Supplementary Materials

Supplementary Tables S1–S6: Supporting Materials for the Development and Validation of the ICU Pain Management E-Learning Module

Related to:
Almutairi, A. M. F., & Said, F. M. (2026). Delphi validation of a pain management e-learning module for critical care nurses in Saudi Arabia. *Nurse Media Journal of Nursing, 16*(1), 152–167. https://doi.org/10.14710/nmjn.v16i1.81024

Supplementary Table S1. Detailed methodology of the literature review used to generate the initial e-learning module content

Component	Description
Review Approach	A focused systematic literature review conducted in accordance with PRISMA guidelines (Page et al., 2021) to identify evidence on the effects of pain management programs on the competency of critical care nurses.
Research Question (PICO)	Population: Critical care nurses; Intervention: Pain management programs; Comparison: Not restricted; Outcome: Competency (knowledge, skills, proficiency).
Databases Searched	PubMed, CINAHL, EMBASE, Cochrane Library, and PsycINFO.
Search Timeframe	Studies published between 2017 and 2024.
Search Terms and Strategy	Search strings were developed using PICO elements and Boolean operators. Population terms included “critical care nurses”, “ICU nurses”, and “intensive care nurses”. Intervention terms included “pain management programme”, “pain management”, and “pain management protocols”. Outcome terms included “competency”, “knowledge”, and “proficiency”. Population, intervention, and outcome terms were combined using AND, while synonyms were combined using OR.
Eligibility Criteria (Inclusion)	Empirical studies with no restriction on design; studies involving nurses or critical care nurses; publications in English; studies published between 2017 and 2024.
Eligibility Criteria (Exclusion)	Editorials, opinion papers, and other non-empirical publications; studies involving healthcare professionals other than nurses; publications in languages other than English; studies published before 2017.
Screening Process	The search yielded 1021 studies. After removing 602 duplicates, 419 titles and abstracts were screened. 369 studies were excluded at this stage. 50 studies were sought for retrieval, but 26 could not be retrieved. 24 full-text articles were assessed for eligibility, with 9 excluded for not meeting inclusion criteria.
Studies Included	15 studies were included in the final review (14 quasi-experimental studies and 1 systematic review).
Quality Appraisal	Methodological quality was assessed using the Joanna Briggs Institute (JBI) critical appraisal tools for quasi-experimental studies and systematic reviews.
Data Extraction	Data were extracted using a structured extraction form including author, year, country, study aim, design, sample characteristics, data collection methods, and main findings.
Evidence Synthesis	Findings were synthesized using narrative synthesis, allowing comparison of study characteristics, identification of patterns, and interpretation of how interventions influenced nurses’ competency.
Use of Evidence for Module Development	Evidence from the included studies informed the initial pool of 25 content items covering key competencies in ICU pain assessment, pharmacological and non-pharmacological pain management, monitoring, and clinical decision-making. These items formed the preliminary content evaluated in the Delphi consensus process.

Supplementary Table S2. Characteristics of studies included in the literature review informing the development of the ICU pain management e-learning module

No	Author & Publication Year	Country	Aim	Design	Sample	Data Collection Methods	Main Findings
1.	Issa et al. (2019)	Saudi Arabia	To evaluate the impact of pain management educational program on the knowledge and attitudes of intensive care unit (ICU) staff nurses toward pain assessment and management.	A quasi-experimental study	181 participants	Self -reporting questionnaire tool	Knowledge and attitudes of nurses were improved through an educational program
2.	Issa et al. (2021)	Saudi Arabia	To investigate the mediating effect of model-based learning on nurses' attitudes toward nurses' pain management awareness during the COVID 19 pandemic in Saudi Arabia government hospitals.	A quasi-experimental study	330 nurses	Self -administered questionnaires	Nurses' attitudes about pain management were improved.
3.	Innab et al. (2022)	Saudi Arabia	To evaluate the effectiveness of a structured education program on nurses' knowledge and attitudes towards pain management.	A quasi-experimental study	124 nurses	Knowledge and attitudes survey regarding pain, satisfaction with and self-confidence in learning, and the learning self-efficacy scale for clinical competency.	Nurses' knowledge and attitudes post-intervention improved in terms of understanding the significance of assessing sedation for patients under pain management using opioids.
4.	Salim et al. (2020)	United Arab Emirates	To assess the effect of the nursing in-service education program on nurses' knowledge and attitudes concerning pain management in one of the governmental hospitals in Dubai, United Arab Emirates	Quasi-experimental design	200 nurses	Structured questionnaire	Educational programs on pain management are effective in improving the competencies of nurses
5.	Olawale et al. (2020)	Nigeria	To determine the effectiveness of a teaching Programme on the knowledge of postoperative pain management among nurses in the adult surgical ward of Lagos University Teaching Hospital, Nigeria.	Quasi-experimental design	60 nurses	Knowledge and Attitudes Survey Regarding Pain (KASRP)	The findings showed positive impacts of a pain educational program on nurse competencies in pain management.
6.	Siddiqui et al. (2024)	Pakistan	To assess the impact of a newly developed educational course in terms of improvement in post-test scores in clinical competency assessment of patients with patient-controlled intravenous analgesia (PCIA) and epidural analgesia	Quasi-experimental design	86 nurses	Structured questionnaires	An educational program improved nurses' competency of pain assessment
7.	Ozawa et al. (2022)	Japan	Examined the effectiveness of the e-learning pain management program on nurses' knowledge and skill acquisition of selected pain scales.	Quasi-experimental design	115 nurses	Structured questionnaire	The program enhanced nurses' competencies in the management of neonatal pain.

