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ORIGINAL RESEARCH

Development of a Clinical Management Pathway for Perioperative Nutritional Risk in Elderly Patients with Hip Fractures

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Objective: The nutritional challenges faced by elderly patients with hip fractures during the perioperative period are significantly associated with clinical outcomes. This study aims to develop a clinical management pathway tailored for elderly hip fracture patients at nutritional risk during the perioperative period, with the objectives of enhancing patient management precision, reducing the duration of hospitalization, and minimizing associated healthcare costs.

Methods: Based on the perioperative time sequence, nursing process framework, and the five-step principle of nutritional diagnosis and treatment, literature review, Delphi method, and priority graph method were employed to determine the content and hierarchical weight indicators of the clinical management pathway for this patient population.

Results: A total of 20 experts participated in two rounds of Delphi consultation, with effective response rates of 100% in both rounds. The authority coefficients of the experts were 0.890 and 0.923; the coefficient of variation ranged from 0.045 to 0.226 and 0 to 0.247, and the Kendall's W coefficients were 0.575 and 0.22 ($P < 0.001$), respectively. The finalized clinical management pathway included 6 primary indicators, 18 secondary indicators, and 103 tertiary indicators.

Conclusion: The constructed clinical management pathway for elderly hip fracture patients at nutritional risk during the perioperative period is scientifically sound, comprehensive in content, and highly specialized. It offers a valuable reference for nutritional management and represents a meaningful step toward precise clinical care in this patient population.

Keywords: hip fracture, aged, delphi technique, nutrition assessment, critical pathways

Introduction

Hip fracture (HF) in the elderly is a significant burden on healthcare expenditure and is associated with high mortality rates and loss of functional independence.[1] The incidence rate of hip fractures is on the rise. By the year 2050, it is projected that the annual number of new hip fracture cases will range from 500,000 to 1 million, with the associated costs estimated to be between 10.3 billion and 15.2 billion US dollars per year.[2] Within the European population aged 50 and above, the risk of experiencing a hip fracture is comparable to that of suffering a stroke.[3,4] Surgical intervention is essential for the restoration of mobility and joint function in affected individuals. Nevertheless, challenges such as prolonged hospitalization and a high risk of complications impose significant demands on perioperative management.[2] Furthermore, the prevalence of malnutrition among patients with hip fractures is reported to be as high as 81.2%.[5] Malnutrition is not only a major risk factor for the occurrence of hip fractures in older adults but also a key determinant of poor prognosis. Numerous studies[6–8] have demonstrated that malnutrition during the perioperative period in elderly HF patients contributes to muscle mass loss, impaired hip function recovery, and even increased mortality, thereby further escalating healthcare costs and challenging

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current payment models.[9] Early nutritional intervention and effective prevention of malnutrition have been shown to improve functional outcomes following hip fracture in older adults.[10] Proactively addressing malnutrition presents a significant challenge for hospitals, health insurance providers, and patients alike.

Nutritional risk screening is the first step in the diagnosis of malnutrition, helping to identify patients at risk who may benefit from targeted nutritional support.[11] Clinical guidelines and national basic health insurance documents[12,13] suggest that patients with nutritional risk but without established malnutrition can still benefit from standardized nutritional interventions, and that nutritional management prior to the onset of malnutrition can yield greater economic benefits. Improving quality and controlling costs have become central themes in hospital management. Hospitals must adapt their linkage mechanisms and management philosophies in accordance with evolving health insurance policies, implementing refined management strategies through institutional support. This shift poses new demands on clinical care and nursing practices, as conventional clinical management models are no longer adequate under the current healthcare reform landscape.[14]

At present, there is no established clinical management pathway specifically targeting elderly patients with hip fracture who are at nutritional risk during the perioperative period. Based on the researchers' previous work,[15] this study aims to develop a scientific, comprehensive, and feasible clinical management pathway by integrating the best available evidence with the Delphi expert consultation method. This initiative represents a meaningful attempt to promote refined patient management in the context of contemporary healthcare reform.

Methods

Establishment of the Research Team

The research team consisted of orthopedic clinicians, senior financial administrators, clinical dietitians, nutrition support specialist nurses, and master's degree nursing students. Specifically, the team included one head nurse, one chief orthopedic physician, one chief physician from the clinical nutrition department, one clinical dietitian, one head of the hospital's financial management department, one ward head nurse, one nutrition support specialist nurse certified by the Chinese Nursing Association, one in-hospital senior nutrition support nurse, and two full-time postgraduate nursing students. The team was responsible for drafting the initial version of the clinical pathway, designing the expert consultation questionnaire, selecting Delphi panel experts, conducting the consultation process, and organizing, summarizing, and analyzing expert feedback. Ethical approval for all procedures was obtained from the ethics committee of Henan Provincial People's Hospital[Approval No.EC-2022-68]. Each participant in the study have given full informed consent and the study complies with the Declaration of Helsinki.

Literature Review

Chinese search terms including "hip fracture", "femoral neck fracture", "intertrochanteric fracture", "subtrochanteric fracture", "nutrition", "nutritional risk", "nutrition management", "nutritional support", and "nutritional supplementation" were used in parallel with English search terms such as "femoral neck fracture", "hip fracture", "nutrition", "nutritional therapy", "nutrition management", "nutritional support", and "nutritional supplement". A comprehensive computerized literature search was conducted in the following databases: UpToDate, BMJ Best Practice, Joanna Briggs Institute (JBI) Evidence-Based Healthcare Database, American Society for Parenteral and Enteral Nutrition (ASPEN), European Society for Clinical Nutrition and Metabolism (ESPEN), Chinese Society for Parenteral and Enteral Nutrition (CSPEN), Cochrane Library, CINAHL, Web of Science, PubMed, Embase, CNKI, Wanfang Data, CBM, and VIP. The search time frame covered all publications from database inception to March 2024. The study population comprises elderly patients with hip fractures (aged≥65 years). The research topics encompass nutritional risk screening, nutritional assessment, nutritional support, nutritional management, and other related nutritional areas. The types of research include clinical decision-making, evidence-based guidelines, expert consensus, recommended practices, evidence summarization, and systematic reviews. Publications are considered in both Chinese and English. The search period extends from January 1, 2014, to March 31, 2024. An example of a literature retrieval strategy utilizing the PubMed, (((((“Hip Fractures”[Mesh]) OR (hip fracture*[Title/Abstract] OR femoral neck fracture*[Title/Abstract] OR intertrochanteric fracture*[Title/Abstract] OR subtrochanteric fracture*[Title/Abstract])) AND ((“Aged”[Mesh:NoExp] OR “Aged, 80

