

Development and Preliminary Application of an Entrustable Professional Activities-Based Evaluation Indicator System for Rehabilitation Nursing among Undergraduate Nursing Interns

Junying Qian

Shandong Provincial QianFoShan Hospital

Ruixin Wang

Shandong First Medical University

Xin Zhang

Shandong Provincial QianFoShan Hospital

Xiaoqing Si

Shandong Provincial QianFoShan Hospital

Yiying Zhu

Shandong Provincial QianFoShan Hospital

Yun Li

Shandong Provincial QianFoShan Hospital

Yue Sun

Shandong Provincial QianFoShan Hospital

Dongxu Liu

Shandong Provincial QianFoShan Hospital

Yan Wang

wangyan197401@163.com

Shandong Provincial QianFoShan Hospital

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Abstract

Background

This study aimed to construct and preliminarily validate an evaluation indicator system for entrustable professional activities (EPAs) in rehabilitation nursing among undergraduate nursing interns.

Methods

An evaluation indicator system for rehabilitation nursing EPAs among undergraduate nursing interns was developed through literature analysis, group discussion and Delphi expert consultation. In September 2025, 57 undergraduate nursing interns at a tertiary grade A hospital were surveyed using the Rehabilitation Nursing EPA Evaluation Form for Undergraduate Nursing Interns, an EPA questionnaire for undergraduate nursing interns, and an evaluation-effect questionnaire to examine the preliminary application of the indicator system.

Results

Eighteen experts completed two rounds of consultation, with effective response rates of 100% in both rounds. The expert authority coefficients were 0.881 and 0.889, and Kendall's coefficients of concordance were 0.522 and 0.602, respectively ($P < 0.05$). The final EPA evaluation indicator system comprised seven first-level indicators, 20 second-level indicators and 46 third-level indicators covering health assessment, rehabilitation nursing content, medical-order processing, hospital infection prevention and control management, emergency response, nursing documentation and rehabilitation nursing education. Preliminary clinical application showed that the score on the entrustable professional activity evaluation scale was 83.07 ± 3.91 , the importance score for EPAs among undergraduate nursing students was 91.26 ± 3.41 , and the evaluation-effect score was 46.12 ± 2.87 .

Conclusions

The constructed evaluation indicator system for rehabilitation nursing EPAs among undergraduate nursing interns showed good content representativeness, expert consensus and preliminary feasibility in clinical application. It may provide a reference for undergraduate rehabilitation nursing education.

Background

With accelerated population ageing and changes in the disease spectrum, demand for rehabilitation services continues to increase [1]. However, the development of rehabilitation nursing in China remains relatively delayed, service supply is still insufficient, and the capacity to provide diversified and individualized rehabilitation nursing services needs improvement [2]. The Outline of the Healthy China

2030 Plan and the Opinions on Accelerating the Development of Rehabilitation Medical Services both state that the training and development of rehabilitation medical personnel should be strengthened. Rehabilitation nursing is an important component of rehabilitation medicine, and cultivating nursing personnel with strong practical ability and professional competence is essential [3, 4].

The third generation of medical education reform emphasizes competency-based education [5]. However, competence is abstract and integrated in nature, making it difficult to observe and measure directly and therefore difficult to use for continuous evaluation of learners' clinical ability [6]. Entrustable professional activities (EPAs) provide a new route for translating competency assessment into practice. EPAs refer to professional activities that require learners to apply specific professional skills to independently complete defined tasks or responsibilities, and they are used to judge whether learners have reached the expected level of ability [7]. By transforming competence into concrete and observable clinical practice activities and evaluating these activities according to supervisors' level of trust, EPAs provide an objective framework for competency assessment [8].

Undergraduate nursing interns are an important reserve force for clinical nursing, and clinical internship is a key stage in the transformation of theoretical knowledge into professional competence. Studies have shown that EPAs can facilitate the connection between clinical teaching, competency assessment and workplace tasks, and can provide a practical and objective teaching approach for cultivating high-quality nursing personnel with professional competence [9]. In recent years, researchers in China and elsewhere have developed EPA indicator systems for the core competencies of undergraduate nursing graduates [10–12]. Nevertheless, research on rehabilitation nursing EPAs among undergraduate nursing students is limited, and an indicator system that reflects the specialty characteristics of rehabilitation nursing and is convenient for clinical observation and evaluation remains lacking. This study therefore aimed to construct and preliminarily validate an EPA evaluation indicator system for rehabilitation nursing among undergraduate nursing interns, so as to provide guidance for rehabilitation nursing education.

Methods

A literature review and focus group interviews were used to develop an initial draft of the indicator system. The quality of the indicators was assessed using the EPA Quality (EQual) rubric to form a candidate EPA evaluation indicator system. Delphi expert consultation was then conducted. After analysis and integration of expert feedback, the final version of the rehabilitation nursing EPA evaluation indicator system for undergraduate nursing interns was formed and preliminarily validated.

Development of the rehabilitation nursing EPA evaluation indicator system

Study team

The research team consisted of 10 members from the rehabilitation department of a tertiary grade A general hospital, including physicians, nurses and rehabilitation therapists. The team included one deputy director of the nursing department, one director of the nursing teaching and research office, two head nurses from the rehabilitation department, two rehabilitation specialist nurses, two chief clinical nursing instructors in the rehabilitation department, one senior rehabilitation physician and one intermediate-grade rehabilitation therapist. The research team was responsible for reviewing the literature, selecting experts, drafting the rehabilitation nursing EPA indicators for undergraduate nursing interns, conducting EQual assessment, preparing the expert consultation questionnaire, implementing the Delphi consultation, collecting and statistically analysing data, and screening and revising indicators according to expert consultation results.