No	Author & Publication Year	Country	Aim	Design	Sample	Data Collection Methods	Main Findings
8.	Mala et al. (2024)	Thailand	To evaluate the impact of an educational program to increase nurses' and midwives' competence in neonatal pain management in Thai neonatal intensive and special care units (NI/SCUs)	Quasi-experimental design	68 nurses	Self-reported questionnaires	Knowledge, attitudes, and nurse-perceived self-competence improved at the end of the program
9.	Narbona et al. (2020)	Spain	To assess knowledge on pain assessment in nurses following an online training course.	A quasi-experimental study	401 nurses	PAINAD-Sp_Hosp scale	There was improved knowledge of nurses about the categories of assessing pain levels among patients who cannot communicate their pain Experiences
10.	Grommi et al. (2023)	Finland	To reveal how pain education interventions affect registered nurses' pain management.	Systematic review	23 studies	NA	Educational interventions improved the ability of the nurses to document, assess, and reassess pain in patients
11.	Germossa et al. (2018)	Ethiopia	To investigate the influence of an in-service educational program on nurses' knowledge and attitudes regarding pain management in an Ethiopian university hospital.	A quasi-experimental study	111 nurses	Knowledge and Attitudes Survey Regarding Pain (KASRP)	There was an improvement in nurses' knowledge and attitudes about managing pain in patients following their engagement in the educational program.
12.	El-Aqoul et al. (2020)	Jordan.	Evaluated the knowledge and attitudes of nurses and how these aspects were impacted by engaging the nurses in a pain educational program	A quantitative, experimental design	150 nurses	Knowledge and Attitudes Survey Regarding Pain questionnaire.	Improvement in knowledge and attitudes were reported by the nurses after the implementation of the educational intervention.
13.	Parvizy et al. (2020)	Iran	Determining how the knowledge, self-efficacy, and attitudes of the nurses can be impacted by training in pain management.	A quasi-experimental methodology	60 nurses	Structured questionnaire	The knowledge and attitudes of nurses improved after the implementation of the educational program.
14.	Uysal & Yilmazer (2021)	Turkey	To identify the practices and knowledge of nurses in managing pain in patients and also evaluate the effectiveness of nurse pain management training on their knowledge and practice levels.	Quasi - experimental study	NA	Pain Knowledge and Practice Questionnaire, Brief Pain Inventory	Knowledge of nurses regarding the management of pain improved after the educational intervention.
15.	Sedighie et al. (2020)	Iran	To investigate the effect of a comprehensive pain management training program on the awareness and attitude of intensive care unit nurses.	Quasi - experimental single-group study	32 intensive care unit nurses	Structured questionnaire	Implementation of the program improved nurses' awareness of comprehensive pain in ICU.

