

Clinical education

Increasing nursing students' knowledge of evidence-based hand-hygiene: A quasi-experimental study

Anne Korhonen^a, Anne Vuori^{b,*}, Anne Lukkari^c, Arja Laitinen^c, Minna Perälä^d, Terttu Koskela^d, Tarja Pölkki^c^a Nursing Research Foundation, Helsinki, Finland^b Lahti University of Applied Sciences, Faculty of Social and Health Care, Hoitajankatu 3, FI-15850, Lahti, Finland^c Department of Children and Women, Oulu University Hospital, Finland^d Oulu University of Applied Sciences, School of Health and Social Care, Finland

ARTICLE INFO

Keywords:

Academic-practice collaboration

Evidence-based competency

Hand-hygiene

Nursing student

ABSTRACT

Aim of study was to evaluate the effects of a multi-component intervention on nursing students' knowledge of evidence-based hand-hygiene. A quasi-experimental design was used.

Nursing students (N = 146) from two universities of applied sciences (experimental group $n = 107$, control group $n = 39$) completed an instrument based on international clinical guidelines related to hand hygiene that consisted of 17 Likert-scale items. Data were collected at three time points (baseline, after university-based training and after clinical training) between autumn 2014 and spring 2016. Group differences were examined using chi-squared or Fisher Exact tests, the Mann-Whitney and U test. Within-group differences were assessed with the McNemar test for paired nominal data.

At the first and second time points the experimental group had better hand hygiene knowledge than the controls. There were no group differences in responses to items concerning the appropriate length of hand disinfection. The experimental group showed improvements in the practice of washing hands with soap and water, but not in the other statements concerning hand disinfection.

Theoretical recap and training at school seemed to influence students' hand hygiene knowledge, but reinforcement during clinical training may be required to ensure that learning practical evidence-based skills, such as hand-hygiene, may be established.

1. Introduction

Evidence-based hand-hygiene is introduced in international guidelines (WHO, 2009) which are based on consistent evidence about guidelines' effectiveness on patient outcomes. Evidence-based practice (EBP) is a central issue in health care in terms of ensuring safe, effective, high quality and patient-centred care. In addition, it is needed to reduce the burden caused by ineffective or even harmful practices (Fixen et al., 2013; Jordan et al., 2016). However, ensuring that EBP becomes embedded in clinical settings is challenging (Stevens, 2013; Melnyk et al., 2015), thus nursing students' knowledge relating to EBP is important to investigate during education.

When learning EBP, the collaboration between practice and education is essential in order to ensure that the students will obtain knowledge needed in safety patient care. A collaborative approach

includes shared responsibility for supporting learning during education and practical training (Numminen et al., 2014). This means that the theoretical knowledge, for example about evidence-based hand hygiene, given to students during education is possible to apply into practice during clinical training (Holland, 2011; Florin et al., 2011).

2. Background

Evidence-based guidelines state that good hand-hygiene prevents healthcare-associated infections, which are costly in terms of organisational and patient outcomes (Boyce and Pittet, 2002; WHO, 2009). Current international evidence-based guidelines (WHO, 2009) emphasize alcohol-based hand disinfection but also washing hands with water and soap in certain situations, such as after touching body secretions. However, it is known that hand hygiene in healthcare organisations is

* Corresponding author. Laiduntie 3, 17200, Vääkky, Finland.

E-mail addresses: anne.korhonen@hotus.fi, annekorhonen25@gmail.com (A. Korhonen), anne.vuori@lamk.fi (A. Vuori), anne.lukkari@ppshp.fi (A. Lukkari), arja.laitinen@ppshp.fi (A. Laitinen), minna.perala@oamk.fi (M. Perälä), dorispekkinen@gmail.com (T. Koskela), tarja.polkki@ppshp.fi (T. Pölkki).

<https://doi.org/10.1016/j.nepr.2018.12.009>

Received 2 January 2018; Received in revised form 13 November 2018; Accepted 29 December 2018

1471-5953/© 2018 Published by Elsevier Ltd.

not always sufficient (Barrett and Randle, 2008; Korhonen et al., 2015). Although infection control principles, including hand hygiene requirements, are covered in nursing curricula, students still show poor compliance with recommended practices in the clinical environment (WHO, 2009; Celik and Kocasi, 2008). Thus experimental studies are needed in order to find effective interventions to increase nursing students' knowledge of EBP.

2.1. Nursing students' learning about hand hygiene

Earlier research on nursing students' learning about hand hygiene have been focused on learning methods (Salmon et al., 2013; Pellowe et al., 2010), hand hygiene skills (Celik and Kocasi, 2008; Kennedy and Burnett, 2011), compliance with hand hygiene protocols (Sundal et al., 2017) and student nurses' experiences of infection prevention measures during clinical placement (Gould and Drey, 2013; Westphal et al., 2014).

