A Comparison of Learning Effectiveness of Confusion Assessment Method-Intensive Care Unit (CAM-ICU) in Clinical Practice for Nursing Staffs between E-Learning and Conventional Face-to-Face

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Objective: *To investigate the learning effectiveness of CAM-ICU between e-learning and face-to-face lecture among nurses.*
Material and Method: *A prospective randomized controlled non-inferiority study was conducted. Nurses were randomly assigned to receive CAM-ICU training either through a face-to-face lecture or e-learning. Post-tests comprising three standardized patients were conducted after the course, and the pass rates compared between the two groups. Learner satisfaction and examiners comments were collected and analyzed.*
Results: *Of the 186 participants originally enrolled, 177 participants completed the analysis (91 in face-to-face group and 86 in e-learning group). No statistically significant difference in baseline characteristics was found between the two groups. The overall pass rate was higher in e-learning group compared to face-to-face group (50.0% vs. 42.9%, p = 0.34). Learner satisfaction was generally higher in the face-to-face lecture group. Participants mostly had difficulties with the flow of assessment, the Richmond Agitation and Sedation Scale (RAAS) and the assessment of disorganized thinking.*
Conclusion: *The overall pass rates were comparable between the e-learning and face-to-face lecture groups. Despite the lower-than-expected pass rate, e-learning is potentially a scalable way to deliver training. The authors believe that CAM-ICU e-learning is worthy of continued development before the real large-scale implementation in a university hospital.*

Keywords: *Delirium, Confusion assessment method-intensive care unit (CAM-ICU), E-learning*

Delirium is an acute and fluctuating disturbance of consciousness characterized by reduced attention, impaired cognition and perception, usually resulting from general physical conditions[1]. This condition contributes to longer hospital length of stay, increased mortality, increased healthcare costs, and long-term cognitive and functional impairment[2-4]. In spite of the high prevalence and deleterious effects of delirium, the condition tends to be under recognized[5]. Delirium can be categorized into hyperactive, hypoactive and mixed form[5]. The mixed and hypoactive forms are the most common, and are often undiagnosed if routine monitoring is not implemented[6].

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Over the years various instruments were developed to assess various aspects of delirium, with the Diagnostic and Statistical Manual (DSM)-V being a standard criteria for delirium diagnosis. Although considered as a diagnostic standard, DSM criterion usually requires a psychiatric expert diagnosis and thus, lacks reliability and reproducibility in daily clinical practice[7]. Among various diagnostic tools, Confusion Assessment Method-Intensive Care Unit (CAM-ICU) is relatively easy to use with commensurate reliability and validity. It has been tested in various studies to be user-friendly and have a high sensitivity and specificity. This tool has been translated into 10 different languages including Thai and is recommended as a gold standard for delirium diagnosis in the PAD (pain, agitation and delirium) guideline for intensive care unit (ICU) patients[8,9]. Moreover, a few researches have also demonstrated the use of CAM-ICU in the non-ICU settings[10].

Systematic reviews evaluating the effectiveness of educational interventions to prevent delirium have found that the combined use of predisposing, enabling and reinforcing strategies are the most effective in producing changes in staff performance and improving patient outcomes[11]. E-learning serves as an attractive alternative teaching approach, as it is more flexible, time-efficient and cost-effective. A meta-analysis by Cook et al[12] has shown that the implementation of e-learning successfully improved healthcare worker's knowledge. More specifically, the use of e-learning appeared to have a positive effect on healthcare workers' recognition and knowledge of delirium. However, studies comparing e-learning to conventional didactic teaching methods for learning effectiveness of CAM-ICU have not been existed.

In view of the strategic position of the nurses as the first line of patient care, proper training of nurses can make a tremendous impact in early delirium detection[13]. In large organizations with high employee turnover rate, an implementation of an appropriate organizational training method is of utmost importance[14]. On the ground that e-learning proves to be a time efficient, flexible and convenient training method, it might be preferable to the traditional lecture.

