



Research Article

Effect of Website-based Learning on Improved Monitoring of Adverse Drug Reactions by Clinical Nurses

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SUMMARY

Purpose: The purpose of this study was to develop website-based learning contents to activate voluntary monitoring and reporting of adverse drug reactions (ADRs) for clinical nurses and to verify their effectiveness.

Method: Using a quasi-experimental control group pretest-posttest design with random allocation, a total of 60 nurses with more than 1 year of clinical experience were recruited from a university hospital in Seoul, Korea. A website was developed that provides learning contents including real cases and the latest drug-related knowledge, as well as video lectures. Knowledge on ADR monitoring, self-efficacy, ADR practice behavior, and medication performance ability were measured at 2 weeks after intervention. A small notebook for monitoring ADRs of nurses was given to the control group. Data were analyzed using descriptive statistics, the chi-squared test, and the independent *t* test using SPSS Statistics Software Version 21.0.

Results: The scores of ADR monitoring knowledge, self-efficacy, and ADR monitoring practice in the experimental group significantly increased after the intervention compared with the control group ($p < .05$). However, there was no significant difference between the two groups in medication performance ability related to ADR monitoring.

Conclusion: To spread a safety culture in which voluntary ADR monitoring and reporting is activated, it is necessary for clinical nurses to share and communicate ADR-related information and real cases through an open website.

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Introduction

Adverse drug reactions (ADRs) are unintended negative reactions that occur when drugs are used in appropriate doses and dosages for treatment, diagnosis, and prevention of diseases and refers to all cases in which a causal relationship with drugs cannot be excluded [1]. The expansion of the market due to the development of new drugs in polypharmacy in response to an aging population and complex chronic diseases increases the importance of preventing related side effects [2,3]. Pharmacovigilance activities related to the detection, evaluation, interpretation, and prevention of drug-related problems, including ADRs [1], are an important

factor in the safe administration of medication by healthcare providers [4].

Statistical data on ADRs by country revealed that, in Canada, side effects of outpatient medications resulted in more than two million emergency room visits and 700,000 hospital admissions, resulting in more than \$1 billion annually in healthcare costs [5]. The United States has reported the loss of \$30 billion in medical expenses each year [6]. In addition, preventive activities through monitoring of ADRs are essential for not only economic reasons but also patient safety and reduction of re-hospitalization rates [7]. Therefore, nurses must provide safe and effective medication, and continuous nursing education is required to prevent ADRs and encourage reports when they do occur [8,9].

Healthcare providers, such as doctors and nurses, recognize that drug administration is very important for patient safety in a hospital. In particular, nurses, who provide care closest to patients, are critical healthcare workers who can perform pharmacovigilance activities to monitor, recognize, and report ADRs [10,11]. However,

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in the clinical field, reports are often delayed due to busy work and are often ignored in the case of common side effects, sidelined in routing to others, or hidden in the case of serious side effects [12]. According to a study conducted with 300 nurses in Iran, after 4 months of training on ADR reporting, nurses' knowledge and attitudes were significantly improved, and the ADR reporting rate was increased [13]. In consideration of this reality, a randomized experimental study emphasized the need for continuous individual education to change nurses' behavior toward ADRs and mentioned web-based educational content as the most appropriate method [14]. To improve nurses' voluntary monitoring and reporting of ADRs, it is necessary to increase their sense of reality in the clinical field as to drug side effects, coping methods, and patient education contents. To establish a drug safety culture, it is essential to develop a program that allows educational institutions and nurses to share and communicate information, rather than a one-time education [15,16]. For the medium of education, nurses were found to prefer online e-learning due to conditions such as shift work [17,18]. In addition, to create a safe medication culture for patient safety, the education should be of a type that induces voluntary reporting and practice through web-based interactive communication such as a website, rather than a one-time presentation [19]. Development of website-based learning content can establish a system that plays an important role in the economic aspect by providing educational materials and information necessary to create a safe medication culture.

Therefore, the purpose of this study was to develop a communication-enabled website that includes error cases and learning content to enhance nurses' awareness of ADRs, to improve their voluntary reporting, and to verify the effect of website-based learning.

