themes inside and outside Europe seemed to be equivalent. (Paper I)

In Phase IIa, the aim of the literature review was to find a knowledge test to measure nurses' knowledge in VLU nursing care. In Phase IIb the aim of the literature review was to find studies measuring the effectiveness of nurses' CE by using the keywords "Wound care AND continuing education" and "Continuing education". The search covered the period from 1966 to 15 May 2019, when the search was updated. One scientific database (MEDLINE) was used. MEDLINE is recommended to be the first-choice database in nursing for any subjects other than those precisely related to the organization of nursing (Brazier & Begley 1996). Searching in both MEDLINE and CINAHL is recommended to obtain the best results. It is also recommended that it would be best to search as many databases as possible. (Subirana et al. 2005.) Searching from other databases as well as manual

search from non-electronic material might have led to some beneficial additional literature.

In Phase IIc, a pilot test of eVLU was conducted in a population similar to the study population. It was executed in computer class and the researcher was present during data collection. Data collection using the PKAK and OC was carried out as planned and either the researcher or research assistant was present at all the data collection times. Data were collected on patient-relevant outcomes (Buhse & Mühlshausen 2015). VLU size measurement is a direct patient-relevant outcome measurement reflecting VLU healing; however, measurement of size can be difficult because VLUs are rarely regular in shape (Gethin 2006, Chronic Leg Ulcers: Current Care Guidelines 2014).

Allocation of time for recruitment is important (Gul & Parveen 2010). In this study, directors of HHC in both cities were contacted for the first time in autumn 2013 to ask for possibility to conduct this study in their organizations, and in the spring 2014, the researcher met the directors. As part of discussion with the directors it was agreed that they would inform staff about the upcoming study. Recruitment of nurses began in June 2014 with briefings to the participating cities' RNs, PHNs and HHC team managers. HHC directors in both cities named a coordinator for this study from their administrative staff. The researcher received the HHC team managers' contact information from the coordinators in both cities. Coordinators and HHC managers were asked to remind the nurses about participation several times during the study. Nurses received common feedback on their weekly answers in eVLU because they participated in eVLU as members of a team and composed team answers together.

Recruitment was planned to motivate nurses' participation (Given et al. 1990, Polit et al. 2007, Shadish et al. 2002, Treweek 2015) as eVLU implementation and data collection was conducted among nurses working in those HHC districts where patients with chronic leg ulcer were cared for. Observations were conducted with nurses who were taking care of patients with VLU. At M0, observers evaluated the ulcers with an ulcer checklist including the characteristics of VLUs. This was carried out to improve the validity of the observations by verifying that the patient had a VLU.

In this study, the challenge was to retain nurses in data collection as well as sufficient number of participants to meet the demands of sample size (100 in each group), and power was not reached (High 2001, Devane et al. 2004, Hulley et al. 2001, Gul & Parveen 2010). This reduces the validity of the results. When the attrition rate exceeds 20%, bias is expected in the results (Polit & Hungler 1995). In this study, the attrition rates varied from 59.4% (IG) to 73.4% (CG) at M0, and from 77.8% (IG) to 81.7% (CG) at M1 and, at M2 from 79.1% (IG) to 83.0% (CG). The reasons for this were not requested. It may have been that nurses did not have enough

motivation or interest to take part in the study, or they may have had negative perceptions about the study (Deane & Degner 1998, Green et al. 2000, Cooley et al. 2003, Corrigan & Salzer 2003). Motivation has a critical influence on participation and on whether learning occurs. In order to learn, the nurse must want to gain something, which can be a reward, sense of pleasure, or meeting goals and needs. (Braungart & Braungart 2008.) Participation in the study was voluntary. However, different kinds of procedures were used to target the data collection precisely at those nurses who took care of patients with VLU during the study. The sampling was conducted with PCS to find out those HHC districts where patients with chronic leg ulcers were cared for, and nurses in these districts were included in the study. In addition to this, ulcer characteristics were evaluated to determine the sample for observations.

Observations were conducted in a neutral and non-judgmental manner, and even positive cues were avoided. However, it is not possible to know how many nurses changed their behavior and tried to look good. Atypical behavior due to awareness of being observed was also impossible to detect. Some nurses seemed shy in front of the video camera. It is possible that nurses assimilated to the observer's expectations; however, the OC was not shown to nurses. Biases in observations distorting events towards the middle position or in the direction of previous observations or a tendency to rate everything positively or too harshly were avoided because observers watched every video together and congruence between ratings was evaluated. This also helped to avoid rating scale bias, which means that the observer is influenced by one characteristic in analyzing another. (Burns & Grove 2009, 329-331, 394-410, Polit & Beck 2010, 351-359)

6.3.4 Validity and reliability of the results

In Phase I, critical appraisal of previous studies about nurses' knowledge in VLU nursing care revealed nurses' knowledge gaps. According to the quality assessment, there was some missing information in the articles. Sometimes there were no descriptions of the context or selection of participants. In some cases, the timing of data collection and information of sample size determination was missing. The sample sizes of studies were often small, and this may reduce the validity of the literature review results as well as make it difficult to generalize the findings. Detailed quality appraisal results are reported in Paper I in Table 1.

