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Surgical Technical Evidence Review of Hip Fracture Surgery Conducted for the AHRQ Safety Program for Improving Surgical Care and Recovery

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Abstract

Background: Enhanced recovery pathways (ERPs) have been shown to improve patient outcomes in a variety of contexts. This review summarizes the evidence and defines a protocol for perioperative care of patients with hip fracture and was conducted for the Agency for Healthcare Research and Quality safety program for improving surgical care and recovery. **Study Design:** Perioperative care was divided into components or "bins." For each bin, a semisystematic review of the literature was conducted using MEDLINE with priority given to systematic reviews, meta-analyses, and randomized controlled trials. Observational studies were included when higher levels of evidence were not available. Existing guidelines for perioperative care were also incorporated. For convenience, the components of care that are under the auspices of anesthesia providers will be reported separately. Recommendations for an evidence-based protocol were synthesized based on review of this evidence. **Results:** Eleven bins were identified. Preoperative risk factor bins included nutrition, diabetes mellitus, tobacco use, and anemia. Perioperative management bins included thromboprophylaxis, timing of surgery, fluid management, drain placement, early mobilization, early alimentation, and discharge criteria/planning. **Conclusions:** This review provides the evidence basis for an ERP for perioperative care of patients with hip fracture.

Keywords

enhanced recovery, hip fracture, patient safety, quality improvement

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Introduction

Hip fracture is an increasingly important US public health concern, with approximately 100 000 hip replacements performed for hip fracture per year.[1] Hip fracture is associated with high morbidity, loss of functional independence, and 1-year mortality up to 36%.[2]

Enhanced recovery pathways (ERPs) are multidisciplinary protocols designed to improve patient outcomes, experience, and efficiency following surgery with a focus on patient and family engagement, multimodal analgesia, avoidance of prolonged fasting, early mobility, as well as best evidence for preventing harm.[3] The ERPs have improved recovery time and length of hospital stay and have resulted in decreased complications for a variety of operations, including orthopedic

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Table 1. Improving Surgical Care and Recovery Hip Fracture Protocol Components.

Preoperative risk assessment
Preoperative nutrition
Diabetes mellitus
Tobacco use
Anemia
Perioperative management
Perioperative venous thromboprophylaxis
Timing of surgery
Perioperative fluid management
Drain placement
Early mobilization
Early alimentation
Discharge criteria and planning

surgeries.[3-6] To support implementation of best practices nationwide, a partnership between the Agency for Healthcare Research and Quality (AHRQ; funder), the American College of Surgeons, and the Johns Hopkins Medicine Armstrong Institute for Patient Safety and Quality formed a collaborative program to enhance the recovery of surgical patients. The program aims to assist hospitals in implementing enhanced recovery practices to improve patient outcomes in a sustainable manner. As part of the program, in addition to the pathways themselves, there are tools designed to help with implementation as well as a data registry that includes pertinent process and outcome measures to assist hospitals in monitoring the effectiveness and impact of their programs. The overarching goal is to define, disseminate, and monitor the effects of evidence-based ERPs for operations across surgical specialties. The objective of this study is to review the evidence in the literature and existing guidelines supporting proposed perioperative ERP components in the area of hip fracture surgery (HFS), with particular attention to the principles of ERP. Combined with a separate review of ERP components specific to anesthesia care, the ultimate goal is to generate an evidence-based pathway for care of patients with hip fracture designed to optimize patient outcomes.

Methods

The ERP components or "bins" were identified using protocols from major health systems along with consultation with a technical expert (Table 1). The focus was on pre- and postoperative factors and practices that affect patient outcome as described previously.[7] Operative considerations such as approach and technique were outside the scope of this review, as the focus was on a developing a transdisciplinary pathway that brought together all members of the care team. We recognize the importance of the operative approach and appreciate that the American Academy of Orthopaedic Surgeons (AAOS) clinical practice guidelines have completed a comprehensive overview in this area that could be used to complement this review. Well-accepted perioperative care practices for which there is considerable evidence were not the focus, as the goal was to review evidence for potentially uncertain components. These well-accepted practices, such as perioperative antibiotic prophylaxis and skin preparation, are included in the implementation program and pathways for the AHRQ safety program.

