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ORIGINAL RESEARCH

Enhancing Perioperative Oral Nutritional Supplements in Elderly Hip Fracture Patients: A Pilot Project on Evidence-Based Practice

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Objective: This study aimed to integrate the most robust evidence on perioperative oral nutritional supplementation (ONS) for elderly patients with hip fractures into clinical practice and to evaluate its effectiveness.

Methods: Using an evidence-based continuous quality improvement model, we synthesized the best available evidence with the specific clinical context of the research institution, translated it into review indicators and implementation plans, and conducted a baseline audit to identify barriers and facilitators. Based on these findings, a targeted action plan was developed and implemented. Evidence-based interventions were incorporated into routine clinical practice from January 2024 to October 2024. Outcomes before and after implementation were compared, including medical staff knowledge of nutrition and related topics, discharge NRS2002 scores, discharge nutritional risk, serum albumin levels,prognostic nutritional index (PNI), length of hospital stay, number of complications, and adherence to review indicators.

Results: A total of 49 cases before and 44 cases after the implementation of evidence-based practice were analyzed. Post-implementation, adherence to the review indicators improved significantly, with overall compliance increasing from 0–10.7% to 25–100% ($P < 0.05$). Medical staff knowledge scores on nutrition and related topics increased significantly from (61.07±12.36) to (85.57±16.89) ($t = 6.195$, $P < 0.001$). In addition, after implementation, discharged patients showed significantly lower nutritional risk and NRS2002 scores, as well as improved PNI ($P < 0.05$). Although discharge serum albumin levels increased and both length of hospital stay and number of complications decreased, these changes did not reach statistical significance.

Conclusion: This pilot project demonstrates that implementing an evidence-based protocol for perioperative ONS in elderly hip fracture patients is both feasible and effective. The intervention significantly improved healthcare staff knowledge, enhanced adherence to care standards, and reduced patients' nutritional risk, thereby supporting faster recovery and promoting continuous quality improvement in nursing care.

Keywords: aged, hip fracture, oral nutritional supplementation, specialized medical formula foods, nutrition, evidence-based nursing practices

Introduction

Malnutrition is common in hospitalized elderly patients with hip fractures,[1,2] with reported prevalence rates as high as 81.2%.[3] It is not only an important etiological factor for hip fractures in this population but also a key determinant of prognosis and clinical outcomes. Inadequate energy and protein intake often persists into the post-discharge recovery phase.[4,5] Previous studies[6,7] have shown that hip fractures are associated with an increased risk of malnutrition, which in turn is linked to loss of muscle mass, muscle dysfunction, delayed joint function recovery, prolonged hospitalization, higher complication rates, and increased mortality. Malnutrition has been identified as an independent risk factor for mortality in patients with hip fractures.[8] Early nutritional intervention and effective prevention of malnutrition can

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improve functional recovery and long-term outcomes in this population.[9] Accordingly, current guidelines recommend that all elderly patients with hip fractures receive nutritional supplementation during hospitalization.[10]

Oral nutritional supplements (ONS) are used to enhance oral nutrient intake by adding nutrient-dense liquid, semi-solid, or powdered formulations to beverages or foods for consumption.[11] These preparations provide a range of macro- and micronutrients and may include enteral nutrition formulas, specialized medical foods, and multivitamin products.[12] According to the Five Steps of Nutritional Diagnosis and Treatment,[13] ONS is a key component of perioperative nutritional support for elderly patients with hip fractures. Building on previous work,[14] our team developed a clinical management pathway for elderly hip fracture patients at risk of perioperative nutritional deficiency. During its development and preliminary implementation, we found that, although general principles for ONS use were outlined, important aspects still required clarification. In particular, specific strategies for patient education, appropriate dosing, routes of administration, and selection of ONS types for different patient groups were not clearly defined. ONS is widely used in clinical practice, and although substantial evidence supports its use, the quality of this evidence is heterogeneous. Despite the recognized benefits of ONS, a standardized, evidence-based protocol for its perioperative management in this population and clinical setting is often lacking.[15–18]

To address this gap, we will conduct an exploratory, non-concurrent controlled pilot study. The implementation will follow the standard procedures of the evidence-based continuous quality improvement model developed by the Joanna Briggs Institute (JBI) Evidence-Based Nursing Collaborative Center at Fudan University.[19] Through four phases—evidence acquisition, status review, evidence implementation, and effectiveness evaluation—the best available evidence will be systematically translated into clinical practice. The study aims to assess the feasibility, acceptability, and preliminary effectiveness of applying best evidence for perioperative ONS in routine clinical care. It is jointly undertaken by the JBI Evidence-Based Nursing Collaborative Center and the Henan Evidence-Based Nursing Center. The project has been registered on the Fudan University Evidence-Based Nursing Center website (Registration No. ER20240689) and filed as an evidence-based nursing practice project with the Henan Provincial Key Laboratory of Nursing Medicine (Project No. HNSYXZKT202405).

Methods

Evidence Acquisition

Formulate Evidence-Based Questions

Using the PIPOST framework, the evidence-based questions were refined as follows. The population (P) consists of elderly patients with hip fractures aged 60–90 years. The interventions (I) include nutritional risk screening, nutritional assessment, dietary counseling, and oral nutritional supplementation. The professionals (P) responsible for implementing these interventions are orthopedic medical staff and clinical nutritionists. The expected outcomes (O) are improved nutrition-related knowledge among medical staff, higher adherence to review indicators, better NRS2002 scores, optimization of nutrition-related laboratory parameters, reduced length of hospital stay, and improved prognostic nutritional indices. The setting (S) is the Bone and Joint Center of a tertiary Grade A general hospital in Henan Province. The types of evidence (T) considered include clinical decision-making tools, evidence-based guidelines, expert consensus statements, recommended practice documents, evidence syntheses, and systematic reviews.

Formation of a Multidisciplinary Team

A seven-member task force was established to develop an evidence-based perioperative ONS practice protocol for elderly patients with hip fractures. The core team comprised one Orthopedic Department nurse manager (responsible for multidisciplinary coordination and overall supervision of the protocol), one ward nurse manager (responsible for protocol refinement and quality control), one orthopedic chief physician (responsible for clinical application and guidance), one attending physician from the Department of Clinical Nutrition (responsible for reviewing and guiding the research protocol), one evidence-based nursing expert (responsible for theoretical and methodological support and evaluation), and two full-time master's nursing students (responsible for evidence retrieval, indicator development, protocol implementation, and statistical analysis). Both students had received systematic training in evidence-based nursing and had relevant practical experience; one held the Johns Hopkins University China Evidence-Based Nursing Faculty

Qualification, the RANO-BPSO evidence-based training certificate from the Registered Nurses' Association of Ontario, and certificates from the Peking University JBI systematic review course and the Fudan University evidence-based theory and practice workshops, while the other held the Clinical Evidence-Based Nursing Practitioner Training Certificate from the Nanfang Hospital JBI Evidence-Based Nursing Collaborative Center. In addition, two orthopedic specialist nurses were responsible for implementing practice changes, quality control, and data collection. 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 has given full informed consent and the study complies with the Declaration of Helsinki.