In Phase IIa, knowledge test development was conducted considering the 12-step process by Downing & Haladyna (2006), which is a useful tool for structuring knowledge test development. In Phase IIb, the study protocol (Paper II) adhered to the CONSORT 2010 Statement (Möhler et al. 2010) was followed to ensure the quality of the protocol. Criteria for reporting the development and evaluation for

complex interventions in health care (CReDECI) (Möhler et al. 2012, 2013 and 2015) promoted the implementation and reporting the outcomes of eVLU.

In Phase IIc, two Finnish cities were divided into IG and CG by lottery. The eligibility of participating nurses was evaluated with PCS. Nurses working in HHC districts with patients with a lower leg ulcer were eligible to participate. There were no significant differences in demographics between IG and CG. Only 6 nurses signed in during each week of eVLU, and attrition of participants in PKAK measurements was high. In addition to this, only 5 VLU nursing care situations were observed at M0, M1 and M2 in both cities. Due to this, the results of this study are not generalizable to all the nurses working in HHC in Finland. However, they may provide evidence for developing EBP VLU nursing care and nurses' CE.

6.4 Implications for future research

In this chapter, suggestions for future research are described. There is a clear need to strengthen the research evidence of CE effectiveness of EBP in VLU nursing care in the context of HHC and in other VLU nursing care environments.

- This study produces new evidence of the outcomes of nurses CE in HHC. The outcomes were studied from nurses' perspective as well as economic perspective. There is a need for further studies to strengthen the evidence base of VLU nursing care and effectiveness of CE in HHC.
- In this study, the effectiveness of eVLU was evaluated in the HHC environment. More studies are needed to determine whether the effects of eVLU can be reproduced in different VLU nursing care environments. Also, the eVLU needs continuous updating as EB guidelines are updated. New solutions such as using more interactive learning in VLU nursing care in eVLU should be developed and tested.
- In this study, only limited outcomes for eVLU could be statistically analyzed. There is a need for further studies to strengthen the evidence base of patient and clinical outcomes of CE in particular. Research of the cost-effectiveness of VLU CE needs to be strengthened as well. To achieve this, there is a need to pay attention to procedures aimed at motivating nurses to participate. The procedures used in this study seemed not to be motivational enough. The role of nursing management in CE participation must be strengthened.
- In this study, the cost effectiveness evaluation of eVLU was limited due to small sample size in the observations. In the future, it is important to evaluate the cost effectiveness of eVLU with larger samples. Nurses' awareness of the importance of participation must be strengthened in the

future. In this study, information about the study was delivered during briefings to nursing managers and RNs/PHNs before the study. It is possible that a personal letter to nurses presenting the study and requesting their participation and guaranteeing full anonymity could enhance participation in the future.

- Nurses need comprehensive EB theoretical knowledge and skills in VLU nursing care. Thus, in further studies, both should be assessed as the outcomes of CE. In addition to this, it is essential to evaluate the feasibility of eVLU with larger samples. In this study, there were almost 250 nurses in both groups who were assessed eligible to participate. During the study, patients with chronic leg ulcers were taken care of in their HHC district, and participation would have offered nurses an excellent opportunity to test their knowledge and skills. However, nurses may not be aware of the gaps in their knowledge and skills and the importance of this awareness must be strengthened in future studies.
- The PKAK -instrument was developed in this study. Further development is needed with larger samples to ensure validity and reliability of the instrument. National and international comparative data are also needed. Test-retest data should be collected to test the stability and reliability of PKAK over time. In addition to this, passing scores in the knowledge test can be established in the future. It could also be useful to assess the item content using professional judgement about the importance of items and subscales, giving possible more weight to some of them.
- To further develop the PKAK and shorten the scale, sensitivity and specificity for nursing practice needs to be further examined.
- PKAK item formatting should also be examined more in the future to ensure that nurses' understanding of them is as uniform as possible. In this study, expert panels evaluated the content and clarity of PKAK, and the results were good. In addition, in pilot test, nurses' evaluation of the content and clarity were good. However, as item formatting is an important part of this kind of instrument development, it should be under continuous evaluation. Furthermore, the PKAK content should be updated whenever evidence-based guidelines are updated.

6.5 Implications for clinical practice

In this chapter, suggestions for clinical practice of VLU nursing care are described. There is a clear need to improve EBP in VLU nursing care (Haram *et al.* 2003, Ribu *et al.* 2003, Fargervik-Morton & Price 2009, Friman *et al.* 2010, Kent 2010, Mosti

et al. 2011, Downe 2012, Clarke-Moloney *et al.* 2014, Neumann *et al.* 2014, Franks *et al.* 2016). Maintenance of professional knowledge and skills is nurses' ethical duty (The Finnish Nurses Association 1996, The Finnish Union of Practical Nurses 2015, The Finnish Association of Public Health Nurses 2017). However, nurses acquire most of their knowledge about VLU nursing care from their own experience, practice, colleagues. The result of this can be the implementation out-of-date practices, and possibly, delayed VLU healing. (Haram *et al.* 2003, Gillespie *et al.* 2014.)