Indicator system construction

The candidate EPA indicators were determined through four main steps: literature review; consultation of EPA development guidelines and undergraduate rehabilitation nursing textbooks to ensure that the drafted EPAs were consistent with current standards and best available content; focus group discussions with clinical nursing teachers and nursing educators to collect opinions; and EPA quality assessment.

Drafting of candidate EPA indicators

The research team searched Web of Science, PubMed, CINAHL, CNKI, Wanfang Data, VIP, the Chinese Biomedical Literature Database and websites of relevant domestic and international associations. Chinese search terms included "entrustable professional activities", "competence", "trusted professional activities", "entrustable activities" and "nursing"; English search terms included "entrustable professional activities", "entrustment", "entrustability", "EPAs", "nursing" and "nurse". Using AMEE Guide No. 99 [13] and AMEE Guide No. 140 [14] as the theoretical basis, drawing on the development steps and content of undergraduate nursing EPAs reported by Lau et al. [10], and referring to the fourth edition of the Rehabilitation Nursing textbook published by People's Medical Publishing House [15], the team developed a candidate EPA indicator framework for rehabilitation nursing among undergraduate nursing interns.

Focus group discussion

Participants in the focus group interviews were recruited by purposive sampling after providing informed consent. Selection focused on individuals with rich expertise and clinical experience in nursing education, training and supervision of undergraduate nursing interns. The interviews were moderated by a trained facilitator. The focus group consisted of 10 participants, including the director of the teaching and research office, head nurses, clinical instructors and rehabilitation specialist nurses.

Before the interviews, the research team prepared a structured interview guide focusing on the professional practice behaviours and competencies required of undergraduate nursing interns during rehabilitation department internships. Key questions included: (1) What professional nursing behaviours are involved during undergraduate nursing interns' rehabilitation nursing practice? (2) Which of these behaviours can be observed? (3) Which practice behaviours can be measured, and which outcomes resulting from these behaviours can be measured? (4) What type of supervision do these practice behaviours require? Interviews continued until information saturation was reached and no new themes emerged. The focus group session lasted approximately 120 minutes. Interview data were coded and analysed to identify recurring themes and form the candidate EPA indicator system.

Revision of candidate EPA indicators

Candidate EPA indicators were rigorously evaluated using the EQual measurement rubric. EQual includes 14 items across three dimensions: discrete and complete clinical task (six items), entrustability and professional standards (four items), and educational application (four items). A group of clinical instructors scored second-level EPA indicators in multiple domains using a 5-point Likert scale. The revision thresholds for the three dimensions were set at 4.17, 4.00 and 4.00, respectively, with a general mean threshold of 4.07. Indicators scoring below the threshold required revision to ensure the quality and relevance of the EPAs. The revised EPA indicator system was then further evaluated using the Delphi method.

Delphi expert consultation

Expert consultation questionnaire

The consultation questionnaire consisted of four parts. The first part comprised an introductory letter to experts, instructions for completing the questionnaire and definitions of relevant concepts. The second part was the EPA consultation form, which contained entrustable professional activity indicators and their content. A 5-point Likert scale was used to rate the importance and observability of first-, second- and third-level indicators, from 1 (very unimportant) to 5 (very important), and columns were provided for suggesting additions or deletions. Experts also graded the expected entrustment level for each second-level EPA indicator. Expected EPA entrustment levels were based on the five-level supervision and entrustment model [16]: level 1, observation only and the student may not perform the professional activity; level 2, the student performs the professional activity under direct supervision; level 3, the student performs the activity under partial supervision; level 4, the student performs the activity independently without supervision; and level 5, the student can supervise and guide novices in completing the professional activity. The third part collected basic expert information, including sex, age, professional title and years of experience in rehabilitation nursing and rehabilitation nursing management. The fourth part assessed experts' judgement basis and familiarity with the consultation content.

Expert selection

The authority and representativeness of consultation experts are important to the credibility of Delphi results, and the appropriate number of experts is generally 15 to 50 [17]. Considering educational background, academic level, professional title and clinical practice experience, this study used purposive sampling to invite 18 nursing experts from rehabilitation medicine departments of tertiary grade A general hospitals in Shandong Province to participate in Delphi consultation from January to April 2025. Inclusion criteria were: at least 8 years of experience in rehabilitation nursing or rehabilitation nursing management; bachelor's degree or above; intermediate or higher professional title; ability to complete two rounds of consultation during the study period; and voluntary participation.

Expert consultation process

From January to April 2025, consultation questionnaires were distributed and collected by email, with each round completed within 2 weeks. After the first round, the research team organized and analysed the data and held group meetings according to expert opinions and indicator screening criteria. Indicators were supplemented and revised to form the second-round questionnaire. After the second round, expert opinions tended to converge, the consultation was concluded, and the final rehabilitation nursing EPA indicator system for undergraduate nursing interns included seven first-level indicators, 20 second-level indicators and 46 third-level indicators. Indicator screening criteria were a mean score > 3.5 and a coefficient of variation < 0.25 .

Preliminary validation

Participants

Cluster sampling was used to select undergraduate nursing students who interned in the rehabilitation medicine department of a tertiary grade A hospital in Jinan, Shandong Province, in 2025. This stage aimed to preliminarily evaluate the feasibility, acceptability and internal consistency of the rehabilitation nursing EPA evaluation indicator system for undergraduate nursing interns and was an exploratory preliminary application study. During the study period, 60 undergraduate nursing students met the inclusion criteria. Three students were excluded because they did not fully participate in the evaluation or had incomplete questionnaires, and 57 students were finally included, yielding an effective participation rate of 95.0%. Inclusion criteria were: internship duration ≥ 3 months; participation in the use of undergraduate rehabilitation nursing EPAs; and voluntary informed consent. Exclusion criteria were withdrawal or transfer to another department during the study period, or incomplete evaluation data or questionnaires.

