Development of active learning materials and use of those materials to educate nursing students primarily in respiratory nursing and to train new nurses

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Abstract: The current study examined the effectiveness of using e-learning to teach respiratory nursing to students and provide continuing education to new nurses. An e-learning system was developed for pre-learning activities in combination with simulations. Ten new nurses were interviewed about nursing practices to identify learning tasks that were appropriate for new nurses. Based on those interviews, the current authors developed teaching materials for the core program. The e-learning system used was a web-based platform that conforms to global standards (TAO, Infosign Inc., Tokyo). The e-learning system was tested with students in their third and fourth years of nursing school at two universities in January and February of 2017. A follow-up indicated that third- and fourth-year nursing students who participated in clinical learning found the e-learning system (which was developed based on the experiences of new nurses) useful.

Keywords: active learning, e-learning, new nurse, nursing student, respiratory nursing

Clinical learning is essential to reach a stage where knowledge gained in the classroom can be put into practice (*1*). However, the skills acquired during practical training depend on the condition of patients and the nursing students themselves. The skills required of a new nurse depend on the role of the facility where the nurse will be working (*2*). The role differentiation of medical facilities presumably contributes to a discrepancy between the skills acquired in nursing school and the practical skills required of new nurses.

E-learning and simulation-based learning have been used in place of clinical learning to educate nursing students (*3,4*). Members of the nursing profession require continuing education, and they must think independently. This type of human resource development necessitates a shift from traditional classroom-based knowledge transfer to active learning, in which students identify problems and find solutions independently (*5-7*).

Goal-based scenarios are an instructional design theory consisting of the following seven elements: mission, cover story, role, learning goals, scenario operations, feedback, and resources (*8*). Although pre-learning usually takes place in lectures, combining goal-based scenarios with e-learning should improve the understanding of learners. In addition, the effectiveness

of an e-learning course can be evaluated by surveying learners regarding their level of interest, the relevance of content, and their level of confidence and satisfaction after completing the course (*9*).

From this perspective, the current study developed an e-learning system for nursing students in order to establish the clinical competencies required of new nurses. This study focused on the continuity of education in respiratory nursing for nursing students as they became new nurses and it evaluated the effectiveness of that education.

This study was conducted in two stages: *i*) an assessment of learning needs and development of e-learning materials, and *ii*) an assessment of the e-learning system's effectiveness.

First stage: Assessment of learning needs

Subjects

Subjects were 10 new nurses who had worked in one of four wards: internal medicine, surgery, internal medicine and surgery combined, or intensive care. The nurses worked in three large general hospitals in metropolitan areas, each with more than 500 beds. A new nurse was defined as a nurse with less than one year of experience.

Assessment

Between October 2015 and February 2016, semi-structured interviews were conducted with the ten new nurses regarding their observations, judgments, performance, and difficulties they experienced due to differences between their nursing school training and actual practice.

Development of the e-learning system

Qualitative data were obtained from transcripts of the recorded interviews. The disease-related specializations of the new nurses and situations in which they had experienced difficulties were noted. The seven elements of the goal-based scenario were identified based on their correspondence to the qualitative data.

Based on these elements, an e-learning system was developed in which a nursing student would play the role of a nurse. The Question and Test Interoperability/ Learning Tools Interoperability of TAO (Infosign Inc., Tokyo), a web-based testing system that complies with international standards, was used for this study.

Ethical considerations

This study was conducted in compliance with the ethical guidelines of the Japanese Ministry of Health, Labor, and Welfare for medical and health research involving human subjects. Approval was obtained from the Ethical Review Board of St. Luke's International Hospital (15-042) before conducting interviews.

Outcomes

Overview of nursing practice
Nine of the 10 new nurses were women. Most of the patients under the care of the new nurses had lung cancer. The remaining patients had pneumonia or pneumothorax. The new nurses worked together with senior nurses who were in charge of educating them. The new nurses had difficulties with several of the tasks, *e.g.* collecting all of the necessary information at one time, sputum suction, supporting patients with dyspnea, and clinically assessing patient results. Although they used viscous fluids to practice sputum suction in school, they still had difficulty performing sputum suction with real patients, as they had to synchronize their actions with the patients' cough reflex. New nurses were unable to interact properly with patients exhibiting dyspnea due to distress in those emergency situations.