and over"[Mesh]) OR (elderly[Title/Abstract] OR geriatric[Title/Abstract] OR (older[Title/Abstract] AND (adult*[Title/Abstract] OR people[Title/Abstract] OR patient*[Title/Abstract])) OR senior*[Title/Abstract] OR "aged"[Title/Abstract] OR "65 and over"[Title/Abstract] OR "≥65"[Title/Abstract]))) AND (((("Nutritional Status"[Mesh] OR "Malnutrition"[Mesh] OR "Nutrition Therapy"[Mesh]) OR (nutrition*[Title/Abstract] OR malnutrit*[Title/Abstract] OR undernutrit*[Title/Abstract] OR "nutritional risk"[Title/Abstract] OR "nutritional assessment"[Title/Abstract] OR "nutritional support"[Title/Abstract] OR "nutritional intervention*"[Title/Abstract] OR "dietary supplement*"[Title/Abstract] OR "oral nutritional supplement*"[Title/Abstract] OR ONS[Title/Abstract] OR "enteral nutrition"[Title/Abstract] OR "parenteral nutrition"[Title/Abstract]))))) AND (("Practice Guideline"[Publication Type] OR "Consensus Development Conference"[Publication Type] OR "Systematic Review"[Publication Type] OR "Meta-Analysis"[Publication Type] OR "Review"[Publication Type] OR ("best practice"[Title/Abstract] OR "evidence summary"[Title/Abstract] OR "clinical pathway"[Title/Abstract] OR "care pathway"[Title/Abstract] OR "management pathway"[Title/Abstract])))) AND ("2014/01/01"[Date - Publication]: "2024/03/31"[Date - Publication]).The detailed search strategy is outlined in Supplementary Material 1.Two researchers certified in evidence-based practice independently conducted the literature search, screening, and quality appraisal using a back-to-back approach. Any disagreements were resolved through expert consultation with an evidence-based practice specialist. A total of 1840 articles were initially retrieved. After removing duplicates, screening titles and abstracts, reading full texts, and performing quality evaluations, 16 articles were finally included (Figure 1). Relevant indicators were extracted from the included literature and combined with clinical realities. Guided by the perioperative time sequence in surgical nursing, the nursing process, and the five-step framework for nutritional diagnosis and treatment, the main dimensions and corresponding indicators of the clinical nursing pathway were established. Based on this structure, a preliminary draft of the clinical management pathway was developed for elderly patients with hip fractures at nutritional risk during the perioperative period. The pathway included 6 primary indicators, 18 secondary indicators, and 103 tertiary indicators. Primary indicators were constructed according

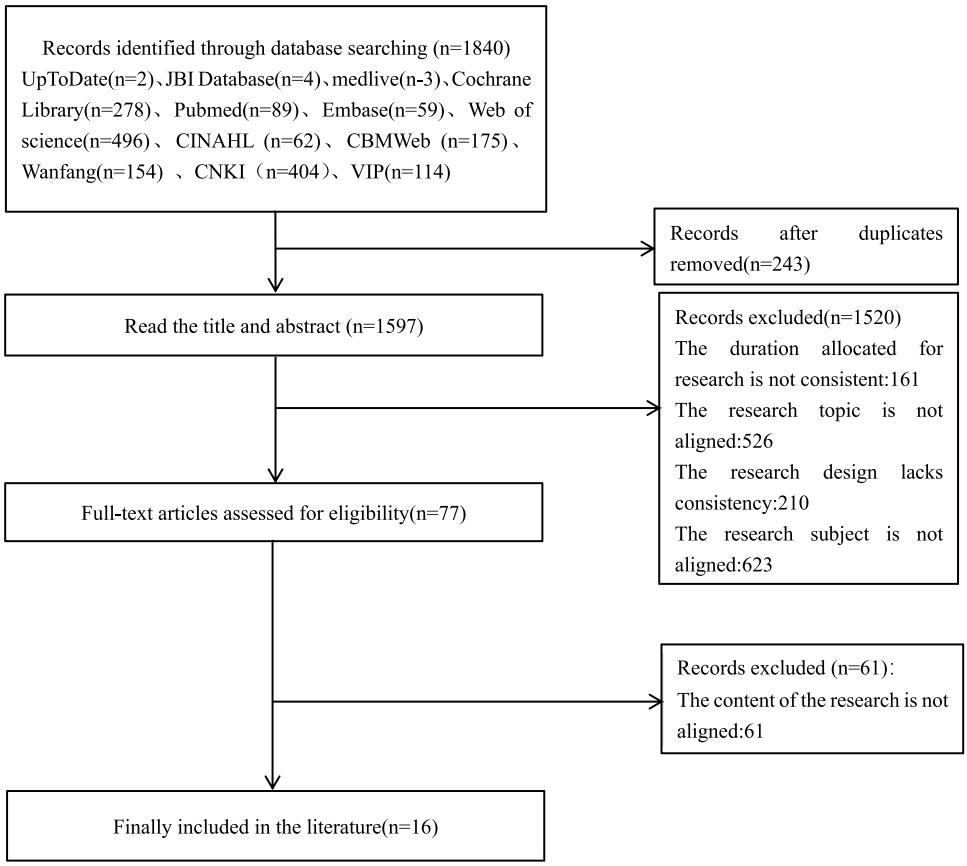

Figure 1 Flow chart of study selections.

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to the perioperative timeline, secondary indicators were guided by the nursing process, and tertiary indicators were based on the five-step principle of nutritional diagnosis and treatment.

Delphi Process

The expert consultation questionnaire consisted of three main sections :① Letter to Experts: This section introduced the background of the study, research objectives, content of the study, instructions for completing the questionnaire, and important notes, including the deadline for questionnaire submission. ② Expert Demographic Information Form: This form collected basic information such as the expert's age, educational background, professional title, area of specialization, and years of work experience. ③ Main Content: This section presented the specific content of each level of indicators along with a comments column for suggested modifications. Experts were asked to evaluate the importance of each indicator using a five-point Likert scale, ranging from "not important at all" to "very important" corresponding to a score of 1 to 5. ④ Self-assessment of Judgment Criteria and Familiarity Level: Experts were also required to provide a self-evaluation regarding the basis of their judgments and their familiarity with the topic.

Selection of Delphi Panel Experts

The inclusion criteria for expert selection were as follows: ① Holding a bachelor's degree or above; ② Possessing an intermediate or senior professional title; ③ Working in clinical orthopedics, nursing, nutrition, or financial management in a tertiary Grade A general hospital in China;④Having at least five years of clinical experience in a hospital setting; ⑤ Demonstrating interest in the research topic and a high level of engagement; ⑥ Willingness to voluntarily participate in the Delphi consultation.