Application of the entrustable professional activity evaluation indicators

A quantitative Rehabilitation Nursing EPA Evaluation Form for Undergraduate Nursing Students was developed. The 20 EPAs were used as evaluation indicators, and clinical instructors served as

supervisors. The entrustment level of each evaluation indicator was used as the evaluation basis. Levels 1 to 5 were assigned scores of 1, 3, 5, 7 and 9, respectively; scores of 2, 4, 6 and 8 were assigned when performance was between two adjacent entrustment levels. The research team provided unified training for supervisors to reduce scoring bias and ensure data quality. Supervisors evaluated and provided feedback to the included nursing students according to the evaluation form, and each student's total EPA score was calculated.

After evaluation feedback, questionnaires were distributed to students. The questionnaire consisted of two parts: a general information questionnaire covering sex, age and internship duration; and the EPA Evaluation Effect Questionnaire for Undergraduate Nursing Interns, which included 10 items scored on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Item 9 was reverse scored. The total score ranged from 10 to 50, with higher scores indicating better perceived evaluation effect.

Statistical analysis

SPSS 33.0 was used for statistical analysis. Measurement data conforming to a normal distribution were described using means and standard deviations. Expert enthusiasm was expressed as the effective questionnaire response rate. The expert authority coefficient (Cr) was calculated as the mean of the familiarity coefficient (Cs) and judgement basis coefficient (Ca), namely $Cr = (Cs + Ca)/2$ [18]. A $Cr > 0.7$ indicates high expert authority. The degree of coordination of expert opinions was measured by the coefficient of variation (Cv) and Kendall's coefficient of concordance (Kendall's W). A $Cv \leq 0.25$ indicates a high degree of expert coordination, and a larger Kendall's W indicates a higher degree of coordination [19]. $P < 0.05$ was considered statistically significant.

Results

Revision of candidate EPAs

Twelve clinical instructors were selected. Their rehabilitation nursing teaching experience ranged from 6 to 15 years; seven had a master's degree and five had a bachelor's degree. The EQual rubric was used to evaluate the quality of second-level EPA indicators. Because first-level indicators were considered a general framework and third-level indicators were specific descriptive content, quality evaluation was performed for second-level indicators. The results showed that, among the 20 indicators, 19 met EPA construction requirements and had mean scores above the threshold. Although the total score for "identifying disease deterioration" was above the threshold, its score in the "discrete and complete clinical task" dimension was unsatisfactory. The total score and all dimension scores for "team collaboration" were below the threshold of 4.07. Based on the survey results, "team collaboration" was deleted and "identifying disease deterioration" was revised. The results are shown in Table 1.

Table 1
Equal rubric scores for candidate EPAs

Candidate EPA indicator	Discrete and complete clinical task (4.17)	Entrustable, essential and important task in the profession (4.00)	EPA as an educational tool (4.07)	Total score (4.07)	SD	Range
General assessment	4.64	4.67	4.48	4.60	0.14	4.29–4.79
Physical examination	4.54	4.58	4.52	4.55	0.18	4.14–4.79
Rehabilitation nursing specialty assessment	4.38	4.46	4.43	4.53	0.16	4.21–4.71
Basic nursing	4.41	4.53	4.52	4.48	0.12	4.21–4.64
Rehabilitation specialty nursing	4.41	4.54	4.52	4.48	0.14	4.14–4.57
Medical-order processing process	4.18	4.02	4.15	4.13	0.10	4.00–4.29
Medical-order processing outcome	4.19	4.02	4.13	4.13	0.06	4.00–4.21
Cross-infection prevention	4.61	4.67	4.48	4.59	0.10	4.36–4.71
Occupational exposure and protection	4.61	4.63	4.44	4.57	0.12	4.29–4.71
Isolation protection for multidrug-resistant organisms	4.63	4.63	4.50	4.59	0.09	4.43–4.71
Medical waste disposal	4.50	4.65	4.50	4.54	0.11	4.29–4.71
Identifying disease severity	4.09	4.07	4.10	4.08	0.13	3.79–4.21
Identifying equipment alarms	4.22	4.04	4.08	4.13	0.13	3.86–4.29
Emergency response to sudden events	4.18	4.02	4.29	4.16	0.13	3.93–4.36

Candidate EPA indicator	Discrete and complete clinical task (4.17)	Entrustable, essential and important task in the profession (4.00)	EPA as an educational tool (4.07)	Total score (4.07)	SD	Range
Team collaboration	4.01	3.71	3.06	3.66	0.15	3.29–3.79
Accurate documentation content	4.24	4.11	4.15	4.17	0.12	3.92–4.43
Timely and standardized documentation	4.22	4.10	4.13	4.14	0.17	3.86–4.43
Medication guidance	4.25	4.13	4.27	4.22	0.12	4.07–4.43
Rehabilitation guidance	4.56	4.46	4.40	4.48	0.09	4.36–4.64
Family guidance	4.53	4.56	4.50	4.53	0.15	4.21–4.79

Basic characteristics of consultation experts

Eighteen experts completed two rounds of consultation. All were women, aged 38 to 52 years (46.17 +/- 3.47 years). Their years of rehabilitation nursing experience ranged from 8 to 22 years (10.17 +/- 4.44 years). Thirteen were experts in rehabilitation nursing management and five were rehabilitation nursing clinical instructors. Thirteen had bachelor's degrees and five had master's degrees. Three were chief nurses, 12 were associate chief nurses and three were supervisor nurses. Five were master's supervisors, 12 were rehabilitation specialist nurses, and 16 participated in teaching at rehabilitation specialist nurse training bases of the Chinese Nursing Association or Shandong Nursing Association.