Systematic Retrieval of Evidence

Evidence was retrieved hierarchically according to the "6S" evidence pyramid model. Search terms included: hip fracture, femoral neck fracture; nutrition, nutritional therapy, nutrition management, nutritional support, nutritional supplementation, enteral nutrition; and guideline, systematic review, meta-analysis, evidence summary, expert consensus. The search period extended from 1 January 2014 to 31 March 2024. In total, 16 articles met the inclusion criteria, comprising one recommended practice article,[18] two clinical decision-making articles,[20,21] three evidence summaries,[22–24] four expert consensus documents,[15,25–27] and six clinical practice guidelines.[28–33] Taking the Cochrane Library as an example, the specific search strategy was: MeSH descriptor: [hip fracture] explode all trees OR (femoral neck fracture): ti,ab,kw OR (hip fracture*): ti,ab,kw AND MeSH descriptor: [Dietary Supplements] explode all trees OR (dietary supplementation): ti,ab,kw OR (protein supplement*): ti,ab,kw OR (oral nutritional supplement): ti,ab,kw OR (oral nutrition supplement*): ti,ab,kw OR (oral nutrition): ti,ab,kw OR (postoperative feeding): ti,ab,kw OR (specially formulated medical food): ti,ab,kw OR (formula food for special medical purposes): ti,ab,kw OR (food for special*): ti,ab,kw OR (food for special medical purposes): ti,ab,kw, with the date range limited to 1 January 2014–31 March 2024.

Evidence Quality Assessment

Two full-time master's nursing students in the Evidence-Based Practice Group appraised the quality of the included clinical practice guidelines using the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument. Expert consensus statements were evaluated with the 2016 authenticity appraisal tool for opinion and consensus papers issued by the JBI Centre for Evidence-Based Health Care. For literature on clinical decision-making, recommended practices, and evidence summaries, we traced back to the primary studies underpinning each extracted evidence item and selected study-design–specific critical appraisal tools according to the type of these original studies.[34,35] Two reviewers independently assessed each study, and any disagreements or uncertainties were resolved through consultation with evidence-based practice experts.

Evidence Synthesis

Using the 2014 JBI evidence grading and recommendation system,[34] we graded the evidence from all included studies. After evidence extraction, classification, and integration, 12 evidence statements across 6 dimensions were synthesized.

Evidence Localization

The Evidence-Based Practice Group localized the best evidence through expert panel meetings, evaluating it across three dimensions: clinical applicability, clinical context, and stakeholder perspectives. Clinical applicability was assessed within the target clinical setting using the FAME framework,[36,37] sequentially examining feasibility, appropriateness, clinical significance, and effectiveness to determine whether evidence should be adopted, with reasons for exclusion documented. Clinical context assessment focused on the practice environment and the availability of human, material, and financial resources. Stakeholder analysis considered their influence, level of support, readiness for change and needs, as well as strategies to enhance stakeholder engagement. Following localization, 12 evidence statements were retained. Based on the principles of merging evidence with similar content and separating evidence with distinct content, 10 review criteria were developed to form the review plan (Table 1).

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Table 1 Evidence Content and Review Method of Perioperative Oral Nutrition Supplementation in Elderly Patients with Hip Fracture

Evidence Item	Content of Evidence (Evidence Level and Recommendation Level)	Review Indicators	Examination Methods	Examination Tools
Nutrition education	Provide nutrition education to health professionals and informal caregivers (1B)	**Indicator 1**: The medical staff underwent training on ONS nutrition knowledge.	A knowledge assessment was administered both prior to and following the training session. A score of 80 points or higher was considered indicative of successful completion and was recorded as "Y," while scores below this threshold were recorded as "N," signifying incomplete status.	Knowledge questionnaire
	Educate patients and caregivers on the importance of adequate nutrition (1B)	**Indicator 2**: Patients and caregivers received ONS-related nutrition education.	The completion was documented as "Y" if nutrition-related questions were posed to assess the understanding of patients and caregivers regarding the significance of nutrition; otherwise, it was documented as "N".	1.On-site interviews 2.Propaganda materials
Nutrition screening and assessment	Nutritional screening was performed by medical staff using NRS2002, MNA-SF, and MUST within 24 hours of admission and after surgery (1A)	**Indicator 3**: The medical staff used NRS2002 to screen the nutritional risk of patients within 24 hours after admission, within 24 hours after operation and before discharge.	Please review the patient's nutritional risk screening form. If the screening has been completed accurately, it should be indicated with a "Y." If it has not been completed, it should be marked with an "N."	View Paper Forms
Energy protein target	The energy target of elderly orthopedic inpatients was 25 ~ 30 kcal/(kg·d), and the protein target intake was 1.0 ~1.5 g/kg (1B)	**Indicator 4**: The energy intake of patients was 25–30 kcal/(kg·d), the protein target intake was 1.0 ~1.5 g/kg	The protein target intake, as measured by the energy meter, was determined by establishing a 24-hour dietary target and utilizing a dietary record sheet. The entries on the record sheet were subsequently verified, with completion denoted by "Y" and non-completion indicated by "N."	Self-designed 24-hour dietary goals and dietary record sheet
ONS supplementary scheme	Oral high-protein food and ONS are recommended for patients with nutritional risk or malnutrition risk (1B)	**Indicator 5**: Patients with NRS≥3 were instructed to take intensive diet or ONS.	Evaluate dietary intake and conduct comprehensive nutrition education on diet and oral nutritional supplements (ONS). Assess the 24-hour dietary objectives and dietary records, marking them as "Y" if completed, or "N" if not.	1.On-site interviews 2.Self-designed 24-hour dietary goals and dietary record sheet
	ONS was started within 24 hours after operation. If ONS could not be performed, tube feeding EN was given (1A) The suggested dosage of ONS is to combine them with the regular diet to meet the recommended daily energy and protein requirements. Alternatively, ONS should provide between 1673.6 and 2510.4 kJ (equivalent to 400 to 600 kcal) per day, in addition to the daily dietary intake (5A) ONS recommends taking it twice a day, between meals or after exercise, and sipping it at 50~100mL/h (1B)	**Indicator 6**: After the operation, the patients were instructed to take ONS twice a day between meals, 400–600 mL/d.	Inquire about the configuration and methodologies of the ONS, review the 24-hour dietary objectives and the content of the dietary record sheet, and mark as "Y" if completed; otherwise, mark as "N".	1.On-site interviews 2.Self-designed 24-hour dietary goals and dietary record sheet
	When combined with chronic diseases, disease-specific ONS was selected for nutritional supplementation (5A)	**Indicator 7**: When combined with chronic diseases (diabetes, chronic kidney disease), choose disease-specific ONS.	When the disease-specific ONS is associated with both diabetes and chronic kidney disease, denote the record with a "Y"; otherwise, denote it with an "N".	Self-designed 24-hour dietary goals and dietary record sheet
	Post-surgery, ONS was used until the patient resumed a normal diet and was stopped once daily intake met nutrient targets (5A)	**Indicator 8**: ONS was stopped upon reaching the nutritional target and continued if the target was not met.	Prior to discharge, the patient's energy and protein requirements were assessed. Oral nutritional supplements (ONS) were discontinued upon achieving the target levels, whereas ONS administration was maintained if the targets were unmet. The achievement of these targets was documented as "Y" for yes, and "N" for no if the targets were not achieved.	1.On-site interviews 2.Telephone follow-up
Adverse reaction monitoring	When supplementing ONS preparations, adjust for the patient's gastrointestinal adaptability and effectively manage any ONS intolerance. (5A)	**Indicator 9**: For ONS-related gastrointestinal issues, reduce administration speed, lower the dose, switch the preparation, and use symptomatic treatment if needed.	Examine the 24-hour dietary record sheet and the nursing record sheet; document completion with a "Y" and indicate non-completion with an "N."	Self-designed 24-hour dietary goals and dietary record sheet
Discharge nutrition follow-up	Patients undergoing grade 4 surgery or at risk of severe malnutrition post-discharge should continue ONS with at least 400 kcal and 30 g of protein daily (5A)	**Indicator 10**: If the nutrition did not reach the standard, ONS 400 kcal/d and protein 30 g/d should be taken.	Upon discharge, continue administration as necessary. If completed, document as "Y"; otherwise, document as "N."	1.Telephone follow-up 2.WeChat group punch the clock