This study was conducted to compare the learning effectiveness of CAM-ICU between e-learning and conventional face-to-face lecture. Furthermore, the authors examined the learner satisfaction between two different teaching methods and sought to identify the causes of inaccurate assessment. The result of this study would provide useful information before the actual implementation of CAM-ICU learning in the authors' hospital.

Material and Method

This prospective randomized controlled non-inferiority study was conducted after the approval by the Institutional Review Board (Si 527/2015). Written informed consent was obtained from all participants. Nursing staffs from the private wards and general wards were invited to participate in this study. Participants were excluded from this study if they met any of the following criteria: previous exposure to CAM-ICU, inability to complete the training courses, and the inability to complete the required three simulated patients' scenarios. All participants were also required to sign an agreement prohibiting disclosure of information to other group. Nursing staffs were then randomized into two groups; face-to-face lecture group and e-learning group. Based on the assumption that

nursing staffs from different units have varying baseline knowledge and experience with delirious patients, stratified block randomization was further used to reduce data variance. To minimize contamination bias, nursing staffs from the same wards were allocated to the same group. Furthermore, participants were also required to sign an agreement prohibiting disclosure of information to other group.

The e-learning course was developed by the hospital's medical education technology center under close supervision of intensivists who already received an inter-rater reliability assessment. Participants received an access through the hospital's intranet Wi-Fi where they were presented with a 90-minute delirium online course. The course focused on the definition, types, incidence, risk factors, and impact of delirium in conjunction with the use of CAM-ICU. Video clips demonstrating CAM-ICU application on real patients were also incorporated. In addition, practice exercise was also available towards the end of the session. On the other hand, the face-to-face learning sessions were conducted by an intensivist who is an expert on the subject matter. Each session lasted for 90 minutes, and the content was kept identical to the e-learning course. The sessions also contained the same video clips and practice exercise. Questionnaires on learner satisfaction were distributed to the participants' right after the session, both in e-learning course and face-to-face groups.

Upon completion of the course, the test was subsequently scheduled after two weeks. Participants were required to take a post-test consisting of three standardized patients. As this assessment was designed to test the participants' understanding rather than memory, CAM-ICU assessment algorithm was provided during the tests. The algorithm starts with assessing level of consciousness using the Richmond Agitation and Sedation Scale (RASS) then the content of consciousness which comprises of acute change or fluctuating course of mental status (feature 1), inattention (feature 2), altered level of consciousness (feature 3) and disorganized thinking (feature 4). Considering the possibility that a correct answer might be by chance, a passing criterion is the correct delirium assessment of all three standardized patients. To ensure data reliability and validity, all examiners were doctors and nurses who are experts in CAM-ICU. The content of the exam was developed and validated by a delirium expert panel to ensure the consistency with real clinical practice. The examiners were blinded to the group assignment, as each participant was assigned a code

unique to that individual.

Statistical analysis

The authors used non-inferiority trial based on the hypothesis that e-learning group was almost as effective as face-to-face group. The sample size calculation was based on the clinical observation among the surgical intensive care nurses. Following the lecture given by the translator and validator of the Thai CAM-ICU, the pass rate among the surgical intensive care nurses was approximately 95%. Considering a 1-sided type 1 error of 0.05, a statistical power of 80% and a non-inferiority margin of 5%, the sample size was at least 86 participants in each group.

Continuous data were reported as means and standard deviation (or median and minimum and maximum as appropriate), while categorical data were reported as frequencies and percentages. Comparisons between the groups were performed with Independent t-test, Mann-Whitney U test, Chi-square test or Fisher's exact test as appropriate. A p-value 0.05 was considered statistically significant. The Cronbach's alpha was used to measure the internal consistency of the questionnaire. Statistical analysis was performed using PASW Statistics for Windows, version 18.0 Chicago: SPSS, Inc.

Results

Of the 186 participants originally enrolled, 177 participants completed the analysis (91 in face-to-face group and 86 in e-learning group). Two participants were initially excluded because of decline to participate. Two and five participants in the face-to-face group and the e-learning group absent for the test (Fig. 1).