Implementation of the Delphi Expert Consultation

The expert consultation was conducted from October to December 2024. Questionnaires were distributed via email, WeChat, or in-person delivery of printed copies. Each round of the Delphi questionnaire was required to be returned within two weeks. The quality of the returned questionnaires was verified, and Email reminders were sent to experts who submitted incomplete responses, unclear answers, or failed to respond within the specified timeframe. Upon collection, all questionnaire data were organized and summarized by members of the research team. Based on expert feedback and the predefined screening criteria, revisions—including additions, deletions, or modifications—were made to the indicators. The Delphi process concluded when expert opinions reached consensus. A total of two rounds of consultation were conducted in this study (Figure 2). The criteria for indicator selection were as follows: Mean importance score ≥ 3.5, Coefficient of variation ≤ 0.25.[16,17]

Statistical Analysis

Microsoft Excel 2021 was used to establish the database, and statistical analysis was performed using IBM SPSS Statistics (Version 26.0; IBM Corp., Armonk, NY, USA). All data were double-checked by two researchers before entry to ensure accuracy. Descriptive statistics for categorical variables were expressed as frequencies and percentages, while continuous variables were presented as arithmetic means and standard deviations. The degree of coordination among expert opinions was assessed using the coefficient of variation (CV) and Kendall's coefficient of concordance (W). The authority level of the experts was represented by the authority coefficient (Cr), calculated as the average of the judgment basis (Ca) and the familiarity level (Cs): $Cr = (Ca + Cs)/2$. The priority graph method was used to construct the judgment matrix and to determine the weight and combined weight of each level of indicators. A two-sided P-value of <0.05 was considered statistically significant.

In this paper, the calculation of weights employs the priority diagram method. The primary steps of this calculation method are as follows: Prior to the second round of inquiry, a priority chart form is designed, and all experts participating in the second round are required to evaluate the importance of the first-level indicators based on a pairwise comparison matrix. In the simplified order chart, the vertical column on the left denotes the comparator, while the horizontal row at the top signifies the compared object. The diagonal line, representing self-comparison, does not require any input. The order chart utilizes three numerical values—1, 0, and 0.5—to express pairwise comparisons: a value of 1 indicates that the comparator is more important than the compared object; a value of 0 signifies that the comparator is less important than the compared

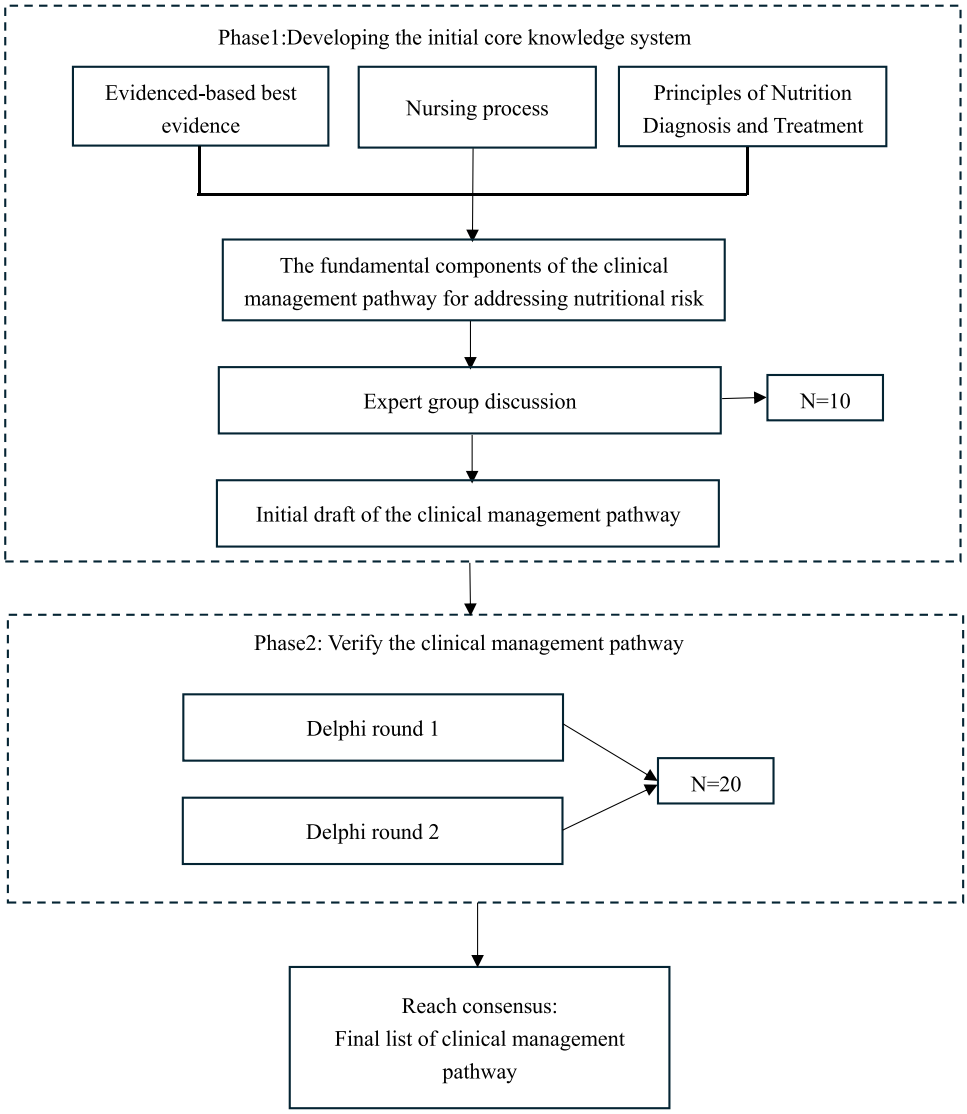

Figure 2 Research trajectory.

object; and a value of 0.5 denotes that both are equally important.For instance, when conducting a comparative analysis between item A and item B, the following procedure should be followed: if item A is deemed more important than item B, input "1" in the second column of the first row and "0" in the first column of the second row. Conversely, if item A is considered less important than item B, input "0" in the second column of the first row and "1" in the first column of the second row. In cases where both items are regarded as equally important, input "0.5" in both the second column of the first row and the first column of the second row. This scoring system is utilized to calculate the weight coefficient of the primary-level indicator. The weight of secondary-level items is determined based on the importance attributed to them by the expert. The composite weight coefficient of a secondary-level item is calculated as the product of its weight and the corresponding weight of the primary-level item. The methodology for determining the weight and composite weight coefficient of tertiary-level items mirrors that of secondary-level items, where the composite weight of tertiary-level items is the product of their weight and the corresponding composite weight of secondary-level items.