Expert enthusiasm, authority and coordination of opinions

In both rounds of Delphi consultation, 18 questionnaires were distributed and 18 were returned, with an effective response rate of 100%, indicating high expert enthusiasm. The Cr values in the two rounds were 0.881 and 0.889, respectively; Ca values were 0.917 and 0.922, and Cs values were 0.844 and 0.855, respectively, indicating high reliability of the consultation results. After two rounds of consultation, the coefficients of variation for all indicators were < 0.25, and Kendall's coefficients of concordance were 0.522 and 0.602 ($P < 0.05$), indicating good expert coordination.

Expert consultation results for the rehabilitation nursing EPA indicators

In the first round, the 18 experts proposed 21 revision suggestions. According to the indicator screening criteria, expert opinions and group discussion results, the second-round consultation results were

adjusted as follows. First, one first-level indicator was revised: "infection management" was changed to "hospital infection prevention and control management". Second, two second-level indicators were added and two were merged. Indicator 1.4, "psychological assessment", was added, while the third-level indicator "assess patients' mental health" under "general assessment" was deleted. Indicator 7.4, "rehabilitation referral", was added. "Accurate documentation content" and "timely and standardized documentation" were merged into "nursing documentation writing". Third, eight third-level indicators were added, three were deleted and five were merged into existing indicators. Because experts considered some indicators insufficiently detailed, corresponding supplements and revisions were made. Five third-level indicators were added under 1.3, "rehabilitation specialty assessment": 1.3.1, "correctly assess patients' functional status"; 1.3.2, "correctly assess motor function"; 1.3.3, "correctly assess cardiopulmonary function"; 1.3.4, "correctly assess perceptual and cognitive function"; and 1.3.5, "correctly assess language function". The original third-level indicator "correctly select rehabilitation nursing assessment items according to different disease types" and the indicators "correctly assess functional status and residual function" and "correctly assess mental health" under general assessment were deleted. Indicators 2.2.8, "correct use of rehabilitation assistive devices"; 5.2.2, "identify the performance of rehabilitation equipment"; and 7.4.1, "have awareness of rehabilitation referral services and provide rehabilitation referral services", were added.

Experts considered that some third-level indicators under 2.1, "basic nursing", overlapped. Therefore, "identify manifestations of disease aggravation", "master the use of emergency drugs" and "master the use of emergency equipment" were merged into the existing indicator 2.1.6, "master basic first-aid skills and the use of first-aid instruments and equipment". "Implement identity identification and checking systems" and "correctly perform therapeutic procedures such as intravenous infusion and intramuscular injection" were merged into the existing indicator 2.1.3, "correctly implement diagnostic and therapeutic medical orders, including collecting various specimens and completing therapeutic procedures".

In the second round, experts made slight revisions to the descriptions of third-level indicators. For example, in 2.1.4, "correctly administer oral medicines and provide education and guidance, ensure that medicines are taken, and observe therapeutic effects and adverse reactions", the phrase "ensure that medicines are taken" was removed.

The final rehabilitation nursing EPA indicators for undergraduate nursing students comprised seven first-level indicators, 20 second-level indicators and 46 third-level indicators, including health assessment, rehabilitation nursing content, medical-order processing, hospital infection prevention and control management, emergency response, nursing documentation and rehabilitation nursing education (Table 2).

Table 2
Rehabilitation nursing EPA evaluation indicator system for undergraduate nursing interns

Indicator	Importance score	Importance Cv	Observability score	Observability Cv
1 Health assessment	5.00	0.00	5.00	0.00
1.1 General assessment	5.00	0.00	4.83 +/- 0.38	0.08
1.1.1 Collect medical history accurately, including chief complaints and symptoms, disease history, family history, medication history, allergy history and surgical history	5.00	0.00	4.83 +/- 0.38	0.08
1.1.2 Understand patients' lifestyle habits, family situation, cultural background, disease or disability process, treatment process and rehabilitation experience	4.22 +/- 0.43	0.10	4.67 +/- 0.49	0.10
1.1.3 Correctly conduct nursing risk assessment, including risk assessment for falls, pressure injury, venous thromboembolism, unplanned extubation and pain	4.94 +/- 0.24	0.05	5.00	0.00
1.2 Physical examination	5.00	0.00	4.56 +/- 0.51	0.11
1.2.1 Correctly select examination tools such as thermometers, sphygmomanometers, stethoscopes and percussion hammers; use appropriate examination sequences and techniques; and conduct specialty assessment in combination with history	5.00	0.00	5.00	0.00
1.2.2 Correctly interpret and analyse auxiliary examination results, know normal ranges and clinical meanings of common laboratory values, identify abnormal values and promptly notify the attending physician	4.11 +/- 0.32	0.08	4.61 +/- 0.50	0.11
1.2.3 Respect patient privacy and comfort	5.00	0.00	4.39 +/- 0.50	0.11
1.3 Specialty assessment	5.00	0.00	4.50 +/- 0.51	0.11
1.3.1 Correctly assess patients' functional status, such as activities of daily living and current residual function	5.00	0.00	4.72 +/- 0.46	0.09