Supplementary Table S3. Methodological description of the focus group discussion used for curriculum refinement

Component	Description
Purpose of Focus Group	To refine the preliminary ICU pain management e-learning curriculum developed from literature review and expert consultation by gathering collective expert feedback on content relevance, structure, and clinical applicability.
Number of Participants	8 participants
Participant Expertise	Participants included ICU nurse educators, clinical ICU nurses, pain management specialists, and nursing faculty with experience in critical care education and pain management.
Sampling Strategy	Purposive sampling was used to recruit participants with recognized expertise in ICU nursing, pain assessment, pain management education, or e-learning curriculum development.
Eligibility Criteria	Participants were required to: (1) have ≥5 years of professional experience in ICU or pain management practice or education; (2) be involved in clinical teaching, curriculum design, or professional training; and (3) demonstrate familiarity with pain management guidelines or ICU clinical protocols.
Recruitment Process	Experts were identified through professional networks and academic institutions. Invitation emails describing the study purpose and focus group objectives were sent, and those who agreed to participate provided informed consent prior to the session.
Focus Group Setting	The session was conducted in a structured academic meeting environment (or virtual platform if applicable) to facilitate open discussion and collaborative review of the proposed curriculum components.
Focus Group Duration	Approximately 60–90 minutes.
Moderation and Facilitation	The discussion was facilitated by the principal investigator, who guided participants through the proposed curriculum modules using a semi-structured discussion guide. An additional researcher served as a note-taker to document key points and group interactions.
Discussion Guide	The guide focused on evaluating curriculum structure, learning objectives, module relevance, clinical applicability, and suggestions for improving instructional content and delivery methods.
Data Collection	Qualitative data were obtained through detailed note-taking and audio recording of the session (if applicable), capturing participant feedback, suggestions, and consensus points.
Data Analysis Approach	The feedback was analyzed using thematic content analysis, whereby responses were reviewed, coded, and grouped into key themes reflecting recommended curriculum modifications.
Outcome of the Focus Group	Findings informed refinement of the curriculum structure, revision of selected learning objectives, and incorporation of additional clinical examples and case-based learning elements prior to the Delphi validation phase.

Supplementary Table S4. Key themes and curriculum refinements derived from the focus group discussion

Theme Identified from Focus Group	Supporting Evidence from Literature Review	Participant Feedback	Curriculum Modification
Importance of structured pain management education for nurses	Multiple studies reported that educational interventions significantly improved nurses' knowledge and attitudes toward pain management (Issa et al., 2019; Germossa et al., 2018; El-Aqoul et al., 2020; Parvizy et al., 2020).	Participants emphasized that many ICU nurses have inconsistent knowledge regarding pain assessment and treatment, highlighting the need for structured educational programs.	Retained Module 1: Introduction to Pain Management in Critical Care and expanded introductory content emphasizing the importance of systematic pain management training.
Need to improve nurses' competency in pain assessment tools	Online and educational training improved nurses' ability to assess and categorize patient pain levels (Narbona et al., 2020; Ozawa et al., 2022).	Experts recommended stronger emphasis on pain assessment tools, especially for critically ill or non-communicative patients.	Added additional content within Module 4: Important Aspects of ICU Pain Management to include examples of validated pain assessment tools and their clinical application.
Role of educational interventions in improving knowledge, attitudes, and clinical competence	Several quasi-experimental studies demonstrated improvements in knowledge, attitudes, and clinical competency following educational programs (Innab et al., 2022; Siddiqui et al., 2024; Mala et al., 2024).	Participants highlighted that training should address not only knowledge but also attitudes and confidence in pain management decisions.	Integrated case-based learning and quizzes across modules to reinforce both knowledge acquisition and decision-making skills.
Importance of pharmacological and non-pharmacological pain management strategies	Evidence indicates that pain management education enhances nurses' clinical practices in both pharmacological and supportive pain management approaches (Salim et al., 2020; Uysal & Yilmazer, 2021).	Experts recommended including practical examples of pharmacological strategies alongside complementary approaches such as positioning and relaxation techniques.	Expanded Module 3: Common Pain Management Strategies in the ICU to include both pharmacological approaches and non-pharmacological interventions.
Need for continuous professional education and competency development	Systematic review evidence shows that pain education interventions improve nurses' ability to assess, document, and reassess pain (Grommi et al., 2023).	Participants stressed that pain management competency requires continuous professional development and reflective practice.	Reinforced Module 4 content on interdisciplinary collaboration and lifelong learning in pain management.
Evaluation of training effectiveness	Many educational studies evaluated programs using pre- and post-intervention assessments of knowledge and attitudes (Issa et al., 2019; Olawale et al., 2020; Sedighie et al., 2020).	Experts recommended incorporating structured evaluation to measure learning outcomes.	Retained Module 6: Evaluation of Program Effectiveness, including pre- and post-test assessments of knowledge, attitudes, and competencies.