Abbreviations: ONS, oral nutritional supplementation; NRS2002, nutritional risk screening2002; MNA-SF, Mini Nutritional Assessment-Short Form; MUST, Malnutrition Universal Screening Tool; EN, enteral nutrition.

Current Status Review

The Evidence-Based Practice Team conducted a baseline audit in accordance with the review plan using three approaches: (1) Questionnaire survey: a self-designed questionnaire on nutrition-related knowledge was administered to assess healthcare personnel's baseline knowledge levels; (2) Electronic medical record audit: nutrition risk assessments and the implementation of ONS were recorded and reviewed in real time via the electronic medical record system; and (3) On-site spot checks: unannounced ward inspections were conducted, during which healthcare personnel, patients, and primary caregivers were interviewed to evaluate baseline practice against the review criteria.

Integration of Evidence into Clinical Practice

Analysis of Facilitators and Barriers

The Evidence-Based Practice Group used structured brainstorming to identify potential facilitators and barriers from three perspectives: best available evidence, practice environment, and potential adopters. Facilitators: (1) The orthopaedic center is a pilot hospital for the National Health Commission's Enhanced Recovery After Surgery (ERAS) program in orthopaedics and a national demonstration center for ERAS in joint surgery accredited by the Chinese Orthopaedic Association; (2) the department director, head nurse, and ward nurse manager strongly support the project, and the head nurse has incorporated the nutrition management program into the 2024 development plan for orthopaedic nursing, designating our ward as the pilot unit; (3) the orthopaedic team is supported by one clinical nutritionist and one clinical rehabilitation therapist from the Department of Clinical Nutrition; (4) the nursing workforce is well structured, with one nutrition support specialist nurse certified by the Chinese Nursing Association, one senior and three junior hospital-level nutrition support specialist nurses; and (5) the team has prior experience and competence in evidence-based nursing practice, having successfully completed a hospital-based evidence-based practice project in 2022. Barriers: (1) During the perioperative period, medical staff often pay insufficient attention to the nutritional status of older patients with hip fracture, and nutritional support is not implemented systematically, with limited understanding of oral nutritional supplements; (2) older patients show low acceptance of health education, and dietary counselling is typically generic, lacking specific guidance on food types and quality; (3) the evidence-based practice plan involves multiple interventions, substantially increasing the nursing workload and potentially constraining implementation; (4) the nutrition risk screening form embedded in the nursing information system is based on the outdated NRS2002 and has not been updated in line with current guidelines; and (5) standardized educational tools for nurses regarding oral nutritional supplements are lacking.

Developing Evidence-Based Practice Protocols

Drawing on the review findings, identified facilitators and barriers, and the human and material resources available in the pilot wards, the evidence-based practice expert team developed standardized practice protocols. In parallel, a knowledge handbook and follow-up checklist for dietary management and oral nutritional supplementation in older adults with hip fracture were compiled. Clinical pathways for nutrition-related diagnosis, treatment, and management in this population were established, and perioperative nutritional management protocols and standards were formulated, thereby further refining and operationalizing the overall evidence-based practice plan.

Implementation of Evidence-Based Practice Programs

Practice Setting

The evidence-based practice was implemented in the Bone and Joint Center ward of a Class III Grade A hospital in Henan Province. The ward has 88 beds and is staffed by 29 physicians and 18 nurses. The nursing team includes one nutrition support specialist nurse certified by the Chinese Nursing Association, one senior and three junior hospital-level nutrition support specialist nurses, three orthopaedic specialist nurses certified by the Chinese Nursing Association, and eight hospital-level orthopaedic specialist nurses. The hospital is also equipped with an Internet-based smart cloud follow-up platform.

Research Subjects

This study enrolled patients with hip fracture who underwent artificial hip arthroplasty at the Bone and Joint Center of a tertiary Class A hospital in Henan Province between January and October 2024, as well as healthcare staff from the pilot ward. The baseline status review was conducted from January to May 2024 and included 49 patients, while the evidence-based practice phase ran from June to October 2024 and included 44 patients. In total, 28 healthcare professionals participated, and a self-controlled before–after design with a non-contemporaneous control was used to evaluate the effectiveness of the evidence-based practice intervention.

Inclusion criteria for medical and nursing staff were: at least two years of work experience in the orthopedics department, a junior or higher professional title, and a bachelor's degree or above. Exclusion criteria were: (1) membership in the evidence-based practice group; or (2) absence from routine clinical work during the study period due to academic leave, maternity or sick leave, rotation, further education, internship, standardized training, or employment as assistant staff. Patient inclusion criteria were age 60–90 years and normal gastrointestinal function. Exclusion criteria were hearing or visual impairment, cognitive dysfunction, or severe mental illness. All participants provided voluntary informed consent.

Transformation of Clinical Practice

Establishment of a Multidisciplinary Team Led by Specialized Nutrition Support Nurses

A multidisciplinary team was established led by specialized nutrition support nurses, under the supervision of orthopedic and joint physicians, with active participation from the departments of clinical nutrition, anesthesiology, rehabilitation, and pharmacy. The specialized nutrition support nurses coordinated team communication, implemented evidence-based practice measures, and supervised monitoring, feedback, and reporting. In this program, specialized nutrition support nurses from China conducted nutritional screening and assessment for enrolled patients, collected information on dietary habits and attitudes toward nutrition, and provided targeted health education. They created nutritional records, liaised with physicians and clinical nutritionists, and formulated individualized ONS goals and implementation plans in accordance with evidence-based practice guidelines. In the hospital setting, senior specialized nutrition support nurses advised patients on dietary optimization, including diversification of food choices, preparation methods, and the selection, preparation, and administration of ONS. Junior specialized nutrition support nurses calculated patients' daily energy and protein intake, evaluated whether these met recommended targets, and provided additional dietary counselling for those who did not meet the standards. Orthopedic and joint physicians were responsible for the clinical safety of the protocol implementation. Rehabilitation therapists provided expert guidance on postoperative functional training. Anesthesiologists and pharmacists managed perioperative gastrointestinal and drug-related discomfort. Clinical nutritionists oversaw the design and adjustment of nutritional plans; when a patient's nutritional diagnosis or treatment step changed, the nutrition team was consulted and the nutritional support plan was modified as needed.