Baseline characteristics of the participants including age, gender, service unit (general or private ward), working experience and previous experiences with delirious patients were presented in Table 1. No statistically significant difference in baseline characteristics was found between the two groups.

The overall pass rate (correct all scenarios) was not statistically significant different between the two groups, however, the e-learning group showed slightly higher percentage (50% vs. 43%, $p = 0.34$)
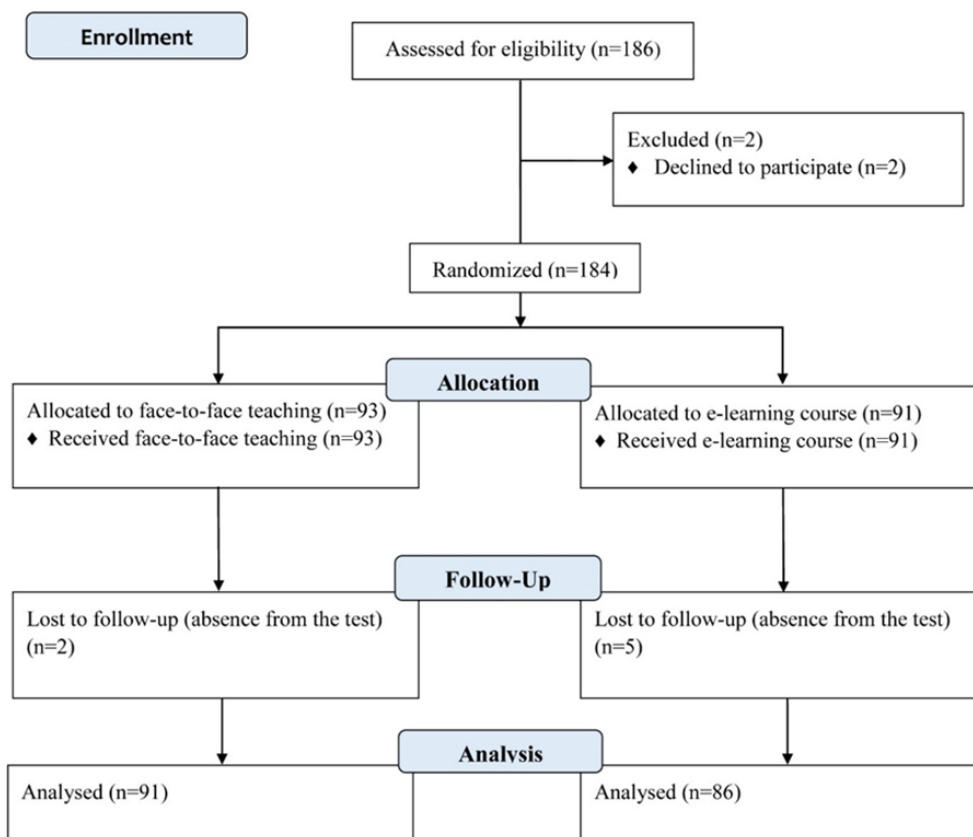

Fig. 1 Consort flow.

Table 1. Demographic data

Variables	Face-to-face (n = 91)	E-learning (n = 86)	p-value
Age (years)	30.7±9.1	32.0±8.9	0.21
Female gender	90 (98.9)	85 (98.8)	0.97
Service unit			0.34
General ward	68 (74.7)	54 (62.8)	
Private ward	23 (25.3)	32 (37.2)	
Working experience (years)	8.2±9.0	9.0±8.8	0.30
Previous experience in taking care delirious patients: Yes	86 (94.5)	78 (90.7)	0.84

Data presented as mean±SD or number (%)

Table 2. Data of nurses who passed the test

	Face-to-face (n = 91)	E-learning (n = 86)	p-value
Overall	39 (42.9)	43 (50.0)	0.34
Scenario 1	72 (79.1)	75 (87.2)	0.15
Scenario 2	68 (74.7)	60 (69.8)	0.37
Scenario 3	54 (59.3)	63 (73.3)	0.06

Data presented as number (%)

