Medical Management of Common Comorbidities in Elderly Patients with Proximal Femur Fractures:

Review and Evidence Based Note Template

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Objectives: Provide a framework for the medical treatment of patients with proximal femur fractures.

Design: Literature review and evidence-based note template.

Intervention: Medical management of patient undergoing operative fixation of proximal femur fracture.

Main outcome measurement: Perioperative morbidity.

Results Proximal femur fractures are common orthopaedic injuries in the geriatric population and present with morbidity and portend mortality. The current evidence suggests that most patients should be surgically managed 24-48 hours from injury in accordance with patient preferences and medical risk stratification. Doing so is likely to improve postoperative outcomes and save both patients and hospital systems financial resources. After proper history and physical examination, imaging with plain radiographs is recommended, with MRI indicated in occult fractures. There are numerous cardiovascular, cognitive, and endocrinologic comorbidities that may delay or impact surgical treatment of hip fracture patients. This review discusses informed consent, cardiovascular implantable electronic devices, anticoagulation, preoperative cardiovascular evaluation, anemia, congenital heart disease, cerebrovascular accident, hyponatremia, diabetes mellitus, end-stage renal disease, osteoporosis, COVID-19 and chronic obstructive pulmonary disease, and history of bariatric surgery.

Conclusions: A proper understanding of how these conditions affect hip fracture patients may help orthopaedic surgeons to expedite surgery safely and effectively and may also serve as a framework in the management of other fragility fractures in patients with comorbidities.

Level of Evidence: IV, systematic review

Keywords: Hip Fracture, Medical co-management, Geriatrics, Fragility fracture, Osteoporosis, Comorbidity, Comorbidity management, Anesthesia, Perioperative morbidity, Cardiovascular, Cerebrovascular, Renal disease, Surgical timing.

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INTRODUCTION

Hip fractures are common injuries in the geriatric population, resulting in approximately 300,000 hospitalizations in the United States annually.[1] These injuries have associated functional sequelae (e.g., disability, depression), financial burden, and mortality.[1,2] As patients with hip fractures are most often managed surgically, current clinical practice guidelines (CPG) from orthopaedic, anesthesiology, cardiac, and geriatric specialties are relevant.[3-6] These guidelines may coincide, as orthopaedic and anesthesiology guidelines recommend hip fracture surgery take place within 36-48 hours of hospital admission.[3,4] Yet guidelines may differ, as one study showed a relationship between cardiac preoperative screening and a subsequent delay to surgery.[6] Additional consultations may be necessary to manage comorbidities (e.g., coronary artery disease, diabetes mellitus, dementia, renal failure) that have been associated with increased mortality rates in hip fracture patients.[7]

Comorbidities need to be treated and assessed properly, yet delays in operative fixation prolong immobilization with concomitant risks for pneumonia, urinary tract infection (UTI), and decubitus skin ulcers.[8] Previously, 48 hours between injury and surgery was the standard, as evidence showed an increase in 1-year mortality for hip fracture patients who underwent surgery more than 48 hours after injury.[9-11]

Table 1: Outline of topics covered

1. Occult Proximal Femur Fracture
2. Informed Consent Considerations
3. Cardiovascular Implantable Electronic Devices
4. Anticoagulation (Venous Thromboembolism, Deep Venous Thrombosis, Atrial Fibrillation)
5. Echochardiography
6. Anemia
7. Congenital Heart Disease
8. Cerebrovascular Accident
9. Hyponatremia
10. Diabetes Mellitus
11. End-Stage Renal Disease
12. Osteoporosis
13. Bariatric Surgery
14. Surgical Timing
15. Mortality and Predictors of Mortality
16. **Evidence Based Template**
17. References

Table 2: History and Physical Exam Section Details

Past Medical History: Examples of comorbidities discussed in this review		
• atrial fibrillation with or without anticoagulation • anemia • cardiovascular implantable electronic devices • cerebrovascular accident	• chronic kidney disease with or without dialysis • chronic obstructive pulmonary disease with or without home oxygen requirement • congenital heart disease	• congestive heart failure • COVID-19 • diabetes mellitus with or without insulin • dementia • hyponatremia • Osteoporosis
Past Surgical History:		
• prior implants and arthroplasty procedures with dates, hospitals, surgeons, and relevant implants		
Medications: Examples of medication classes discussed in this review		
• Anticoagulants • Antidepressants • Anti-psychotics	• Antiresorptives • Chronotropes • Diuretics	• Insulin • Mood stabilizers • Urinary retention medications