Enhancing Nutrition-Related Training for Healthcare Personnel

Members of the evidence-based practice team provided standardized training to healthcare staff in the pilot wards. Training sessions were conducted during routine morning rounds in the physicians' office, with 20-minute sessions delivered once daily over five consecutive days, coordinated by the ward nurse manager. The training covered: Nutritional status of elderly hip fracture patients during the perioperative period; The role and function of oral nutritional supplements in perioperative nutritional management and within clinical pathways; The objectives, significance, and evidence-based practice protocol of this study, including standardized instruction on protocol content and implementation procedures; and The required collaborative tasks and workflow arrangements among healthcare personnel. Post-training evaluation consisted of knowledge questionnaires and bedside simulation assessments. All healthcare staff achieved passing scores (≥80 points) and were certified as qualified to implement the evidence-based practice protocol.

Development of an ONS Nutrition Management Process

(1) Nutritional risk screening and assessment: In 2024, our hospital implemented the new nursing "Xinxing" system, which incorporates the nutritional risk screening2002 (NRS2002) form. However, the embedded form was based on an outdated version. In accordance with the relevant guideline,[38] the form content was updated and submitted to the nutrition support group for approval. To meet the specific needs of evidence-based practice in our ward, uniform screening time points were defined at within 24 hours of admission, 24 hours after surgery, and before discharge, and integrated into a single form to facilitate clarity, dynamic comparison, and ease of completion. For patients with nutritional risk (NRS2002≥3), further nutritional assessment was performed. Skinfold calipers, handgrip dynamometers, and measuring tapes were procured to assist in evaluating the nutritional status of elderly hip fracture patients.

(2) Calculation of target energy and protein: Based on the results of nutritional risk screening and assessment, individualized target energy and protein requirements were calculated for each patient. A "24-Hour Dietary Energy and Protein Record Sheet for Elderly Hip Fracture Patients During the Perioperative Period" was developed. Daily evaluations of energy and protein intake over the previous 24 hours were conducted, and the ratio of actual protein intake to the target value was calculated, using protein intake as the primary reference indicator.

(3) Enhancement of dietary nutrition education: According to the 24-hour dietary energy and protein intake ratio and in combination with the dietary pyramid, individualized dietary nutrition education was provided to optimize the types and proportions of food intake. Education emphasized perioperative nutritional requirements in elderly hip fracture patients,with particular focus on high-quality protein intake. To support and standardize clinical dietary education, tools such as the "Perioperative Dietary List for Elderly Patients with Hip Fracture" and the "High-Quality Protein Education Instruction Sheet" were developed to improve the effectiveness of nutritional counseling.

(4) ONS education and standardized implementation: Multi-modal perioperative education on oral nutritional supplementation was provided, covering dietary guidance, oral nutritional supplements, and foods for special medical purposes. Educational materials included the Accelerated Recovery Program (ARP) Joint Replacement Patient Health Education Manual, health education prescriptions, an orthopedic surgery dietary checklist, an oral nutritional supplementation leaflet, and a discharge follow-up manual for elderly hip fracture patients. Education was delivered through bedside one-on-one counselling, color display boards, QR codes linking to educational resources, and health education videos. Key educational touchpoints were integrated throughout the perioperative period, including admission nutritional screening and assessment, preoperative education, initiation of postoperative oral intake, first postoperative ambulation, and nutritional reassessment at discharge. The effectiveness of education was evaluated using the Teach-back method[39] at critical time points and for core content, and reinforced until patients demonstrated adequate mastery of essential oral nutritional supplementation knowledge.

(5) Gastrointestinal function monitoring during ONS: Throughout ONS administration, patients' gastrointestinal function was systematically monitored to ensure tolerance and effectiveness. During the perioperative period, the use of anesthetics and sedatives frequently leads to nausea, vomiting, and other gastrointestinal discomfort, which may reduce oral intake. Accordingly, gastrointestinal symptoms such as diarrhea, abdominal pain, and constipation were closely observed during ONS use. When such symptoms occurred, the multidisciplinary team was consulted to identify potential causes and optimize management. Interventions included reducing the rate of ONS administration, adjusting the dosage, or modifying the ONS formulation. When necessary, symptomatic pharmacological treatment was provided in accordance with medical advice.

(6) Pre-discharge evaluation and follow-up: Before discharge, patients underwent repeat nutritional risk assessment. Those identified as being at nutritional risk were advised to continue increasing high-quality protein intake and to maintain oral nutritional supplementation. A follow-up manual was provided, which specified target post-discharge energy and protein requirements and instructed patients on how to record their nutritional intake. At the same time, caregivers were encouraged to join a nutrition follow-up group. This group used an internet-based smart cloud platform to monitor and support patients' nutritional intake after discharge.

Outcome Evaluation and Data Collection

Evaluation of Review Indicator Implementation Rate

The implementation rate of the review indicators was evaluated by members of the evidence-based practice team through document review, on-site observation, and staff interviews. For each indicator, effective implementation was recorded as "Y" whereas non-implementation or ineffective implementation was recorded as "N". The implementation rate was calculated as: implementation rate = (number of "Y"/total number of required implementations) × 100%.

Nutrition and Related Knowledge Questionnaire Score

Based on the best available evidence, a self-developed questionnaire on nutrition-related knowledge was used to evaluate the awareness of medical staff in the Bone and Joint Center before and after implementation of the evidence-based practice. Theoretical test scores were recorded at both time points. The total score was 100, with ≥80 defined as a passing score, and the pass rate was subsequently calculated. The questionnaire consisted of 50 items across six dimensions: general nutrition knowledge, nutrition screening and assessment, enteral nutrition, parenteral nutrition, nutrition monitoring and evaluation, and nutrition education. It included 45 single-choice and 5 multiple-choice questions, each worth 2 points.

Enhancement of Nutritional Status and Related Indicators

During the evidence-based practice phase, the following indicators were systematically collected: prognostic nutritional index (PNI), serum albumin level at discharge, NRS2002 score at discharge, nutritional risk status at discharge, length of hospital stay, and incidence of complications. The PNI was calculated as: albumin concentration (g/L) + peripheral blood lymphocyte count (×10^9/L) × 5. A higher PNI reflects better nutritional and immune status.[40] A PNI < 45 is commonly used as a threshold for undernutrition;[41,42] accordingly, patients were classified into a well-nourished group (PNI ≥ 45) and an undernourished group (PNI < 45).