Integrating theory and practice is an important aspect of learning effective hand hygiene practice during nursing education. Salmon et al. (2013) examined experiential learning amongst final-year nursing students ($n = 398$) using auditor training followed by a period of hand hygiene observation. The students' compliance with hand hygiene procedures was evaluated during the pre-intervention, intervention and post-intervention periods. After the intervention, nursing students were 40% ($p < .001$) more likely to comply with hand hygiene practices and almost all of them (98%) felt that the experience would enhance their own hand hygiene practice. According to the researchers, experiential learning of hand hygiene was a highly valuable educational technique and improved compliance with hand hygiene protocols. Electronic devices have also been used in learning hand hygiene practices and they have proved a practical option (Pellowe et al., 2010) due to its easy to use nature. In addition, the programme had the advantage of flexibility, because students could access to learning material when and where they wanted. Bloomfield et al. (2010) investigated the effects of an interactive, multimedia, self-directed computer-assisted learning module in a randomised control trial involving 242 nursing students. Data were collected at four time points. Both study groups showed increases in knowledge scores, but only the experimental group had better performance scores at the eight-week follow-up assessment. The authors concluded that computer-assisted learning module was an effective method of teaching hand hygiene to nursing students. Despite evaluations of the effects of different tools on nursing students' hand hygiene learning, it remains unclear whether these interventions have long-term and sustain effects on EBP.

2.2. Evaluating nursing students' hand hygiene

Nursing students' skills related to hand hygiene have been evaluated in many studies from the point of view of compliance (Valim et al., 2014; Sundal et al., 2017) and knowledge, attitudes and practice (Kennedy and Burnett, 2011). For example, in an observational study it was found that overall nursing students' ($n = 29$) compliance with hand hygiene was high (84%) and it was highest in relation to what might be considered self-protective procedures, such as washing one's hands after touching patient surroundings, patients and after exposure to body fluids (Sundal et al., 2017). These results are in line with previous studies of healthcare workers' compliance with hand hygiene protocols (Korhonen et al., 2015; Valim et al., 2014). Kennedy and Burnett (2011) found that third-year nursing students ($n = 104$) had a slightly better knowledge base and understanding of hand hygiene than the students in their second year ($n = 75$).

Students' experiences during training periods may promote or hinder the application of theory to the practice of hand hygiene. A national survey (Gould and Drey, 2013) of nursing students ($n = 488$) indicated that the reality of clinical practice did not accord with the expectations, which the students had developed during preclinical

training. The students reported witnessing failures in infection control practice; most of them related to hand hygiene. For example, more than 75% of respondents had witnessed qualified staff failing to wash hands between patients and 60% had noticed nurses wearing nail polish or nail extensions, meaning that the qualified nurses did not provide good role models for the students. These findings are in line with Westphal et al. (2014) who revealed that fourth-year baccalaureate students have observed nurses' work-arounds for hand hygiene procedures in clinical settings.

In conclusion, the research to date shows that much effort is being made to improve nursing students' hand hygiene knowledge. However, there exists few studies concerning intervention aiming at increase hand hygiene knowledge in the context of evidence-based practice and in collaboration with education and practice. It seems that whilst students gain theoretical knowledge in education, discrepancies between theory and practice may become apparent during clinical training. In this study, we focus on an intervention taking place during education and clinical training as a mean to improve nursing students' knowledge of evidence-based hand-hygiene.

3. Aim

The aim of the study was to evaluate the effects of a multi-component hand-hygiene intervention (MCHHI) on nursing students' knowledge of evidence-based hand-hygiene. Our hypothesis was that the students in the experimental group would have better knowledge of hand hygiene than students' in the control group.

4. Methods

4.1. Design, sample and data collection

A quasi-experimental design was used. The sample consisted of nursing students in their third year of study period or enrolled on a family nursing course in two universities of applied sciences. All students who met these inclusion criteria were invited to participate in the study, thus a power analysis for sample size calculation was not appropriate. In Finland 210 ECTS credits (The European Credit Transfer and Accumulation System) are required to qualify as a registered nurse (RN) and training takes approximately 3.5 years (Finnish Nurses Association, 2017). The sequence of courses varies between universities. In this study, the experimental group consisted of third-year students whereas the control group consisted of a mixture of second- and third-year students depending on their individual learning plan. The experimental group ($n = 107$, women = 89%) was recruited by one of the researchers and by the teacher from a university of applied sciences on Oulu. The control group ($n = 39$, women = 79%) was recruited at another university of applied sciences in Lahti by one teacher involved in the study. Recruiting the participants from geographically distant universities was a practical arrangement *i.e.* the students' from the same university should accomplish their clinical training similar way. Thus selecting the two universities supported students' coequal treating during clinical training. The both groups followed their curriculum based on national and international requirements (European Federation of Nurses Associations, 2013; Finnish Nurses Association, 2017) at universities and during clinical training. In addition, the experimental group participated the study intervention (MCHHI) during their third year.

A multi-component hand-hygiene intervention (MCHHI) consists of four elements: i) a recap lesson of the theoretical basis of evidence-based hand hygiene practices, ii) intensive hand hygiene practice training at university before clinical training, iii) observing the hand hygiene practices of qualified nurses during clinical training and iv) teacher-led reflection on staff's hand hygiene practice following clinical training (Fig. 1). The intervention was based on the opinions of expert panel (a researcher, two clinical student coordinators and two senior