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Results

Basic Information of Delphi Experts

A total of two rounds of Delphi expert consultation were conducted in this study. Ultimately, 20 experts were selected from tertiary grade A general hospitals in four regions of China: Beijing, Guangzhou, Henan Province, and Inner Mongolia. The experts specialized in orthopedics, nursing, nutrition, and financial management. The average age of the experts was (39 ± 6.04) years, and their average length of professional experience was (13.9 ± 8.44) years. Among them, 10 held senior professional titles and 10 held intermediate titles. Regarding educational background, 6 held doctoral degrees, 11 held master's degrees, and 3 held bachelor's degrees. The panel included 9 clinical orthopedic experts, 5 clinical nursing experts, 5 clinical dietitians, and 1 senior financial management expert.

Expert Enthusiasm, Authority, and Degree of Consensus

Two rounds of expert consultation were conducted in this study. In the first round, 20 questionnaires were distributed and 20 valid questionnaires were returned; in the second round, 20 questionnaires were again distributed and 20 valid questionnaires were returned, resulting in a 100% response rate for both rounds. In the first and second rounds, 13 experts (65%) and 7 experts (35%), respectively, provided constructive feedback and suggestions. An authority coefficient exceeding 0.7 is deemed effective, thus confirming that the selected experts satisfy the criteria for participation in the Delphi study.[16,18] The authority coefficients from the two rounds of inquiry, as presented in Table 1, demonstrate that the experts possess substantial authority, representativeness, and credibility within the context of the inquiry. Furthermore, the coefficient of variation, the degree of expert opinion coordination, and the chi-square value ($P<0.001$) from both rounds of inquiry (Table 1) suggest a high level of consistency and coordination among the experts across various indicators, with a statistically significant P value of less than 0.001.[16,18]

Results of the Delphi Expert Consultation

Following the first round of expert consultation, revisions were made to the pathway indicators based on the predefined screening criteria, expert feedback, and research team discussions, including the addition of 7 indicators such as psychosocial factors assessment, health education on prevention of potential adverse complications, selection of nutrition education content based on the nutrition ladder, timing and safety evaluation of the first postoperative oral intake, health education on prevention of prosthesis dislocation, adjustment of the nutrition ladder if dietary intake fails to meet target requirements, and selection of appropriate oral nutritional supplement formulations based on comorbidities and laboratory indicators; refinement of 1 indicator by revising "provide enteral nutrition for patients unable to eat orally and without contraindications" to for patients unable to eat orally and without contraindications to enteral nutrition, a nasogastric or nasoenteric tube may be placed to initiate enteral nutrition; modification of 28 indicators, for example, changing "comorbidities" to "Charlson Comorbidity Index" "gastrointestinal disease and digestive function assessment" to "assessment of gastrointestinal, swallowing, and digestive function" "muscle strength and blood circulation of affected limb" to "assessment of neural function and blood circulation in the affected limb" "no nutritional risk, re-screen weekly" to "no nutritional risk, re-screen weekly or postoperatively" "patients unable to tolerate enteral nutrition, provide parenteral nutrition" to "patients with contraindications to enteral nutrition should receive parenteral nutrition" "evaluate auxiliary examination results" to "evaluate prognostic nutritional index and creatinine/height index based on laboratory findings" "instruct patients to fast for 8 hours and abstain from liquids for 2 hours preoperatively" to "guide preoperative fasting and fluid restriction time based on anesthesia assessment" "instruct on high-calorie, vitamin-rich, high-fiber, and

Table 1 Expert Enthusiasm, Authority Coefficient, and Degree of Consensus

Round	Expert Authority Coefficient	Coefficient of Variation	Degree of Consensus (Kendall's W)	χ^2 Value
First round	0.890	0.045~0.226	0.575	1482.32
Second round	0.923	0~0.247	0.22	449.731

easily digestible diet" to "instruct on high-calorie, easily digestible, and nutrient-dense diet" "assess anemia based on skin and mucosal color" to "assess anemia in conjunction with complete blood count results" "gait training, strengthen muscle power to prevent falls and hip dislocation" to "gait training, progressively strengthen muscle power" and "relationship between malnutrition and poor outcomes of hip fracture" to "patient education on the relationship between nutritional status and poor hip fracture outcomes"; and deletion of 27 indicators.

Following the second round of expert consultation, five indicators were revised as follows: "Assessment of gastrointestinal, swallowing, and digestive function" was revised to "Assessment of swallowing and gastrointestinal function"; "Patient education on the relationship between nutritional status and poor hip fracture outcomes" was revised to "Patient education on the relationship between nutritional status and disease recovery"; "Implementation of ONS nutritional assessment and monitoring" was revised to "Implementation of nutritional assessment and outcome monitoring"; "Assessment of pre-discharge nutritional intake and proportion" was revised to "Assessment of target nutritional intake achievement before discharge"; and "Guidance on post-discharge nutritional indicator monitoring" was revised to "Monitoring of post-discharge nutritional status." Based on these revisions, the final version of the clinical nursing pathway for elderly hip fracture patients at nutritional risk during the perioperative period under the DIP payment model was established, consisting of 6 primary indicators, 18 secondary indicators, and 103 tertiary indicators, with indicator weights and combined weights determined by integrating the Delphi consultation results with the priority graph judgment matrix, as shown in Table 2.

Our indicators encompass three dimensions, comprising a total of six primary indicators. Experts emphasize the significance of weight coefficients particularly on the 7th day of admission (discharge day), the 1st day of admission, and the 4th day of admission (postoperative 1st day). These days are crucial for arranging the patient's pre-discharge nutrition plan, implementing the patient's home nutrition rehabilitation plan, conducting the initial comprehensive evaluation post-admission, and reassessing the patient's nutritional status on the first day following surgery. Additionally, there are 18 secondary indicators. Analysis of the combined weights reveals that the successful implementation of the pathway hinges on the execution of the clinically determined nursing plan, alongside the education and evaluation of this plan. This involves dimensions such as nursing evaluation, nursing planning and implementation, and health education. A total

Table 2 Clinical Nursing Pathway for Elderly Hip Fracture Patients at Nutritional Risk During the Perioperative Period

		Tertiary Indicators (Relevant Items in the Pathway Form)	Importance Rating		Weight
			Importance Score (Points, Mean ± SD)	Coefficient of Variation	
I. Day 1 of Admission			4.5±0.51	0.114	0.1883
	I-1. Nursing Assessment		4.6±0.6	0.13	0.0109
		I-1-1. Age, vital signs, oxygen saturation, etc.	5.00	0	0.0007
		I-1-2.Body mass index (BMI)	4.7±0.73	0.156	0.0006
		I-1-3.Charlson Comorbidity Index	4.45±0.76	0.171	0.0005
		I-1-4.Medication status	4.9±0.31	0.063	0.0006
		I-1-5.Cognitive function assessment	4.95±0.22	0.045	0.0006
		I-1-6.Pain assessment	4.8±0.41	0.085	0.0006
		I-1-7.Oral and chewing function assessment	4.95±0.22	0.045	0.0006
		I-1-8.Swallowing and gastrointestinal function assessment	4.35±0.81	0.187	0.0005
		I-1-9.Nutritional Risk Screening	4.75±0.55	0.116	0.0006
		I-1-10.Assessment of Neural Function and Blood Circulation in the Affected Limb	4.4±0.6	0.136	0.0006
		I-1-11.Psychosocial Factors Assessment	4.25±0.55	0.129	0.0006

(*Continued*)

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Table 2 (Continued).