A systematic review (SR) for each bin was conducted between January 2017 and February 2017 by searching MEDLINE since inception for English-language articles. Search criteria are listed in Supplemental Table 1 and were generated with the assistance of a research librarian (EW). Additional citations were provided by the technical expert and by mining references of included studies. Predefined inclusion/exclusion criteria were generated for each bin (Supplemental Table 2). Across all bins, included studies were SRs, meta-analyses (MAs), randomized controlled trials (RCTs), or observational studies and primarily focused on surgical management of hip fracture. When no literature existed pertaining to surgical management of hip fracture, research in similar surgical fields was explored to provide guidance. Specific exclusion criteria were tailored to each bin; however, common exclusion criteria included non-SRs, editorials, case reports, articles for which the full text was not available, and interventions not relevant to US hospitals. After initial title/abstract screen, full texts were retrieved and reviewed against these inclusion/exclusion criteria. A hierarchy of evidence was used to construct the review and recommendations. Where well-conducted SRs or MAs were available, these were prioritized as the foundation for the review with additional evidence from studies published after the SR/MA. Data extracted for each study included sample size, population characteristics, intervention/independent variable, comparison, and clinical outcomes. These outcomes included complication rates, length of stay (LOS), functional capacity, and mortality. Due to heterogeneity, no attempt was made to perform statistical pooling. A review covering anesthesia aspects of care for hip fracture, published separately, includes preanesthetic medication, carbohydrate loading and fasting, intraoperative anesthesia, and postoperative analgesic regimens. The 2014 AAOS and 2017 National Institute for Health and Care Excellence (NICE) guidelines were also included where applicable (Table 2). The AAOS provides health policy and educational support in the treatment of musculoskeletal patients.[8] The NICE guidelines are intended to provide evidence-based guidance to promote integrated care for the National Health Service of the United Kingdom.[9]

Results

Preoperative Risk Assessment

Preoperative nutrition

Rationale. Optimizing preoperative nutrition should be associated with improved clinical outcomes following surgery.

Evidence. The literature search identified 276 articles, of which 10 met inclusion criteria: 2 RCTs and 8 observational studies.

Two small RCTs of about 100 patients each addressed preoperative nutritional optimization for hip fracture surgery

Table 2. Summary of Improving Surgical Care and Recovery Hip Fracture Protocol Components: Surgery, Outcomes, and Literature/Guideline Support.

Intervention	Outcome(s)	Studies	Evidence	Guidelines
Preoperative medical assessment				
Preoperative nutrition	Poor nutrition associated with decreased mobility and wound healing, and possibly increased mortality. Unclear how best to evaluate may be confounded by associated factors.	2 RCTs, 8 OS	+	−
Diabetes mellitus (DM)	Increased complications and poor functional outcome correlates with DM severity.	1 SR, 4 OS		−
Tobacco use	Increased risk of postoperative complications. Likely decreased pain and improved healing following smoking cessation.	1 OS, additional indirect evidence	+, additional indirect evidence	−
Anemia	Preoperative anemia associated with poor outcomes; however, postoperative treatment has not proven beneficial.	1 MA, 1 RCT, 1OS	+	−
Perioperative management				
Perioperative venous thromboprophylaxis	↓ VTE with ASA, VKA, heparins, and factor Xa inhibitors. Extended treatment superior.	4 SR/MA,3 RCTs, 2 OS	+	+
Timing of surgery	Early surgery for hip fracture is beneficial, ideally within 24-48 hours of admission.	2 SR/MA, 8 OS	+	+
Perioperative fluid management	Evidence does not support the use of formal protocols or advanced hemodynamic monitoring to guide perioperative fluid management	1 SR	+	−
Drain placement	Evidence does not support drain placement.	2 SR	+	−
Early mobilization	Ambulation by postoperative day 1 is safe and improves functional outcomes; may reduce complications and hospital stay.	1 RCT, 1 SR, 3 OS	+	+
Early alimentation	No evidence found to support nasogastric or parenteral nutrition, protein or vitamin supplementation.	1 SR	+	+
Discharge criteria and planning	Standardized discharge plans and criteria improve quality of life and functional independence.	2 RCTs, 1 SR, 8 OS	+	+

Abbreviations: ASA, acetylsalicylic acid; MA, meta-analysis; OS, observational study; RCT, randomized controlled trial; SR, systematic review; VKA, vitamin K antagonist; VTE, venous thromboembolism.