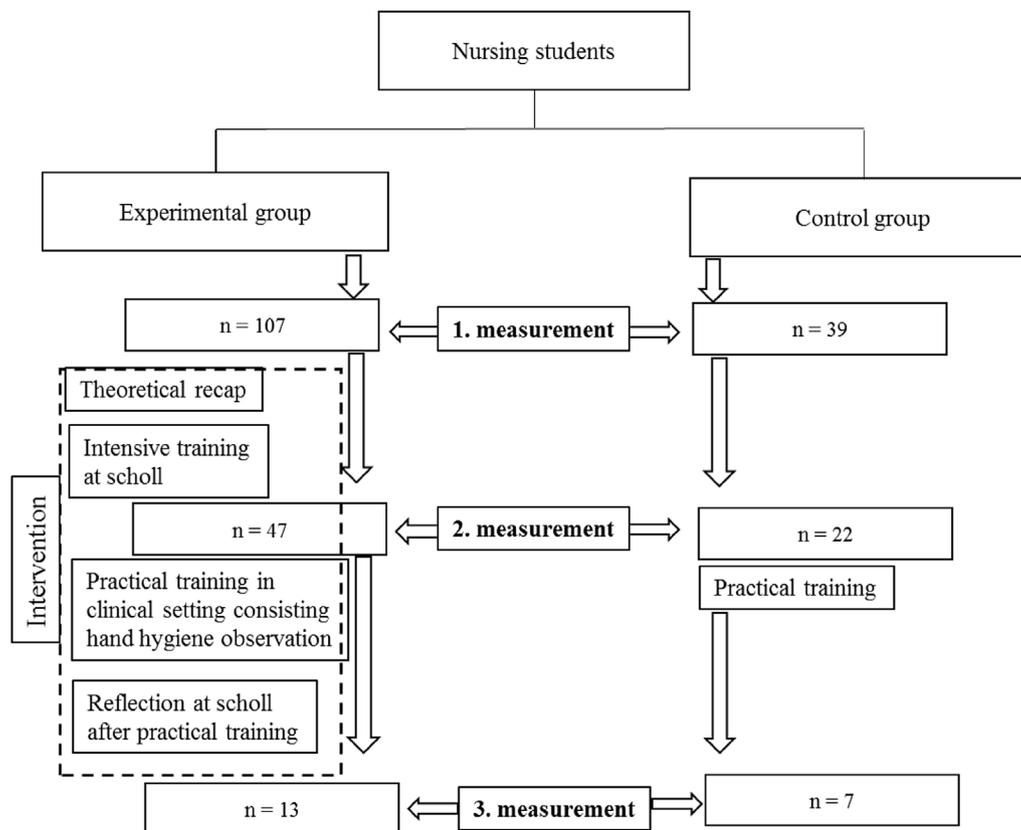


Fig. 1. The intervention and timing of data collection.

lecturers) and “The awareness to adherence” model (Pathman et al., 1996). The model consists of four steps which were applied into the MCHHI as follows: i) Increasing the students' awareness of evidence-based hand-hygiene was facilitated by theoretical recap. ii) Intellectual agreement with the evidence was supported by practical training during education and observing the actualization of hand hygiene of qualified nurses during clinical training. iii) Teacher-led reflection after clinical training aimed at increase deciding to adopt the evidence, which will lead iv) to adherence of evidence based hand hygiene.

(Fig. 1). The awareness about good hand hygiene will form a basis to evidence-based hand hygiene practices, but impacts of this awareness on the students' adherence to guidelines need more research (see also Glaziou and Haynes, 2005).

Data were collected by an instrument developed specifically for the study by an expert group which consisted of infection control experts and a researcher ($N = 4$). The instrument was based on evidence-based clinical guidelines for hand-hygiene (Boyce and Pittet, 2002; WHO, 2009) and on expertise of infection control nurses. It was piloted for understandability in 20 nursing students. After piloting some clarifications of the expressions were done to the statements. The instrument consisted of 17 statements to which responses were given using a five-point Likert scale (completely agree; agree; do not know; disagree; completely disagree). Data were collected between autumn 2014 and spring 2016 by the recruiters at three time points: before the intervention (T1), after academic-based training (T2) and after clinical training (T3) using the same questionnaire (Fig. 1).

4.2. Data analysis

The data were analysed using IBM SPSS 22 for Windows. Percentages, means, standard deviations and minimum and maximum values were used to summarise the descriptive data. The five Likert scale scores for hand-hygiene knowledge were divided into two classes

(right/wrong responses) according to evidence-based hand hygiene guidelines (WHO, 2009), when ‘don't know’ responses (3 points) were classified as wrong. Group differences in hand-hygiene knowledge were analysed using the chi-squared test or Fishers Exact test (when the expected numbers were small), and group differences in length of hand disinfection were examined using the Mann-Whitney U test. Finally, we examined within-group differences using the McNemar test for paired nominal data. In all tests, p -values $\leq .05$ were considered statistically significant.

4.3. Ethical considerations

Ethical principles were followed throughout the study (Finnish Advisory Board on Research Integrity, 2012). Approval (Dno 7/2015) was granted by the Oulu University Hospital and both of the universities of applied sciences gave their consent. Participants were informed orally and in writing about the purposes of the study and its confidential nature and voluntary and anonymous participation. The students gave written consent to participation after receiving this information. The data were analysed and reported in such a way that the participants cannot be identified.

5. Results

5.1. Group differences in hand hygiene

5.1.1. Baseline (T1)

We found baseline differences between the control and experimental groups in three statements (Table 1). The experimental group were more likely than the control group to give correct responses to the following statements: “Approximately 20 s disinfection is effective in a ward” (83% vs. 50%, $p < .001$), “The recommended length of hand disinfection is 30 s” (97% vs. 77%, $p < .001$) and “Hands should be

Table 1
Differences between the experimental and control groups before the intervention (T1).

