E-LEARNING AS AN EFFECTIVE METHOD IN THE PREVENTION OF PATIENT FALLS

E-IZOBRAŽEVANJE KOT UČINKOVIT UKREP ZA PREPREČEVANJE PADCEV PACIENTOV

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ABSTRACT

Keywords:
falls, patients, nurses, e-learning, effectiveness, prevention

Objectives: Patient falls deteriorate patients' functional condition and quality of life, and increase their treatment costs. E-learning is considered an effective way to gain knowledge and competencies for quality and safety in nursing practice. The aim of the study is to evaluate the effectiveness of an e-learning course for nurses in preventing in-patient falls.

Methods: The research design was mixed. In the first phase of the study, a five-year retrospective analysis of 2,280 in-patient falls was performed. Based on the analysis of risk factors for patient falls and group interviews with clinic managers an e-learning course was designed and completed by 250 nurses from five surgical and internal departments. The course's effectiveness was evaluated based on the incidence of patient falls and the consequences of the falls before and after e-learning.

Results: At surgical departments, there was a statistically significant decrease in patient fall indices after the implementation of the e-learning course (from 4.4 to 2.6 falls per 1,000 patients; p=0.022). On the contrary, in internal departments, this index increased in the monitored period (from 19.0 to 26.9 falls per 1,000 patients; p=0.001). In all departments, there was a decrease in the incidence of patient injuries caused by falls after the implementation of the e-learning course; in internal medicine, this decrease was statistically significant (from 54.5% to 33.3%; p=0.014).

Conclusions: The study confirmed that e-learning forms of education for healthcare professionals have a positive effect in preventing patient falls.

IZVLEČEK

Ključne besede:
padci, pacienti, medicinske sestre, e-izobraževanje, uspešnost, preprečevanje

Cilji: Padci pacientov poslabšajo njihovo funkcijsko stanje in kakovost življenja ter povečajo stroške zdravljenja. E-izobraževanje velja za učinkovit način pridobivanja znanj in kompetenc na področju kakovosti in varnosti zdravstvene nege. Cilj raziskave je oceniti uspešnost e-izobraževanja za medicinske sestre pri preprečevanju padcev hospitaliziranih pacientov.

Metode: Raziskava je bila zasnovana kot mešana raziskava. V prvi fazi raziskave je bila opravljena petletna retrospektivna analiza 2.280 padcev hospitaliziranih pacientov. Na podlagi analize dejavnikov tveganja za padce pacientov in skupinskih razgovorov z vodji klinik je bilo zasnovano e-izobraževanje, ki ga je opravilo 250 medicinskih sester iz petih kirurških in internih oddelkov. Uspešnost izobraževanja je bila ocenjena na podlagi pojavnosti padcev pacientov in posledic padcev pred e-izobraževanjem in po njem.

Rezultati: V kirurških oddelkih je bilo ugotovljeno statistično značilno znižanje stopnje padcev pacientov po izvedenem e-izobraževanju (s 4,4 na 2,6 padca na 1.000 pacientov; p = 0,022). Nasprotno se je v internih oddelkih ta stopnja v opazovanem obdobju povišala (z 19,0 na 26,9 padca na 1.000 pacientov; p = 0,001). V vseh oddelkih je bilo ugotovljeno zmanjšanje pojavnosti poškodb pacientov zaradi padcev po izvedenem e-izobraževanju – v internem oddelku je bilo to zmanjšanje statistično značilno (s 54,5 na 33,3 %; p = 0,014).

Zaključki: Ta raziskava je potrdila, da oblike e-izobraževanja pozitivno vplivajo na zdravstvene delavce pri preprečevanju padcev pacientov.

