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Effect of e-learning program on risk assessment and pressure ulcer classification — A randomized study

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ABSTRACT

Background: Pressure ulcers (PUs) are a problem in health care. Staff competency is paramount to PU prevention. Education is essential to increase skills in pressure ulcer classification and risk assessment. Currently, no pressure ulcer learning programs are available in Norwegian.
Objectives: Develop and test an e-learning program for assessment of pressure ulcer risk and pressure ulcer classification.
Methods: Design, participants and setting: Forty-four nurses working in acute care hospital wards or nursing homes participated and were assigned randomly into two groups: an e-learning program group (intervention) and a traditional classroom lecture group (control). Data was collected immediately before and after training, and again after three months. The study was conducted at one nursing home and two hospitals between May and December 2012.
Analysis: Accuracy of risk assessment (five patient cases) and pressure ulcer classification (40 photos [normal skin, pressure ulcer categories I–IV] split in two sets) were measured by comparing nurse evaluations in each of the two groups to a pre-established standard based on ratings by experts in pressure ulcer classification and risk assessment. Inter-rater reliability was measured by exact percent agreement and multi-rater Fleiss kappa. A Mann–Whitney U test was used for continuous sum score variables.
Results: An e-learning program did not improve Braden subscale scoring. For pressure ulcer classification, however, the intervention group scored significantly higher than the control group on several of the categories in post-test immediately after training. However, after three months there were no significant differences in classification skills between the groups.
Conclusion: An e-learning program appears to have a greater effect on the accuracy of pressure ulcer classification than classroom teaching in the short term. For proficiency in Braden scoring, no significant effect of educational methods on learning results was detected.

1. Introduction

Pressure ulcers (PUs) are a problem in health care with a PU prevalence ranging from 0% to 46% in acute care and 4.1% to 32.2% in nursing home settings (National Pressure Ulcer Advisory Panel, 2014). Most PUs can be prevented. Staff competency in skin assessment and identification of patient risk factors are paramount to prevention (National Pressure Ulcer Advisory Panel, 2014). Yet a Norwegian PU prevalence pilot study showed deficient knowledge among nursing staff in terms of reliable classification of PU and PU risk assessment (Bjøro and Ribu, 2009). However, currently no PU learning programs are available in Norwegian, thus development of a program for PU classification and risk assessment is deemed necessary.

E-learning programs are commonly considered an efficient and effective means of training large numbers of nurses, yet few studies have been conducted to develop and test the effect of e-learning programs on PU risk assessment and classification. Reviews have found that web-based training/e-learning program and traditional classroom instruction require equal administration time, and no differences have been found in staff knowledge or skills acquisition (Cook et al., 2008,

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2010, Lahti et al., 2014, Militello et al., 2014). Thus, more research is needed to test the effectiveness of e-learning programs as a mode of teaching nurses PU classification and risk factor identification.

2. Background

Few studies have investigated the effect of training in use of a PU risk assessment tool. The Braden Scale for Predicting Pressure Ulcer Risk (Braden scale) was developed to help health professionals; especially nurses assess a patient's risk of developing a PU (Bergstrom et al., 1987a, 1987b). Braden scale is the most used and tested PU risk assessment tool. The scale includes six subscales (sensory perception, moisture, activity, mobility, nutrition and friction/shear). Each subscale is rated from one (worst condition) to four, with the exception of friction/shear rated one to three. This gives a sum score from six to 23, the lower the sum score, the higher the risk. Web-based training in risk assessment with the Braden scale increased performance (Magnan and Maklebust, 2008, 2009). New users of the Braden scale increased the accuracy of their subscale scoring significantly after training, whereas regular users of the scale did not increase their subscale scorings significantly (Magnan and Maklebust, 2009). Furthermore, in a post-test only study, regular users of the Braden scale correctly identified significantly more patient cases with high risk and moderate risk than new users (Magnan and Maklebust, 2008).