Methods

Study design

This study was a quasi-experimental control group pretest–posttest design with random allocation for developing website-based learning content and verifying its effectiveness on voluntary reporting of ADRs in nurses with more than 1 year of clinical experience.

Development of website-based learning contents

The website, including the learning content, was developed according to the web-based learning design model with five steps: analysis, design, development, application, and evaluation. In the analysis stage, in July 2017, 210 clinical nurses were surveyed about their preferred educational form and content for ADR reporting. Among them, 10 individual interviews were conducted to explore the reasons for the difficulty of voluntary reporting. The survey revealed that they desired education mainly in four areas: side effects by organ system (20%), patient condition observation methods prior to and after administration (17.0%), ADRs (16.7%), and side effects reporting procedures (15.7%). In addition, the scope and contents of the learning contained in the website were checked through a literature review on ADRs and a search of the Korean Ministry of Food and Drug Safety website.

In the design stage, the information to be delivered was developed. On the main screen, the menu was divided into four headings: Online lectures, ADR evaluation cases, information on individual drugs provided, and frequently asked questions (FAQs) about ADRs; notice boards were composed of newsletters (Table 1). In addition, questions and answers, posters, slogan contest campaigns and information on prizes were made on the website to

facilitate mutual communication with learners and to strengthen motivation for learning. The “How in this case?” banner part is structured so that information necessary for patient safety can be shared by two-way communication through questions and prompt feedback from the manager and by sharing clinical cases. After a participant watched the video lecture, questions were answered when asked. By clicking on the banner of “Knowing it is medicine” on the website, learners can take five online lectures, totaling about 2 hours of learning (Table 2). To provide information, this researcher, a nurse at a local drug safety center, took an online lecture on procedures for reporting ADRs, drug side effects and allergic reactions, symptoms and their management, high-risk drugs that require monitoring, and patient cases with side reactions.

In the development stage, after selecting a developer, the purpose, target, and contents of the site were explained, and development was carried out through technical support for security policies, characteristics of each screen, and individual menu management. As an administrator, this researcher has the authority to organize and provide information on the website and allows learners to write questions and opinions on the notice board. Finally, in the application stage, the final website-based education program that was revised and completed after validation by the expert group was applied to the experimental group. A group of experts consisting of two pharmacists from local drug safety centers, one internal medicine professor, two nursing professors, and ten clinical nurses with more than 10 years of clinical experience, evaluated the website's properties and its learning content using a health information website evaluation criteria tool consisting of 13 questions [20]. The validity of the developed website after use by 10 nurses showed a content validity index (CVI) of 0.9 or higher in all questions. Some learning contents and parts that need to be supplemented in terms of continuity and ease of use were modified, and finally website-based learning contents were developed (Figure 1). A domain (www.drugsafe.kr) was purchased, and the website was named “Drug Safety for Nurses.”

This research design was applied for the evaluation of the developed website-based education program. In the experimental group, consent was obtained for the use of personal information (e-mail, contact information, affiliation) for website membership registration and learning contents. Learning contents were developed to be linked to the Smart Teaching and Learning Center of the affiliated university and the experimental group was registered as students and connected with personal identifications (ID) and passwords through this link to take courses. Through the website manager page, we checked the number of accesses for learners to use the website.

Setting and participants

The number of samples in this study was calculated based on the evidence of the educational effect with a large effect size in several previous studies on ADR reporting for clinical nurses [12]. Using G*Power program 3.1.9.2, the number of samples that fit the *t* test with an effect size of .80, significance level of .05 for the two-tailed test, and power of 80% was at least 26 in each group.

The criteria for selection of participants were nurses working at a university hospital in Seoul and general ward nurses with clinical experience of 1 to 25 years, excluding new nurses and chief nurses. New nurses were excluded from the participants because they had little experience with drug side effects and lacked drug-related clinical judgment skills that required critical thinking [21]. To secure the homogeneity of clinical experience among a total of 266 participants who met the criteria, 60 participants were selected through a randomization program (Microsoft Excel 2010), divided

Table 1 Website-based Learning Content Composition for Adverse Drug Reactions.