Indicator	Importance score	Importance Cv	Observability score	Observability Cv
1.3.2 Correctly assess motor function, including muscle strength, muscle tone, range of motion, balance and coordination	5.00	0.00	4.50 +/- 0.51	0.11
1.3.3 Correctly assess cardiopulmonary function, including cardiac functional class, and understand metabolic equivalents and permissible activities under different cardiac functional states	4.94 +/- 0.24	0.05	4.22 +/- 0.43	0.10
1.3.4 Correctly assess perceptual and cognitive function	4.06 +/- 0.24	0.06	4.56 +/- 0.51	0.11
1.3.5 Correctly assess language function, and know types of language disorders and assessment methods	4.94 +/- 0.24	0.05	4.56 +/- 0.51	0.11
1.4 Psychological assessment	4.33 +/- 0.49	0.11	4.50 +/- 0.51	0.11
1.4.1 Correctly assess patients' mental health, such as cognitive function, depression and anxiety	4.17 +/- 0.38	0.09	4.17 +/- 0.38	0.09
2 Rehabilitation nursing content	5.00	0.00	5.00	0.00
2.1 Basic nursing	4.83 +/- 0.38	0.08	4.44 +/- 0.51	0.11
2.1.1 Accurately monitor and record vital signs, identify abnormal vital signs and notify the attending physician	5.00	0.00	5.00	0.00
2.1.2 Accurately observe changes in condition, such as vital signs, consciousness and disease progression	4.94 +/- 0.24	0.05	4.28 +/- 0.46	0.11
2.1.3 Correctly implement diagnostic and therapeutic medical orders, including collecting specimens and completing procedures such as intravenous infusion, injections, aerosol inhalation, nasal feeding, catheterization, perineal care and oral care	5.00	0.00	5.00	0.00
2.1.4 Correctly administer oral medicines and provide education and guidance, and observe	4.33 +/- 0.49	0.11	4.22 +/- 0.43	0.10

Indicator	Importance score	Importance Cv	Observability score	Observability Cv
medication adherence, efficacy and adverse reactions				
2.1.5 Dynamically conduct nursing risk assessment and provide education, guidance and implementation of risk-prevention measures	4.22 +/- 0.43	0.10	4.17 +/- 0.38	0.10
2.1.6 Master basic first-aid skills and the use of emergency instruments and equipment, including cardiopulmonary resuscitation, defibrillation, electrocardiographic monitoring, oxygen inhalation and negative pressure suction	5.00	0.00	4.89 +/- 0.32	0.10
2.2 Rehabilitation specialty nursing	5.00	0.00	4.50 +/- 0.51	0.11
2.2.1 Correctly position patients with various diseases in anti-spastic postures and perform position transfers, including bed mobility and transfer techniques	5.00	0.00	5.00	0.00
2.2.2 Master and correctly implement respiratory training, including respiratory muscle training, diaphragmatic breathing and pursed-lip breathing, and master and correctly implement sputum-expectoration techniques such as effective coughing, assisted coughing, percussion, vibration and postural drainage	4.94 +/- 0.24	0.05	5.00	0.00
2.2.3 Master and correctly implement nursing techniques for dysphagia, including tube feeding and oral feeding training	4.22 +/- 0.43	0.10	4.39 +/- 0.50	0.11
2.2.4 Master and correctly implement neurogenic bowel training techniques	4.11 +/- 0.32	0.08	4.28 +/- 0.46	0.11
2.2.5 Master and correctly implement neurogenic bladder training techniques and clean intermittent catheterization	4.22 +/- 0.43	0.10	4.39 +/- 0.50	0.11

Indicator	Importance score	Importance Cv	Observability score	Observability Cv
2.2.6 Master and correctly implement activities-of-daily-living training techniques, including eating training, dressing and undressing, personal hygiene and wheelchair toileting training	5.00	0.00	5.00	0.00
2.2.7 Use psychological rehabilitation nursing techniques to counsel patients, improve psychological endurance and restore psychological balance	4.78 +/- 0.43	0.09	4.17 +/- 0.38	0.09
2.2.8 Master and guide the correct use of rehabilitation assistive devices	5.00	0.00	5.00	0.00
3 Medical-order processing	4.22 +/- 0.43	0.10	4.17 +/- 0.38	0.09
3.1 Medical-order processing process	4.11 +/- 0.32	0.08	4.17 +/- 0.38	0.09
3.1.1 Correctly implement double checking and the three checks and ten rights system	5.00	0.00	5.00	0.00
3.1.2 Correctly distinguish long-term and clinical medical orders, and ensure that execution time and frequency meet requirements	5.00	0.00	4.94 +/- 0.24	0.05
3.2 Medical-order processing outcome	4.11 +/- 0.32	0.08	4.22 +/- 0.43	0.10
3.2.1 Identify erroneous medical orders and refuse to implement them	5.00	0.00	5.00	0.00
3.2.2 Identify the accuracy of medical orders	5.00	0.00	5.00	0.00
3.2.3 Correctly implement medical orders and record them in a timely manner	5.00	0.00	4.94 +/- 0.24	0.05
4 Hospital infection prevention and control management	4.94 +/- 0.24	0.05	4.78 +/- 0.43	0.09
4.1 Cross-infection prevention	4.89 +/- 0.32	0.07	4.89 +/- 0.32	0.07
4.1.1 Correctly perform hand hygiene	5.00	0.00	5.00	0.00