More recently, however, studies have investigated the outcomes of surgery within 24 hours of presentation. A retrospective cohort study found that 30-day mortality was increased with each passing hour (1.8%) from presentation to surgery but did not reach significance until 24 hours. The authors concluded that co-morbidities confound mortality assessment by both increasing the complexity of medical care and prolonging immobilization.[12] Additional studies, including one systematic review and three observational studies, demonstrated that surgery within 12 hours of hip fracture diagnosis was associated with lower mortality risk.[10,13-15] In addition, two randomized trials showed decreased hospital stays in patients who received accelerated hip fracture management.[16,17] In 2021, a meta-analysis of 15 studies found reduced mortality for hip fracture patients operated within 24 hours compared with those operated on beyond 24 hours.[18]

These primary studies prompted an international, randomized controlled trial, 'HIP ATTACK,' between March 2014 and May 2019 to hypothesize that accelerated surgery (median 6 hours, interquartile range (IQR) 4-9 hours) in patients with hip fracture could improve outcomes relative to the standard group (median of 24 hours, IQR 10-42 hours). There were no differences in 90-day mortality nor composite of major complications between the two groups. However, advantages of accelerated surgery included shorter hospital stay (~1 day shorter), faster postoperative mobilization, lower postoperative pain, as well as fewer cases of postoperative stroke, delirium, infection without sepsis, and UTI.[19] The study also found that patients with elevated troponin levels at baseline had a lower mortality risk with accelerated surgery compared to standard care, which prompted the authors to suggest further research into this association. The authors concluded that accelerated surgery was safe if there was an appropriate assessment pathway to address co-morbidities prior to surgery.

The aim of this literature review is to assess the evidence for treating patients who present with hip fractures complicated by comorbidities to unify the co-managing teams and specialists.

METHODS

This article is a level of evidence IV literature review. Pubmed, Web of Science, and Embase were searched from 2000 to 2020, with the search query "hip fracture" AND "accelerated surgery" according to PRISMA guidelines.[20] Search returned 12 articles. After duplicates were removed, seven articles remained and were reviewed by title and abstract. All articles were relevant but one was excluded for being a pilot study, three were removed for being the protocols for another citation, and one was excluded for inadequate methodology. From the remaining studies, medical comorbidities implicated in additional preoperative evaluation were identified and enumerated (Table 1).[19,21]

Clinical practice guidelines were reviewed from organizations including the American Academy of Orthopaedic Surgeons (AAOS), American Geriatrics Society, the Journal of the American Medical Association (JAMA), American Society of Anaesthesiologists (ASA), Association of Anaesthetists, British Orthopedic Association (BOA), Eastern Association for the Surgery of Trauma (EAST), National Health Services (NHS), American Association of Endocrinologists (AACE), and American Diabetes Association (ADA). The following evidence elucidates approaches for perioperative evaluation and treatment of medical comorbidities in patients with hip fractures.

RESULTS

Diagnostic Considerations: Atypical Femur Fractures, Pelvic Ring Injuries, Occult Proximal Femur Fractures

Following history and physical exam, diagnostic evaluation of patients presenting with hip pain suspicious of fracture includes radiographs of anterior-posterior (AP) pelvis, AP and lateral hip, AP and lateral femur, AP and lateral knee. Patients with atypical femur fractures may be queried about contralateral hip pain and radiographic evaluation for osseous abnormalities, particularly lateral cortical thickening and

Table 3: Imaging recommendations for diagnosis of concomitant injuries, occult fractures, and delayed presentation.