Site map		Contents	Content classification
Online lecture	Knowing it is medicine!	Online lecture	• Display format: Link to www.selc.or.kr via banner - Under the management of the arbitration participant's list, email, and contact information - Individual identification/password provided - E-learning progress management and encouragement, Q&A, etc. - Communication possible
Cases by drug system	What happened?	ADR evaluation case	• Widely used in case data from the Korea Pharmaceutical Safety Administration is drug-oriented data and evaluation provided by the Ministry of Pharmacy Provide data on cases
Drug information	Aha like that!	Drug information update	• Provides a list of recently stocked drugs and precautions • Provides information on drugs that have been changed due to safety issues • Lists drugs that require caution when administering (high-risk drugs, etc.) • Suggestion of error points and solutions • FAQ provided • Comment function: general member - If you have any questions, you can communicate through comments
FAQ	How in this case	FAQ information	
Notice board uses	Newsletter	Provide information	• Newsletter provided by local drug safety center • Trends and events on ADRs inside and outside the hospital • Excellent reporter and department selected by the regional drug safety committee
	Great reporter	Motivation	Center motivation by uploading photos and lists
	Notice board	Reference room, through notices, user guides, etc. Provide information	• Information on events and usage through notices • Data can be downloaded and written by members in the data room
	Campaign	Motivation	• Promotion of events such as slogans, posters, and logos

Note. ADRs = adverse drug reactions; FAQ = frequently asked questions.

into 5 years and less than 5 years, and assigned to an experimental group and a control group. All 60 participants agreed to participate in the study, and there were no dropouts; 30 in the experimental group and 30 in the control group were used for the final analysis.

Procedures and data collection

The experimental group and the control group were collected from the same hospital. To prevent the contamination of the experiment, after collecting control group data, we proceeded to the parallax design in which data for the experimental group were collected.

Control group data were collected from February to March 2018, and experimental group data were collected from March to April.

Considering the characteristics of nurses working in shifts, intervention activities of the experimental group asked participants to attend online lectures and upload new drug information and newsletters through the website for 14 days. The researcher monitored the learning history after registering as a course system administrator to check the learning history of the experimental group. To manage the learning history, it was registered as a course in the H university smart teaching and learning center system so that the researcher could check the learning history through the learning management system through the individual ID/PW of each experimental group. To protect the personal information of the test participants, when a member registered on the site, the administrator allowed access after approval, and security was maintained so that personal information and contents were not exposed.

Table 2 The Contents of Online Lecture "Knowing it its Medicine."

List	Content	Running time
1. ADR terminology and how to report (basic)	• What is an ADR? • The importance of ADRs in nurses • ADR reporting system • ADR evaluation method	35 min
2. Clinical features of ADRs by system (basic)	• Drug-induced skin/liver/renal/gastrointestinal/ cardiovascular disease	26 min
3. Prevention and management of ADRs (advanced)	• Contrast adverse reaction management, computer program, symptoms, pretreatment, prevention	17 min
4. Anaphylaxis symptoms and management (advanced)	• Underlying diseases and causes • Symptoms • Examination and diagnosis • Treatment	18 min
5. Drugs requiring monitoring (advanced)	• High-risk and cause serious adverse reactions drugs • Management of side effects of anticancer drugs • Drugs need to be monitored by the Ministry of Food and Drug Safety in case of occurrence	35 min

Note. ADRs = adverse drug reactions.