Table 3. Students' view points toward two teaching methods

Questions	Face to face (n = 91)	e-learning (n = 86)	p-value
1. Teaching publicity and level of convenience to participate	3.8±0.8	3.7±0.8	0.24
2. Clarity of teaching objectives	4.2±0.6	3.9±0.6	<0.01
3. Suitability of teaching method	4.2±0.7	3.8±0.7	<0.01
4. Knowledge received after the course	4.3±0.6	3.9±0.7	<0.01
5. Competency of academic staffs	4.5±0.6	3.9±0.6	<0.01
6. Difficulty of subject description	3.9±0.8	3.8±0.7	0.64
7. Suitability of learning media/equipment	3.9±0.7	3.7±0.7	0.02
8. Suitability of timing	4.1±0.7	3.8±0.7	<0.01
9. Opportunity to clarify questions	4.3±0.6	3.0±1.1	<0.01
10. Potential future application of knowledge	4.3±0.6	3.9±0.8	<0.01
11. This teaching method should be continued in the future	4.4±0.6	3.9±0.8	<0.01
12. Overall satisfaction	4.3±0.6	3.8±0.8	<0.01

Data presented as mean ± SD

(Table 2). An individual analysis of each scenario showed that the pass rates for the face-to-face group were 79.1%, 74.7% and 59.3% for scenario 1, 2, and 3 respectively. On the contrary, the pass rates for the e-learning group were 87.2%, 69.8% and 73.3%, correspondingly.

Learner satisfaction was assessed with questionnaires consisting of 12 questions as shown in Table 3. The Cronbach's alpha of the questionnaire was 0.93. Participants were asked to rate each component of the course on a 5-Likert scale.

The examiners identified some of the causes of the participant' incapability of delirium assessment. Firstly, some participants misunderstood the flow of the assessment, for instance, the lack of feature 1 (acute onset and fluctuating course of mental status) and feature 2 (inattention) in the presence of feature 3 (altered level of consciousness) and 4 (disorganized

thinking) was already perceived as CAM-ICU positive. Some participants would only consider CAM-ICU to be positive in the presence of all four components. Some participants also failed to understand the concept of delirium assessment, neglecting the CAM-ICU algorithm upon seeing agitated patients. In addition, some participants struggled with the RAAS assessment and the assessment of disorganized thinking (feature 4).

Discussion

This study investigated the learning effectiveness of CAM-ICU between e-learning and conventional face-to-face lecture. The primary outcome measured was the pass rate between the two groups. Although non-statistically significant, the overall pass rate was higher in the e-learning group compared to the face-to-face lecture group. However, the pass rate was significantly lower than that from the preceding clinical implementation. This might be explained by the different population group being studied. The preceding clinical implementation involved the ICU nurses who received frequent bedside demonstration of CAM-ICU assessment and lecture from the intensivists trained for inter-rater reliability assessment prior to the outcome measurement. This is consistent with previous studies[15,16] which found that the sensitivity and specificity of CAM-ICU was reduced to approximately 50% in routine clinical practice.

It is noteworthy that the pass rate for scenario 3 was significantly higher in the e-learning group compared to the face-to-face lecture group. According to the delirium expert panel who designed the content of the test, the complexity of the questions proceeds from scenario 1, 2 and 3 in an ascending manner. The result of an individual analysis of the pass rates for each question was therefore deemed logical in the face-to-face group, with the highest pass rates being for scenario 1 then 2 and 3 respectively. However, the results for the e-learning group was rather conflicting, with a higher pass rate for scenario 3 compared to 2. The reason for this was unclear, and it is difficult to generalize that e-learning is associated with a more effective complex learning process.

The results from the student satisfaction questionnaires showed that the face-to-face lecture received a higher rating in all components, most remarkably regarding the opportunities to clarify questions. However, the causes of lower ratings in e-learning were not intensively explored in this study. A meta-analysis by Sun PC et al[17] summarized 6 dimensions that contribute to a successful e-learning, namely learner dimension, instructor dimension, course dimension, technology dimension, design dimension and environmental dimension. The study pointed out some factors that might influence e-learning dissatisfaction, for example computer anxiety, technology and internet quality, student-to-instructor communication. Although this is beyond the scope of this study, an extensive exploration into this is crucial to the development of effective and successful e-learning.