		Tertiary Indicators (Relevant Items in the Pathway Form)	Importance Rating		Weight
			Importance Score (Points, Mean ± SD)	Coefficient of Variation	
	I-2. Nursing Planning and Implementation		4.8±0.41	0.085	0.0118
		I-2-1.Medical History Collection	4.8±0.52	0.109	0.0007
		I-2-2.Dietary Intake Assessment	4.85±0.49	0.101	0.0007
		I-2-3.Anthropometric Measurements	4.5±0.61	0.135	0.0006
		I-2-4.Nutritional Evaluation	4.85±0.49	0.109	0.0007
		I-2-5.Calculation of Energy and Protein Targets: 20–25 kcal/(kg·d) for energy, 1.2–1.5 g/(kg·d) for protein	4.8±0.52	0.109	0.0007
		I-2-6.For Patients with Dysphagia: Adjustment of Food Texture and Liquid Consistency	5.00	0	0.0007
		I-2-7.Patient Participation (Based on Willingness): Development of a Balanced Dietary Guidance Plan	4.9±0.31	0.063	0.0007
		I-2-8.Respiratory Function Training	4.4±0.6	0.136	0.0006
		I-2-9.Turning with Traction Position Alignment	4.15±0.81	0.196	0.0005
		I-2-10.Full-Range Joint Movement and Functional Exercises for Both Upper Limbs and the Unaffected Lower Limb	4.25±0.79	0.185	0.0006
	I-3.Health Education		4.35±0.67	0.154	0.0099
		I-3-1.Health Education on the Relationship Between Nutritional Status and Disease Recovery	4.15±0.88	0.211	0.0004
		I-3-2.Health Education on the Relationship Between Nutritional Status and Disease Recovery	4.45±0.61	0.136	0.0005
		I-3-3.Instruction on Proper Expression of Pain	4.3±0.73	0.17	0.0005
		I-3-4.Non-Pharmacological Methods and Techniques for Pain Relief	4.4±0.6	0.136	0.0005
		I-3-5.Education on High-Quality Protein Diets	4.85±0.37	0.076	0.0006
II. Day 2 of Admission (Preoperative)			4±0.56	0.14	0.1317
	II −1. Nursing Assessment		4.05±0.76	0.187	0.0057
		II-1-1. Assessment of Prognostic Nutritional Index and Creatinine-to-Height Index Based on Auxiliary Examination Results	4.5±0.51	0.114	0.0004
		II-1-2.Evaluation of Bowel and Bladder Function	4.5±0.51	0.114	0.0004
		II-1-3.Assessment for the Presence of Removable Dentures	4.25±0.64	0.15	0.0004
		II-1-4.Evaluation of 24-Hour Dietary Intake	4.85±0.37	0.076	0.0005
	II −2Nursing Planning and Implementation		4.25±0.44	0.105	0.0073
		II-2-1.Guidance on Necessary Skin Cleaning	3.95±0.95	0.239	0.0003
		II-2-2.Instruction on Removal of Removable Dentures	4.05±0.95	0.233	0.0004
		II-2-3.Establishment of a Multidisciplinary Nutrition Support Team	4.75±0.55	0.116	0.0006

(*Continued*)

Table 2 (Continued).

		Tertiary Indicators (Relevant Items in the Pathway Form)	Importance Rating		Weight
			Importance Score (Points, Mean ± SD)	Coefficient of Variation	
		II-2-4.For Patients with Normal Oral Intake: Provide Dietary Guidance	4.8±0.52	0.109	0.0006
		II-2-5.For Patients with Inadequate Oral Intake: Provide Dietary Guidance and Oral Nutritional Supplementation	4.85±0.37	0.076	0.0006
		II-2-6.For Patients with Inadequate Oral Intake: Provide Dietary Guidance and Oral Nutritional Supplementation	4.8±0.52	0.109	0.0006
		II-2-7.For Patients with Contraindications to Enteral Nutrition: Provide Parenteral Nutrition Support	4.8±0.41	0.085	0.0006
	II −3.Health Education		4.6±0.6	0.13	0.0076
		II-3-1.Selection of Nutrition Education Content Based on the Nutrition Ladder	4.85±0.49	0.101	0.0006
		II-3-2.Inform the Patient About the Surgical and Anesthesia Method	4.25±0.79	0.185	0.0005
		II-3-3.Provide Fasting and Fluid Restriction Instructions Based on Anesthesia Evaluation Results	4.8±0.41	0.085	0.0006
		II-3-4.Instructions and Purpose of Preoperative and Postoperative Cooperation	4.4±0.75	0.171	0.0006
		II-3-5.Prevention and Management of Common Postoperative Discomfort	4.85±0.49	0.101	0.0006
III. Day 3 of Admission (Day of Surgery)			4.55±0.51	0.112	0.1233
	III-1.Nursing Assessment		4.1±0.64	0.156	0.0059
		III-1-1.Timing and Safety Evaluation of First Postoperative Oral Intake	4.85±0.37	0.076	0.0005
		III-1-2.Trend of Nutrition-Related Laboratory Indicators	4.5±0.89	0.197	0.0004
		III-1-3.Pain Assessment	4.7±0.73	0.156	0.0005
		III-1-4.Urine Output Assessment	4.5±0.61	0.135	0.0005
		III-1-5.Sensory and Motor Function of Limbs	4.35±0.75	0.171	0.0005
		III-1-6.Blood Circulation in the Affected Limb	4.4±0.75	0.171	0.0005
	III-2.Nursing Planning and Implementation		4.75±0.44	0.094	0.0076
		III-2-1.Adjust Infusion Rate and Volume Based on the Patient's Hemodynamic Status	4.85±0.37	0.076	0.0007
		III-2-2.After Regaining Consciousness from Anesthesia, Guide the Patient to Sip Warm Water <50 mL per Time According to Swallowing Function	4.8±0.52	0.109	0.0006
		III-2-3.At 3–4 Hours Postoperatively, Assess Gastrointestinal Tolerance and Encourage Intake of Liquid Food, ≤200 mL per Time	4.7±0.57	0.122	0.0006
		III-2-4.At 6 Hours Postoperatively, Guide to Semi-Sitting Position, Assess Gastrointestinal Tolerance, and Increase Frequency and Volume of Intake	4.75±0.55	0.116	0.0006

(*Continued*)

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Table 2 (Continued).