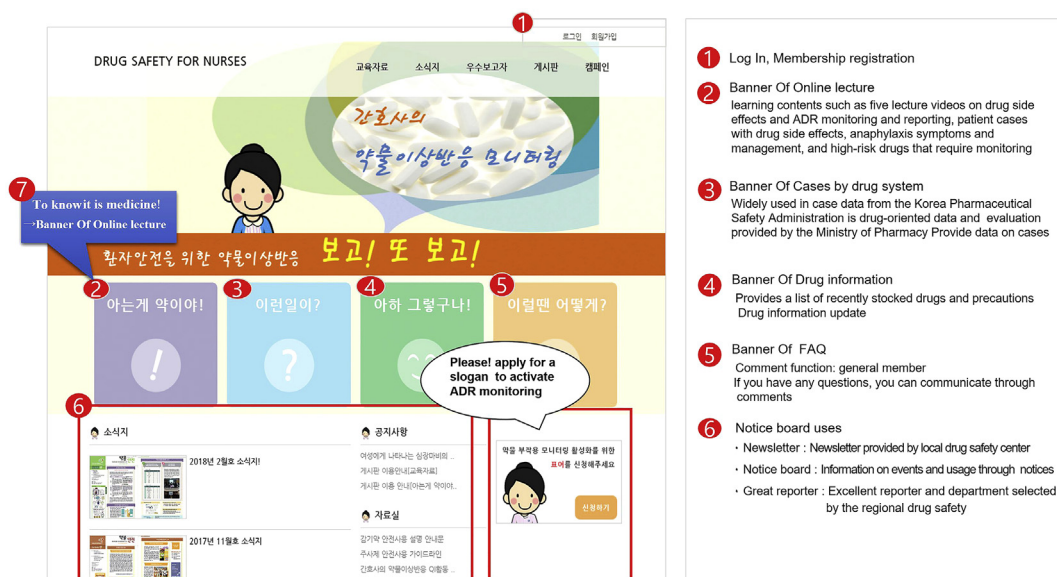


Figure 1. The first screen of website "Drug Safety for Nurses."

The two groups' pretest general characteristics, knowledge about ADR monitoring, self-efficacy, practice behavior, and medication performance ability were assessed prior to the intervention, using self-administered questionnaires. In the control group, a small notebook for nurse monitoring of ADRs was created and distributed, and a follow-up survey was conducted 2 weeks after the intervention. Based on previous literature showing that the period of transition to a behavioral change after individual learning was 2 weeks [22], the follow-up survey in this study was also conducted two weeks after completion of the 2 weeks learning access period. After that, learners were no longer allowed to access the website. The learners in the experimental group were able to access the website at any time, listen to lecture videos when needed, and browse materials at any time during a two-week period.

Data collection instrument

(1) Knowledge on ADRs

Questions related to the level of knowledge on ADRs were developed by a researcher with 6 years of experience in ADRs work at a local pharmacovigilance center and drug error management work in the Quality Improvement department. This tool consists of 20 questions with 1 point for a correct answer and 0 points for an incorrect answer, for a total of 20 points. This tool measured the CVI for each item from professional experts of 6 doctors and 4 nursing professors. Initially, there were 25 items, but 5 items with a S-CVI (scale-level content validity index) of .80 or less were removed through agreement with the experts. Item validity was in the range of .85–1.00, and the S-CVI was .94. The reliability of the KR-20 (Kuder-Richardson Formula 20) in this study was .60.

(2) Self-efficacy on ADR monitoring

The Korean version of the original tool developed by Sherer et al. [23] was used with the permission of the original author as an evaluation tool for the level of confidence in adapting to the ADR monitoring task. This tool consists of 10 questions on a 4-point

Likert scale (1–4 points), and each item has an S-CVI value ranging from .85 to .97. The higher the sum of each score, the higher the sense of self-efficacy. The validity was adequate, and the reliability of the tool was verified, with a Cronbach's α of .89.

(3) ADR monitoring practice

This tool developed by Kim and Lee [24] was used for the early detection of ADRs, establishment of rapid countermeasures and monitoring to prevent adverse reactions. It was developed based on the educational materials of the local pharmacovigilance center and consists of 10 questions such as checking and sharing patient information on ADRs, reporting adverse reactions, confirming drugs, and using the reporting system. This tool consists of a total 10 items on a 5-point Likert scale (1–5 points). A higher sum of each score indicates a higher sense of ADR monitoring practice. The reliability test in a Kim and Lee [24] study revealed a Cronbach's α of .86; that in the current study was .78.