Studies investigating the effect of training on PU classification have shown that training improves performance (Beeckman et al., 2008, 2010, Ham et al., 2015). In a repeated measures design study, Beeckman and colleagues compared the effect of an e-learning (PUCLAS2, Pressure Ulcer Classification tool) and a classroom program with the same content on PU classification in a sample of nurses and nursing students (Beeckman et al., 2008). While both programs increased PU classification skills, the nursing students achieved better results with the e-learning program. In the nurse group, no differences between the methods were found (Beeckman et al., 2008). Beeckman et al. (2010) compared the classification skills of a group receiving PUCLAS2 as a one-hour classroom training with another group receiving a 15-min standardized rehearsal of the EPUAP classification system. Results showed increased classification skills in both groups, but significantly more so for the group receiving PUCLAS2. A one-group study involving classroom training found significant improvement in PU classification skills after training of emergency staff (Ham et al., 2015).

Most studies of training in risk assessment and classification have compared either an e-learning program or classroom training to a control group with no additional training or an alternative method of training. As far as we know, few studies have used a program with the same content to compare an e-learning program and classroom training in an RCT (Beeckman et al., 2008). Furthermore, we have found no studies testing both skills in PU classification and the use of a PU risk assessment scale in the same study.

Regularly updating knowledge is a challenge in health care. Often hospital wards experience high turnover and health care personnel have problems finding time to leave the ward for in-service education due to workload demands. Therefore, efficient methods of training nurses are needed.

3. Purpose and research questions

The purpose of this intervention study was to develop and test an e-learning program for assessment of PU risk factors and PU classification in a Norwegian setting. The research questions for the study were: 1) Is an e-learning program more effective than classroom lecture training for learning the use of a risk assessment scale and 2) Is an e-learning program more effective than classroom lecture training for learning PU classification?

4. Methods

4.1. Design

Participants were randomly assigned to one of two groups: the intervention group (e-learning program) and a control group (classroom lecture training). Three tests were carried out: a baseline pre-test before training, a post-test immediately after training (post-test I), and a three month follow-up test (post-test II). The effect of the intervention was measured by the post-test immediately after training.

The study protocol included a third group without additional training and a test six months after training, but because of massive dropout, we excluded this group and test from this study. Data were collected between May and December 2012.

4.2. Ethics

The privacy protection officials of each investigating hospital approved the study. All participating nurses gave written consent.

4.3. Setting and sample

Nurses from two hospitals and four nursing homes participated. Inclusion criteria: 1) registered nurse 2) employed in acute care hospital or nursing home. Testing was conducted at one nursing home and two hospitals.

We included 25 nurses in each group. We used block randomization with six in each block to ensure even distribution within the groups (Lin et al., 2015). A study coordinator prepared the randomization using closed, opaque numbered envelopes to conceal group allocation. When a participant who met the inclusion criteria agreed to participate, the principal investigator opened an envelope to assign group. The participant received information regarding the time and place of the testing. Information about their group allocation was given the day they performed testing. The study has reference number NCT01567410 in the Clinical Trials.gov Protocol Registration System (http://clinicaltrials.gov/).

Before the pre-test, the participants completed a form with questions about personal information including gender, work place, education and work experience. Five participants did not show up on test day, and one of those who came had not completed the necessary pre-test forms. Forty-four participants completed the pre-test. All forty-four nurses in the two groups completed the post-test immediately following the training. Eighteen nurses completed the post-test after three months (Fig. 1).

4.4. Development of the training programs

No training program was available in Norwegian for either the use of the Braden risk assessment scale or PU classification. Therefore, we developed two individual training programs, one for the use of the Braden scale and one for PU classification.

Pedagogical principles guided the development of the training programs including motivation for learning, active engagement of the learner, concrete material facilitate learning and individualization allowing learners to work at their own space (Hiim and Hippe, 2004).