		Tertiary Indicators (Relevant Items in the Pathway Form)	Importance Rating		Weight
			Importance Score (Points, Mean ± SD)	Coefficient of Variation	
		III-2-5.Oral Intake Should Follow a Gradual Progression: From Water → Clear Liquid → Thick Liquid → Semi-liquid → Soft → Regular Diet	4.9±0.31	0.063	0.0007
		III-2-6.After Regaining Consciousness, Perform Active Full-Range Joint Movement of the Unaffected Limbs	4.3±0.57	0.133	0.0006
		III-2-7.Prevent and Manage Gastrointestinal Discomfort in a Timely Manner	4.85±0.37	0.076	0.0007
		III-2-8.Comprehensive Nutritional Assessment; Discuss with Dietitian and Physician; Provide Oral Nutritional Supplementation if Dietary Intake Is Inadequate	4.75±0.55	0.116	0.0006
	III-3.Health Education		4.55±0.61	0.133	0.0071
		III-3-1.Education on Early Symptoms and Prevention of Nerve and Vascular Injury	4.35±0.59	0.135	0.0005
		III-3-2.Instruction on the Use of Patient-Controlled Analgesia (PCA) Pump	4.35±0.59	0.135	0.0005
		III-3-3.Education and Guidance on Oral Nutritional Supplementation	4.65±0.67	0.144	0.0006
		III-3-4.Education on Supine Positioning and Body Position Changes	4.3±0.66	0.153	0.0005
IV.Day 4 of Admission (Postoperative Day 1)			4.8±0.41	0.085	0.1783
	IV-1.Nursing Assessment		4.3±0.66	0.153	0.0093
		IV-1-1.Reassessment of Nutritional Risk	4.75±0.64	0.134	0.0005
		IV-1-2.Assessment of Postoperative Energy Expenditure and Metabolic Demands	4.7±0.66	0.14	0.0005
		IV-1-3.Assessment of Dietary Intake	4.9±0.31	0.063	0.0006
		IV-1-4.Evaluation of Whether Actual Intake Meets Target Energy and Protein Requirements	4.8±0.52	0.109	0.0005
		IV-1-5.Reassessment of Gastrointestinal Tolerance After Gradual Resumption of Eating	4.9±0.31	0.063	0.0006
		IV-2.Nursing Planning and Implementation	4.85±0.37	0.076	0.0113
		IV-2-1.Calculation of Postoperative Energy and Protein Targets: 25–30 kcal/(kg·d) for energy, 1.5–2.0 g/(kg·d) for protein	4.7±0.66	0.14	0.0006
		IV-2-2.Guidance on High-Calorie, Easily Digestible, and Nutrient-Dense Foods	4.85±0.37	0.076	0.0007
		IV-2-3.Adjustment of Nutrition Ladder When Dietary Intake Fails to Meet Target Requirements	4.8±0.52	0.109	0.0007
		IV-2-4.Selection of Appropriate Oral Nutritional Supplement Formulations Based on Comorbidities and Laboratory Indicators	4.75±0.55	0.116	0.0007
		IV-2-5.Proactive Management of Gastrointestinal Discomfort Symptoms	4.85±0.37	0.076	0.0007

(*Continued*)

Table 2 (Continued).

		Tertiary Indicators (Relevant Items in the Pathway Form)	Importance Rating		Weight
			Importance Score (Points, Mean ± SD)	Coefficient of Variation	
		IV-2-6.Recommended Daily Fluid Intake: ≥1.6 L for Elderly Women, ≥2.0 L for Elderly Men	4.35±0.59	0.135	0.0006
		IV-2-7.Instruction on Transfer Training (Supine to Sitting) and Assistance with Proper Positional Alignment	4.35±0.75	0.171	0.0006
		IV-2-8.Encourage Independent Bowel Movements	4.85±0.37	0.076	0.0007
	IV −3.Health Education		4.5±0.51	0.114	0.0105
		IV-3-1.Education on the Importance of Postoperative Protein Supplementation for Surgical Recovery	4.85±0.37	0.076	0.0006
		IV-3-2.Education on the Safety and Effectiveness of Position Transfers	4.4±0.76	0.171	0.0006
		IV-3-3.Education on Joint Exercise Methods and Precautions	4.85±0.49	0.101	0.0006
		IV-3-4.Education on Prevention of Prosthesis Dislocation	4.75±0.64	0.134	0.0006
V.Day 5–6 of Admission (Postoperative Days 2–3)			4.9±0.31	0.063	0.1483
	V-1.Nursing Assessment		4.65±0.49	0.105	0.009
		V-1-1.Assess Anemia in Conjunction with Complete Blood Count (CBC) Results	4.9±0.31	0.063	0.0007
		V-1-2.Dynamic Assessment of Pain After Analgesic Use, During Subsequent Activity, and Post-Rehabilitation Training	4.7±0.73	0.156	0.0006
		V-1-3.Observe Incision Healing Status	4.8±0.52	0.109	0.0006
		V-1-4.Observe Incision Healing Status	4.8±0.52	0.109	0.0006
	V-2.Nursing Planning and Implementation		4.85±0.37	0.076	0.0094
		V-2-1.Provide Guidance on a Diet Rich in Protein, Dietary Fiber, Vitamins, and Calcium	4.9±0.45	0.091	0.0007
		V-2-2.Correct Use of Oral Nutritional Supplements	4.8±0.62	0.128	0.0006
		V-2-3.Conduct Nutritional Assessment and Monitor Outcomes	4.15±0.93	0.225	0.0004
		V-2-4.Gradually Increase Out-of-Bed Activity Time	4.15±1.04	0.25	0.0004
		V-2-5.Gait Training and Progressive Muscle Strengthening Exercises	4.2±0.95	0.227	0.0005
	V-3.Health Education		4.3±0.47	0.109	0.0083
		V-3-1.Education on Balanced Diet Knowledge	4.25±0.97	0.227	0.0004
		V-3-2.Non-Pharmacological Measures to Improve Appetite	4.8±0.52	0.109	0.0006
		V-3-3.Education on Prevention of Incision Infection	4.8±0.52	0.109	0.0006
		V-3-4.Education on Fall Prevention	4.05±0.1	0.247	0.0004

(*Continued*)

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Table 2 (Continued).