Items	Experimental group		Control group		p-value
	right ^b f(%)	wrong f(%)	right f(%)	wrong f(%)	
1. Hands should be disinfected before touching the patient	104(98)	2(2)	38(97)	1(3)	.61 ^a
2. Hands should be disinfected before aseptic/clean procedure.	106(100)	0(0)	39(100)	0(0)	–
3. Hand disinfection is more effective at destroying microbes than hand-washing with soap and water.	83(78)	23(22)	29(74)	10(26)	.62
4. Hand disinfection is not needed before donning gloves	102(95)	5(5)	38(97)	1(3)	.49 ^a
5. Hands should be disinfected after handling blood and other secretions.	98(93)	7(7)	39(100)	0(0)	010 ^a
6. Approximately 20 s disinfection is effective in a ward.	89(83)	18(17)	19(50)	19(50)	< .001
7. Hands should be disinfected after touching the patient's immediate surroundings.	87(83)	18(17)	30(77)	9(23)	.42
8. Hands should be disinfected after touching the patient.	104(97)	3(3)	37(95)	2(5)	.40 ^a
9. Hands should be washed using soap and water when they are visibly dirty or after touching secretions.	106(100)	0(0)	39(100)	0(0)	–
10. Hand disinfection protocols only apply to nursing staff.	106(99)	1(1)	39(100)	0(0)	.73 ^a
11. Artificial nails are safe if they are new.	106(99)	1(1)	39(100)	0(0)	.73 ^a
12. The recommended length of hand disinfection is 30 s.	104(97)	3(3)	30(77)	9(23)	< .001 ^a
13. Hands should be disinfected after taking off gloves.	106(99)	1(1)	33(85)	6(15)	.002 ^a
14. Hand disinfection is not needed after taking off gloves.	106(100)	0(0)	37(97)	1(3)	.26 ^a
15. Hand-washing with soap and water should last 1 min if it is to be effective.	50(48)	55(52)	23(59)	16(41)	.23
16. Wearing rings with work attire is not permitted.	100(94)	6(6)	38(97)	1(3)	.39 ^a
17. Wristwatches are a barrier to good hand hygiene.	99(93)	7(7)	36(92)	3(8)	.54 ^a

^a Fisher Exact test.

^b A five-point Likert scale ranging from completely agree to completely disagree were divided into two classes (right/wrong responses).

disinfected after taking off gloves" (99% vs. 85%, $p = .002$). In addition, both groups responded the most often wrongly to three statements, although there was no group difference: "The length of washing hands with soap and water should last 1 min if it is to be effective" (52% vs. 41%), "Hand disinfection is more effective at destroying microbes than hand-washing with soap and water" (22% vs. 26%), and "Hands should be disinfected after touching a patient's immediate surroundings" (17% vs. 23%).

5.1.2. After university-based training (T2)

There were group differences in responses to two statements after the intervention (T2), which consisted of theoretical lessons and practical training in the laboratory environment (Table 2). These statements consisted of "Approximately 20 s disinfection is effective in a ward" (93% vs. 45%, $p < .001$) and "Hand disinfection is not needed before donning gloves" (98% vs. 82%, $p = .039$).

In addition, the three statements which attracted the most wrong responses were the same for both groups, but there were no group

differences in responses to them: "When soap and water is used hands must be washed for 1 min if washing is to be effective" (27% vs. 29%), "Hand disinfection is more effective at destroying microbes than hand-washing with soap and water" (16% vs. 29%), and "Hands should be disinfected after touching a patient's immediate surroundings (7% vs. 18%).

5.1.3. After clinical training (T3)

There were no group differences in knowledge of hand hygiene when the students had had practical training in clinical context (T3) (Table 3).

In both groups similarly high proportions of students gave wrong responses to the following three statements: "When soap and water is used hands should be washed for 1 min if washing is to be effective" (23% vs. 50%), "Approximately 20 s disinfection is effective in a ward" (8% vs. 33%) and "Hands should be disinfected after touching a patients' immediate surroundings" (8% vs. 17%).

Table 2
Differences between the experimental and control groups after theoretical lessons and practical training in the laboratory environment at school (2. measurement).

Items	Experimental group		Control group		p-value
	right ^b f(%)	wrong f(%)	right f(%)	wrong f(%)	
1. Hands should be disinfected before touching the patient	44(98)	1(2)	21(96)	1(4)	.55 ^a
2. Hands should be disinfected before aseptic/clean procedure.	44(98)	1(2)	22(100)	0(0)	.67 ^a
3. Hand disinfection is more effective at destroying microbes than hand-washing with soap and water.	38(84)	7(16)	15(71)	6(29)	.18 ^a
4. Hand disinfection is not needed before donning gloves	43(98)	1(2)	18(82)	4(18)	.039 ^a
5. Hands should be disinfected after handling blood and other secretions.	41(91)	4(9)	21(96)	1(4)	.47 ^a
6. Approximately 20 s disinfection is effective in a ward.	42(93)	3(7)	10(45)	12(55)	< .001 ^a
7. Hands should be disinfected after touching the patient's immediate surroundings.	41(93)	3(7)	18(82)	4(18)	.16 ^a
8. Hands should be disinfected after touching the patient.	43(96)	2(4)	21(96)	1(4)	.70 ^a
9. Hands should be washed using soap and water when they are visibly dirty or after touching secretions.	44(98)	1(2)	22(100)	0(0)	.67 ^a
10. Hand disinfection protocols only apply to nursing staff.	44(98)	1(2)	21(100)	0(0)	.68 ^a
11. Artificial nails are safe if they are new.	44(98)	1(2)	21(100)	0(0)	.68 ^a
12. The recommended length of hand disinfection is 30 s.	45(100)	0(0)	20(95)	1(5)	.32 ^a
13. Hands should be disinfected after taking off gloves.	44(98)	1(2)	18(86)	3(14)	.09 ^a
14. Hand disinfection is not needed after taking off gloves.	44(98)	1(2)	20(95)	1(5)	.54 ^a
15. Hand-washing with soap and water should last 1 min if it is to be effective.	33(73)	12(27)	15(71)	6(29)	.87
16. Wearing rings with work attire is not permitted.	43(96)	2(4)	19(91)	2(9)	.38 ^a
17. Wristwatches are a barrier to good hand hygiene.	42(93)	3(7)	19(91)	2(9)	.51 ^a

^a Fisher Exact test.