4.5. The Braden scale program

One of the co-authors (KB) had previously translated the Braden scale into Norwegian. The Braden scale training program was based on patient cases published in an instructional CD purchased from the Braden scale homepage (www.bradenscale.com), other studies (Maklebust et al., 2005) and from a web site based on the Braden scale instructional CD (http://ced.muhealth.org/resources/bradenCD/menu.html), as well as on cases from our own experience. Each case

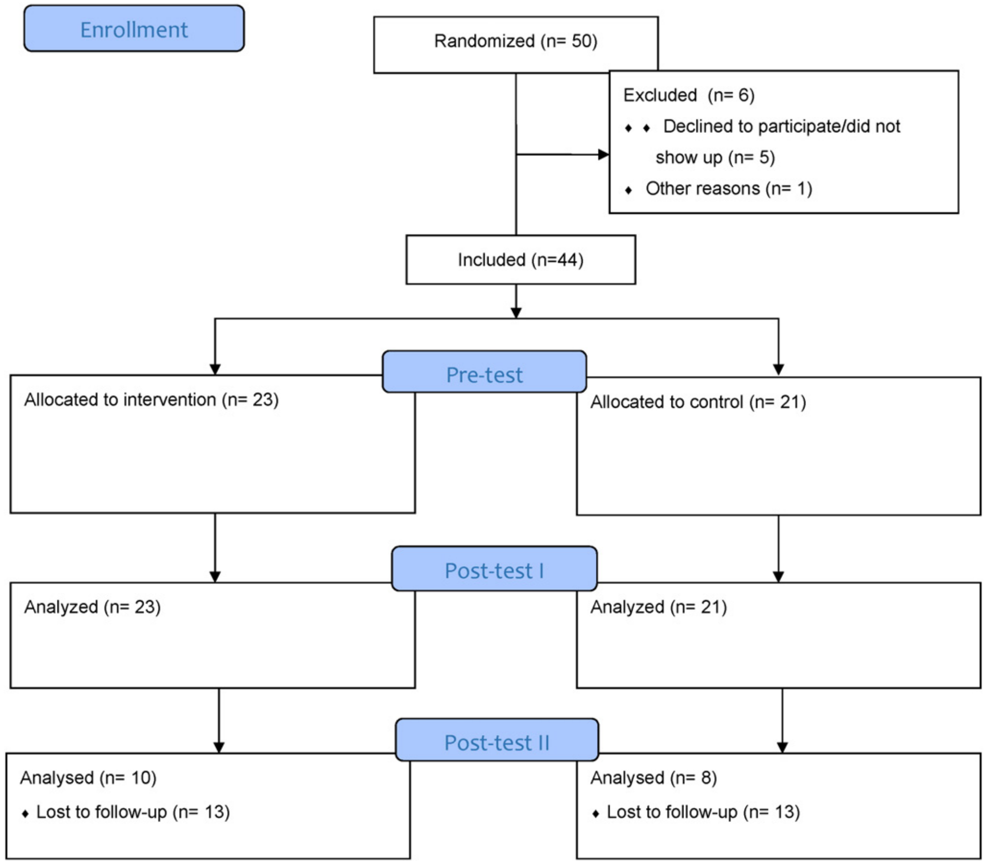

Fig. 1. Flow chart of participants for the current study.

contained patient information necessary to score each of the six subscales of the Braden scale. For the cases from the CD and website and from other studies, the cases' authors gave the correct assessment. For the cases from our own experience, our research group determined the correct assessment. The initial set included 13 cases illustrating different risk levels.

We validated the patient cases in two phases of testing. We recruited a group of five experienced nurses to score 13 cases each. We then compared the expert nurses' responses to the correct response. The exact percent agreement for the mean subscale scores for each case ranged from 53.3% to 90%. We revised case texts on the basis of nurses' responses.

We validated the revised version of the 13 cases in a new group of four expert nurses, all experienced in PU prevention. This second group of nurses had a higher exact percent agreement than the first group with scores ranging from 62.5% to 95.8%. This step was primarily designed to select the cases that were most clear-cut and interpretable. The final set of patient cases used in the program and testing included the eight cases (at different risk levels) that received the highest agreement scores from the second test group.

The Braden scale training program included a general definition of PU, followed by a presentation of the Braden scale with individual slides to present each of the six subscales, the scoring system and the scale risk levels ("Not at risk" to "Very high risk") (Bergstrom et al., 1987a, 1987b). We used one case to illustrate the scoring levels of each subscale and to demonstrate the scoring of the subscale and total score.