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1 INTRODUCTION

One of the most common adverse events in healthcare facilities is patient falls. Demographic trends and related prognoses predict an increasing number of patients in higher age groups, where the risk of falls is increased. The incidence of falls in hospitals and social facilities is two to three times higher than in the general community, and the rate of injuries caused by falls is also higher in institutional environments (1). The effectiveness of prevention programmes is usually reported as a reduced incidence of falls or a reduced number of people injured as a result of falls (2-4). These healthcare indicators can be reported as indices: the number of falls or injuries caused by falls per 1,000 patients or the number of falls or injuries caused by falls per 1,000 treatment days (5, 6). Multifactorial intervention programmes (not only) in the field of fall prevention include the training of health professionals (7). Staff training, which should be didactically correct and relevant, is described as the dominant area of healthcare (8). E-learning is considered an effective way to acquire nursing knowledge, skills, and competencies regarding quality and safety in the healthcare environment (9-11).

This study assessed the effectiveness of the established prevention programme for patient falls. The main goal was to determine whether the completion of an e-learning programme focused on preventing patient falls and designed for general nurses affects the incidence (index) of falls or injuries caused by patient falls.

2 METHODS

2.1 Study design

It was a prospective observational-interventional study. The research design was mixed. The concept of sequential triangulation was used, where the quantitative and qualitative phases alternate (QUANT -> QUAL -> QUANT). This is used when the results of one method are important for the use of another method (12). This research design is suitable for hierarchically organised institutions, such as hospitals (13).

2.2 Setting

The study took place in one of the largest teaching hospitals in the Czech Republic, which has 1,739 beds in 21 clinical departments, 19 further departments, and 6 institutes and which employs 4,828 health professionals (2019). It provides general, specialised, and super-specialised medical care for the catchment area of approximately 800,000 inhabitants of the Czech Republic (approximately 8% of the Czech population). Five departments (3 internal and 2 surgical), where diagnostic and medical inpatient care is provided, were included in

the study. As part of its nursing care quality and safety policy, the hospital has established preventive anti-fall measures (a standard of nursing care quality focused on patient falls and subsequent preventive measures for fall risk detection, safe environments, nursing interventions, and patient education).

2.3 Research phases

The research took place in the period from 2012 to 2019 and was divided into three stages.

2.3.1 First phase – Retrospective five-year analysis of in-patient falls (QUANT)

In the first phase of the research, a five-year (2012-2016) retrospective analysis of patient falls at a given medical facility was performed. Data on past falls (n=2,280) was collected from mandatory patient fall protocols from all disciplines. The incidence of falls and injuries caused by falls was determined and the results were correlated with the determined risk of patient falls. Data on past falls was described by descriptive statistics; the x2-chi-squared test and Fisher's exact test were used to test the relationships. The statistical tests were evaluated at a significance level of 5%. Stata version 13 was used. SPSS Answer Tree version 3.1 was used to identify risk groups.

2.3.2 Second phase – Design and implementation of an e-learning course for selected sites (QUAL)

Group interviews with selected managers of departments (n=8), where the highest incidence of falls was found (internal departments, surgical departments, geriatric ward and long-term care ward), discussed topics focused on the results of the retrospective analysis of falls with emphasis on statistically significant areas. The aim of this exploratory technique was to achieve the most specific description possible, obtain new stimuli and inspirations, and reach the maximum saturation of information and suggestions based on experts' experience. Five field-oriented areas included in the e-learning programme were evaluated (risk factors for falls, risk assessment of falls, evaluation tools, field-oriented preventive measures, and relevant legislative standards presented as a motivational basis emphasising the importance of education in the field).

The results of the retrospective analysis of patient falls and group interviews became the basis for the creation of an asynchronous e-learning course created in the environment of the Moodle Learning Management System. The programme was created in accordance with the most used concept for the creation of e-learning courses, the ADDIE model (analysis, design, development, implementation, evaluation) (14).

The course consisted of ten separate lessons, whose content respected Bloom's innovated taxonomy of educational goals (retrieval; comprehension; analysis; knowledge utilisation; metacognition; and self-system thinking) (15). The curriculum of the e-learning training programme included the issues of quality and safety of healthcare. The content focused on falls risk factor detection and falls risk assessment, assessment tools, preventive measures, and relevant current legislative standards presented as a motivational background highlighting the importance of education in this area. Current professional recommendations on the falls of institutionalised persons and the principles of andragogic didactics were taken into account (16).