^b A five-point Likert scale ranging from completely agree to completely disagree were divided into two classes (right/wrong responses).

Table 3
Differences between the experimental and control groups after practical training in clinical context (T3).

Items	Experimental group		Control group		p-value
	right ^b	wrong	right	wrong	
1. Hands should be disinfected before touching the patient	13(100)	0(0)	6(100)	0(0)	–
2. Hands should be disinfected before aseptic/clean procedure.	13(100)	0(0)	6(100)	0(0)	–
3. Hand disinfection is more effective at destroying microbes than hand-washing with soap and water.	12(92)	1(8)	5(83)	1(17)	.54 ^a
4. Hand disinfection is not needed before donning gloves	12(100)	0(0)	6(100)	0(0)	–
5. Hands should be disinfected after handling blood and other secretions.	11(85)	2(15)	6(100)	0(0)	.46 ^a
6. Approximately 20 s disinfection is effective in a ward.	12(92)	1(8)	4(67)	2(33)	.22 ^a
7. Hands should be disinfected after touching the patient's immediate surroundings.	12(92)	1(8)	5(83)	1(17)	.54 ^a
8. Hands should be disinfected after touching the patient.	13(100)	0(0)	6(100)	0(0)	–
9. Hands should be washed using soap and water when they are visibly dirty or after touching secretions.	13(100)	0(0)	6(100)	0(0)	–
10. Hand disinfection protocols only apply to nursing staff.	13(100)	0(0)	6(100)	0(0)	–
11. Artificial nails are safe if they are new.	13(100)	0(0)	4(80)	1(20)	.28 ^a
12. The recommended length of hand disinfection is 30 s.	12(92)	1(8)	6(100)	0(0)	.68 ^a
13. Hands should be disinfected after taking off gloves.	13(100)	0(0)	6(100)	0(0)	–
14. Hand disinfection is not needed after taking off gloves.	13(100)	0(0)	6(100)	0(0)	–
15. Hand-washing with soap and water should last 1 min if it is to be effective.	10(77)	3(23)	3(50)	3(50)	.26 ^a
16. Wearing rings with work attire is not permitted.	12(92)	1(8)	6(100)	0(0)	.68 ^a
17. Wristwatches are a barrier to good hand hygiene.	11(85)	2(15)	6(100)	0(0)	.46 ^a

^a Fisher Exact test.

^b A five-point Likert scale ranging from completely agree to completely disagree were divided into two classes (right/wrong responses).

5.2. Within-group changes in knowledge of hand hygiene

In the experimental group, there was an increase in the proportion of correct responses to one statement between T1 and T2. Before the intervention less than half of the experimental group (48%) responded correctly to the following statement “Hand-washing with soap and water should last 1 min if it is to be effective” and this had risen to 73% after theoretical lessons and practical training at college ($p = .022$). There were no changes in the knowledge scores of the control group.

5.3. Length of hand disinfection

There was no group difference in length of hand disinfection and no within group changes over the course of the study period (Table 4).

6. Discussion

Our hypothesis was that after the intervention the experimental group would have better knowledge of hand hygiene than the control group. The hypothesis was supported in two phases after university-based training and after clinical training concerning the length of hand washing with soap and water but not in the other statements concerning hand disinfection. *At the first time point, the experimental group had better knowledge of hand hygiene than the controls*, which means that the groups were not similar at the beginning of the study. Recruiting the two groups from two universities and from different geographical areas made it more difficult to ensure they would have exactly similar knowledge and be at a similar stage in their studies. In previous studies,

Table 4
Comparison of the length of hand disinfection (seconds) in experimental and control groups at three time points.

	Experimental group			Control group		
	T1 ^a	T2 ^b	T3 ^c	T1 ^a	T2 ^b	T3 ^c
Mean	34.76	30.0	32.50	31.84	32.86	31.67
SD	25.81	0	8.66	12.91	9.56	4.08
Min.	0	30	30	20	20	30
Max.	180	30	60	90	60	40

^a T1 = before the intervention.

^b T2 = after academic-based training.

^c T3 = after clinical training.

the participants have been recruited from one organisation (Barrett and Randle, 2008; Sundal et al., 2017; Cruz and Bashtawi, 2015). An exception was a study conducted in the four countries of the United Kingdom (England, Wales, Scotland, and Northern Ireland) by Gould and Drey (2013), where the students were recruited via an electronic link to the survey placed on the website of the Royal College of Nursing (RCN). Other studies have compared students at different stages of their studies, for example students doing a master of nursing science degree or a nursing diploma (Barrett and Randle, 2008) and students in the second semester of a nursing course and those registered for levels 3–8 (years 2–4 of the BSN, Bachelor of Science in Nursing-programme) (Cruz and Bashtawi, 2015). There are also studies in which all participants were at a similar stage in their studies, such as in the study of Nasirudeen et al. (2012) the participants were final-year nursing students from a single institution. In this current study, recruiting both groups from a single school or single course would make it easier to eliminate baseline differences, but would also increase the probability of inequality in treating the students during clinical training depending on whether they belong into intervention or control group. In addition to this ethical point of the study, a practical arrangement justified recruiting from two different institutions.