		Tertiary Indicators (Relevant Items in the Pathway Form)	Importance Rating		Weight
			Importance Score (Points, Mean ± SD)	Coefficient of Variation	
VI.Day 7 of Admission (Day of Discharge)			4.15±0.59	0.141	0.2017
	VI-1.Nursing Assessment		4.2±0.77	0.183	0.0095
		VI-1-1.Assessment of Lower Limb Gait and Muscle Strength	4.2±0.95	0.227	0.0003
		VI-1-2.Evaluation of Follow-up Laboratory Test Results	4.65±0.67	0.144	0.0005
		VI-1-3.Assessment of Whether Pre-Discharge Nutritional Intake Meets Target Requirements	3.95±0.95	0.239	0.0003
		VI-2.Nursing Planning and Implementation	4.3±0.733	0.17	0.0101
		VI-2-1.Based on the Assessment Results, Collaboratively Confirm Post-Discharge Nutritional Support Goals and Plans with the Dietitian, the Patient, and the Primary Caregiver	4.9±0.31	0.063	0.0006
		VI-2-2.For Patients with Inadequate Nutritional Intake, Continue Oral Nutritional Supplementation of at Least 400 kcal/day and 30 g/day of Protein	4.3±0.92	0.215	0.0004
		VI-2-3.Monitor Post-Discharge Nutritional Status	4.15±0.88	0.211	0.0004
		VI-2-4.Provide Daily Living Guidance Based on the Patient's Self-Care Ability	4.15±0.93	0.225	0.0004
		VI-2-5.Develop a Post-Discharge Rehabilitation Plan Jointly with the Physician According to Patient Needs and Preferences	4.25±0.91	0.214	0.0004
	VI-3.Health Education		4.15±0.49	0.118	0.0105
		VI-3-1.Education on the Importance of Continued Nutritional Support After Discharge	4.75±0.64	0.134	0.0005
		VI-3-2.Education on the Importance of Continued Nutritional Support After Discharge	4.85±0.49	0.101	0.0006
		VI-3-3.Education on Improving Adherence to Nutritional Support	4.75±0.55	0.116	0.0005
		VI-3-4.Post-Discharge Exercise Guidance	3.9±0.91	0.234	0.0003
		VI-3-5.Monitoring for Complications	4.05±0.95	0.233	0.0003

of 103 tertiary indicators have been identified. Analysis of the combination weights reveals that the implementation and evaluation of clinical nutrition assessments, as well as nutrition-related intervention plans, constitute critical components and present significant challenges within the clinical nutrition management pathway. It is imperative that clinical practices are meticulously organized and seamlessly integrated at these crucial junctures.

Discussion

The Constructed Clinical Management Pathway for Elderly Hip Fracture Patients at Nutritional Risk During the Perioperative Period is Scientifically Sound and Reliable

This study was developed around the perioperative time sequence and based on the nursing process framework and the five-step principle of nutritional diagnosis and treatment.[19] Using literature analysis, the Delphi expert consultation method, and the priority graph method,[20] we constructed a clinical management pathway for elderly patients with hip

fractures who are at nutritional risk during the perioperative period. The theoretical foundation is well-established, and the research methods are rigorous. A total of 20 experts from hospitals with mature experience in managing such patients were selected to participate in two rounds of Delphi consultation, ensuring high representativeness. These experts possessed rich clinical experience in medicine, nursing, nutrition, and financial operations. Among them, 17 held a master's degree or above, and 10 had senior professional titles. The panel included orthopedic department directors, clinical nutrition department heads, financial department managers, directors of administrative offices, head nurses, nutrition support specialist nurses, and others with extensive practical and managerial experience. One of the consulted experts was the director of a health policy research department, who provided evaluation from the perspective of health policy and healthcare economics. The indicators of the constructed pathway were closely aligned with the real-world clinical context of perioperative care in elderly hip fracture patients. Secondary indicators were structured around nursing assessment, planning and implementation, health education, and evaluation. Tertiary indicators were developed in accordance with the five-step principle of nutritional diagnosis and treatment, incorporating a comprehensive assessment of each stage of the perioperative period and elaborating on the clinical significance of each time point and indicator. This clinical pathway emphasized early identification of nutritional risk, early intervention with nutritional strategies, and accelerated recovery, ultimately aiming to improve patients' nutritional status progressively. The effective recovery rate for both rounds of expert questionnaires was 100%, indicating high expert engagement. The authority coefficients of the experts were 0.890 and 0.923, reflecting a high degree of credibility. The coefficients of variation ranged from 0.045 to 0.226 and 0 to 0.247, while the Kendall's W coefficients were 0.575 and 0.22 (both $P < 0.001$), demonstrating good consistency among experts. The Kendall Harmony Coefficient is a measure used to assess the degree of agreement among multiple experts regarding a single indicator.[21] In this study, the complexity of the constructed nursing pathway led to a wide range of divergent opinions among experts during the initial round of evaluation. However, following the second round of expert consultation, discrepancies in opinions regarding the pathway items significantly diminished, with the majority of evaluations scoring 4 or 5 points. Consequently, the harmony coefficient for the second round of expert evaluations was lower than that of the first round. A review of the literature reveals similar findings in previously published studies.[16,22] For any unspecified issues, further critique and correction are encouraged.In addition, the priority graph method was used to assign weights and calculate the combined weights of each indicator level. In summary, the clinical management pathway developed in this study for elderly hip fracture patients at nutritional risk during the perioperative period is scientifically grounded, methodologically robust, and reliable. It provides a valuable reference for clinical practice.