According to the results of this study, the following implications for clinical practice can be presented.

- This study provided new evidence of CE in improving EBP in VLU nursing care in HHC. The improvement of knowledge was short-lived and because of this, continuous efforts will be needed in the future to ensure EBP in VLU nursing care.
- Taking care of patients with VLUs is at the very focus of nursing care. Patients are entitled to safe and consistent EBP nursing care. The maintenance of EBP in VLU nursing care requires continuous effort from nurses and nursing managers. This includes awareness of existing gaps in knowledge and skills. eVLU can be one option for them to utilize in ensuring EBP in VLU nursing care.
- HHC is a challenging nursing care environment to conduct CE due to the working conditions. Internet-based education allows learning that is not dependent of time or place, and with eVLU this is possible in context of VLU nursing care.
- In this study, nurses' main source of VLU nursing care knowledge were their colleagues. In the future, there is the need to strengthen nurses' usage of EB guidelines as their main source of knowledge. Organizational support is needed; for example, EBP mentors and ready availability of research articles may help the implementation of EBP in VLU nursing care.
- In this study, nurses perceived knowing more than they actually knew. Thus, nurses' awareness of the gaps in their knowledge and skills also needs to be strengthened, as well as their awareness of the fact that thinking you know something is not the same as actually knowing. Nurses' realistic perception of their own knowledge can enhance their participation in CE.

- Nurses reported that they lacked time to complete eVLU. Based on the pilot test eVLU was evaluated to be adaptable in HHC workplaces. However, the adaptability needs further studies.

6.6 Implications for nursing management

In this chapter, the implications for management are described. One of the most important forms of support for nurses' EBP is nursing management and leadership (Eskes *et al.* 2012, Mortenius *et al.* 2013, Govranos & Newton 2014, Gunawan *et al.* 2017, Traav *et al.* 2018). VLUs have high impact on patients' well-being and on health care costs (Franks *et al.* 2016, Nussbaum *et al.* 2018). Based on Finnish legislation, the employer of health care staff is obliged to monitor nurses' professional development. Employer must create conditions for staff to participate the CE required. (MSHA 2010.) CE is recommended to be seen as an investment for the future (Coventry *et al.* 2015).

According to the results of this study, the following implications for management can be presented.

- The results of this study provided new evidence of EBP in VLU nursing care in HHC. The results revealed gaps in nurses' knowledge and skills in many areas of VLU nursing care. This can be used in nursing management to direct the actions in competence management.
- Competence management is nursing managers' central area of expertise to ensure safe and EBP in nursing care of patients with VLU. To achieve this, they need up-to-date information of nurses' knowledge and skills. The PKAK instrument developed in this study may provide them one possibility to evaluate nurses' knowledge in VLU nursing care.
- The EB guideline implementation process needs to be systematically evaluated by managers as they are in key role when it comes to implementation.
- The nurses in this study reported not having enough time to complete eVLU. However, it is managers' responsibility to organize nurses' daily work to enable the time for CE. In the future, eVLU could be one opportunity for them to utilize in improving nurses' EBP in VLU nursing care.

7 Conclusions

EBP in VLU nursing care is complex, and nurses need comprehensive knowledge and skills of patient's unique situation and VLU to implement quality nursing care. In addition to this, HHC is a demanding context of nursing care, because nurses work in patients' homes without colleague present. Population in Finland as well as in other European countries is ageing, meaning that the prevalence of VLUs will also increase. Older patients with VLU usually live in their own homes and need nurse's help to take care of the VLU. In the future, the goal in older people care in Finland is to increase the number of patients taken care of in HHC and decrease institutional care.

These demands call attention to the importance ensuring HHC nurses' knowledge and skills in VLU nursing care. However, patients in all nursing care environments are entitled to high-quality EBP in nursing care. This study provided one example in improving EBP in VLU nursing care in HHC.

This study provided new knowledge in several ways. First, the literature review showed that nurses may not have sufficient EB knowledge to support VLU healing and patients' well-being. The knowledge and skills gaps identified addressed the need to increase them with CE. The results of this study at M0 confirmed previously found knowledge gaps. Second, the results of the literature reviews revealed that there is no knowledge test and internet-based CE education program available about VLU nursing care. Third, two new instruments to evaluate nurses' knowledge and skills (PKAK and OC) were partly modified and partly developed to evaluate EBP in VLU nursing care. Fourth, an internet-based learning program (eVLU) was developed and its effectiveness was evaluated. Implementation of eVLU was carefully planned and it was targeted at nurses who took care of patients with chronic leg ulcers during the study. This was considered to motivate nurses' participation. During the observations, patient-related outcomes reflecting VLU healing were also recorded, which is rarely seen as outcome evaluation in CE studies.

This study is the utmost importance as statistics showed that eVLU had a statistically significant effect on the increase in nurses perceived and theoretical knowledge as well as congruence between them. eVLU' s effect on nurses' skills remain unclear. Overall, nurses' participation in eVLU and its evaluation was low, and because of this, the results must be interpreted with caution.

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