At the second time, point the experimental group had better results than the controls, indicating that theoretical recap and intensive training during laboratory sessions produced improvements in knowledge of hand hygiene. However, the effect was smaller than we had expected. During the laboratory sessions the students were required to perform hand hygiene according to recommended procedures (taking off rings and watches) combined with discussions of the role of artificial nails in infection control. In addition, the students measured the length of hand disinfection for each other. In an earlier study (Nasirudeen et al., 2012) it was reported that nursing students considered laboratory sessions an effective as clinical internship programmes as a way of learning hand hygiene and both laboratory sessions and clinical internships were rated more effective than other methods of hand hygiene education.

We did not find any group differences at the third time point which indicates that the intervention had no sustainable effects on nursing students' knowledge relating to evidence-based hand hygiene. This was a surprising result, because the experimental group had completed the intervention by this point. Our preliminary hypothesis was that the intervention would increase cognitive theory-practice conflicts among the students and thus strengthen their understanding of good hand hygiene. In addition, it was supposed that increased awareness about

hand hygiene requirements and its realization in clinical environment (Pathman et al., 1996; Glaziou and Haynes, 2005) would increase the knowledge base concerning good hand hygiene. At this stage of the study the experimental group had participated in theoretical recap, university-based training of good hand-hygiene practices and observed hand hygiene practices of qualified nurses during clinical training.

We were not able to identify which components of this multi-component intervention were effective (Proctor et al., 2013) and so further research is needed. More attention should be paid to the discrepancy between evidence-based practices and actual clinical practices, which are not always satisfactory by nature (Korhonen et al., 2015; Aasekjær et al., 2016). Based on the previous studies Barrett and Randle (2008); Gould and Drey (2013); Numminen et al. (2014) it may be possible that qualified nurses' poor role model in performing hand hygiene may have disturbed students' knowledge concerning evidence-based hand hygiene. In addition, students have described isolated examples of good practices, but they also have observed evidence of lack of compliance with hand hygiene guidelines (Gould and Drey, 2013). In another study (Barrett and Randle, 2008), students reported that they did not have time enough for hand hygiene during busy mornings; they also believed that hand hygiene is less important in 'everyday' activities and that their efforts to 'fit in' to the nursing team had had a negative impact on their hand hygiene practices. These results are consistent with the other studies (Numminen et al., 2014; Celik and Kocacali, 2008) which have raised a question, whether nursing students' socialization into the team during clinical training would have impacts on the students' emerging understanding about evidence-based hand hygiene. It is obvious that consistent hand hygiene practices are needed during education and clinical training. Otherwise, conflicting experiences during clinical training may maintain or even widen the gap between theory of evidence-based hand-hygiene and practice among nursing students.

Students in both groups responded wrongly to the same statements at the first and second time points and there were similar weaknesses in responses to two statements (the length of washing hands and hand disinfection after touching patient environments) at all-time points. Also in the study by Bloomfield et al. (2010) no differences were found between the groups. This indicates that there may be more emphasis on some aspects of good hand hygiene than on others during education and clinical training. In addition, hand disinfection has been emphasised in common discussions more often than washing hands with soap and water during the study period. However, *within the experimental group there were improvements in knowledge of the correct procedure for hand washing with soap and water in relation to hand hygiene.*

The last finding related to the length of hand disinfection. We found *no group difference in responses to a statement on the appropriate length of hand disinfection.* One possible explanation for this would be that nursing students learn the appropriate length of hand disinfection during their studies in the curriculum. Another explanation relates to confounding factors relating to external environment of the study contexts. After the beginning of our study, the issue of hand hygiene began to attract public interest and was discussed in many national and international professional and public journals as well in many in-hospital infection control lessons.

Our study revealed the importance of ensuring that clinical training sites and academic universities give consistent messages about hand hygiene to promote a high level of knowledge and good clinical practice (Salmon et al., 2013). This study is worth for starting an analytical, deliberate process of clarifying determinants of learning evidence-based practices and choosing strategies to improve situations where students are expected to learn EBP. Common determinants relate both to learning and to implementation, such as knowledge, cognitions, attitudes, routines, social influence, organisation, and resources. These are often specific for innovation, context, and target groups. (See Van Achterberg et al., 2008). However, more research is needed especially in the area of learning EBP; as well the long-term effects of different interventions aiming at enhance learning of EBP. In addition, the

research is important to focus on which components of the interventions are effective in improving nursing students' learning of EBP and within it hand hygiene practices.

EBP is one of the keys to high quality, safe patient care in any caring environment. Thus learning it by focusing on its application to a routine aspect of nursing, such as hand hygiene, may enhance students' understanding of EBP. It may provide also a foundation for subsequent implementation of EBP in relation to specific illnesses. However, academic and clinical collaboration is one of the foundations of effective learning of evidence-based competences, because consistency of advice, information and implementation of EBP during nursing education and clinical training placements helps to encourage nursing students to use evidence in their clinical practice.