Components of the e-learning system
The e-learning system included two scenarios: *i*) ambulatory support for patients after surgery for lung cancer, and *ii*) support for patients with chronic obstructive pulmonary disease (COPD) and dyspnea. Each program consisted of three parts: collection of information, provision of care, and reporting (Table 1).

In the lung cancer scenario, the mission of the new nurse was to provide ambulatory support for a

Table 1. Elements of the goal-based scenarios

A case of a patient after right lower lobectomy for lung cancer	
Scenario context	
Learner's mission	The learner is to provide proper care and report to the lead nurse to help treat the patient.
Cover story	The cover story is that the learner observes the patient and then reports to the lead nurse. At the beginning, the learner observes and evaluates the patient and predicts possible changes in the patient's condition. Then, the learner provides necessary care. Finally, the learner reports on the patient's condition and care to the lead nurse.
Learner's role	After receiving detailed information on the patient's surgery, the learner (A) observes and evaluates the patient, (B) provides care and evaluates the patient's condition, and (C) reports the care provided and the patient's condition to the lead nurse.
Learning goals	(1) Procedural knowledge Using what the learner has observed, judged, performed, and evaluated as information, the learner will be able to develop the skills to prepare a report that will facilitate the patient's treatment. (2) Declarative knowledge Based on a case of lung cancer, the learner will be able to understand postoperative complications and impacts of invasive surgery on the patient's body and learn how to manage drains. Based on a case of COPD, the learner will be able to understand hypoxemia and hypercapnia and learn how to assist the patient in performing pursed-lip breathing.
Scenario operations	To promote nursing practice, questions are prepared on (A) observation and evaluation, (B) care and evaluation, and (C) reporting. When the learner fails to give the correct answer, the correct answer is provided before the learner proceeds to the next section.
Scenario framework	
Feedback	The learner can receive feedback after answering each question. After completing all of the questions, the learner can watch a video that explains the two cases.
Resources	Information that serves as the basis for the answer is available whenever the learner wants it.

patient one day after surgery. The learning goals were to acquire the ability to observe patients to prevent postoperative complications and to provide necessary support. Learners were allowed to comment freely in their responses using the Situation, Background, Assessment, and Recommendations (SBAR) method.

The mission of the new nurse in the COPD scenario was to provide care to a patient complaining of dyspnea after walking to the bathroom. The learning goals were to acquire the ability to observe a patient with COPD and to provide the requisite support. Learners were allowed to comment freely using the SBAR method to answer questions for their report.

When the learner clicked on the answer button, the correct answer was displayed as feedback. A video explaining the two scenarios was viewed at the end of the program.

Second stage: Assessing the effectiveness of the e-learning system

Subjects

Subjects were third- and fourth-year nursing students from two schools.

Assessment

Assessment was performed in January and February of 2017. Subjects were asked to use the e-learning system and fill out a follow-up questionnaire, which was generated using TAO. The questionnaire was used to evaluate interest, relevance, confidence, and satisfaction on a four-point scale and also included an open-ended question about the e-learning system.

Methods of analysis

Descriptive statistics were calculated based on the answers to questions about the e-learning materials, and the responses to the open-ended question were analyzed qualitatively.

Ethical considerations

The study was conducted in compliance with the ethical guidelines of the Japanese Ministry of Health, Labor, and Welfare for medical and health research involving human subjects. Approval was obtained from the Ethical Review Boards of the National Center for Global Health and Medicine (NCGM-G-002354-00) and Nagoya City University (172026-2) before this stage of the study.

Outcomes

Overview of the subjects

Responses from 43 nursing students who answered two or more of the questions were analyzed. All but one of the students were using the e-learning system for the first time. Of the 33 respondents, 27 (82%) were female students. Eighteen (56%) of thirty-two respondents were fourth-year students.