Statistical Methods

After double-checking by two investigators, data were first entered into Microsoft Excel and then imported into SPSS version 26.0 for analysis. Categorical variables were summarized as frequencies and percentages, and between-group comparisons were performed using the chi-square test. Normally distributed continuous variables were presented as mean ± standard deviation and compared using the independent-samples *t*-test. Non-normally distributed continuous variables were expressed as median and interquartile range and compared using the Mann–Whitney *U*-test. A p-value < 0.05 was considered statistically significant.

Results

General Characteristics of Study Participants

Patient Characteristics

A total of 93 patients were included in this study, with 49 enrolled before and 44 after the implementation of evidence-based practice. The cohort comprised 23 males and 70 females, with a mean age of 77.83 years (SD = 8.24). There were 80 cases of femoral neck fracture and 13 cases of intertrochanteric fracture. Statistical analysis showed no significant differences in baseline characteristics between the pre– and post–evidence-based practice groups (P > 0.05), as summarized in Table 2.

Characteristics of Medical Staff

The study involved 28 medical staff members with a mean age of 32.46 years (SD = 5.17), including 9 males (32.1%) and 19 females (67.9%). With respect to professional title, 14 held junior titles (50.0%), 9 held intermediate titles (32.1%), and 5 held senior titles (17.9%). The professional roles included 9 clinicians (32.1%) and 19 nurses (67.9%), of whom 3 were specialized nutrition support nurses (10.7%). Educational attainment comprised 4 doctoral degrees (14.3%), 6 master's degrees (21.4%), and 18 bachelor's degrees (64.3%). The mean duration of professional experience was 8.71 years (SD = 5.11).

Table 2 Comparison of General Data Between the Two Groups of Patients

Variables	Comparison Group (N=49)	Implementation Group (N=44)	t/χ^2	P-value
Gender, N (%)			0.003	0.955
Male	12 (24.5)	11 (25.0)		
Female	37 (75.5)	33 (75.0)		
Marital status, N (%)			2.334	0.127
Married	32 (65.3)	35 (79.5)		
Widowed	17 (34.7)	9 (20.5)		
Diagnosis, N (%)			1.332	0.248
Femoral neck fracture	44 (89.8)	36 (81.8)		
Femoral intertrochanteric fracture	5 (10.2)	8 (18.2)		
Age, mean±SD (years)	78.45±9.08	77.14±7.25	0.765	0.446
CCI, mean±SD	0.92±0.98	1.07±0.95	0.208	0.456
BMI at admission, mean±SD (kg/m^2)	22.27±3.19	22.72±3.75	0.629	0.531
Admission NRS2002 score, mean±SD	2.41±0.64	2.43±0.63	0.670	0.858
Admission nutritional risk, N (%)			1.006	0.316
No	25 (51.0)	27 (61.4)		
Yes	24 (49.0)	17 (38.6)		
Nutritional status of admission prognosis, N (%)			1.035	0.309
Well-nourished	11	14		
Subnutrition	38	30		
Serum prealbumin level at admission, mean±SD (mg/L)	177.45±38.39	165.93±43.08	1.363	0.176
Admission serum albumin level, mean±SD (g/L)	35.62±4.50	35.85±3.55	1.934	0.787

Abbreviations: CCI, Charlson Comorbidity Index; BMI, body mass index; SD, standard deviation.

Comparison of Implementation Rates of Review Indicators Before and After Evidence-Based Practice (Table 3)

Comparison of Nutrition- and Related Knowledge Questionnaire Scores in Medical Staff Before and After Evidence-Based Practice

The nutrition- and related knowledge questionnaire scores of medical staff increased from 61.07 ± 12.36 before implementation of evidence-based practice to 85.57 ± 16.89 afterward. This difference was statistically significant (t = 6.195, P < 0.001).

Table 3 Comparison of the Implementation Rate of Review Indicators Before and After Evidence-Based Practice

Review Indicators	Before Evidence Implementation (N=49)			After Evidence Implementation (N=44)			χ^2	P-value
	Y	N	Compliance Rate, N (%)	Y	N	Compliance Rate, N (%)		
1	3	25	10.7	23	5	82.1	28.718	<0.001*
2	0	49	0	44	0	100	93.000	<0.001*
3	2	47	0	44	0	100	85.326	<0.001*
4	0	49	0	44	0	100	93.000	<0.001*
5	0	49	0	44	0	100	93.000	<0.001*
6	0	49	0	25	19	56.8	38.077	<0.001*
7	0	49	0	44	0	100	93.000	<0.001*
8	0	49	0	44	0	100	93.000	<0.001*
9	0	49	0	44	0	100	93.000	<0.001*
10	0	49	0	11	33	25.0	13.893	<0.001*

Notes: "Y" indicates correct execution, and "N" indicates non-execution or unqualified execution. "*"means P < 0.05.

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Table 4 Comparison of Patient Outcome Indicators Before and After Evidence-Based Practice

Variables	Before Evidence Implementation (N=49)	After Evidence Implementation (N=44)	t/χ^2	P-value
NRS2002 before discharge, mean±SD	3.80±0.41	2.77±0.42	11.866	<0.001*
Nutritional risk at discharge, N (%)			10.222	0.001*
No	0	10		
Yes	49	34		
Serum albumin level at discharge, mean±SD (g/L)	29.26±3.13	29.44±2.49	0.297	0.767
Prognosis of nutritional status after discharge, N (%)			5.062	0.024*
Well-nourished	0	6		
Subnutrition	49	38		
LOS, mean±SD (days)	12.02±3.7	11.64±2.87	0.555	0.58
Number of complications, N (%)	1.37±0.86	1.09±0.98	1.447	0.151

Notes: "*"means P < 0.05.
Abbreviations: NRS2002, nutritional risk screening 2002; SD, standard deviation; LOS, length of hospital stay.

Comparison of Patient Outcomes Before and After Evidence-Based Practice

Compared with the pre-implementation period, post-implementation outcomes showed statistically significant improvements in discharge nutritional scores, lower nutritional risk, better prognostic nutritional status, and enhanced immune function ($P < 0.05$). Although serum albumin levels at discharge, length of hospital stay, and the number of complications all tended to improve after implementation, these differences did not reach statistical significance ($P > 0.05$), as shown in Table 4.

Discussion

This single-center exploratory pilot study demonstrated the feasibility of implementing an evidence-based perioperative ONS protocol for older adults with hip fracture within a continuous quality improvement model in routine clinical practice. Feasibility was demonstrated across three domains: at the process level, marked improvements in the implementation rates of review indicators confirmed the protocol's operational practicality; at the provider level, significant increases in healthcare professionals' knowledge scores suggested reinforcement of intrinsic drivers of behavior change; and at the patient level, effective control of nutritional risk and improvements in the prognostic nutritional index indicated clinically meaningful benefits.