7. Limitations

The study had some limitations. Firstly, the groups were not equal at the start of the study, which makes it more difficult to analyse subsequent group differences. Our study confronted challenges in recruiting students from two universities. Two institutions and characteristic of the Finnish nursing studies, such as studies are based on students' individual learning plan, made it difficult to find students who had been taught using similar methods, followed similar curricula, studied in environments with a similar teaching and learning culture and had similar personal learning plans. Our efforts of involving the students who were in their third year of study or enrolled on a family nursing course ensured that the students were potentially almost at the same level of studies.

The participants in all the three measurements filled out the same questionnaire for assessing knowledge concerning hand hygiene. It is potentially possible that this issue impacted on the results for example through learning from the questionnaire. In order to reflect to this concern, the students were not offered feedback after data collection phases.

Finally, the attrition rate over the course of the study was high in both groups. In the experimental group, the attrition rate was 67% between T1 and T2 and 88% between T1 and T3, whereas in the control group the attrition rate was 44% between T1 and T2 and 85% between T1 and T3. It seems that the attrition rate increases with the number of assessments, as others have reported (Bloomfield et al., 2010). Because we measured only hand hygiene knowledge, we cannot determine whether the students who completed the assessment at T3 were similar to those who dropped out in terms of motivation, engagement and knowledge. We are also unable to determine whether students' knowledge of their group status affected their responses.

8. Conclusion

The aim of the study was to evaluate the effects of a multi-component hand hygiene intervention (MCHHI) on nursing students' knowledge of evidence-based hand-hygiene. Intensive training in hand hygiene at the university had a limited impact on students' knowledge and the group difference disappeared after clinical training. University-based teaching of evidence-based skills, such as evidence-based hand hygiene procedures must be reinforced consistently during clinical training. Our study highlights the need for shared responsibility of integrating evidence into practice between academic and clinics. Further research is also needed to determine the impact of interventions relating to evidence-based practices, in this case hand hygiene practices, on nursing students' practical performance.

The authors' contribution to study

AK, AV, ALu, ALa, MP and TK contributed to study planning and acquisition of data, AK and TP performed data analysis and interpretation, All the authors contributed to drafting the article and

revising critically for important content of the article. In addition, they all have given their approval for the manuscript to be submitted in its present form.

Ethical approval

Ethical principles were followed throughout the study. Approval (Dno 7/2015) was granted by the Oulu University Hospital and both of the universities of applied sciences gave their consent.

The study did not get any support (grants, equipment, drugs or all of the above) and there are no conflict of interest.

Acknowledgements

The authors give their gratitude to all students participating in this study and to MA, statistician Helena Laukkala for her help in data analysis.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.nepr.2018.12.009>.