Indicator	Importance score	Importance Cv	Observability score	Observability Cv
4.2 Occupational exposure and protection	5.00	0.00	4.89 +/- 0.32	0.07
4.2.1 Know occupational exposure-related factors, comply with occupational exposure protection systems and master emergency management of occupational exposure	5.00	0.00	4.56 +/- 0.51	0.11
4.3 Isolation protection for multidrug-resistant organisms	5.00	0.00	4.89 +/- 0.32	0.07
4.3.1 Know isolation and protection measures for multidrug-resistant organisms and comply with the related systems	4.94 +/- 0.24	0.05	5.00	0.00
4.4 Medical waste disposal	5.00	0.00	4.94 +/- 0.24	0.05
4.4.1 Know medical waste classification and disposal measures, and correctly dispose of medical waste	5.00	0.00	5.00	0.00
5 Emergency response	4.28 +/- 0.46	0.11	4.28 +/- 0.46	0.11
5.1 Identifying disease deterioration	4.22 +/- 0.43	0.10	4.28 +/- 0.67	0.16
5.1.1 Identify clinical manifestations of primary disease deterioration and know the critical-value warning and handling procedure in the medical office system	4.22 +/- 0.43	0.10	3.78 +/- 0.43	0.11
5.2 Identifying equipment alarms	4.44 +/- 0.51	0.12	4.11 +/- 0.32	0.08
5.2.1 Identify the performance of rescue instruments and equipment, recognize alarms and urgently call the clinical instructor	5.00	0.00	4.06 +/- 0.24	0.06
5.2.2 Identify the performance of rehabilitation instruments and equipment, recognize rehabilitation equipment alarms and urgently call the clinical instructor	4.83 +/- 0.38	0.08	4.22 +/- 0.43	0.10
5.3 Emergency response to sudden events	4.44 +/- 0.51	0.12	4.22 +/- 0.43	0.10

Indicator	Importance score	Importance Cv	Observability score	Observability Cv
5.3.1 Promptly identify accidents involving rehabilitation patients during procedures, such as infusion reactions, aspiration, choking and cardiac arrest, and cooperate in and participate in emergency treatment under teacher guidance	4.94 +/- 0.24	0.05	4.22 +/- 0.43	0.10
6 Nursing documentation	4.33 +/- 0.49	0.11	4.11 +/- 0.32	0.08
6.1 Nursing documentation writing	4.17 +/- 0.38	0.09	4.00 +/- 0.34	0.09
6.1.1 Write all types of nursing documentation in a timely, accurate, complete, concise and standardized manner	4.28 +/- 0.46	0.11	4.56 +/- 0.51	0.11
7 Rehabilitation nursing education	4.33 +/- 0.49	0.11	4.06 +/- 0.24	0.06
7.1 Medication guidance	4.17 +/- 0.38	0.09	4.56 +/- 0.51	0.11
7.1.1 Urge patients to take medicines as prescribed, ensure medication adherence and guide patients in identifying adverse drug reactions	5.00	0.00	4.33 +/- 0.49	0.11
7.2 Rehabilitation guidance	4.33 +/- 0.49	0.11	4.83 +/- 0.38	0.08
7.2.1 According to short- and long-term goals in the rehabilitation plan, guide patients to perform correct functional rehabilitation exercises, such as limb, swallowing, language, urination, position transfer and activities-of-daily-living exercises	4.28 +/- 0.46	0.11	4.89 +/- 0.32	0.07
7.3 Family guidance	4.39 +/- 0.50	0.11	4.83 +/- 0.38	0.08
7.3.1 Guide family members to master basic rehabilitation training knowledge and skills and improve family support during home rehabilitation	4.11 +/- 0.32	0.08	4.44 +/- 0.51	0.12
7.4 Rehabilitation referral	4.22 +/- 0.43	0.10	4.17 +/- 0.38	0.09

Indicator	Importance score	Importance Cv	Observability score	Observability Cv
7.4.1 Have awareness of rehabilitation referral services and provide rehabilitation referral services, such as assisting patients in referral to rehabilitation institutions, community rehabilitation or home rehabilitation	4.11 +/- 0.32	0.08	4.06 +/- 0.24	0.06

Expected entrustment levels

After two rounds of expert consultation, experts reached agreement on the expected entrustment levels for rehabilitation nursing EPAs among undergraduate nursing interns. The entrustment levels are shown in Table 3.

Table 3
Expected entrustment levels for second-level rehabilitation nursing EPA indicators

First-level indicator	Second-level indicator	Expected level at the end of rehabilitation medicine internship
Health assessment	General assessment	3
Health assessment	Physical examination	3
Health assessment	Specialty assessment	3
Health assessment	Psychological assessment	3
Rehabilitation nursing content	Basic nursing	2
Rehabilitation nursing content	Rehabilitation specialty nursing	2
Medical-order processing	Medical-order processing process	2
Medical-order processing	Medical-order processing outcome	2
Hospital infection prevention and control management	Cross-infection prevention	4
Hospital infection prevention and control management	Occupational exposure and protection	3
Hospital infection prevention and control management	Isolation protection for multidrug-resistant organisms	3
Hospital infection prevention and control management	Medical waste disposal	3
Emergency response	Identifying disease deterioration	2
Emergency response	Identifying equipment alarms	2
Emergency response	Emergency response to sudden events	2
Nursing documentation	Nursing documentation writing	3
Rehabilitation nursing education	Medication guidance	2
Rehabilitation nursing education	Rehabilitation guidance	2
Rehabilitation nursing education	Family guidance	3

First-level indicator	Second-level indicator	Expected level at the end of rehabilitation medicine internship
Rehabilitation nursing education	Rehabilitation referral	2

Application of the rehabilitation nursing EPA evaluation indicators

Fifty-seven undergraduate nursing interns participated in the evaluation, including eight male students (14%) and 49 female students (86%). Their ages ranged from 21 to 24 years (21.94 +/- 0.44 years), and internship duration ranged from 4 to 10 months (6.15 +/- 1.91 months). Supervisor-based clinical evaluation showed that the total EPA score of all students was 83.07 +/- 3.91. Cross-infection prevention had the highest score (7.37 +/- 0.49). Lower scores were observed for identifying disease deterioration, identifying equipment alarms, emergency response to sudden events, medical-order processing process and medical-order processing outcome, with scores of 2.68 +/- 0.47, 2.63 +/- 0.49, 2.67 +/- 0.48, 2.79 +/- 0.41 and 2.65 +/- 0.48, respectively. The score for rehabilitation specialty assessment was 5.38 +/- 0.49, and the score for rehabilitation specialty nursing was 3.24 +/- 0.43 (Table 4).