4.6. The PU classification program

The training program for PU classification contained a definition of PU and the four PU categories (National Pressure Ulcer Advisory Panel, 2014), as well as a description of suspected deep tissue injury and unstageable PUs as category IV. We used photos as well as a schematic illustration for each ulcer category. We included instructions on how to classify redness of skin. We also presented the differences between PUs and Incontinence-Associated Dermatitis (IAD). We used PU photos purchased from the National Pressure Ulcer Advisory Panel (NPUAP), the categories of which had been determined by NPUAP experts.

4.7. E-learning system

The e-learning program was mounted on the Mohive e-Learning Publishing System (http://www.crossknowledge.com/en_US/elearning/technologies/mohive.html) used by the South-Eastern Norway Regional Health Authority and familiar to hospital nurses participating in the study. The e-learning program was not available online during the testing period. Therefore, a link to the program was placed on the desktop of each computer and the program was only available to the participating nurses in the e-learning group during the testing.

4.8. The testing of the intervention

We constructed three test sets for the Braden scale, each consisting of five cases. All three test sets included three cases: one very high risk, one medium risk and one not at risk. We replaced two cases and changed the order of the cases in each test set to reduce the effect of learning bias.

The competence test for the classification program consisted of 40 photos of PUs representing different categories (normal skin, categories I–IV). We used NPUAP photos both in the training program and in the tests. In order to ensure comparability of test results between the groups, the test photos as well as the competence tests were printed on paper. We divided the photos into two sets, as shown in Table 1. In post-test II we used a random selection of 20 of the 40 photos

Table 1
Number of photos per PU category in the in the photo tests.

	Set A (20)	Set B (20)	Set A + B (40)	3 months
Normal skin	1	3	4	1
Category I	5	0	5	3
Category II	4	2	6	4
Category III	6	6	12	6
Category IV	4	9	13	6

(Table 1). To minimize recognition, the order of photos was changed in each of the tests.

Because the Braden scale is not a well-known assessment tool in Norway, an explanation of the Braden scale and an illustration of the PU categories were included as an aid during testing. After the pre-test, the intervention group and classroom group proceeded immediately to the training modules. The intervention and classroom training groups received training identical in content. The participants in the e-learning program group worked independently with their program in a computer room, each on his/her own terminal. A research assistant oversaw the training and made sure participants did not communicate with each other while completing the program. The classroom group received a traditional lecture delivered by an experienced nurse using a PowerPoint presentation. The lecture lasted about 45 min and allowed for questions from the participants.

4.9. Outcome measures

The outcome measures were the number of correct Braden subscale scores of patient cases and the number of PU photos correctly classified before and after training.

4.10. Data analysis

All the test variables were dichotomized into correct or incorrect answers compared to the predetermined correct answer. Missing data was registered as an incorrect answer. We calculated the exact percent agreement (number of observed agreements that match exactly the gold standard divided by the number of possible agreements × 100) for the six Braden subscales and for the PU photos (normal skin and the four categories) respectively. We focused on the Braden subscale scores since the total score may camouflage variation in risk scores across subscales. Due to small sample size, comparisons between groups were analyzed with a Chi-square test or a Fisher Exact test for categorical variables and a Mann–Whitney U test for continuous variables. The chosen significance level was $p < .05$.

To adjust for chance agreement, the multi-rater Fleiss' kappa were calculated for the Braden subscales and for all the photos in each photo set. We used the Fleiss' kappa because it measures group agreement, whereas Cohen's kappa only measures the agreement between two participants. The values of the Fleiss' kappa vary from −1 to 1, where kappa values below 0.2 are considered poor, while values above 0.60 are good agreement (Altman, 1991). Data were analyzed using SPSS 21 and the Statstodo web-based calculator for the Fleiss' kappa (https://www.statstodo.com/CohenKappa_Pgm.php).

5. Results

The majority of participants were female (97.7%) and worked at hospitals (81.8%). The nurses' work experience ranged from zero years to 32 years, and over half of the participants had six years work experience or more. Slightly more than 10% of the participating nurses had postgraduate specialization. There were no significant differences in these characteristics across the two groups (Table 2).