References

- Aasekjær, K., Valen Waehle, H., Ciliska, D., Nordtvedt, M.W., Hjalmlhult, E., 2016. Management involvement -A decisive condition when implementing evidence-based practice. *Worldviews Evidence-Based Nurs.* 13, 32–41. <https://doi.org/10.1111/wvn.12141>. Epub 2016 Jan 20.
- Van Achterberg, T., Schoonhoven, L., Grol, R., 2008. Nursing implementation science: how evidence-based nursing requires evidence-based implementation. *J. Nurs. Scholarsh.* 40, 302–310. <https://doi.org/10.1111/j.1547-5069.2008.00243.x>.
- Barrett, R., Randle, J., 2008. Hand hygiene practices: nursing students' perceptions. *J. Clin. Nurs.* 17, 1851–1857. <https://doi.org/10.1111/j.1365-2702.2007.02215.x>.
- Bloomfield, J., Roberts, J., While, A., 2010. The effect of computer-assisted learning versus conventional teaching methods on the acquisition and retention of hand-washing theory and skills in pre-qualification nursing students: a randomised controlled trial. *Int. J. Nurs. Stud.* 47, 287–294. <https://doi.org/10.1016/j.ijnurstu.2009.08.003>.
- Boyce, J.M., Pittet, D., 2002. Guideline for hand hygiene in health-care settings. Recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. 2002. *MMWR (Morb. Mortal. Wkly. Rep.)* 51 RR-16. <https://www.cdc.gov/mmwr/PDF/rr/rr5116.pdf>.
- Celik, S., Kocasli, S., 2008. Hygienic hand washing among nursing students in Turkey. *Appl. Nurs. Res.* 21, 207–211. <https://doi.org/10.1016/j.apnr.2006.12.001>.
- Cruz, J.P., Bashtawi, M.A., 2015. Predictors of hand hygiene practice among Saudi nursing students: a cross-sectional self-reported study. *Journal of Infection and Public Health* 9, 485–493. <https://doi.org/10.1016/j.jiph.2015.11.010>.
- European Federation of Nurses Associations, 2013. Guideline for the Implementation of Article 31 of the Mutual Recognition of Professional Qualifications Directive 2005/36/EC, Amended by Directive 2013/55/EU. EFN Competency Framework. 2015 Retrieved from. <http://www.efnweb.be/wpcontent/uploads/EFN-Competency-Framework-19-05-2015.pdf>.
- Finnish Advisory Board on Research Integrity, 2012. Responsible Conduct of Research and Procedures for Handling Allegations of Misconduct in Finland. Finnish Advisory Board on Research Integrity, Helsinki. <http://www.tenk.fi/en>.
- Finnish Nurses Association, 2017. Nursing and Nurse Education in Finland. Retrieved April 13th, 2017, from. https://www.nurses.fi/nursing_and_nurse_education_in_f/.
- Fixen, D., Blasé, K., Metz, A., Van Dyke, M., 2013. Statewide implementation of evidence-based programs. *Council for Exceptional Children* 79, 213–230.
- Florin, J., Ehrenberg, A., Wallin, L., Gustavsson, P., 2011. Educational support for research utilization and capability beliefs regarding evidence-based practice skills: a national survey of senior nursing students. *J. Adv. Nurs.* 68, 888–897.
- Glaziou, P., Haynes, B., 2005. The paths from research to improved health outcomes. *EBM* 2005 10, 4–7.
- Gould, D., Drey, N., 2013. Student nurses' experiences of infection prevention and control during clinical placements. *Am. J. Infect. Contr.* 41, 760–763. <https://doi.org/10.1016/j.ajic.2013.01.025>.
- Holland, K., 2011. A decade of contributing to scholarship and developments in nurse education internationally. *Nurse Educ. Pract.* 11, 1–3. <http://doi.org/10.1016/j.nepr.2010.11.002>.
- Jordan, Z., Lockwood, C., Aromataris, E., Munn, Z., 2016. The Updated JBI Model for Evidence-based Healthcare. Retrieved March 20th, 2016, from. [http://joannabriggs.org/assets/docs/approach/The JBI Model of Evidence-Healthcare-A Model Reconsidered.pdf](http://joannabriggs.org/assets/docs/approach/The%20JBI%20Model%20of%20Evidence-Based%20Healthcare-A%20Model%20Reconsidered.pdf).
- Kennedy, M., Burnett, E., 2011. Hand hygiene knowledge and attitudes: comparisons between student nurses. *Journal of Infection Prevention* 12, 246–253. <https://doi.org/10.1177/1757177411411124>.
- Korhonen, A., Ojanperä, H., Puhto, T., Järvinen, R., Kejonen, P., Holopainen, A., 2015. Adherence to hand hygiene guidelines – significance of measuring fidelity. *J. Clin. Nurs.* 24, 3197–3205. <https://doi.org/10.1111/jocn.12969>.
- Melnyk, B.M., Buck, J., Gallagher-Ford, L., 2015. Transforming quality improvement into evidence-based quality improvement. *Worldviews Evidence-Based Nurs.* 12, 251–252. <https://doi.org/10.1111/wvn.12112>.
- Nasirudeen, A.M.A., Koh, J.W.N., Lau, A.L.C., Li, W., Lim, L.S., Ow, C.Y.X., 2012. Hand hygiene knowledge and practices of nursing students in Singapore. *Am. J. Infect. Contr.* 40, e241–e243. <https://doi.org/10.1016/j.ajic.2012.02.026>.
- Numminen, O., Laine, T., Isoaho, H., Hupli, M., Leino-Kilpi, H., Meretoja, R., 2014. Do educational outcomes correspond with the requirements of nursing practice: educators and managers' assessments of novice nurses' professional competence. *Scand. J. Caring Sci.* 28, 812–821. <https://doi.org/10.1111/scs.12115>.
- Pathman, D.E., Konrad, T.E., Freed, G.L., Freeman, V.A., Koch, G.G., 1996. The awareness-to-adherence model of the steps to clinical guideline compliance. The case of pediatric vaccine recommendations. *Med. Care* 34, 873–889.
- Pellowe, C., Adams, J., Elliott, S., Murrell, K., Cox, D., 2010. The use of an e-learning infection prevention programme in the pre-registration nursing curriculum. *Journal of Infection Prevention* 11, 55–57. <https://doi.org/10.1177/1757177410362498>.
- Proctor, E.K., Powell, B.J., McMillen, C., 2013. Implementation strategies: recommendations for specifying and reporting. *Implement. Sci.* 8, 139. Available: www.oimplementationscience.com/content/8/1/139.
- Salmon, S., Wang, X.P., Seetoh, T., Lee, S.Y., Fisher, D.A., 2013. Novel approach to improve hand hygiene compliance of student nurses. *Antimicrob. Resist. Infect. Contr.* 2 (16). <https://doi.org/10.1186/2047-2994-2-16>.
- Stevens, K., 2013. The impact of evidence-based practice in nursing and the next big ideas. *Online J. Issues Nurs.* 18 (2). <https://doi.org/10.3912/OJIN.Vol18No02Man04>.
- Sundal, J.S., Aune, A.G., Stovring, E., Aasland, J.K., Fjeldsæter, K.L., Torjuul, K., 2017. The hand hygiene compliance of student nurses during clinical placements. *J. Clin. Nurs.* 26, 4646–4653. <https://doi.org/10.1111/jocn.13811>.
- Valim, M.D., Marziale, M.H.P., Richart-Martinez, M., Sanjuan-Quiles, A., 2014. Instrument for evaluating compliance with infection control practices and factors that affect it: an integrative review. *J. Clin. Nurs.* 23, 1502–1519. <https://doi.org/10.1111/jocn.12316>.
- Westphal, J., Lancaster, R., Park, D., 2014. Work-arounds observed by fourth-year nursing. *West. J. Nurs. Res.* 36, 1002–1018. <https://doi.org/10.1177/0193945913511707>.
- WHO, 2009. WHO Guidelines on Hand Hygiene in Health Care. First Global Patient Safety Challenge. Clean Care Is Safer Care. Author Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/44102/1/9789241597906_eng.pdf.