(HFS).[10,11] One studied the impact of preoperative multinutrient supplements and focused on patients with normal nutrition or with mild malnutrition.[10] The other investigated preoperative carbohydrate drinks and intravenous (IV) glucose and included all patients with hip fracture.[11] Both studies also included interventions targeted at the postoperative period. While 1 study did find an improvement in biochemical markers postoperatively,[10] the other did not.[11] Neither study found a significant difference in complications, LOS, or discharge location.

Eight observational studies, 50 and 600 patients each, evaluated preoperative nutritional status and its impact on clinical outcomes in HFS.[12-19] Nutritional parameters were varied and included serum markers (albumin, total lymphocyte count, transferrin, and prealbumin), nutritional status surveys such as the Mini Nutritional Assessment, and anthropomorphic data. Most studies found associations between poor nutrition and worsened outcomes, such as increased risk of fixation failure,[12] delayed wound healing,[14] diminished mobility,[15] increased postoperative complications,[17] and increased mortality.[15,18,19] Two studies found that the effect of nutritional parameters became nonsignificant in adjusted analysis.[13,18] The AAOS guidelines recommend postoperative nutritional supplementation to reduce mortality and improve postoperative outcomes (Table 3).[8]

Summary and recommendations. Consistent observational evidence indicates that poor nutritional status increases risk of poor wound healing, decreased mobility, and possibly mortality. Although the ability to correct malnutrition in the acute setting of hip fracture management is limited, it is important to acknowledge the role preoperative malnutrition has on outcomes. This condition should be considered when discussing the risks of surgery with the patient.

Diabetes mellitus

Rationale. Optimizing preoperative control of diabetes mellitus (DM), including glucose control, in the acute setting should be associated with improved outcomes following surgery.

Evidence. The literature search revealed 126 articles, of which 5 met inclusion criteria: 1 MA and 4 observational studies.

A MA of predictors of 1-year mortality following HFS found the hazard ratio for patients with a diagnosis of DM was 1.44 (confidence interval [CI], 1.13-1.82).[2]

One observational study of 80 000 patients found that DM was associated with longer LOS, lower functional status, and reduced odds of discharge to home.[20] Other observational studies have identified either DM or elevated admission blood sugar as risk factors for postoperative kidney dysfunction,[21]

Table 3. Summary of Guidelines Supporting Improving Surgical Care and Recovery Protocol Components for hip fracture.

Intervention	Guideline	Recommendation
Preoperative medical assessment		
Preoperative nutrition	AAOS	Moderate evidence for postoperative nutritional supplementation to reduce mortality and improve outcomes.
Diabetes mellitus	NICE	Identify and treat uncontrolled diabetes as soon as possible to avoid delaying surgery.
Tobacco use	n/a	
Anemia	n/a	
Perioperative management		
Perioperative venous thromboprophylaxis	AAOS	Moderate evidence for VTE prophylaxis.
Timing of surgery	AAOS	Moderate evidence for surgery within 48 hours.
	NICE	Perform surgery within 2 days of admission.
Perioperative fluid management	n/a	
Drain placement	n/a	
Early mobilization	NICE	Offer a physiotherapy assessment; mobilize patients on postoperative day 0 unless contraindicated, and daily thereafter.
Early alimentation	AAOS	Moderate evidence supports postoperative nutritional supplementation including vitamin D and calcium to reduce mortality.
Discharge criteria and planning	NICE	For patients who are medically stable, able to transfer and mobilize but have not yet achieved full rehabilitation potential, and who are mentally able to participate in rehabilitation, consider early supported discharge with continued involvement of a multidisciplinary hip fracture team. Consider inpatient or residential rehabilitation only if such care is included in a standardized program and the primary team retains clinical and managerial leadership of the rehabilitation program.