Table 4
Undergraduate nursing students' rehabilitation nursing EPA scores

Item	EPA score
General assessment	5.19 +/- 0.40
Physical examination	5.16 +/- 0.37
Specialty assessment	5.38 +/- 0.49
Psychological assessment	5.03 +/- 0.19
Basic nursing	3.24 +/- 0.43
Rehabilitation specialty nursing	3.24 +/- 0.43
Medical-order processing process	2.79 +/- 0.41
Medical-order processing outcome	2.65 +/- 0.48
Cross-infection prevention	7.37 +/- 0.49
Occupational exposure and protection	5.37 +/- 0.49
Isolation protection for multidrug-resistant organisms	5.25 +/- 0.43
Medical waste disposal	5.23 +/- 0.46
Identifying disease deterioration	2.68 +/- 0.47
Identifying equipment alarms	2.63 +/- 0.49
Emergency response to sudden events	2.67 +/- 0.48
Nursing documentation writing	4.84 +/- 0.49
Medication guidance	3.31 +/- 0.47
Rehabilitation guidance	3.07 +/- 0.42
Family guidance	5.16 +/- 0.37
Rehabilitation referral	2.79 +/- 0.41
Total EPA score	83.07 +/- 3.91

Undergraduate nursing interns' importance score for EPAs was 91.26 +/- 3.41, and their EPA evaluation-effect score was 46.12 +/- 2.87, indicating a high level of recognition of the importance of the EPA evaluation system and a favourable evaluation effect. The Cronbach's alpha coefficients for the supervisor clinical evaluation scale, the student EPA importance scale and the student EPA evaluation-effect questionnaire were 0.788, 0.773 and 0.857, respectively.

Discussion

Scientificity and reliability of the evaluation indicators

This study strictly followed the EPA development process [14], used EPA guidelines as the theoretical framework [13, 14], referred to the fourth edition of the undergraduate Rehabilitation Nursing textbook published by People's Medical Publishing House [15], and constructed a rehabilitation nursing EPA evaluation indicator system for undergraduate nursing interns through literature review, focus group interviews and Delphi expert consultation. These steps support the scientific nature of the research process. The 18 selected experts were all from provincial tertiary grade A hospitals and all had more than 8 years of professional experience in rehabilitation nursing or rehabilitation nursing management. They had solid theoretical knowledge of rehabilitation nursing and rich clinical practice experience. Five experts had master's degrees, five were master's supervisors, 12 had national or provincial rehabilitation specialist nurse qualifications, and 16 participated in national or provincial rehabilitation specialist nurse teaching, indicating good authority and representativeness.

The response rates in both rounds of consultation were 100%, indicating strong expert engagement. The authority coefficients in the two rounds were 0.881 and 0.889, indicating a high level of expert authority. In the second round, the coefficients of variation for the importance and observability of all indicators were < 0.25 , and Kendall's coefficients of concordance were 0.522 and 0.602, respectively, with P values < 0.05 . Expert opinion coordination was therefore significant, and the consultation results showed good scientificity and reliability.

Comprehensiveness and specialty specificity of the evaluation indicators

The rehabilitation nursing EPA system constructed in this study comprised seven first-level indicators, 20 second-level indicators and 46 third-level indicators. From a time-course perspective, it covered the whole process from patient admission and discharge to transfer to the community. In terms of content, it covered basic nursing, specialty assessment and specialty nursing techniques, indicating that the EPA indicators essentially covered the main nursing activities of undergraduate nursing students during rehabilitation department internships. Indicator 1, health assessment, included both general assessment and rehabilitation nursing specialty assessment. Indicator 2.2, rehabilitation specialty nursing, reflected nursing techniques specific to the rehabilitation department. Indicator 7.4 described patient rehabilitation referral. The construction of the indicator system was consistent with the requirements of undergraduate rehabilitation nursing textbooks, namely that rehabilitation nursing should include the content of basic nursing while highlighting the characteristics of rehabilitation nursing. Nursing care without rehabilitation characteristics cannot be considered rehabilitation nursing. Therefore, the indicator system showed good specialty specificity.

Practicality and feasibility of the evaluation indicators

The evaluation indicator system constructed in this study was a competency-oriented teaching design, which is fully consistent with the competency-based educational philosophy of third-generation medical education reform [20]. The formulation of EPAs for undergraduate nursing students should focus on basic and comprehensive key clinical activities, enabling the EPAs to meet students' learning expectations, satisfy clinical requirements and support comprehensive evaluation of students' clinical nursing competence according to expected entrustment levels [10]. The rehabilitation nursing EPA indicators developed in this study covered all clinical nursing scenarios encountered by interns in the rehabilitation department. The indicators were observable, could be evaluated at any time in the daily work of undergraduate nursing students, and could accurately assess clinical nursing competence [21]. In addition, the expected entrustment levels established in this study can help students select rehabilitation nursing practices according to their own entrustment level and focus their learning selectively. They can also help clinical instructors conduct formative evaluation [22]. Overall, the rehabilitation nursing EPA evaluation indicator system constructed in this study is suitable for undergraduate nursing students' rehabilitation nursing internship teaching environments and is practical and feasible.