The dropout rate for the three-month test for the total sample was 59%. The dropout rate was high in both groups (Fig. 1).

Table 2
Characteristics of study participants.

	E-learning n = 23 n (%)	Classroom n = 21 n (%)	Total N = 44 n (%)
Education			
Bachelor	22 (95.7)	17(81)	39 (88.6)
Postgraduate specialization	1 (4.3)	4 (19)	5 (11.4)
Workplace			
Hospital	20 (87)	16 (76.2)	36 (81.8)
Nursing home	3 (13)	5 (23.8)	8 (18.2)
Work experience			
0–2 years	2 (8.7)	3 (14.3)	5 (16.4)
3–5 years	9 (39.1)	3 (14.3)	12 (27.3)
>6 years	12 (52.2)	15 (71.4)	27 (61.4)

Chi-square/Fisher Exact test not significant between the two groups.

5.1. Braden scale risk assessment

No significant Braden subscale score differences were found between the groups in any of the three tests, either for categorical variables (Table 3) or for subscale sum scores between the groups in pre-test and post-test I (data not shown). We calculated the Fleiss' kappa for each subscale for both groups in all tests. The Fleiss' kappa had a range from −0.05 to 0.59.

5.2. PU classification

In post-test I immediately after the training, the e-learning program group scored significantly higher than the classroom group on all categories except category IV when comparing the same photo set used in the pre-test (photo set A) (Table 4). A Mann–Whitney U test showed significant differences between the group sum scores for the same photo set used in pre-test and post-test 1 U = 126,0, z = −2738, $p = .006$. In the set with the 20 photos used only in post-test I (photo set B) and for the scores in post-test II, there were no significant differences between the two groups (Table 4). The Fleiss' kappa scores for all photos in each photo set ranged from 0.13 to 0.29.

6. Discussion

No significant differences were found in Braden subscale scores between the e-learning program group and the classroom group in any of the three tests. For the PU classification program, the e-learning program group scored significantly better than the classroom group in some of the categories in the post-test immediately after training.

6.1. Braden scale risk assessment

The Braden training program had no effect on the risk assessment of subscales in our study. Magnan and Maklebust (2009) found that a web-based Braden training program increased assessment accuracy, measured by exact percent agreement, in the post-test compared to the pre-test for new users of the Braden scale. According to our results, the nurses did quite well in the pre-test but did not increase their accuracy scores in the post-test immediately after training. In comparison, our intervention group had lower accuracy scores for the subscales than did the new users in the sample from Magnan and Maklebust (2009).

6.2. PU classification

In our study, the PU classification training program had a short-term effect for the intervention group compared to the classroom group in post-test I. Beeckman et al. (2008) also compared classroom and e-learning programs, and found that both groups improved significantly

Table 3
Exact agreement and Fleiss' kappa scores for Braden subscales in pre- and post-tests by groups.