Abbreviations: AAOS, American Academy of Orthopedic Surgeons (guidelines updated 2014); NICE, National Institute for Health and Care Excellence (guidelines updated 2017); n/a, not applicable; VTE, venous thromboembolism.

increased postoperative cardiac complications, pressure ulcers,[22] increased hospital LOS, and higher mortality.[23] The NICE guidelines recommend identifying and treating uncontrolled diabetes as soon as possible to minimize delays before surgery but do not define specific cutoffs for blood glucose prior to surgery (Table 3).[9]

Summary and recommendations. DM confers an increased risk of complications after HFS. This condition should be considered when discussing the risks of surgery with the patient. Evidence does not support a particular definition for preoperative measures of DM severity; each institution should consider developing a protocol for glucose optimization prior to surgery.

Tobacco use

Rationale. Tobacco use has been associated with poor outcomes after orthopedic surgery. However, in the urgent HFS setting, history of tobacco use should primarily help inform preoperative counseling regarding the risk of complications.

Evidence. The literature search revealed 11 articles related to HFS and tobacco use, of which 1 observational study met inclusion criteria. Three additional references were identified during review. Observational studies of multiple risk factors found higher mortality following hip fracture among patients with a history of tobacco use[24,25] as well as a higher rate of surgical complications.[26] Smoking was found to be associated with increased odds of postoperative gastrointestinal hemorrhage (odds ratio [OR] 3.1, $P = .023$) in patients with hip fracture.[27]

Although no studies on preoperative smoking cessation specific to HFS were found, smoking cessation is associated with decreased complications in elective joint surgery.[28,29] Although HFS patients do not have the opportunity to stop smoking before surgery, this condition should be considered when discussing the risks of surgery with the patient.

Summary and recommendations. Smoking is associated with an increased risk of postoperative complications after joint surgery including HFS, and patients who smoke should be counseled regarding their higher risk of complications.

Anemia

Rationale. Preoperative anemia increases the risk of blood transfusion, which may be associated with poor surgical outcomes.

Evidence. The literature search identified 170 articles, of which 3 met inclusion criteria: 1 MA, 1 observational study, and 1 RCT. A recent MA[30] found preoperative anemia (hemoglobin <13 men, <12 women) was associated with increased 30-day and 1-year mortality in patients undergoing HFS. These findings were corroborated in 1 additional contemporary observational study.[31] The associations between preoperative anemia and outcomes, including LOS, readmission rate, functional status, and postoperative complications, were mixed. There was also no consistent evidence of benefit from postoperative treatment with IV and oral iron. A recent trial[32] randomized patients to 3 arms—preoperative erythropoietin + IV iron, IV iron + placebo, or 2 placebos—and found no difference in

postoperative transfusion, adverse events, quality of life (QoL) or mortality.

Summary and recommendations. Preoperative anemia is associated with poor outcomes after HFS; however, postoperative treatment has not proven beneficial. The presence of this condition should guide preoperative counseling.

Perioperative Management

Perioperative thromboprophylaxis

Rationale. Preoperative and perioperative chemical thromboprophylaxis may prevent venous thromboembolism (VTE) but may also increase the risk of bleeding.

Evidence. The literature search identified 457 articles, of which 2 SR/MAs and 5 RCTs met inclusion criteria. Additional recommendations were obtained from 3 published guidelines.

Aspirin: A MA of 8 trials comparing postoperative aspirin versus other anticoagulants found comparable deep vein thrombosis (DVT) rates but lower rates of bleeding in the aspirin group following HFS of any kind.[33] A randomized double-blind trial not included in the MA evaluated symptomatic VTE and bleeding events in 13 356 patients undergoing HFS who received either 160 mg aspirin or placebo starting preoperatively and continued for 35 days postoperatively found that aspirin reduced risk of DVT by 29% and pulmonary embolism (PE) by 43%.[34] However, patients taking aspirin had a 24% increased risk of transfusion.

Heparins: A Cochrane review including 31 studies concluded that heparins were effective at reducing the incidence of DVT after surgery for proximal femoral fracture.[35] Most, but not all, of the included studies began heparin administration preoperatively. In trials comparing low-molecular-weight heparin (LMWH) to unfractionated heparin (UFH), DVT risk was lower with LMWH. An RCT comparing fondaparinux initiated postoperatively to enoxaparin initiated preoperatively in patients undergoing HFS found a relative risk reduction for VTE at early time points; however, by day 49, the incidence of symptomatic VTE was similar.[38] There were no differences in rates of PE or clinically significant bleeding including fatal bleeding, bleeding leading to reoperation, and bleeding involving a critical organ.