Ambulatory support for patients after surgery for lung cancer
When asked about the most common complications observed one day after surgery, 21% (9/43) of the nursing students responded correctly. Fifty-three percent (20/38) provided the correct answer regarding methods of identifying subcutaneous emphysema. Sixty-five percent (24/37) correctly identified the location of the fourth rib on the midclavicular line for auscultation. The location of the spinous process on the back of the seventh cervical vertebra was correctly identified by 73% (21/35) of the nursing students. Eight-one percent (35/43) of the nursing students responded to questions about the provision of care was 81% (35/43), and the correct answer rate was 60% (21/35). Forty percent (17/43) of the nursing students responded to questions about reporting, and 82% (14/17) of the correct answers were based on the SBAR method.

Support for patients with COPD and dyspnea
Seventy-seven percent (33/43) of the nursing students responded to questions in the section on information collection. The correct answer rate for causes of dyspnea was 76% (25/33). Twenty-four percent (8/33) of the nursing students correctly identified the causes of hypoxemia and hypercapnia. Nine percent (3/34) answered correctly regarding methods of identification. Seventy-nine percent (34/43) of the nursing students responded to the section on providing, and 79% (27/34) of the respondents answered correctly. Forty-four (19/43) of the nursing students responded to the section on reporting, and 79% (15/19) of the answers were based on the SBAR method.

Motivation to learn using the e-learning system
Questions regarding interest, relevance, confidence, and satisfaction had a response rate of 76% (33/43). Responses were rated on a four-point scale. The mean score for interest, or avoiding boredom, was 3.3. The mean score for relevance was 3.1. The mean score for confidence was 2.1 and that for satisfaction was 1.5.

Comments in the open-ended answer portion included the following: "The materials allowed learners to more fully understand what they had previously understood superficially" and "It would be nice if there were scenarios for other diseases." Students learned that information should be collected with a purpose.

The necessity of a learning program that encourages continuous learning

The students had not practiced the nursing techniques required for new nurses in a clinical setting. Many of the new nurses had not cared for patients with lung cancer or COPD as nursing students, and they had never practiced suction. Even in Japan, where lung cancer and pneumonia are the leading causes of death (*10*), nursing students having difficulty acquiring the requisite skills to become professional nurses through practical training.

Suction is an essential technique for regulating breathing, but the resulting damage to the airway mucosa and coughing are painful for the patient. Synchronizing the patient's coughing with the timing of aspiration allows the patient to be aspirated painlessly. However, new nurses are forced to learn techniques that may require patient cooperation in the field. This indicates that new nurses lack certain skills, and this can lead to patient harm (*11*). While aspiration skills are important for new nurses in respiratory facilities, different skills are required for nurses who begin employment in other types of facilities. Based on these facts, the specific clinical skills that will be required of new nurses in different facilities need to be considered. Creating tailored programs with the most appropriate learning tasks for nursing students will help them respond to changes in medicine and the workplace and facilitate reemployment.

Providing learners with opportunities for safe and repeated training through e-learning

The combination of pre-learning in nursing school, the freedom of e-learning, and repeated on-site care training will contribute to the development of knowledge, critical thinking, and problem-solving skills in the nursing profession. Nursing students who use Information and Communication Technology (ICT) are reported to have a stronger sense of self-efficacy than nurses (*12*). Incorporating ICT into primary nursing education and its use after graduation will showcase the strengths of nursing students. Self-managed e-learning is also more effective than being taught by others (*13,14*).

The results of the current study highlight the need for repeated learning opportunities in realistic situations, which will enable new nurses to practice in a clinical setting without experiencing anxiety. This is evinced by higher rates of anxiety and restlessness after nurses care for patients, so they benefit more by learning in a simulator (*15*). Therefore, learners need to be given the opportunity to learn repeatedly and safely via e-learning, and care-based training needs to be combined with improved reproducibility in the field.

Limitations and challenges for the future

E-learning and evaluations were performed only in the context of pre-learning in this study. In the future, simulation-based learning for nursing students will need to be investigated and changes in the practical skills of new nurses will need to be assessed. The opportunity to learn repeatedly and safely through e-learning must be available to learners.

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