X-ray
• Order biplanar imaging for joint above and below pain, tenderness to palpation, or ecchymosis • Include upper extremity, as indicated • Minimum plain radiograph imaging for hip fracture is AP pelvis, ipsilateral hip AP/lateral, ipsilateral femur AP/lateral, ipsilateral knee AP/lateral, and views of entire implants and bone for any other lower extremity implants • Contralateral hip AP/lateral view indicated in setting of atypical subtrochanteric fracture with bisphosphonate use • Internal rotation traction view improves sensitivity in classifying proximal femur fractures to inform operative management
CT
• Suspected pelvic ring injury where CT is the diagnostic gold standard • Negative hip x-ray as alternative to MRI for assessing occult fracture due to contraindication or unavailability • Added benefit of screening for osteoporosis using CT analysis
MRI
• Indications: occult fractures, isolated greater trochanter fractures to evaluate for intertrochanteric extension to visualize associated edema and is the gold standard for diagnosing these fractures in 3-4% of patients where plain radiographs were inconclusive; however, MRI is costly, not always available, and is contraindicated in patients with certain implants • T1-weighted coronal MRI is the most sensitive sequence of imaging • Contraindications: Multiple absolute and relative contraindications, including cardiac implantable electronic device, implantable neurostimulation systems, some cochlear implants, and other implants that may be safe on 1.5-tesla scanners only • Occult hip fracture o No fracture seen on AP pelvis nor hip x-rays with history and exam concerning for pelvic or hip fracture. Specific risks factors include age ≥ 80 years, ambiguous x-ray, and history of trauma. o Up to 39% of patients with negative x-ray will have occult hip fracture on MRI that may change management. • If MRI contraindicated, MRI, CT and bone scan have a hip fracture sensitivity of 79% and 87%, when compared to MRI respectively
Duplex Scanning
• ≥ Two-day delay in presentation from injury, delay in surgery of > 48 hours, clinical concern for symptomatic VTE • Inconsistent correlation of duplex screening with symptomatic VTE in trauma patients

increased diaphyseal cortical thickness portending impending fracture.[22] Internal rotation traction view improves sensitivity in classifying proximal femur fractures to inform operative management.[23,24] Plain radiographs do not detect all fractures and there are three common scenarios in which further imaging is recommended, specifically, plain film evidence of pelvic ring injury, clinical suspicion for an occult fracture not identified on radiographs and diagnosing isolated greater trochanteric fractures.

Suspected pelvic ring injuries with evidence of rami fractures on plain films are best evaluated with CT to evaluate for acetabular and posterior ring injuries.[25,26] In a systematic review of 35 studies involving 2992 older adult patients with suspected hip fracture (mean age 77 years), 1110 (39%) had a hip fracture despite a negative radiograph.[27] The highest risk patients for occult hip fracture were those aged at least 80 years, those with an ambiguous x-ray, and those with a history of trauma. In the case of suspected occult fractures of the hip, CT or MRI is indicated.[27,28] In a 2015 systematic review of 7 studies involving 110 patients, 90% of the patients with isolated greater trochanteric fractures diagnosed on plain radiographs revealed extension of the fracture into the intertrochanteric region when MRI was performed.[29]

MRI is superior to CT due to higher sensitivity and lower radiation burden.[27,30] T(1)-weighted coronal MRI is the optimal sequence for identifying an occult hip fracture.[31,32] However, a CT is the next best option if MRI is not accessible or is contraindicated (i.e. ferromagnetic metal in body, pacemaker)[33-37]. CT has the advantage of being faster, more easily accessible, and has fewer contraindications. A bone scan is also an option to consider, although it is often less readily available than CT and has been deemed "usually not appropriate" by the American College of Radiology.[28] When compared to MRI, CT and bone scan have a hip fracture sensitivity of 79% and 87%, respectively.[27] Further management considerations can be found in the 2015 AAOS Clinical Practice Guidelines.[38]

Informed Consent Considerations: Dementia, COVID-19

Medical professionals have a moral and legal obligation to assess capacity in the patient and communicate all pertinent information to obtain informed consent. Informed consent is considered an important part of shared decision-making between a patient and their physician. Capacity is defined as the patient's ability to make a decision at a particular time in a specific situation, and is ideally assessed by a physician who is familiar with the patient.[39] The physician assesses four functional pillars of capacity: understanding, appreciation, reasoning, and expressing a choice.[40] The capacitated patient will show consistent choice

Table 4: Informed consent considerations for patients with hip fractures.