Pilot Study on Evidence-Based Practice Enhancing Implementation Rates of Review Indicators

In this pilot study, implementation of the evidence-based practice program significantly increased the implementation rates of all review indicators ($P < 0.05$), indicating that most best-evidence recommendations were successfully translated into routine clinical practice. These findings demonstrate that abstract evidence was operationalized into concrete strategies that were both acceptable to, and actionable for, clinical teams. The marked improvement in process indicators provides strong support for the feasibility and acceptability of the evidence-based practice program and represents the primary success outcome of the pilot phase, consistent with previous reports.[43,44] This effect is likely attributable to the structured clinical adaptation analyses conducted with stakeholders, the in-depth assessment of barriers, and the development of targeted measures to strengthen facilitators and reduce obstacles to implementation. On this foundation, the study established an ONS Evidence-Based Practice Pathway, a tiered responsibility framework for clinical nutrition specialists, standardized nutrition management protocols, and core quality control standards. Collectively, these frameworks provide robust support for timely detection of implementation issues and feedback to clinical staff, thereby facilitating program roll-out. The evidence-based practice plan also extensively incorporated stakeholder input, selecting the most appropriate clinical evidence according to actual needs and preferences, which further promoted evidence translation and clinical change. By systematically assessing both enabling and limiting factors, the plan minimized the

impact of barriers while maximizing the effect of evidence-based facilitators, thereby enhancing the feasibility and fidelity of practice-change measures. From the outset, multidisciplinary teams led by specialized nutrition support nurses were established in response to the evidence-based questions. The project involved nurses certified by the Chinese Nursing Association, as well as hospital-based senior and primary nutrition support nurses. Within this framework, a clear hierarchical division of responsibilities among specialized nurses was achieved, and, under their guidance and supervision, other nurses improved adherence to review indicators. Through these evidence-based practice activities, the project actively explored task division and responsibility allocation among specialized nurses at different levels, representing an effective attempt to broaden the scope and depth of specialized nursing practice. Following the implementation of multidisciplinary collaboration led by specialized nutrition support nurses, these nurses served as key liaisons coordinating interdisciplinary work, enabling efficient division of labor, effective collaboration, and comprehensive monitoring of implementation and evaluation. The significant improvement in the implementation rates of multiple measures (review indicators 1–9) demonstrates that this specialized nurse-led evidence-based practice model enhanced compliance with review indicators and supports the feasibility of integrating best evidence into routine clinical workflows. On the basis of these findings, we propose two specific implications for practice and policy. First, nutritional risk screening and management should be incorporated as a core component of the "Hip Fracture Clinical Pathway" ensuring standardized and continuous nutritional assessment and support for all elderly hip fracture patients throughout the perioperative period.[45] Second, a multidisciplinary collaboration model led by a nutrition support team[46,47] should be promoted, with clearly defined roles and processes for the joint participation of orthopedic surgeons, nurses, dietitians, and rehabilitation therapists,[48] thereby institutionalizing and normalizing the successful practices identified in this study. This approach moves beyond the constraints of individual projects and promotes system-level improvements in nursing practice.

Despite marked improvements in in-hospital review indicators, adherence to review indicator 10 remained low (25%), indicating poor compliance with post-discharge nutritional follow-up. This finding highlights a structural limitation in the initial design of the project: the evidence-based practice protocol was overly confined to the inpatient setting and did not adequately address post-discharge nutritional follow-up or home-based nutrition management. We consider this to be primarily attributable to three factors. First, discontinuity in care transitions: the protocol did not establish a seamless linkage between hospital and home care. After discharge, patients no longer received the structured reminders and supervision provided in hospital, resulting in a gap in the continuity of nutritional support.[49] Second, insufficient integration of key caregivers: although family members or primary caregivers were identified as targets for nutrition education, they were not systematically incorporated into the nutrition education, ONS management, and evaluation framework. Older adults often have limited capacity for dietary self-regulation and meal preparation, and their eating patterns are strongly influenced by caregivers;[50] consequently, post-discharge nutritional management in elderly hip fracture patients depends heavily on caregivers' knowledge, motivation, and competence. Third, limited and largely passive follow-up modalities: reliance on conventional outpatient visits, telephone follow-up, or social media groups, without proactive, user-friendly, and continuous remote support (eg, teleconsultation), made it difficult to overcome mobility constraints and reduced engagement among older patients, thereby undermining sustained follow-up. Future refinements should therefore extend beyond the hospital setting[51] and focus on developing an integrated, continuous nutritional care model. Potential strategies include: (1) establishing a coordinated hospital-community-home nutritional management pathway by strengthening transitional care mechanisms, involving caregivers in discharge planning and remote consultations, and clearly defining the roles of community nurses, family physicians, and other providers to ensure continuity of nutritional support; (2) implementing structured caregiver education programs that deliver standardized training during hospitalization, actively involve caregivers in the formulation and execution of the nutrition plan, and explicitly prepare them for post-discharge responsibilities; and (3) integrating digital health technologies[52] by leveraging information-based follow-up platforms and artificial intelligence[53] to develop dedicated mobile tools for post-discharge monitoring and reminders, thereby providing patients and caregivers with a low-threshold, highly accessible support channel and enabling continuous home-based nutrition management. Further research is warranted to evaluate the impact of these evidence-based strategies on long-term nutritional outcomes, including more detailed analyses of barriers to implementation and the design of subsequent cycles of sustained evidence translation.

Evidence-Based Practice Pilot Study to Enhance Nutrition-Related Knowledge Levels

Currently,there is a shortage of clinical nutritionists,[54] and frontline nursing staff remain primarily responsible for providing nutritional guidance to patients. In this study, we established an evidence-based practice team to systematically synthesize nutrition-related knowledge, drawing mainly on ONS guidelines; to identify key perioperative nutritional management priorities and protocols for older adults with hip fracture; and to explore collaborative models involving specialized nutrition support nurses at different levels in conjunction with multidisciplinary teams. Standardized training was implemented, supported by an assessment and evaluation mechanism embedded within ward-level quality control to ensure ongoing oversight. This initiative aimed to increase nutrition-knowledge questionnaire scores to (85.57±16.89) points and to standardize clinical nurses' nutritional support practices. The significant improvement in healthcare providers' nutrition knowledge scores confirms the effectiveness of this practice-transformation model, which integrates high-quality evidence, contextualized application, and targeted strategies to overcome implementation barriers. This model provides a useful reference for the design of continuing education programs in other hospital departments. By adopting this approach, healthcare administrators can enhance team-wide capacity for evidence-based practice through systematic knowledge translation rather than fragmented didactic sessions, thereby promoting continuous and sustainable improvements in nursing quality.