Three internal and two surgical departments were selected for e-learning (two general fields with the highest incidence of patient falls). All general nurses (n=250) from these departments completed the e-learning course within a 6-month period (from January 2018 to June 2018).

2.3.3 Third phase – Evaluation of the effectiveness of the e-learning course (QUANT)

2.3.3.1 Knowledge of the participants

The initial and final knowledge of the participants of the e-learning course was tested using knowledge examinations whose content and predictive validity and reliability were tested within the preliminary research. The degree of mutual homogeneity of the test tasks content was monitored using the Cronbach's alpha method. For pedagogical diagnostics, a result of the coefficient α greater than 0.8 is required (17). The value of Cronbach's alpha coefficient for determining the internal consistency of the items was 0.82 for the initial test and 0.85 for the final test, i.e. it was a sufficiently strong result of data reliability. Spearman's coefficient was used for an overall view of the reliability and predictive validity of the data. The positive dependence between the tests was confirmed (coefficient value of 0.467). The content validity of the initial and final test was assessed by erudite experts from clinical practice with pedagogical experience.

To compare the knowledge of medical staff, the Stuart-Maxwell test was used in both tests in the e-learning programme. The evaluation of results in pairs was used where it is necessary for each individual to know their result in the first and in the second test (18). The staff's knowledge by individual departments and by field.

2.3.3.2 Incidence of falls and consequences of falls

To evaluate the effectiveness of the e-learning course, the incidence of patient falls and the consequences of falls – all injuries and severe injuries (unconsciousness, commotion and contusion of the brain caused in direct connection with the fall, laceration with suture, fracture)

in the period before and after e-learning were compared with respect to the number of hospitalised patients and the number of treatment days. The evaluation was focused on the field (surgical and internal field). A period of 12 months before the start of the programme (from January 2017 to December 2017) and 12 months after the completion of all participants (from July 2018 to June 2019) was compared. By comparing the periods of one year, the effect of seasons on the results (such as the amount of natural light) was eliminated.

Statistical tests were evaluated in MS Excel (version 1908) and RStudio Desktop (version 1.2.504, R version 3.6.3) at a significance level of 5%. Significance levels of 1% and 0.1% were presented as auxiliary.

2.3.3.3 Comparison of patient characteristics

To verify the homogeneity of the characteristics of both compared groups of patients (with a fall before and after e-learning), the Bonferroni correction was used, at the significance level of 5% (19). 14 selected patient characteristics were tested (age, sex, length of hospital stay, risk of falls, mobility, cooperation, self-sufficiency, aids, mental state, drugs / re-categorisation and selected drugs). If the significance level of 5% of the overall test was to be maintained, the individual tests had to be evaluated at the level of significance 0.05/14. Fisher's exact test and its generalisation were used to verify agreement in groups. In the field comparison (internal and surgical), the results of the changes can be considered relevant, because it was not shown that the groups of patients with a fall before the e-learning (n=195) and after the e-learning (n=217) differed in the assessed characteristics (p>0.05).

2.3.3.4 Statistical matching

With regard to the possible influence of confounding factors (a disadvantage of observational studies), a method that minimises the influence of these factors – propensity score matching – was subsequently used. This method attempts to create a control (counterfactual) group that is as similar as possible to the supported group. The similarity is determined based on the observed variables (covariates), which are monitored in the period before the support and should not be affected by participation in the programme. Using the propensity score, control patients could be assigned to exposed patients, and a balanced set was created that is close to patients in a randomised study where there is a random distribution of input factors (20). Subgroups of patients with a fall before the e-learning (control) and after the e-learning (treated) thus became the result of statistical pairing, where both had the same extent. In these groups, it was determined whether there was a higher incidence of injuries in any of the monitored periods.

The MatchIt package (version 3.0.2) in R was used for pairing, and the 2 – independence test in contingency tables was used to evaluate the incidence of injuries.

3 RESULTS

3.1 Retrospective analysis of patient falls

The results of the five-year retrospective analysis of falls became the basis for the creation of the e-learning course and were published in 2018 in the Journal of nursing, social studies, public health and rehabilitation (21).