To the author's knowledge, no existing literature compares the learning effectiveness of CAM-ICU between e-learning and face-to-face lecture. However, many studies in the past were able to demonstrate that e-learning was superior to the face-to-face lecture, both in terms of knowledge acquisition[18] and student satisfaction[19]. There are also some studies that found no significant difference in student performance in the e-learning versus the lecture group[20,21], in which they argued that the differences in the e-learning design can affect learning effectiveness. Nonetheless, the aforementioned studies still advocated to e-learning integration due to its many promising benefits.

This study has a number of strengths, including a large sample size, and an objective and practical outcome measurement. Various tools have been used to assess the efficacy of e-learning including multiple choice questions, short essay questions and standardized patients. In this context, however, the use of standardized patients might be perceived as the most practical method as it most parallels real clinical situation, and is described as a "gold standard" to test health professionals competency[22].

However, this study is not without limitations. Firstly, the pass rate was assumed to be much higher during the sample size calculation. The disparity between the preceding clinical implementation and this study was previously discussed. Moreover, due to a schedule constraint, it was unable to conduct a more recent test window. Therefore, the confounding effects of retention of knowledge might be questionable. It might be possible that some participants did not revise before the test, consequently leading to an exam failure. Last but not least, this study only investigates the short term knowledge acquisition. Whether this translates into a sustained clinical behavior change and better patient outcome needs further scrutiny.

Nonetheless, this study has several important implications for future research and improvement

concerning e-learning of CAM-ICU. Firstly, the examiners identified that some participants were confused with the CAM-ICU assessment algorithm. A more simplified version might be developed for future use. Furthermore, some participants struggled with the Richmond Agitation and Sedation Scale (RAAS) assessment which is the outset of the CAM-ICU assessment algorithm, leading to subsequent misidentification. Upon revision of the content outlines, RAAS assessment was not emphasized enough both in the e-learning and the conventional face-to-face lecture. In addition, there were some nurses had difficulty with assessment of disorganized thinking, the forth step of CAM-ICU assessment tool. Although CAM-ICU has been considered a relatively easy tool to assess delirium, a better approach to learning such as an integration of e-learning with traditional face-to-face teaching might be more suitable[23]. Another study suggests that the four steps to skill acquisition should include "demonstration of the skill, repeat demonstration with dialogue, repeat demonstration guided by one of the learners and repeat demonstration by the learner"[24]. The preceding clinical implication also implies that bedside teaching leads to a higher learning effectiveness. Furthermore, in the e-learning group, participants reported a lower rating concerning the "sufficiency of opportunities to clarify questions". This can be further improved by an implementation of an improved online student-instructor interaction such as through e-mail or a shared online forum. A study by Rovai et al has suggested the use of an online discussion forum indeed improved student participation and promotes a "sense of community"[25]. Most importantly, our e-learning vignette may potentially serve as a learning tool that can be used nationwide.

Conclusion

E-learning demonstrated a higher pass rate in CAM-ICU learning compared with the conventional face-to-face lecture. Despite a lower-than-expected passing rate, e-learning is potentially a scalable way to deliver training. It boasts the advantages of being more accessible, self-paced and cost-effective. For these reasons, the authors believe that CAM-ICU e-learning is worthy of continued development before the real large-scale implementation in the authors' institution.

What is already known on this topic?

Delirium is poorly understood among healthcare providers and is often under recognized.

One of the key aspects in the healthcare professional's performance is an ongoing education program. Delirium teaching is particularly important among nurses, who represent the first lines of patient care. E-learning has proven to be effective in several settings including a cardiopulmonary resuscitation (CPR) training.

What this study adds?

This study was able to illustrate that e-learning had a similar overall pass rate compared to the face-to-face lecture approach. In spite of the low passing rate, the benefits of e-learning are well documented in terms of its increased accessibility, cost-effectiveness, learner flexibility and interactivity. Further investment in e-learning development based on the feedback received in the course of this study is therefore valuable.