The Constructed Clinical Management Pathway for Elderly Hip Fracture Patients at Nutritional Risk During the Perioperative Period is Comprehensive and Specialty-Oriented

The General Office of the State Council issued the "National Nutrition Plan (2017–2023)",[23] which emphasizes the importance of implementing clinical nutrition strategies, strengthening nutritional diagnosis and therapy, and improving the nutritional status of patients. This aligns well with the concept of Enhanced Recovery After Surgery (ERAS).[24] Nutritional status is closely associated with recovery and prognosis in patients with hip fractures. Malnutrition serves as both a risk factor and a prognostic determinant in elderly hip fracture patients.[7,8] However, a universally accepted and clear diagnostic criterion for malnutrition is still lacking.[25] Clinical studies have shown that implementing nutritional interventions in patients identified as at nutritional risk through screening yields favorable outcomes and aligns with the concept of cost-effective and precise healthcare management.[26,27] This study focuses on elderly hip fracture patients at nutritional risk during the perioperative period, aiming to initiate early nutritional support and establish a comprehensive perioperative nutritional care pathway from admission to discharge. By intervening before the onset of severe malnutrition-related complications, the pathway may help reduce hospitalization costs and overall hospital expenditure. Nutritional diagnosis and treatment in elderly hip fracture patients present unique challenges. Based on previous research,[15] this study developed a more targeted and specialized nutritional risk pathway as a sub-pathway of the main clinical care pathway. Given the advanced age and frequent comorbidities in this population, perioperative

complications are common,[5,28] making refined clinical management particularly difficult. In response to these challenges, a specialty-specific sub-pathway for nutritional risk management in elderly hip fracture patients was developed. Analysis of the pathway indicators and their weights suggests that perioperative nutritional risk management should prioritize nutritional risk screening and comprehensive assessment upon admission, implement dynamic monitoring, and set individualized energy and protein intake targets according to metabolic demands at different perioperative stages. Postoperative day 0 is often a neglected phase in nutritional support; during this period, patients have not yet recovered from surgical trauma, and insufficient dietary intake may lead to additional physiological stress, hindering recovery. Importantly, discharge-phase nutrition management received the highest indicator weight in this study. Previous research[29,30] has shown that insufficient energy and protein intake is common among patients recovering from hip fractures after discharge. Therefore, for elderly patients at nutritional risk, pre-discharge evaluation and home nutrition guidance should be emphasized.[31] In conclusion, the clinical management pathway developed in this study demonstrates comprehensiveness and specialty orientation. It provides valuable guidance for clinical practice in managing elderly hip fracture patients at nutritional risk during the perioperative period.

The Constructed Clinical Management Pathway Represents a Valuable Exploration Tailored to a Specific Patient Population and Real-World Clinical Context

In current clinical practice, perioperative nutritional management for elderly hip fracture patients tends to focus primarily on the diagnosis of malnutrition. However, according to the Nutritional Risk Screening 2002 (NRS-2002) tool, most patients in this population are already at nutritional risk and therefore require nutritional intervention.[11] It is important to note that nutritional risk screening is not equivalent to a diagnosis of malnutrition. In real-world clinical settings, healthcare providers often overlook early nutritional intervention, thereby increasing the likelihood of patients progressing to malnutrition, which adversely affects long-term prognosis and contributes to additional perioperative complications and unfavorable outcomes. A study by Jin Zhanping et al[32] reported that the incidence of nutritional risk among elderly hip fracture patients was 62.98%, and that patients identified as nutritionally at risk experienced higher rates of postoperative complications and prolonged hospital stays. Nutritional support strategies based on nutritional risk management have demonstrated significant clinical benefits.[33,34] Given the high prevalence of comorbidities in elderly hip fracture patients, there is an increasing demand for cost control and refined inpatient management. Clinical pathways, grounded in evidence-based medicine and continuous quality improvement, offer a standardized approach to care. They ensure that patients receive consistent and continuous medical services throughout hospitalization, playing a vital role in ensuring quality of care, enhancing efficiency, controlling costs, and reducing resource consumption. Therefore, this study focused specifically on perioperative patients at nutritional risk and developed a clinical pathway tailored to the characteristics of this patient population. It emphasizes early and detailed intervention, aligning with the five-step model of nutritional diagnosis and therapy. Starting with nutritional education, the pathway incorporates individualized nutrition assessments to guide the progressive implementation of enhanced dietary counseling, oral nutritional supplementation, enteral nutrition, and parenteral nutrition. This approach enables patients to receive standardized, cost-effective nutritional management during the perioperative period,[35] thereby reducing hospitalization expenses and alleviating the healthcare burden.

Regarding the implementation of the 103 indicators in a manner that does not overburden the staff, we propose the following approach. Certain elements within the clinical management pathway require enhancement and systematic evaluation in our routine practice, necessitating reinforcement in clinical operations. While some evaluative components are currently documented within the hospital's nursing information system, newly introduced elements, such as assessments of patients' medical histories and comorbidities, are now included in the admission nursing evaluation form. However, these records are often incomplete. To address this, it is essential to provide training for personnel on the application of the pathway form, refine the content that needs to be documented, and thereby improve subsequent assessments of nutritional status and disease severity. To confirm nutritional risks and associated pathways for nutritional interventions, we have developed a specialized form designed to record nutritional assessments and intervention measures. This form is strategically placed at the patient's bedside for daily review by the assigned nurse, integrating

seamlessly into our routine workflow. Nurses are required to maintain and update these records as part of their daily responsibilities. Concurrently, we are implementing this clinical management pathway in practice and systematically collecting pertinent data. The roles and systems related to the nutritional responsibilities of nursing staff are currently undergoing revision and enhancement. Numerous indicators necessitate further refinement and validation, underscoring the need for future research to inform measurement techniques and implementation strategies.

In the future, clinical practice efforts can be informed by the established clinical management pathway for elderly patients at perioperative nutritional risk due to hip fractures. Firstly, this pathway offers nursing managers a framework for developing management strategies and controlling critical processes. Secondly, it provides nursing staff with a comprehensive perspective for managing patients throughout the perioperative period, facilitating the practical application of nursing procedures. Additionally, the pathway enables the identification of high-risk patients and individualized nutritional risk factors through a thorough assessment, thereby allowing for the implementation of tailored nutritional interventions. Nonetheless, this pathway encompasses a substantial amount of content, necessitating the adaptation of its applicability to align with the specific research setting and patient characteristics in clinical applications. It is imperative to seamlessly integrate evaluation tools, intervention strategies, and effectiveness assessments. Furthermore, this integration should extend to workflows, systems, and management frameworks to alleviate workload and enhance operational efficiency.

Conclusion

The experts consulted in this study had extensive practical and managerial experience in clinical orthopedics, nursing, and nutritional therapy. In addition, health policy researchers, hospital operations managers, and financial management experts were invited to provide evaluations of the clinical pathway from the perspectives of hospital management and healthcare economics. Their proposed revisions and suggestions for the indicators offered valuable clinical insights. The final clinical management pathway developed for elderly hip fracture patients at nutritional risk during the perioperative period comprises 6 primary indicators, 18 secondary indicators, and 103 tertiary indicators. The content is comprehensive and scientifically grounded. However, the proposed pathway requires further validation in clinical practice to establish a more refined and mature system that can effectively accelerate patient recovery.

Disclosure

Weiyu Pan and Yu Xie are co-first authors for this study. The authors report no conflicts of interest in this work.

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