3.2 Evaluation of the e-learning course's effectiveness based on the knowledge of nurses

Staff (n=250) knowledge was tested at five departments before and after the course. An improvement was recorded in 43.2% of the course participants' knowledge; deterioration occurred in 4.8%. The knowledge of 52% of participants neither improved nor deteriorated after completing the e-learning course and their test results were evaluated as satisfactory.

155 nurses took part in the course at internal departments. In 38.1% of them there was an improvement in the results and in 6.5% of them a deterioration in the score of the initial versus the final knowledge test occurred. In 55.4% of participants, the test results were unchanged (satisfactory).

At the surgical departments, out of the total number of 95 participating surgical nurses, 51.6% improved their knowledge compared to the initial test and in 2.1% a deterioration occurred. There was no change in the results for 46.3% of them.

No difference in knowledge test results between internal and surgical departments was demonstrated (p=0.061).

The e-learning course had an impact on the course participants' knowledge, and they improved after its completion (p<0.001).

3.3 Evaluation of the e-learning course effectiveness based on the incidence of falls and their consequences (test of equality of parameters of two alternative distributions)

Internal departments that completed the e-learning saw the number of falls per 1,000 patients increase from 19.0 to 26.9 (p=0.001) and the number of falls per 1,000 treatment days increase from 1.8 to 2.5 (p=0.002) in the observed period. However, the number of falls with injuries per 1,000 treatment days was reduced from 3.1 to 1.1 and the number of falls with severe injuries per 1,000 treatment days decreased from 0.3 to 0.1 (p=0.009).

Surgical departments that completed the e-learning saw the number of falls per 1,000 patients decrease from 4.4 to 2.6 (p=0.022) and the number of falls per 1,000 treatment days decrease from 0.8 to 0.5 (p=0.028) in the observed period. At the same time, there was a decrease in the number of injuries per 1,000 patients from 2.5 to 1.1 (p=0.025) and a decrease in the number of injuries per 1,000 treatment days from 0.5 to 0.2 (p=0.030). There were no statistically significant differences in the incidence of severe injuries in this field; the incidence stagnated in both indices (from 0.5 to 0.4 falls per 1,000 patients; p=0.801; and 0.1 falls per 1,000 treatment days before and after the intervention; p=0.826), (Table 1). The results of both fields are positive.

Table 1. Statistically significant results of the intervened departments.

Fields/ Depart-ments	falls / 1,000 patients			falls / 1,000 treatment days			injuries / 1,000 patients			injuries / 1,000 treatment days			serious injuries / 1,000 patients			serious injuries / 1,000 treatment days		
	before	after	trend / p-val	before	after	trend / p-val	before	after	trend / p-val	before	after	trend / p-val	before	after	trend / p-val	before	after	trend / p-val
Internal	19.0	26.9	↑ 0.001 **	1.8	2.5	↑ 0.002 **	9.9	9.8	↔ 0.931 **	0.9	0.9	↔ 0.903 **	3.1	1.1	↓ 0.009 **	0.3	0.1	↓ 0.009 **
Surgical	4.4	2.6	↓ 0.022 *	0.8	0.5	↓ 0.028 *	2.5	1.1	↓ 0.025 *	0.5	0.2	↓ 0.030 *	0.5	0.4	↔ 0.801 *	0.1	0.1	↔ 0.826 *

Legend: ↑ Increase in observed changes, ↓ decrease, ↔ no change, * statistically significant difference at the significance level of 5%, ** 1%, and *** 0.1%

Table 2. Occurrence of patient injuries at the intervened departments in the individual periods – matching.

Characteristics	injuries – overall		serious injuries	
	internal departments	surgical departments	internal departments	surgical departments
	p=0.014	p=1	p=0.353	p=0.713
before e-learning	54.5%	53.3%	36.4%	46.7%
after e-learning	33.3%	53.3%	28.8%	40.0%

3.4 Evaluation of effectiveness according to the incidence of injuries after a fall (statistical pairing)

Statistical pairing yielded 66 internal medicine patients with a fall before (control) and 66 patients after e-learning (treated). There were 15 patients in the surgical fields (control/treated). Thanks to statistical pairing, it was ensured that two groups of patients with a fall (before and after e-learning), which could be considered identical in terms of patient characteristics, entered the analysis.