Vitamin K antagonists (VKAs; eg, warfarin): A SR of 30 RCTs comparing VKA initiated prior to HFS found reduced DVT and PE incidence in the VKA groups compared to control groups without prophylaxis.[36] A 3-armed RCT separate from the SR included 194 patients and compared warfarin (international normalized ratio 2.0-2.7), aspirin (650 mg twice daily), and no prophylaxis.[37] This study found that when agents were continued for 21 days postoperatively, warfarin, but not aspirin, decreased the incidence of VTE. There were similar rates of clinically relevant bleeding between the groups. The study defined major bleeding as requiring transfusion of at least 2 units of blood, a decrease in hemoglobin of 2 g/dL or more, or retroperitoneal or intracranial bleeding.

Timing of thromboprophylaxis: A large observational study comparing preoperative versus postoperative start of LMWH (dalteparin or enoxaparin) in patients with hip fracture found that postoperative initiation was associated with a higher risk of death and reoperation due to infection or hematoma.[39] The NICE guidelines recommend that fondaparinux should be started 6 hours after surgical closure, and LMWH/UFH should be stopped 12 hours prior to surgery and restarted 6 to 12 hours after surgery.[36] The American College of Chest Physicians (CHEST (American College of Chest Physicians)) recommends patients receiving LMWH start either 12 hours or more preoperatively or 12 hours or more postoperatively.[40]

Duration of thromboprophylaxis: A RCT comparing fondaparinux started on the day of surgery and continued for either 25-31 days or 6-8 days followed by placebo found that extended prophylaxis was associated with a 95.9% relative reduction in VTE.[41]

The AAOS guidelines also recommend VTE prophylaxis based on moderate evidence (Table 3).

Summary and recommendations. Several MAs and subsequent RCTs have evaluated various pharmacological agents to protect against VTE in HFS patients. Pulmonary embolus prevention is difficult to assess due to low incidence. Aspirin, VKA, heparins, and factor Xa inhibitors reduce DVT risk, but it is unclear which agent is preferred. Although guidelines from CHEST and NICE provide recommendations, there is insufficient evidence to conclude whether thromboprophylaxis should be started preoperatively or postoperatively. Depending on the agent, extended therapy for 21 to 31 days appears to be superior for the prevention of VTE.

Timing of surgery

Rationale. Early HFS has been associated with improved outcomes; however, the opportunity to optimize management of modifiable comorbidities by delaying surgery must be considered.

Evidence. The literature search identified 160 articles, of which 10 met inclusion criteria: 2 SR/MAs and 8 observational studies. A recent SR/MA (through 2011) found that early surgery within 24 to 48 hours of admission was associated with decreased mortality with a pooled OR of 0.74 (95% CI, 0.67-0.81) and decreased risk of pressure sores.[42] However, the effect on other complications and LOS was too heterogeneous for combined analysis. Of note, many of the studies included in the SR/MA did not adjust for comorbidities, and an MA adjusting for this important factor was not possible.

Several observational studies on HFS have addressed surgical timing since publication of the SR in 2011. A prospective cohort study found that each day of delay prior to surgery increased mortality for those with preexisting functional impairment but did not affect mortality for patients with high baseline functional status.[43] Another prospective cohort study found that surgery within 12 hours of admission decreased mortality compared to surgery within 24 hours, which in turn was associated with lower mortality compared to surgery

within 36 hours.[44] Retrospective cohort studies have yielded conflicting results. Studies supporting early surgery have found a benefit to surgery within 2 days of admission when adjusting for age and comorbidities[45]; a 1.8% increase in mortality per hour of delay that became significant at 24 hours after admission[46]; and improved mortality at 30 days and 1 year when surgery was performed within 48 hours of admission compared to 72 hours or more.[47] Other studies have identified no benefit to early surgery after adjusting for age, gender, and comorbidities[48] and no significant effect on mortality when comparing surgery within 3 days of fracture to >3 days after fracture.[49]

A SR/MA of delayed versus early (<48 hours) surgery on patients with hip fracture taking clopidogrel did not identify any significant differences in mortality or transfusion rates, although hospital stays were shorter with early surgery.[50] Since publication of the MA, 1 small study compared transfusion rates, thrombotic events, and mortality in patents taking antiplatelet therapy (clopidogrel or clopidogrel/aspirin) who underwent surgery before or after 48 hours, but the number of events in each group was too small to reliably demonstrate significance.[51]

Both AAOS and NICE guidelines recommend surgery within 48 hours of admission (Table 3).