Pre-test	E-learning (n = 23)		Classroom (n = 21)		*p*-Value	Total (N = 44)
	Agreement (%)	Fleiss' kappa (95% CI)	Agreement (%)	Fleiss' kappa (95% CI)		Agreement (%)
Sensory perception	86/115 (74.8)	0.22 (0.17–0.28)	82/105 (78.1)	0.08 (0.02–0.14)	.563	168/220 (76.4)
Moisture	90/115 (78.3)	0.03 (0.02–0.09)	85/105 (81)	0.01 (−0.06–0.07)	.621	175/220 (79.5)
Activity	92/115 (80)	−0.01 (−0.07–0.04)	79/105 (75.2)	0.01 (−0.05–0.07)	.396	171/220 (77.7)
Mobility	99/115 (86.1)	0.01 (−0.05–0.07)	85/105 (81)	0.12 (0.06–0.18)	.304	184/220 (83.6)
Nutrition	89/115 (77.4)	0.10 (0.05–0.16)	79/105 (75.2)	0.22 (0.16–0.28)	.707	168/220 (76.4)
Friction/shear	103/115 (89.6)	0.03 (−0.03–0.08)	91/105 (86.7)	0.05 (−0.01–0.11)	.506	194/220 (88.2)
Post-test I	(n = 23)		(n = 21)		*p*-Value	(N = 44)
Sensory perception	82/115 (71.3)	0.07 (0.02–0.13)	69/105 (65.7)	0.25 (0.19–0.31)	.372	151/220 (68.6)
Moisture	76/115 (66.1)	0.04 (−0.01–0.10)	63/105 (60)	0.15 (0.06–0.21)	.350	139/220 (63.2)
Activity	73/115 (63.5)	0.05 (−0.01–0.10)	62/105 (59)	0.16 (0.10–0.22)	.500	135/220 (61.2)
Mobility	79/115 (68.7)	0.08 (0.02–0.13)	73/105 (69.5)	0.21 (0.15–0.27)	.894	152/220 (69.1)
Nutrition	71/115 (61.7)	0.15 (0.09–0.20)	58/105 (55.2)	0.25 (0.19–0.31)	.328	129/220 (58.6)
Friction/shear	79/115 (68.7)	−0.01 (−0.07–0.04)	65/105 (61.9)	0.15 (0.09–0.21)	.290	144/220 (65.5)
Post-test II	(n = 10)		(n = 8)		*p*-Value	(n = 18)
Sensory perception	40/50 (80)	0.19 (0.06–0.33)	33/40 (82.5)	0.13 (−0.03–0.30)	.763	73/90 (81.1)
Moisture	42/50 (89)	−0.03 (−0.16–0.11)	32/40 (80)	0.24 (0.08–0.41)	.622	74/90 (82.2)
Activity	35/50 (70)	−0.05 (−0.18–0.08)	29/40 (72.5)	0.19 (0.03–0.36)	.795	64/90 (71.1)
Mobility	40/50 (80)	0.53 (0.40–0.66)	35/40 (87.5)	0.05 (−0.11–0.22)	.343	75/90 (83.3)
Nutrition	38/50 (76)	0.59 (0.46–0.72)	35/40 (87.5)	0.51 (0.34–0.68)	.166	73/90 (81.1)
Friction/shear	41/50 (82)	−0.04 (−0.17–0.09)	35/40 (87.5)	0.12 (−0.05–0.28)	.474	76/90 (84.4)

Chi-square/Fisher Exact test for p-value between the groups exact agreement.

in the post-test compared to the pre-test and significantly more in their e-learning program group. However, this study had a mixed sample of nursing students and registered nurses. In contrast to findings in the total sample, a sub analysis of only the registered nurses group found no differences between training methods in either of their post-tests (Beeckman et al., 2008). An explanation of the better results for the e-learning program in our study compared to the sub group of nurses in the Beeckman et al. (2008) study may be the high number of newly graduated nurses in our e-learning program group. The seven-year difference between data collection in these two studies has to be taken into account. Our nurses may have been more familiar with e-learning programs as well as with using a computer.

A one-group study also found significant improvement in classification skills for the group receiving a power-point presentation based on the PUCLAS2 tool (Ham et al., 2015). In their study Ham et al. (2015) had higher exact agreement in their post-test than we did in our classroom group. However, they had only half the number of photos included in their test and only tested staff working in an emergency ward, which may have influenced the scoring accuracy.

The comparison of results must take into account the elements of different settings (single and multicenter samples) and the sample sizes in the other studies. Both the Ham et al. (2015) and Beeckman et al. (2008) studies had larger group samples than our study did.

The exact agreement was rather good in our study, but the Fleiss' kappa showed mostly poor agreement across the raters. The kappa values remained low after training, indicating that more training and/or program change is essential for improvement.