Potential conflicts of interest

None.

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การเปรียบเทียบประสิทธิภาพของการเรียนการสอน Confusion Assessment Method-ICU (CAM-ICU) ในพยาบาลโดยการเรียน
ผ่านสื่ออิเล็กทรอนิกส์กับการเรียนการสอนโดยครูผู้สอน

ภาวิณี ปางทิพย์อำไพ, พัชรียา นิวัฒน์ภูมินทร์, รัตนาภรณ์ ตันกูล, ภูริวัส โตอดิเทพย์, ชรัสนิกูล ยิ้มบุญณะ, จันทนา นามเทพ,
อรอุมา ชัยวัฒน์

วัตถุประสงค์: เพื่อเปรียบเทียบประสิทธิภาพของการเรียนการสอน CAM-ICU ในพยาบาลระหว่างการเรียนผ่านสื่ออิเล็กทรอนิกส์และการเรียน
จากครูผู้สอน

วัสดุและวิธีการ: เป็นการศึกษาวิจัยเชิงทดลองแบบสุ่มชนิดไม่ด้อยกว่าพยาบาลถูกแบ่งแบบสุ่มให้เรียน CAM-ICU โดยการเรียนผ่านสื่ออิเล็กทรอนิกส์
หรือเรียนจากครูผู้สอนและถูกทดสอบโดยผู้ป่วยมาตรฐาน จำนวน 3 สถานการณ์เมื่อสิ้นสุดการเรียน ทำการเปรียบเทียบผลการสอบผ่านของทั้งสองกลุ่ม
บันทึกและวิเคราะห์ความพึงพอใจของผู้เรียนและข้อคิดเห็นของกรรมการสอบ

ผลการศึกษา: จากพยาบาล 186 คนที่เชิญให้เข้าร่วมการวิจัย มี 177 คน ที่เข้าร่วมจนสิ้นสุดการวิจัย (กลุ่มที่เรียนกับ ครูผู้สอน 91 คน และกลุ่ม
ที่เรียนกับสื่ออิเล็กทรอนิกส์ 86 คน) ไม่พบมีความแตกต่างของข้อมูลพื้นฐานระหว่างทั้งสองกลุ่ม พบว่าอัตราการสอบผ่านของกลุ่มที่เรียนกับ
สื่ออิเล็กทรอนิกส์สูงกว่ากลุ่มที่เรียนกับครู (ร้อยละ 50.0 เปรียบเทียบกับ ร้อยละ 42.9, p = 0.34) กลุ่มที่เรียนกับครูผู้สอนให้คะแนนความพึงพอใจ
ต่อการเรียนมากกว่า กลุ่มที่เรียนกับสื่ออิเล็กทรอนิกส์ พบว่าผู้เข้าร่วมวิจัยส่วนใหญ่ไม่เข้าใจขั้นตอนของการประเมิน CAM-ICU, การประเมินระดับ
ความรู้สึกตัวโดยใช้ Richmond Agitation and Sedation Scale (RAAS) และการประเมินเรื่องความคิดไม่เป็นระบบ

สรุป: การเรียนการสอนผ่านสื่ออิเล็กทรอนิกส์ ทำให้ผู้เรียนสามารถสอบผ่านการใช้ CAM-ICU ได้ไม่ด้อยกว่าการเรียนกับครูผู้สอน แม้ว่าผลการสอบผ่าน
จะต่ำกว่าที่คาดไว้ แต่เป็นวิธีที่นำไปปรับใช้ได้ คณะผู้นิพนธ์เชื่อว่าวิธีการสอนผ่านสื่ออิเล็กทรอนิกส์ได้ประโยชน์ในแง่ความสะดวก ประหยัดเวลา
และค่าใช้จ่ายในอนาคต โดยเฉพาะเมื่อนำไปพัฒนาใช้กับโรงพยาบาลขนาดใหญ่ เช่น โรงพยาบาลมหาวิทยาลัย