(4) Medication performance ability related to ADR monitoring

The level of medication performance ability of the participants was examined using a tool modified by Kim and Lee [24] based on the perceived medication ability developed by Lee [25]. The tool consists of six questions related to understanding of the drug actions, necessary precautions, potential allergies, assessment of patient records, understanding the patient situation prior to and after administration, and drug education. On a 6-item, Likert-type 5-point scale (1–5 points), for each item, the higher was the score, the higher was the medication performance ability. Permission of the original author was obtained for use of this tool, which showed reliability through a Cronbach's α of .81.

Data analysis

The data were analyzed using IBM SPSS Statistics Software Version 21.0 (IBM, Armonk, NY, USA). General characteristics of the participants were analyzed as real numbers, percentages, and mean

Table 3 General Characteristics of Participants and Homogeneity Test for Dependent Variables ($N = 60$).

Variables	Categories	Exp (n = 30)	Cont. (n = 30)	χ^2 or t	p
		n (%) or M $\pm$ SD	n (%) or M $\pm$ SD		
Gender	Men	3(10.0)	0(0.0)	3.16	.237 ^b
	Women	27(90.0)	30(100.0)		
Age (years)		31.83 $\pm$ 6.68	30.87 $\pm$ 5.57	–0.59	.559
Education	College	6(20.0)	5(16.7)	0.51	.774 ^b
	Bachelor's	22(73.3)	24(80.0)		
	Master's	2(6.7)	1(3.3)		
Marital status	Married	10(33.0)	8(26.7)	0.32	.573
	Single	20(67.0)	22(73.3)		
Total clinical Experience (month)		99.10 $\pm$ 82.55	88.8 $\pm$ 71.81	0.54	.911
	12–<36	7(23.3)	9(30.0)		
	36 $\leq$ –<60	8(26.7)	6(20.0)		
	60 $\leq$ –<120	7(23.3)	7(23.3)		
Working department	≥ 120	8(26.7)	8(26.7)	0.33	.849
	Medical ward	14(46.7)	15(50.0)		
	Surgical ward	12(40.0)	10(33.3)		
	Others ^a	4(13.3)	5(16.7)		
Reporting experience	Yes	16(53.3)	21(70.0)	1.76	.184
	No	14(46.7)	9(30.0)		
Education experience	Yes	18(60.0)	22(73.3)	–1.20	.273
	No	12(40.0)	8(26.7)		
Knowledge		14.57 $\pm$ 2.42	14.00 $\pm$ 2.27	–0.94	.354
Self-efficacy		35.90 $\pm$ 4.31	37.27 $\pm$ 5.63	1.06	.296
Monitoring practice		32.83 $\pm$ 4.54	33.50 $\pm$ 4.29	0.58	.561
Medication performance ability		21.27 $\pm$ 3.15	20.60 $\pm$ 2.46	0.91	.365

Note. Cont. = control group; Exp. = experimental group; M = mean; SD = standard deviation.

^a Psychiatric ward, Emergency ward.

^b Fisher's exact test.

and standard deviations. The prior homogeneity of the two groups was verified by the Chi-square test, Fisher's exact and t tests, and the Kolmogorov–Smirnov test for normality, and the Levene's test for equality of variance. To verify the effect of the intervention, the differences prior to and after the intervention were identified between the experimental group and the control group by independent t test.

Ethical considerations

Ethics approval and consent to participate This study was Institutional Bioethics Committee (Approval no. HYUH 2017-06-014-002) of Hanyang University Hospital in Seoul, Korea. Prior to data collection, researchers explained to all respondents that all data acquired would not be used for other purposes than research, and respondents could refuse a survey at anytime. Participants in this survey provided their informed consent with written paper.

Results

Verification of the effectiveness of the website-based learning interventions

1) Homogeneity test of participant's general characteristics and variables

As a result of the analysis to verify the homogeneity of the general characteristics and dependent variables of the two groups, there was no statistically significant difference, and the two groups were homogeneous (Table 3). In this study, participants visited the website an average of 7.03 times, but mainly used learning content rather than commenting or posting, and mainly asked questions about how to use the program. This appears to be the result of the short mediation period and lack of publicity.