- Legal specifics vary by state
- The ability to act under presumed consent requires three factors: patient incapacity, clinical urgency and clarity on the correct course of action, with a 36-hour window that has been applied to geriatric hip fractures
- COVID-19 positive patients undergoing hip fracture surgery have increased risk of postoperative complications, including lower respiratory tract infection, ARDS, deep vein thrombosis and pulmonary embolism, increased requirement for intensive care admission, longer inpatient stay, and higher risk of mortality
- Templates available through British Orthopaedic Association

over time when reassessed.[41] The ability to act under presumed consent requires three factors: patient incapacity, clinical urgency and clarity on the correct course of action, with a 36-hour window that has been applied to geriatric hip fractures.[42]

The process of informed consent is inadequate in the absence of formal documentation. Individual organizations can establish their own informed consent policies, though large governing bodies provide adequate framework for obtaining consent. The BOA provides thorough, evidence-based informed consent templates.[43] The American Academy of Orthopedic Surgeons also provides guidance for informed consent, suggesting consent should be timely, accurate, understandable, complete, and surgeon-led.[44]

Dementia is a risk factor for sustaining a hip fracture and is a common comorbidity with an incidence of 14% among hip fracture patients.[45] As dementia and other cognitive impairments exist on a continuum, there is likely not a clear threshold at which serial reassessment of choice is preferred before consent for hip surgery is validated. Hip surgery may be expedited without reassessment in patients with highly functional mild dementia whereas a medical power of attorney consultation would be indicated for patients with severe impairment.

Patients with dementia cannot be assumed to be incapacitated. Mild to moderate dementia patients have shown the ability to perform the four functional pillars of capacity. Furthermore, United States' law iterates that all adults have capacity until evidence proves otherwise.[46] The Association of Anaesthetists has put forth the following guidelines: "1. People with cognitive impairment should receive the same standards of, and access to, healthcare as people without cognitive impairment. 2. Preoperative assessment processes should identify people with cognitive impairment so that their management and follow-up can be tailored to their needs. 3. Preoperatively, the risk of perioperative cognitive changes should be explained to patients and their relatives. 4. Rigorous assessment and management of cognitive impairment should apply equally to patients requiring elective or emergency surgery."[47]

Another important consent consideration is COVID-19. Patients with active COVID-19 infection undergoing hip fracture surgery should be informed of the additional risk of postoperative complications including lower respiratory tract infection, ARDS, deep vein thrombosis and pulmonary embolism (PE), increased requirement for intensive care admission, longer inpatient stay, and higher risk of mortality.[48]

Cardiovascular Implantable Electronic Devices

Cardiovascular implantable electronic devices (CIEDs), including pacemakers and implantable cardioverter-defibrillators (ICDs), may present with patients at risk of hip fracture. A 2012 study found that pacemaker implantation significantly reduced the incidence of falls and fractures in people diagnosed with sinus node disease by 15% and 6%, respectively. This corresponded to a relative risk reduction of 75% in falls and 63% in falls resulting in injury. Despite this risk reduction, there are many in this population that still experience a hip fracture and require surgical intervention.[49]

No specific guidelines have been established specifically for patients with CIEDs who need surgery for hip fractures. However, general preoperative advisories for patients with CIEDs have been developed by the following societies: the American Society of Anesthesiologists (ASA),[50] the Heart Rhythm Society (HRS)[51], and the Canadian Anesthesiologists' Society (CAS) in conjunction with the Canadian Cardiovascular Society (CCS).[52]

The summary of these advisories is that before undergoing elective surgery, CIEDs should be interrogated or have had a recent interrogation (within 6-12 months). Preoperative CIED evaluation is prioritized in patients with procedures superior to the umbilicus, as they are at greatest risk of electromagnetic interference. Preoperatively for hip fractures, CIED evaluation might not be possible due to inadequate time for appropriate CIED evaluation.[50-52]

Table 5: Cardiovascular Implantable Electronic Devices (CIEDs) considerations for patients with hip fractures.