In the monitored periods, there were various occurrences of injuries after a fall. In the period after e-learning, the number of falls with injuries decreased. Statistical pairing showed a statistically significant reduction in the incidence of injuries caused by falls from 54.5% to 33.3% (p=0.014).

In the surgical fields, a significant decrease in the number of injuries caused by a fall could not be demonstrated (p=1).

The incidence of severe injuries decreased in both fields (in the internal field from 36.4% to 28.8%, and in the surgical field from 46.7% to 40.0%; without statistical significance, p>0.05) (Table 2).

3.5 Results summary

A statistically significant decrease in patient fall indices was found in the intervened surgical departments (number of falls / 1,000 patients; p=0.022; and the number of falls / 1,000 treatment days; p=0.028).

In the field of internal medicine, there was an increase in these indices in the observed period (p=0.001 versus p=0.002).

In both fields, however, there was a decrease in the incidence of patient injuries caused by falls (all injuries in the surgical field; p<0.05; and severe injuries in the internal field; p<0.01).

The equality test for the parameters of two alternative distributions enabled a summary statement regarding the occurrence of falls and the consequences of patient falls in a given medical facility before and after the established e-learning intervention.

Statistical pairing enabled evaluation of the consequences of falls in groups of patients (before and after the intervention) with balanced characteristics and with the elimination of confounding factors. Propensity score matching creates a balanced set of patients that is close to that of a randomised study and therefore leads to a more accurate estimate of the effectiveness of the established change, in this case the e-learning course. This method only showed a statistically significant decrease in the number of patient injuries in the fields of internal medicine (p=0.014). The e-learning staff training thus had a positive effect on the occurrence of the consequences of falls among internal medicine patients.

4 DISCUSSION

The aim of the current study was to confirm the effectiveness of healthcare education created not only for patients but also for healthcare professionals. Only the level of medical staff's knowledge is usually assessed but not the impact of educational intervention on nursing practice in relation to specific indicators (22, 23). However, the results of our study showed an increase in nurses' knowledge about fall prevention (p<0.001) in connection with the completion of the e-learning course and subsequently also the impact of this form of education on a specific area of nursing practice (safety and quality of care). We managed to prove a decrease in the incidence of severe injuries caused by falls in internal fields where nurses completed the e-learning course. This result suggests that it is a possible effective preventive measure with regard to the characteristics of internal medicine (polymorbidity, polypharmacy) patients.

The effectiveness of e-learning education for healthcare professionals on fall prevention in elderly patients was examined by the study of Lasater et al. In interdisciplinary education (nursing, medicine, social work and pharmacology), the participants (healthcare professionals) were trained in strategies to reduce the risk of falls among the elderly. The effectiveness of this training had a positive evaluation and the mutual interactive approach helped increase knowledge, self-confidence, and team commitment to change its practice with a focus on promoting the health and safety of the elderly. The authors emphasised the need to use individualised educational strategies to implement evidence-based prevention programmes in a variety of practice settings. However, specific clinical indicators of the effect of

training on the incidence of falls were not evaluated in this study (24).

The effectiveness of the training programme for fall prevention among patients at large in-patient facilities, which was focused both on healthcare professionals (education of healthcare professionals) and patients (general and individual interventions), was evaluated by Brabcová et al. Here, the effectiveness of education was evaluated by comparing it to direct indicators from nursing practice. The study has shown a reduction in fall indices (the number of falls per 1,000 patients and the number of falls per 1,000 treatment days) only in surgical, psychiatric, and follow-up and rehabilitation care departments. However, the statistical significance of these changes has not been proven (p=0.737); the study's authors nonetheless state that the lack of statistical insignificance does not prove the training ineffective (25).