Supplementary Table S5. Instructional design and prototyping process for the ICU pain management e-learning module

Development Component	Description	Output Produced
Instructional design framework	The educational module was developed using ADDIE structured instructional design approach to ensure alignment between learning objectives, teaching methods, and assessment strategies.	Framework guiding the development of learning content, teaching strategies, and evaluation methods.
Storyboard development	Detailed storyboards were prepared for each module to outline the sequence of topics, key learning points, instructional materials, and learner activities. The storyboards helped structure the flow of the educational content before digital production.	Structured storyboard document describing module content, narration scripts, visual elements, and learner interaction points.
Selection of pedagogical formats	Multiple teaching strategies were incorporated to enhance learner engagement and support knowledge retention. These included video lectures, interactive case scenarios, quizzes, and discussion prompts.	A blended instructional format integrating multimedia learning resources and interactive learning activities.
Development of video lecture content	Short recorded lectures were designed to present key theoretical concepts related to ICU pain management, including principles of pain assessment, pharmacological management, and clinical considerations.	Video lecture scripts and visual presentation slides.
Interactive case simulations	Case-based scenarios representing typical ICU patient situations were developed to allow learners to apply theoretical knowledge to clinical decision-making contexts.	Interactive patient cases focusing on pain assessment and management strategies.
Formative learning activities	Formative quizzes and reflective questions were integrated throughout the module to reinforce learning and provide immediate feedback to participants.	Embedded quizzes and reflective prompts within the learning modules.
Module structure and duration	The draft educational module consisted of six structured sections covering introduction, clinical considerations, pain management strategies, interdisciplinary aspects, application of learning, and evaluation. The total estimated completion time was approximately 2 hours and 30 minutes.	Draft e-learning module structured into six sequential learning sections.
Development of assessment tools	Pre- and post-training assessments were incorporated to evaluate participants' improvement in knowledge, attitudes, and competencies related to ICU pain management.	Structured pre-test and post-test evaluation instruments.
Prototype preparation for expert review	The complete draft module, including learning objectives, teaching materials, and assessment components, was compiled into a prototype version for evaluation by the Delphi expert panel in the subsequent stage of the study.	Prototype e-learning module prepared for Delphi consensus validation.

Supplementary Table S6. Alignment between learning objectives, instructional activities, and assessment methods in the ICU pain management e-learning module

Module	Learning Objective	Instructional Activities	Assessment Method
Module 1: Introduction to Pain Management in Critical Care	To explain the importance of effective pain management in critically ill patients and identify common challenges in ICU pain control.	Video lecture introducing key concepts of pain management in critical care; short reading material summarizing major ICU pain management challenges; discussion forum encouraging participants to share experiences and strategies.	Pre-test questions assessing baseline understanding of pain management concepts; short formative quiz following the lecture.
Module 2: Considerations for Critically Ill Patients	To describe factors influencing pain assessment and management in critically ill patients, including sedation, physiological instability, and non-pharmacological approaches.	Interactive case study illustrating an ICU patient scenario; infographic summarizing clinical considerations; short quiz on sedation and supportive pain management approaches.	Scenario-based quiz questions evaluating learners' ability to identify appropriate pain management considerations in critically ill patients.
Module 3: Common Pain Management Strategies in the ICU	To identify commonly used pharmacological and procedural pain management strategies in ICU settings and determine appropriate use in different clinical contexts.	Interactive multimedia module explaining opioid infusions, patient-controlled analgesia, neuromuscular blockade, and regional anesthesia; virtual simulation demonstrating PCA and opioid administration; discussion board encouraging reflection on clinical decision-making.	Case-based quiz assessing understanding of appropriate pain management strategies for different patient conditions.
Module 4: Important Aspects of ICU Pain Management	To recognize the importance of regular pain assessment, interdisciplinary collaboration, and ongoing professional education in improving patient outcomes.	Interactive quiz on pain assessment tools and interdisciplinary roles; recorded panel discussion featuring expert perspectives on collaborative pain management; reflective self-assessment exercise.	Knowledge-based quiz evaluating understanding of pain assessment tools and team-based management approaches.
Module 5: Conclusion and Application	To integrate learned concepts and apply pain management principles to practical ICU scenarios.	Interactive case scenario requiring learners to develop a pain management plan; reflective assignment encouraging participants to consider application of learning in their own clinical practice.	Application-based questions within the case scenario; short reflective submission describing how knowledge will be implemented in practice.
Module 6: Program Evaluation	To evaluate participants' improvement in knowledge, attitudes, and perceived competency in ICU pain management following completion of the module.	Completion of structured pre- and post-training assessments; feedback questionnaire regarding learning experience and module effectiveness.	Comparison of pre-test and post-test scores measuring improvement in knowledge, attitudes, and competencies related to pain management.