Summary and recommendations. Early HFS within 24 to 48 hours appears to be beneficial. The benefit is most pronounced for frail patients and appears to be linearly related to time to surgery.

Perioperative fluid management

Rationale. Hip fractures are significant traumatic events often occurring in a medically frail population. Appropriate fluid resuscitation may reduce complications.

Evidence. The literature search identified 104 articles, of which 1 current SR met inclusion criteria.[52] This SR synthesized evidence from 5 studies of 403 patients comparing methods of monitoring appropriate fluid resuscitation. Comparison groups included formal protocol algorithms based on blood pressure, urine output, and central venous pressure, advanced hemodynamic monitoring (such as transesophageal Doppler and pulse contour analysis), and usual care. There was no benefit of these algorithms on morbidity, mortality, LOS, or discharge condition.

Summary and recommendations. The evidence does not support the use of a specific protocol or advanced hemodynamic monitoring to guide fluid resuscitation in patients with hip fracture beyond usual care. Providers should use basic clinical parameters to guide perioperative fluid management.

Drain placement

Rationale. Drain placement has been used to reduce hematoma formation; yet the impact on infection and blood loss is less clear.

Evidence. The literature search identified 212 articles, of which 2 met inclusion criteria: 1 SR/MA and 1 MA. A SR and MA of RCTs comparing drain placement versus no drain placement for HFS included 6 studies representing 664 patients. No difference was found in wound infection, hematoma formation, reoperation, or blood transfusion rates, or in postoperative hemoglobin levels.[53] The other study was a MA that combined results from 36 studies (5500 patients) undergoing a variety of orthopedic procedures (including hip fracture, elective total hip arthroplasty and total knee arthroplasty, shoulder and spinal surgeries, cruciate ligament reconstruction, meniscectomy, and fracture fixation) comparing closed suction drainage versus no drainage. No difference was found in wound infection, hematoma, dehiscence, or reoperation rates. Blood transfusion was more frequent with drain placement, and more ecchymosis and more frequent need to reinforce dressings was found without drains.[54]

Summary and recommendations. There is no evidence of benefit from drains, and placement may increase transfusion requirements. Routine drain placement after HFS is not recommended.

Early mobilization

Rationale. Early mobilization after HFS may result in decreased complications, shorter hospital stay, and better functional outcomes.

Evidence. The literature search identified 19 articles, of which 6 met inclusion criteria: 1 SR, 1 RCT, and 4 observational studies.

An SR addressing early ambulation as part of care packages for optimal treatment of hip fracture with internal fixation, hemiarthroplasty, or total arthroplasty[55] found that survival and functional recovery improved with shorter duration of immobility. Each day of delay to ambulation was an independent predictor for the development of pneumonia (OR 1.5), new-onset delirium (OR 1.72), and prolonged hospital stay with nearly a 5-day difference in stay between patients ambulating on postoperative day 1 versus postoperative day 4.[56] One RCT comparing first walk on postoperative day 1-2 versus day 3-4 found those in the early ambulation group were able to walk twice as far by postoperative day 7 (66 vs 30 meters), required less assistance, and were more likely to be discharged home (17% vs 3%).[57]

An observational study found that HFS patients who ambulated by day 5 had a shorter hospital stay by 6.5 days, were 60% more likely to be discharged home, and had improved 180-day survival (OR 2.8).[58] A second observational study found that mobilization within 24 hours postoperatively was the strongest predictor of decreased 30-day mortality (OR 0.6), risk of readmission (OR 0.84), and LOS.[59] A prospective study of ambulation on postoperative day 1 reported a surgical revision rate for loss of fixation, nonunion, osteonecrosis, or prosthetic dislocation of 3.4%, similar to the revision rate in contemporary articles regardless of weight-bearing protocol.[60] A prospective cohort study found patients were less likely to achieve early weight bearing and ambulation within 48 hours if they were

older, had more comorbidities or disability, or underwent surgery before a holiday or weekend.[61]

The NICE guidelines recommend physiotherapy assessment and mobilization on postoperative day 0 unless contraindicated (Table 3).