Recognition by supervisors and undergraduate nursing students

In this study, the constructed rehabilitation nursing EPA evaluation indicators were used to evaluate undergraduate nursing interns, and the total EPA score was 83.07 ± 3.91 . Because the expected entrustment levels of the 20 EPAs differed, the expected score corresponding to each indicator also differed. Therefore, total scores should not be used directly to classify students' ability levels. According to the expected entrustment levels of each EPA and the scoring rules, the expected total score of the 20 indicators was 82, while the actual mean score in this study was 83.07. This indicates that the overall entrustment level was close to the expected requirement. However, the total score may obscure differences in ability across professional activities, so actual scores and expected scores for individual EPAs should still be analysed in detail.

Among the EPAs, the expected entrustment level for cross-infection prevention was level 4, corresponding to an expected score of 7. The actual score was 7.37 ± 0.49 , reaching the expected level and suggesting that students performed well in hand hygiene and cross-infection prevention. The expected entrustment levels for identifying disease deterioration, identifying equipment alarms, emergency response to sudden events, medical-order processing process and medical-order processing outcome were all level 2, corresponding to an expected score of 3. Their actual scores were 2.68 ± 0.47 , 2.63 ± 0.49 , 2.67 ± 0.48 , 2.79 ± 0.41 and 2.65 ± 0.48 , respectively, all slightly below the expected level. This suggests that students still need strengthening in disease-condition recognition, equipment alarm judgement, emergency response and medical-order processing. These professional activities are highly integrated and involve relatively high clinical risk. In addition to relevant knowledge and skills, students also need clinical judgement, risk recognition and teamwork ability. Therefore,

clinical teaching should include more simulation, case-based teaching and practical opportunities under stratified supervision to improve students' ability to manage complex clinical situations.

The expected entrustment level for specialty assessment was level 3, corresponding to an expected score of 5, and the actual score was 5.38 ± 0.49 . The expected entrustment level for specialty nursing was level 2, corresponding to an expected score of 3, and the actual score was 3.24 ± 0.43 . Both met or slightly exceeded the expected level. These findings preliminarily indicate that students basically met the expected internship requirements in specialty assessment and specialty nursing, but further validation with larger samples and multicentre studies is still needed.

Undergraduate nursing students' importance score for EPAs was 91.26 ± 3.41 , and their evaluation-effect score was 46.12 ± 2.87 , indicating good acceptability and recognition of the evaluation indicator system. EPAs use clinical practice activities as the carrier of evaluation, helping students clarify internship learning goals and the entrustment levels required for different professional activities, while also providing a reference for clinical instructors to conduct formative evaluation and provide targeted feedback. However, the sample size in this study was small, and students' evaluations may have been affected by social desirability bias. Therefore, the application effect of the system needs further examination in larger samples.

Limitations and future directions

This study has several limitations. The consultation experts were all from tertiary grade A hospitals in Shandong Province and were all female nursing experts. The regional distribution, sex composition, professional composition and institutional levels were relatively limited, which may constrain expert representativeness. In addition, the preliminary clinical application used cluster sampling, the sample source was narrow and the sample size was small. To date, only internal consistency, preliminary feasibility and user acceptability of the indicator system have been evaluated, and its structural validity, inter-rater reliability and cross-institutional applicability have not been fully examined. Future studies should include experts from different regions, institutions at different levels, and different sexes and professional backgrounds, including rehabilitation physicians, rehabilitation therapists and nursing education experts. Multicentre, large-sample studies should also be conducted to further examine the reliability, validity, inter-rater consistency and clinical application effects of the indicator system, and to continuously revise and improve it according to research findings.

Conclusions

Based on literature analysis, focus group interviews and Delphi expert consultation, this study constructed a rehabilitation nursing EPA evaluation indicator system for undergraduate nursing interns. The system included seven first-level indicators, 20 second-level indicators and 46 third-level indicators, and established expected entrustment levels for undergraduate nursing students during rehabilitation internships. Preliminary clinical application indicated that the system was practical and well recognized. Expert consultation results showed high expert enthusiasm and authority, with good consistency of

expert opinions. Preliminary application results indicated that the indicator system had certain feasibility and user acceptability and may provide a reference for competency evaluation and clinical teaching in rehabilitation nursing among undergraduate nursing interns.

Abbreviations

AMEE

Association for Medical Education in Europe

Ca

Judgement basis coefficient

Cr

Expert authority coefficient

Cs

Familiarity coefficient

Cv

Coefficient of variation

EPAs

Entrustable professional activities

EQual

EPA Quality

VTE

Venous thromboembolism

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Bio-medical Research Ethics Committee of Hunan Normal University (Ethics No.: 2024-381). All procedures complied with the Declaration of Helsinki. Written informed consent was obtained from all participants (undergraduate nursing interns and expert panel members) prior to data collection. Participants were informed that participation was voluntary and they could withdraw from the study at any time without penalty.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

Junying Qian: Writing – original draft, Resources, Methodology, Investigation. Yan Wang: Writing – review & editing, Supervision, Project administration. Xiaoqing Si: Resources. Ruixin Wang and Yiyang Zhu: Methodology. Dongxu Liu and Yue Sun: Investigation. Yun Li and Xin Zhang: Writing – review & editing.

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

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