The evidence-based practice team initiated patient engagement at admission and sustained it throughout the perioperative period and into home-based nutritional follow-up. Using multiple channels—including the patient portal of the Internet hospital–based follow-up platform, dedicated follow-up groups, and telephone contact—the team delivered structured health education. Through the Teach-back model,[39] patients and caregivers were encouraged to identify existing nutritional problems themselves, thereby positioning them as primary stewards of their own nutritional management and actively involving them in perioperative nutritional care. This approach enhanced patient and caregiver engagement and improved the effectiveness of nutritional management. On-site interviews and reviews of 24-hour dietary records indicated a marked increase in awareness of enriched diets and ONS among patients and caregivers. Nevertheless, even after implementation of the evidence-based practice program, substantial gaps remained in nutrition-related knowledge—particularly regarding ONS—among nurses, patients, and caregivers. Future work should prioritize continuous monitoring and dynamic reassessment, with iterative adjustment of educational strategies according to evolving clinical needs. Potential measures include integrating the dietary pyramid model[55] into educational materials, organizing targeted patient education activities, and incorporating bedside ONS preparation practice sessions to sustain the impact of evidence-based interventions. This pilot study focused on older patients who transition to self-care after discharge; in this population, it is essential to ensure mastery of dietary and ONS preparation, the ability to recognize and manage gastrointestinal discomfort, and improved adherence. The evidence-based ONS management protocol provided comprehensive nutritional support during hospitalization through multimedia health education displays, printed booklets, QR codes linked to educational content, multimedia devices, and smart nursing platforms. These tools assisted patients undergoing total hip arthroplasty in understanding perioperative nutritional support, recognizing key determinants of nutritional risk, accurately assessing their own nutritional status, acquiring practical skills related to diet and ONS, and improving overall nutritional literacy.[56] After discharge, nurses used the Interconnected Smart Cloud Hospital Platform and the NewStar Nursing System to deliver ongoing nutritional guidance and to conduct standardized long-term follow-up in accordance with a structured follow-up manual. When patients encountered diet- or ONS-related problems, nurses assisted them in appropriately adjusting their diet, selecting suitable foods and nutritional supplements, preventing progression of malnutrition, and reducing complications such as prosthetic loosening and joint infection, thereby improving long-term outcomes. As nurses play a pivotal role in the nutritional care of hospitalized older adults,[57] sustained improvements in nutritional intake will depend on strengthening patient education, fostering a multidisciplinary culture that prioritizes nutrition, and empowering patients, families, and communities.[58]

Pilot Study on Evidence-Based Practice Reducing Nutritional Risk and Improving Post-Discharge Nutritional Status

Perioperative nutritional support in elderly patients with hip fracture is a core element of ERAS pathways. Previous studies[59] have shown that ERAS can improve nutritional status and shorten the length of hospital stay in this population. Consistent with these findings, our pilot study demonstrated that implementation of an evidence-based practice protocol significantly reduced nutritional risk scores at discharge and improved post-discharge nutritional status and immune function. These results suggest that evidence-based nutritional management effectively lowers nutritional risk, optimizes nutritional status, and accelerates postoperative recovery in elderly hip fracture patients, in line with the results reported by Zhang et al.[58] Serum albumin levels at discharge showed an upward trend, although the difference did not reach statistical significance. This may be related to the relatively short duration of in-hospital ONS intervention and the approximately 21-day half-life of albumin, indicating that longer follow-up is required to fully characterize its trajectory.[60,61] Following implementation of the evidence-based practice protocol, patients' PNI improved, consistent with the findings of Tunçez et al,[62] who reported that patients with low PNI experienced longer postoperative courses, prolonged hospitalization, and higher preoperative transfusion requirements compared with those with higher PNI. The significant improvement in PNI observed in our study is therefore clinically meaningful. As a composite indicator reflecting both systemic inflammation and nutritional status, PNI has been identified in multiple studies as an independent risk factor for postoperative mortality in elderly hip fracture patients and as a robust predictor of postoperative complications, infection risk, and long-term survival.[41,62] The increase in PNI in our cohort thus implies a reduced risk of complications and greater rehabilitation potential. From a health economics perspective, these findings provide a strong rationale for hospital administrators to invest in structured perioperative nutritional support programs. Early, standardized oral nutritional interventions are likely to yield substantial returns by reducing the costs of managing complications, shortening length of stay, and improving bed turnover.[63] Accordingly, we recommend that hospital decision-makers regard standardized oral nutritional management not as a discretionary expense but as a cost-effective strategic investment.[64]

The Pilot Study on Evidence-Based Practice Suggests Favorable Trends in Complications and LOS

No statistically significant differences were observed in complication rates or LOS. This is likely attributable to the limited sample size, relatively short study duration, and lack of randomization, all of which reduced the power to detect changes in clinical outcomes that are influenced by multiple determinants. Beyond these methodological constraints, the findings also warrant consideration of underlying clinical and practice-related factors. The absence of a significant reduction in LOS is consistent with the results reported by Lai et al,[65] and with the systematic review by Rempel et al,[66] which likewise found no significant effect of ONS on LOS in elderly hip fracture patients. These authors emphasized that LOS is a highly multifactorial outcome, strongly shaped by non-nutritional factors such as health insurance policies, availability of rehabilitation resources, and family support. In this context, inpatient ONS alone is unlikely to offset the influence of these powerful systemic and social determinants. Similarly, with respect to complications, our findings align with the systematic review by Lai et al,[65] which demonstrated a favorable trend toward reduced complication rates with ONS but noted that large sample sizes are often required to achieve statistical significance. Some studies[44,67] have reported significant reductions in specific complications; such discrepancies may reflect differences in nutritional intervention protocols, patient characteristics, or the definitions and range of complications assessed. Notably, our results differ from those of Williams et al,[68] who reported that ONS shortened LOS without increasing costs, and from other studies[69] showing that perioperative nutritional support significantly reduced hospitalization duration. Closer examination suggests that these successful interventions embedded nutritional support within a comprehensive ERAS pathway, incorporating core elements such as early mobilization, multimodal analgesia, and proactive complication prevention. Under such conditions, nutritional support may exert synergistic effects with other ERAS components. By contrast, in our pilot study—focused primarily on a single intervention component—the independent effect of nutritional support may have been attenuated by uncontrolled clinical variables. Taken together, these findings suggest that meaningful

improvements in complex, multifactorial outcomes such as LOS and complication rates in elderly hip fracture care are unlikely to be achieved through isolated nutritional interventions alone. Rather, multidimensional, bundled strategies—or the integration of ONS-based nutritional support into a full ERAS pathway—are likely to be required. The process improvements and gains in nutritional indicators observed in this pilot study provide an important foundation and rationale for positioning ONS as a core, structurally embedded element within such integrated care models.