The different findings for training effect for PU risk assessment and classification in this study may indicate that a task such as PU classification was easier to learn than the use of the risk assessment instrument. We used written patient cases with limited information, yet PU risk assessment in general is a comprehensive assessment that includes a validated risk assessment scale, skin assessment and clinical judgment (National Pressure Ulcer Advisory Panel, 2014). All these factors help nurses to identify the risk of developing PU and further determine which preventive measures the patient should take, such as type of pressure-redistributing mattress and regular repositioning. This assessment may be more complex than what can be taught by an e-learning program or in traditional classroom training. Magnan and Maklebust (2008) found that when the patient cases were very high or moderate risk, new users with Braden scale training alone were less likely to reliably assess risk compared to regular users with both training and experience working with Braden scale. Training as well as reflection are essential for proficiency in patient risk assessment. In organizations with high turnover and little time for in-service training, e-learning programs could be a good alternative to classroom lecture in-service. However, a variety of training methods should also be used including simulation and group discussion of PU categories and different PU risk patient cases, to increase competency and focus on patient safety.

The non-significant differences between the two risk assessment training methods are similar to findings of systematic reviews. No statistical differences were found between e-learning programs and classroom lecture groups in skills and knowledge improvement in health professions (Cook et al., 2008, Lahti et al., 2014). However, our results for classification training showed significant differences between the training methods, which suggest that more studies are required in the field of e-learning programs, especially for long-term effect.

6.3. Strengths and limitations of the study

The two training programs had the same content. Most training studies have studied one type of training or compared training programs with a slightly different content or a training group to one with no training at all. Our study also included training in both risk assessment and PU classification.

There were limitations to our study. First, we did not do a power calculation prior to this study, thus increasing the risk of Type II error: our sample size was probably too small to detect clinically important differences between the groups for the Braden scale. Confounding factors may have affected the results, but small sample size limits the opportunity for multivariate analysis. Furthermore, the exact percent agreement does not correct for chance agreement and may overestimate the level of agreement. On the contrary, it is easier to compare exact percent agreement with other study results than kappa statistics.

The exclusion of the control group with no additional training (necessitated by the large dropout) limits the long-term effect comparison. Moreover, those who completed the post-test II might have been more interested in PU prevention and more familiar with risk assessment and classification of PU than the dropouts; if correct, this hypothesis would underestimate the training effects. Using real patients instead of photos

Table 4
Percent exact agreement and Fleiss' kappa for the PU classification scores in pre- and post-tests by group.

Pre-test	Agreement (%) E-learning (n = 23)	Agreement (%) Classroom (n = 21)	*p*-Value	Agreement (%) Total (N = 44)
Photo set A				
Normal skin	10/23 (43.5)	8/21 (38.1)	.717	18/44 (40.9)
Category I	71/115 (61.7)	64/105 (61)	.905	135/220 (61.4)
Category II	73/92 (79.3)	61/84 (72.6)	.296	134/176 (76.1)
Category III	73/138 (52.9)	80/126 (63.5)	.081	153/264 (58.0)
Category IV	83/92 (90.3)	75/84 (89.3)	.839	158/176 (89.8)
All photos	310/460 (67.4)	288/420 (68.6)	.708	598/880 (68.0)
Fleiss' kappa all photos (95% CI)	0.21 (0.18–0.24)	0.13 (0.09–0.16)		
Post-test I	(n = 23)	(n = 21)	*p*-Value	(N = 44)
Photo set A				
Normal skin	19/23 (82.6)	10/21 (47.6)	.014	29/44 (65.9)
Category I	85/115 (73.9)	50/105 (47.6)	<.001	135/220 (61.4)
Category II	71/92 (77.2)	52/84 (61.9)	.027	123/176 (69.9)
Category III	90/138 (65.2)	64/126 (50.8)	.018	154/264 (58.3)
Category IV	86/92 (93.5)	78/84 (92.9)	.870	164/176 (93.2)
All photos	351/460 (76.3)	254/420 (60.5)	<.001	605/880 (68.8)
Fleiss' kappa all photos (95% CI)	0.17 (0.14–0.20)	0.24 (0.21–0.27)		
Photo set B				
Normal skin	54/69 (78.3)	45/63 (71.4)	.365	99/132 (75)
Category I	–	–	–	–
Category II	36/46 (78.3)	36/42 (85.7)	.365	72/88 (81.8)
Category III	65/138 (47.1)	66/126 (53.4)	.391	131/264 (49.6)
Category IV	157/207 (75.8)	161/189 (85.2)	.019	318/396 (80.3)
All photos	312/460 (67.8)	308/420 (73.3)	.074	620/880 (70.5)
Fleiss' kappa all photos (95% CI)	0.22 (0.19–0.35)	0.29 (0.26–0.32)		
Photo set A + B				
Normal skin	73/92 (79.4)	55/84 (65.5)	.039	128/176 (72.7)
Category I	85/115 (73.9)	50/105 (47.6)	<.001	135/220 (61.4)
Category II	107/138 (77.5)	88/126 (69.8)	.155	195/264 (73.9)
Category III	155/276 (56.2)	130/252 (51.6)	.292	285/528 (54)
Category IV	243/299 (81.3)	239/273 (87.5)	.039	482/572 (84.3)
All photos	663/920 (72.1)	562/840 (66.9)	.019	1225/1760 (69.6)
Fleiss' kappa all photos (95% CI)	0.20 (0.18–0.22)	0.27 (0.25–0.29)		
Post-test II	(n = 10)	(n = 8)	*p*-Value	(n = 18)
Normal skin	6/10 (60)	7/8 (87.5)	.196	13/18 (72.2)
Category I	14/30 (46.7)	9/24 (37.5)	.498	23/54 (42.6)
Category II	28/40 (70)	28/32 (87.5)	.076	56/72 (77.8)
Category III	36/60 (60)	35/42 (83.3)	.012	71/102 (69.6)
Category IV	44/60 (73.3)	32/42 (76.2)	.745	76/102 (74.5)
All photos	128/200 (64)	111/160 (69.4)	.283	239/360 (66.4)
Fleiss' kappa all photos (95% CI)	0.22 (0.16–0.29)	0.17 (0.09–0.25)		