The results of our research also failed to show a statistically significant reduction in the fall index in surgical workplaces; however, in the surgical fields, they confirmed a decrease in the indices of injuries caused by falls (the number of injuries per 1,000 patients, p=0.025; the number of injuries per 1,000 treatment days, p=0.030). Our study has highlighted the importance of educating healthcare professionals, which should be in line with educational principles – clear design, planning, evaluation, repeatability, and comparability, and with an impact on nursing practice (26). Therefore, the e-learning educational programme is used as part of the in-house training of the nurses of the healthcare provider in question.

Considering the impartiality of the final observations, it is necessary to mention the influence of potential factors and situations that are to be respected due to the longitudinal research focus. The content of the e-learning programme reflected current legislative requirements, relevant preventive recommendations, and environmental changes. However, any potential changes in terms of human resources, such as staff behaviour and their attitudes towards the issue and prevention of patient falls, were not covered by the research. In this respect, it should be noted that an Australian research team, Shaw et al., published a review study (2008-2019) examining the topic of training in the prevention of falls among healthcare professionals and caregivers (physicians, general nurses, patient relatives and welfare facilities personnel). The results highlighted some complex shortcomings in that particular area. In their conclusions, the review authors recommend assessing the effect of training in terms of its impact on the level of competence and skills acquired during training and its impact on clinical and economic indicators. Moreover, they also encourage the evaluation of behavioural change in healthcare personnel with respect to the educational course, bearing in mind that behavioural change is the educational objective (27).

However, our research did not examine the impact of educational programmes on the behavioural change of participating healthcare personnel; the e-learning programme was developed respecting the dimensions of the educational process, i.e. the educational objectives (according to the updated Bloom's taxonomy) that the participants of the programme should achieve.

The fact that the personnel did not report all falls that occurred constitutes yet another confounding factor that must be mentioned for the sake of impartiality. However, the incentive for nurses to report adverse events (falls) is relatively high in the Czech Republic (71.4%) (28). However, it is impossible to determine in retrospect whether all adverse events were reported accurately. Thus, the e-learning programme can promote the necessity of reporting all falls that occur (following the current definition of a fall), taking into account the repeated emphasis on non-repressiveness in reporting falls and explanations on the importance of recording and evaluating the occurrence of adverse events and the related legislative standards.

We have attempted to minimise any confounding factors in our study. Randomised clinical trials are among the most important sources of evidence-based medicine. In some cases, however, randomisation is not possible for ethical or financial reasons, or due to other limitations. Therefore, there is an increase in the number of observational studies (29). The disadvantage of observational studies is that it is not possible to obtain an unbiased estimate of the intervention by direct comparison of the two groups and the results are burdened by the confounding factor. If controlling the influence of confounding factors is impossible or insufficient, it is necessary to reduce or eliminate it by appropriate statistical procedures. Therefore, more advanced statistical methods (such as propensity score matching) are chosen when processing an observation study, which can reduce or eliminate unwanted confounding factors. In our research, the use of the statistical pairing method increased the relevance of the resulting statements. Thanks to propensity score matching, it was possible to create balanced groups of patients and the resulting findings regarding the effectiveness of the e-learning programme could be extended to interpret the effects of the course without distortion.

5 CONCLUSION AND IMPLICATIONS

The results of the study showed a positive effect of the e-learning educational programme on specific indicators of clinical practice. Statistical pairing demonstrated a statistically significant reduction in the incidence of fall injuries in the fields of internal medicine. In surgical fields, the incidence of patient falls decreased. The e-learning programme had a positive effect on the incidence of

patient falls and their consequences. The study has shown that education of medical staff based on the principles of science and the needs of clinical practice can be a possible effective preventive intervention in the field of patient falls. For a healthcare facility, any adverse event is a potential forensic and economic risk that can be minimised by certain procedures. Despite all preventive measures, zero incidences of patient falls cannot be expected. However, an important role of hospital management is to put effective preventive measures (such as modern and sophisticated methods of e-learning) into practice in order to minimise the number of patient falls and mitigate their consequences.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

ETHICAL APPROVALS

The research was approved by the hospital management and was conducted in accordance with the ethical principles of the Declaration of Helsinki.

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