Summary and recommendations. Ambulation as early as the first 24 hours postoperatively is recommended following HFS as it appears to be safe and effective at improving outcomes. Each day of immobility appears to have a deleterious effect.

Early alimentation

Rationale. Early postoperative alimentation may speed gastrointestinal recovery and shorten hospital stay.

Evidence. The literature search identified 52 articles, of which 1 SR on hip fracture care including 41 studies met inclusion criteria.[62] Main findings included that oral multinutrient feeds may reduce complications, but there is no effect on mortality. In the very malnourished, there was no evidence supporting nasogastric (NG) multinutrient feeding, and NG feeding was generally poorly tolerated; there was no evidence supporting high-protein intake or vitamin/mineral supplementation (thiamine, water soluble vitamins, vitamin D, iron, α-ketogluterate, taurine, and multivitamin/minerals) on mortality or complications.

The AAOS guidelines recommend postoperative vitamin D and calcium to reduce mortality based on moderate evidence (Table 3).

Summary and recommendations. Although a well-done SR has addressed the question of postoperative nutrition in patients recovering from hip fractures, there is no current evidence supporting the use of NG or parenteral nutrition or supplementation with respect to mortality or complications. There is some evidence supporting multinutrient feeding in reducing rates of complications but no evidence of overall effect on mortality. Enteral nutrition should be started as soon as tolerated postoperatively.

Discharge criteria and planning

Rationale. Use of evidence-based discharge planning strategies may result in fewer readmissions, fewer complications, shortened LOS, and improved patient experience.

Evidence. The literature search identified 529 articles, of which 12 studies met inclusion criteria: 1 SR, 2 RCTs, and 9 observational studies.

Preoperative scoring systems. A scoring system for patients with hip fracture to predict prolonged nursing home stay, including physical impairment, ambulatory status, ability to perform activities of daily living (ADLs), and living situation, was significantly associated with remaining in a nursing home in 1 observational study.[63] Another study evaluated the Nottingham Hip Fracture Score, previously validated for predicting 30-day and 1-year mortality based on admission data, as a score for predicting ability to return home after HFS.[64] Increasing scores correlated with decreased return to home. A retrospective cohort used to define a prediction score for discharge to a setting other than the patient's home included higher age, female gender, dementia, the absence of partner, and preoperative mobility limitation.[65] Positive predictive value was 79%. The likelihood ratio of discharge to a setting other than the patient's home for a score of 30 or more was 2.4. This score was then externally validated using a retrospective cohort of 125 patients from other centers.[66]

Discharge planning strategy. There was heterogeneity in the studies identified with respect to interventions, outcomes, and definitions of inpatient versus home health rehabilitation. Many of the home health regimens involved multiple nursing visits. The systematic review (SR) of musculoskeletal disorders including hip fracture and joint replacement in older patients (>55 years old)[67] compared outcomes from home-based rehabilitation versus inpatient rehabilitation. Home rehabilitation was associated with equal or improved function, cognition, QoL, and patient satisfaction. Four studies found that home rehabilitation had better functional outcomes, while the others found that the 2 settings were equivalent. One study found that home rehabilitation was associated with lower rates of delirium, 4 studies demonstrated higher QoL with home rehabilitation, and higher satisfaction was demonstrated in 2 studies. In the 4 studies that compared hospital LOS, the home rehabilitation group had shorter LOS, although the LOS was longer in articles that defined LOS as admission until completion of rehabilitation. No difference in mortality was found in the 4 studies that examined this variable.

A retrospective study comparing groups before and after implementation of a standardized multidisciplinary rehabilitation and discharge planning protocol from admission through discharge[68] found that the modified Barthel index, a validated objective measure of functional ability and independence, was lower at 3 months for control patients with low social support compared to controls with high levels of support. No difference based on level of social support was seen for intervention patients. Low support control patients were also more likely to be institutionalized in long-term care facilities at 6 months. The intervention appeared to mitigate differences in the level of social support.