2) Effects of website-based learning on research-dependent variables

The difference in ADR knowledge score of 2.93 ± 2.80 in the experimental group was significantly higher than the 1.20 ± 1.92 found in the control group ($t = -2.80$, $p = .007$). The score difference of self-efficacy on ADR monitoring in the experimental group was 3.50 ± 4.99 points, which was significantly higher than the -0.13 ± 5.18 points of the control group ($t = -2.77$, $p = .008$). The difference in scores of monitoring ADRs in the experimental group (5.07 ± 6.28) was higher than the 1.27 ± 6.19 found in the control group, and the difference was statistically significant ($t = -2.36$, $p = .022$). The difference in post-pre scores of medication performance ability related to ADR monitoring in the experimental group was 1.93 ± 3.29 ,

Table 4 Comparison of Variables Between the Two Groups ($N = 60$).

Variables	Group	Pre	Post	Difference	t	p
		M $\pm$ SD	M $\pm$ SD	M $\pm$ SD		
Knowledge on ADR	Exp.(n = 30)	14.57 $\pm$ 2.42	17.50 $\pm$ 1.22	2.93 $\pm$ 2.80	–2.80	.007
	Cont.(n = 30)	14.00 $\pm$ 2.27	15.20 $\pm$ 1.85	1.20 $\pm$ 1.92		
Self-efficacy on ADR	Exp.(n = 30)	35.90 $\pm$ 4.30	39.40 $\pm$ 5.06	3.50 $\pm$ 4.99	–2.77	.008
	Cont.(n = 30)	37.27 $\pm$ 5.63	37.13 $\pm$ 6.70	–0.13 $\pm$ 5.18		
ADR monitoring practice	Exp.(n = 30)	32.83 $\pm$ 4.54	37.90 $\pm$ 5.36	5.07 $\pm$ 6.28	–2.36	.022
	Cont.(n = 30)	33.50 $\pm$ 4.30	34.77 $\pm$ 4.91	1.27 $\pm$ 6.19		
Medication performance ability	Exp.(n = 30)	21.27 $\pm$ 3.15	23.20 $\pm$ 3.33	1.93 $\pm$ 3.29	–1.67	.100
	Cont.(n = 30)	20.60 $\pm$ 2.46	21.13 $\pm$ 2.39	0.53 $\pm$ 3.19		

Note. ADR = adverse drug reaction; Cont. = control group; Exp. = experimental group; M = mean; SD = standard deviation.

which was higher than the 0.53 ± 3.19 evident in the control group, but the difference was not statistically significant ($t = -1.67$, $p = .100$) (Table 4).

Discussion

The current study developed website-based learning content to establish a culture of information sharing and two-way communication by focusing on the behavior change of voluntary ADR monitoring by nurses in busy clinical settings [15,16]. For two-way communication with learners, the researcher gave responses to the learners' questions after listening to video lectures or through FAQs and notice board banners. In addition, efforts were made to strengthen learners' motivation to learn by posting a slogan contest campaign and prize information. However, considering that there were few inquiries related to nursing practice other than lecture-related inquiries, it is believed that this was because the focus was on learning due to the limited study period of two weeks. It is necessary to analyze the contents of the question through long-term application in the future.

Whereas information about drugs was previously shared through e-mail, oral, and written media, it was possible in this study to implement a positive environment in which open discussion about drug-related knowledge and opinions can be achieved by using a website. A similar system was shown to be an effective means of communication [26,27] that avoids time and space restrictions through the design and development of learning content using a website.

In this study, the knowledge on ADRs was significantly increased in the experimental group than in the control group, which supports the result that seven out of 13 studies in a systematic literature review on the effect of web-based education were more effective than traditional face-to-face education [28]. However, there was no significant difference between two methods in five studies [28]. Therefore, it is necessary to consider when designing an educational method that variables such as participant characteristics and educational topics can affect the effectiveness of the educational method.