Reflections on Implementation Barriers and Facilitators

This study systematically identified key barriers and facilitators to translating evidence into practice, providing context-specific insights to guide future implementation efforts in similar settings. Several major barriers emerged.[1,70] First, healthcare providers faced substantial time and cognitive burdens. The primary obstacle arose not from patients but from the initial pressure of redesigning clinical workflows. Nurses reported feeling overloaded by the additional time required to complete nutritional risk screening, deliver ONS-related health education, document detailed dietary intake, and calculate target energy and protein requirements within already demanding routines. In parallel, some clinicians were initially skeptical about the potential impact of nutritional support on surgical outcomes, creating an additional attitudinal barrier. Second, system-level and resource constraints further impeded implementation. At baseline, ONS products were not routinely stocked on the wards, and the cumbersome retrieval process directly contributed to delays. In addition, gaps in interdisciplinary communication—for example, delays in submitting or responding to nutrition consultation requests—undermined the continuity of nutritional interventions. To address these challenges, several facilitators and counter-measures were introduced. First, key processes were embedded into existing systems: the updated NRS2002 screening was integrated into the electronic admission assessment with automated reminders, reframing it from "extra work" into routine practice. Second, leadership support and resource allocation were actively secured. By presenting preliminary data and the underlying evidence-based rationale to nursing and orthopedic leadership, we obtained administrative endorsement, and coordinated efforts with the nutrition department resulted in standardized ward-based ONS supply protocols, resolving accessibility issues. Third, data feedback and multidisciplinary collaboration were strengthened.[48] Ward-level compliance with review indicators was regularly visualized and presented at departmental meetings, fostering constructive interteam comparison and collaboration. Concurrently, a structured feedback mechanism between Orthopedics and Nutrition substantially improved cross-disciplinary communication. These experiences underscore that effective implementation of evidence-based practice requires more than knowledge dissemination; it depends on proactively identifying and addressing barriers at the levels of individuals, processes, and systems. Future projects should therefore allocate dedicated resources to mitigate time burdens, optimize supply chains, and secure sustained managerial support, thereby enhancing the success of evidence translation.

Strengths

The novelty of this study lies in its systematic and methodologically rigorous exploration of pathways to bridge the "evidence-to-practice" gap,[71] thereby generating a multilevel, logically coherent chain of evidence. At the implementation level, we showed that a structured model integrating barrier analysis, targeted strategies, and indicator-based feedback substantially improved adherence to perioperative ONS management among older adults with hip fracture in a single-center Chinese setting, increasing compliance from very low baseline levels (0–10.7%) to highly acceptable rates (25–100%). This pragmatic implementation framework, together with its demonstrated impact, provides important methodological guidance for scaling similar interventions in settings with comparable resource and cultural contexts. A second strength is the integrity of the evidence chain. Our findings delineate a clear logical sequence that extends beyond single-dimension reporting. Knowledge: the evidence-based pilot program significantly improved healthcare providers' nutrition-related knowledge. Behavior: these knowledge gains translated into behavioral change, as reflected by comprehensive improvements in compliance with review indicators. Patient outcomes: these behavioral changes were associated with significant improvements in patients' nutritional status. This complete chain provides robust support for the conclusion that the evidence-based pilot program improved patient outcomes primarily through modification of healthcare provider behavior. In addition, the in-depth interpretation of non-significant findings offers further insight for the field. The absence of clear effects on length of stay and complications suggests that a stand-alone ONS strategy is

unlikely, by itself, to substantially modify complex, multifactorial clinical outcomes in elderly hip fracture care. Future implementation efforts may therefore need to embed ONS-based nutritional support as a core component within comprehensive care pathways, such as ERAS, rather than applying it as an isolated intervention.

Limitations

This study has several limitations. First, it was a single-center pilot study with a small sample size (n = 93), determined by feasibility rather than an a priori power calculation. Accordingly, we conducted a post hoc power analysis. For example, for changes in healthcare providers' knowledge scores (MD=24.5; pooled standard deviation=14.8; Cohen's d = 1.66), the sample of 56 providers yielded >99% power to detect this effect at α= 0.05. Although these analyses indicate very high statistical power for the main process and knowledge outcomes, the study was likely underpowered to detect smaller effect sizes in clinical endpoints such as length of hospital stay and complications, thereby limiting both the generalizability of the findings and the robustness of these outcome analyses. Second,the relatively short, 5-month intervention and follow-up period constrained the observation of long-term nutritional indicators (eg, serum albumin), which may have contributed to the absence of significant differences in additional clinical outcomes. Third, the nonrandomized pre-post design is inherently vulnerable to uncontrolled confounding. Consequently, the results should be regarded as preliminary, hypothesis-generating evidence that informs and refines future research, rather than as definitive proof of efficacy.

Implications for Future Research

Building on the findings and limitations of this pilot study, we propose a three-phase roadmap to further validate and extend the current results. Phase I (near term, 1–2 years): design a multicenter, cluster-randomized controlled trial, with randomization at the hospital or ward level to minimize contamination at the individual level. This trial should evaluate the effectiveness of the evidence-based practice protocol on key clinical endpoints (eg, complication rates, LOS) in a larger population. Parameters obtained from the present study—such as implementation rates of process indicators and improvements in PNI—can be used to inform a priori sample size calculations and ensure adequate statistical power. This phase will directly address the current study's limitations related to sample size, randomization, and statistical power. Phase II (mid term,2–3 years): further investigate determinants of implementation of the ONS evidence-based practice protocol across different healthcare settings and assess its cost-effectiveness.[63,64] A particular focus should be the application of artificial intelligence and digital health technologies,[53] for example, developing an integrated clinical decision support system embedded within electronic health records to automatically generate nutritional risk alerts, recommend individualized ONS regimens, and support post-discharge follow-up and adherence monitoring via patient-facing applications. This phase will help overcome identified challenges such as gaps in care transitions, difficulties with follow-up, and system-level barriers, thereby enhancing the scalability and personalization of ONS interventions. Phase III (long term, 3–5 years): building on robust evidence from the first two phases, conduct dissemination and implementation research to evaluate real-world outcomes following policy adoption. This stage should identify optimal strategies for scaling the model across different levels of care and advocate for incorporation of mature ONS management protocols into authoritative hip fracture clinical pathways and guidelines.[45] Overall, this roadmap—from evidence generation, through technology-enabled optimization, to policy translation—aims to shift perioperative ONS management for elderly hip fracture patients from an optional quality-improvement initiative to a standardized component of high-quality routine nursing care.

Conclusion

As a single-center pilot study, this work indicates that integrating an evidence-based perioperative ONS protocol for older adults with hip fracture into a continuous quality improvement framework is feasible, preliminarily effective, and potentially scalable. The intervention enhanced healthcare teams' nutrition-related knowledge, improved adherence to key process indicators, and optimized the nutritional status of older hip fracture patients. However, the limited sample size and nonrandomized design must be acknowledged. These constraints imply that the findings should be interpreted as preliminary and require confirmation in broader, more diverse populations. Future research should therefore prioritize

longer-term, large-scale, multicenter randomized controlled or cluster-randomized trials with adequate sample sizes to verify the impact of this evidence-based protocol on long-term prognosis and clinical outcomes, including complication rates and length of stay. This pilot project provides essential practical experience and parameters for subsequent sample size estimation, offers a reproducible model for clinical education and training, supplies an economic rationale for hospital resource allocation, and delivers evidence-based support for embedding nutritional support into standard clinical pathways and health policies.

Abbreviations

ONS, oral nutritional supplementation; NRS2002, nutritional risk screening 2002; PNI, prognostic nutritional index; ARP, accelerated recovery program; ERAS, enhanced recovery after surgery; LOS, length of hospital stay; MD, mean difference.

Disclosure

The authors report no conflicts of interest in this work.

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