An RCT of 126 HFS patients randomized to a discharge planning intervention consisting of visits and planning by a trained nurse versus usual care found that intervention patients had decreased LOS, improved survival, and ADLs as well as higher 36-Item Short Form Survey (SF-36) scores.[69]

An RCT of HFS patients evaluated a standardized discharge plan including assessment of discharge needs, nursing instructions, coordinated services, and discharge placement based on the assessment as well as 2 home visits after discharge.[70] The control group received nonstructured discharge planning with no standardized procedure. Patients receiving the intervention had higher measures of self-care knowledge and improved QoL measured by the SF-36 at 3 months.

A retrospective cohort analysis compared differences in outcomes based on discharge to rehabilitation nursing homes versus traditional nursing homes versus traditional rehabilitation facilities.[71] Adjusting for differences such as age and baseline disability, patients with fewer comorbidities who went to rehabilitation nursing homes had improved ADL-independent scores. For sicker patients, there was no difference.

A prospective cohort study compared outcomes for patients discharged to skilled nursing facilities (SNFs) versus inpatient rehabilitation versus home health.[72] Patients in inpatient rehabilitation and home health had lower self-care function at discharge compared to patients in SNFs. The average LOS of home health patients was 2 weeks longer than SNF patients, and SNF patient stays were 9 days longer than that for inpatient rehabilitation patients.

A prospective cohort study of HFS patients "suitable for early discharge" compared the effect of discharge to home rehabilitation versus inpatient rehabilitation.[73] More patients selected for discharge home returned to their preinjury residence and level of independence at 6 weeks. This was not significant at later time points.

Evaluation of discharge criteria. A multicenter cohort study evaluated the impact of active clinical problems at discharge, including fever, tachycardia, bradycardia, hypertension and hypotension, tachypnea, hypoxia, altered mental status, lack of oral intake, shortness of breath, chest pain, arrhythmia, wound infection, and new incontinence, new bedridden status, and new decubitus ulcer.[74] The presence of any of the active clinical issues on discharge was associated with an increased adjusted risk of death, readmission, and major medical event. The presence of new impairments was associated with increased readmission, major medical events, and worsened functional mobility.

The NICE guidelines recommend early supported discharge for appropriately selected patients as well as continued involvement of the primary team in inpatient rehabilitation when needed (Table 3).

Summary and recommendations. Standardized discharge plans following HFS appear to improve patient outcomes, including QoL and functional independence. The use of standardized discharge criteria assessing medical stability as well as functional recovery and strength is recommended.

Discussion

The use of evidence-based, multidisciplinary ERPs has been found to improve outcomes following surgery.[3] For orthopedic surgery, standardized multimodal surgical pathways are increasingly implemented.[75-77] In this review, the evidence supporting perioperative management components was synthesized into an ERP designed to improve complication rates, functional recovery, and mortality for patients with hip fracture. Extensive review of the literature spanning many topics was performed to define recommendations.

Recognizing that hip fracture is an unexpected condition, comorbid conditions such as malnutrition, DM, smoking status, and anemia impact risk of surgery but cannot be realistically modified before surgery. Therefore, consideration should be made to screen for these conditions and optimize as much as possible while not significantly delaying the procedure. Importantly, they should be considered when counseling the patient about the risks of surgery and potential long-term outcomes. Important elements to include in hip fracture pathways include time to surgery, deliberate plan for VTE prophylaxis, early mobility, and multidisciplinary discharge planning. In totality, this represents the surgical components of the pathway. The anesthesia components will be reported separately.

This review has several limitations. Due to the heterogeneity of topics and evidence available for each topic, only broad parameters for SR could be applied. No formal assessment of study quality was done. In many cases, no evidence specific to HFS was available, and results had to be extrapolated from other procedures. The HFS technique was frequently not described in included studies, so factors related to specific procedures could not be defined. This review serves as a starting point for individual hospital pathways to build upon, adding other best practices components as needed.

This review evaluated the evidence for a variety of pathway components to aid refinement of evidence-based programs for HFS that will improve patient clinical outcomes and satisfaction and reduce hospital stay and unnecessary resource utilization. Drain placement is not recommended. Preoperative counseling regarding the risk of complications is recommended for patients with DM, anemia, or poor nutrition and for current smokers. Surgery within 24 to 48 hours of presentation, ambulation at 24 hours postoperatively, enteral nutrition as soon as possible postoperatively, extended VTE thromboprophylaxis, and standardized discharge plans are recommended during the perioperative treatment of hip fracture.

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