Chi-square/Fisher Exact test for *p*-value between groups exact agreement.

and written cases could have strengthened the study, but would also have prolonged the data collection period. Because a further adjusted version of these training programs was to be included in a larger PU prevalence study later the same year, a prolonged data collection period was not possible.

In retrospect, the Braden scale test should have included the same five cases in each test. Moreover, in the PU classification test, all photos should have been included in post-test II for improved analysis. The replacement of two cases in each of the Braden scale tests may have had an impact on the poor accuracy of the results. The cases may require more refinement to achieve more accurate scoring between the nurses.

We did not ask the nurses about their computer knowledge and preferred learning method. As most hospitals and nursing homes have implemented electronic documentation systems long ago, one may assume the respondents were not unfamiliar with computer output and input. Nurse participation was voluntary, and this may affect the external validity: the participating nurses may be more PU-conscious than the average nurse, which could be a possible reason for the small skill improvement findings.

6.4. Clinical implications

In order to ensure patient safety and meet patients' fundamental care needs, fundamental knowledge, practical skills and techniques of nursing, along with interaction between nurse and patients, are important (Kitson et al., 2014). Knowing how to assess risk and skin is important in patient care and for patient safety issues. Several studies have shown that fundamental PU knowledge is lacking among nurses, and it is important to find efficient ways to both increase and maintain knowledge; this remains a challenge. Nursing schools have a responsibility to increase nurses' knowledge about PU assessment and prevention. In addition, hospital wards and other health care institutions need to include PU assessment and prevention training in their orientation of new hires and continue it with in-service education. Pocket cards listing the most important PU risk factors as well as the different PU categories may also be a reminder supplementing continuing education. Training is essential for valid and reliable data collection in studies. Implementation of PU risk assessment and correct classification of PUs is essential since a PU is an indicator of the quality of care (National Pressure Ulcer Advisory Panel, 2014). As it is readily available, an e-learning program may be preferable as a method for continuous improvement subsequent to a test of accuracy.

7. Conclusion

Continuing education is essential for maintaining and increasing nurse proficiency in PU risk assessment and PU classification. The high workload on wards may represent a challenge to attendance at traditional classroom lectures, as they require more planning, an educator, and a lecture room. We found equal or better results for our e-learning program compared to classroom lectures. An e-learning program may be a more efficient method as the nurses can take the program at their own convenience. Moreover, they can repeat the program and testing until they achieve a proficient level.

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Competing interest

The authors declare that they have no competing interests.

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