Self-efficacy on ADR monitoring showed a statistically significant increase in the scores of the experimental group compared with the control group. This result supports the finding that web-based self-learning significantly increased self-efficacy in ventilator management education compared with face-to-face training [29]. However, it is contrary to the finding that there was no significant difference in self-efficacy in web-based anticancer chemotherapy nursing education compared with face-to-face education [30]. Repeated and continuous efforts are required to increase self-efficacy in complex clinical settings [27,30]. Since the developed website-based learning content can be continuously updated and allows repeated review and learning, it is expected to be used for nursing education management in the future.

In the monitoring practice of ADRs, the experimental group showed a significantly greater difference in scores prior to and after the intervention than did the control group. This result, although a single group study design, partially support the finding that after receiving in-hospital education on ADR monitoring for hospital nurses, their knowledge and attitudes were significantly improved compared with prior to education, and there were 26 voluntary reports after 4 months [13]. But, in this study, there seems to be some difference in that it was measured as a questionnaire asking the will to change behavior toward practice rather than as a measurement of the reporting rate. Since some nurses and other medical staff are not aware of their duty to report ADRs, it is necessary to produce a network that can provide feedback and promote the necessity, purpose, and method of reporting with a wide range of customized educational activities [18]. Since a

structured format for ADR monitoring is required for a safe medication culture for nurses [31], it is necessary to continuously apply the website-based learning developed in this study to nurses in practice as a practical method.

In terms of medication performance ability related to ADRs, there was no statistically significant difference in the increased scores between the experimental and control groups prior to and after the intervention. It is thought that the evaluation could not be done generously because only six items were extensively asked about their medication nursing capacity, and the difference in responses could not be confirmed with a short study period.

The strength of this study is that it was intended to contribute to the creation of a safety culture in hospitals by developing website-based learning contents that allow repeated learning and interaction of the latest information and case-oriented education to activate ADR reporting by clinical nurses. In particular, the study is significant in that it confirmed the importance of voluntary ADR monitoring and reporting by clinical nurses by verifying the effect through the experimental design of randomized subject assignment. In addition, it has established an educational platform for clinical nurses, and it is also suggested to verify the effectiveness of ADR after educational application for nursing students in the future [32].

However, it also had some limitations. First, the study sample was small and involved participants from one university hospital in Korea. In addition, as a self-report questionnaire, there is a limitation that posttest measurement was performed 2 weeks after the intervention. In the future, it is necessary to verify the effect of the intervention through more objective measurement and to confirm whether the effect of the experiment lasts for a longer period of time. The second limitation was that the study period was short, but as a result of the activation of ADR monitoring and reporting, the actual number of self-reports of the participants could not be confirmed. In this study, participants visited the website an average of 7.03 times, but mainly used learning content rather than commenting or posting, and mainly asked questions about how to use the program. This appears to be the result of the short mediation period and lack of publicity. Finally, there is a limitation in that the number of ADR-related nursing behaviors or reports of participants in the study could not be actually measured. Third, there is a limitation in that the number of ADR-related monitoring or reports of the study participants was not actually measured, so it is necessary to confirm this in future studies.

Conclusion

The website content developed in this study included video lectures, case studies about ADRs, information on individual drugs, and FAQs about ADRs. In addition, various notice board functions were used to enable two-way communication such as sharing cases and providing feedback, providing drug safety information issued monthly by the local product safety center, and posting reports related to ADRs. Nurses who learned through the website significantly increased their knowledge of ADRs, self-efficacy, and monitoring practices compared with the control group. Sharing and communication through such an open website induces clinical nurses to practice monitoring for ADRs and activates voluntary reporting, leading to a safer medication culture in hospital settings.

Availability of data and material

The data sets generated and analyzed during the current study are not publicly available due to participant's privacy and decision of IRB but are available from the corresponding author on reasonable request.

Authors' contributions

HJK designed this study, performed data analysis, and drafted the manuscript. SYH designed this study, performed data collection, and drafted the manuscript. All the authors reviewed and approved the final version of the manuscript.

Conflict of interest

The authors have no conflict of interest to disclose.

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