- American Society of Anesthesiologists (ASA) Cardiac Implantable Electronic Device Management Guidelines
- Canadian Cardiovascular Society/Canadian Anesthesiologists' Society/Canadian Heart Rhythm Society joint position statement on the perioperative management of patients with implanted pacemakers, defibrillators, and neurostimulating devices
- Heart Rhythm Society (HRS)/American Society of Anesthesiologists (ASA) Expert Consensus Statement on the perioperative management of patients with implantable defibrillators, pacemakers and arrhythmia monitors

In high-volume settings or wherever it is feasible, it is beneficial to have an anesthesia team trained to interrogate the CIED, devise a management plan, and perform preoperative and postoperative programming of the device.[53] When this is not possible in a timely manner, it is acceptable to continue with surgery using a magnet to produce asynchronous pacing or disabling ICD high-energy therapy, provided that the patient position does not interfere with magnet access or observation. After surgery, the ASA recommends performing a postoperative CIED interrogation if emergency surgery occurred without appropriate preoperative CIED evaluation.[50-52]

Anticoagulation

Anticoagulant and antiplatelet use is common among patients undergoing hip fracture surgery, as coronary artery disease, cardiac valve replacement, atrial fibrillation, and venous thromboembolism are common. In a 2017 study of geriatric trauma patients in Florida, 42% of patients admitted were on antiplatelet therapy or anticoagulated.[54] The increased risk of bleeding associated with these agents varies depending on the procedure, since percutaneous pinning will likely cause less blood loss than total hip arthroplasty or revision arthroplasty, but bleeding is both expected and potentially problematic in all hip fracture surgeries. In a 2020 cohort study of patients at two level II trauma centers between January 2010 and May 2016, analysis showed that patients on anticoagulation required more allogenic packed red blood cell (pRBC) transfusions, developed hematomas, and had longer hospital stays compared to those presenting without active anticoagulation.[55] Additionally, bleeding can lead to obscured surgical field visualization and postoperative surgical site infections.[56] A 2020 retrospective study showed that surgical drain placement decreased the risk of postoperative hematoma but was also associated with increased blood loss, transfusion requirement, and duration of hospitalization.[57] When considering anticoagulation preferences regardless of cost, direct oral anticoagulants, namely dabigatran, apixaban, and rivaroxaban, were preferred over low molecular weight heparin (LMWH), which was preferred over warfarin for patients undergoing total hip arthroplasty.[58]

Table 6: Considerations for patients with hip fractures presenting with active pharmaceutical anticoagulation and peri-operative venous thromboembolism prophylaxis

- For pre-injury vitamin K antagonist usage (e.g. warfarin), recommend bridging anticoagulation if the patient has a history of VTE within the last three months, has atrial fibrillation with a CHADS2 >5, has a mechanical heart valve, or has a known genetic clotting disorder
- Routine thromboprophylaxis with rivaroxaban 10mg daily starting on the first day of the patients' admission
- Alternative, enoxaparin subcutaneous of either 30 mg every 12 hours or 40 mg once daily

Venous thromboembolism (VTE) is an important perioperative consideration. VTE encompasses superficial vein thrombosis (SVT), deep vein thromboses (DVT), and pulmonary embolism (PE). SVT without risk factors for thrombus progression do not generally need anticoagulant therapy, as nonsteroidal anti-inflammatory drugs may be sufficient for symptom relief.[59] However, some studies have shown an increased risk of concomitant or subsequent DVT and PE in patients with SVT; therefore, patients with SVT should be evaluated for DVT using a doppler ultrasound and screened for clinical symptoms of PE. In patients with high risk, anticoagulation may be appropriate; however, further studies are needed to establish a protocol for SVT in preoperative hip fracture patients.[59-61]

Preoperative DVT incidence has been reported at 6-9% in patients with hip fractures receiving surgery within 48 hours and 54.5-62% when the delay is more than 48 hours.[62] There is low evidence for the use of regular duplex screening in preoperative hip fracture patients. However, studies have supported the use of imaging for lower extremity DVTs preoperatively, especially when a delay in surgery of >48 hours from the initial injury has occurred.[63,64] Multiple studies have shown a significant difference in the prevalence of thrombosis in the patients who had a delay >48 hours before admission to the hospital.[63-65]. One of these studies concluded that patients for whom there was a delay >48 hours between a hip fracture and admission to the hospital should be considered at high risk and screened for lower extremity DVT preoperatively.[63] A later study, however, showed inconsistent results of duplex scanning in preoperative hip fracture patients, and concluded that adherence to evidence-based VTE prophylaxis protocol is more important than surveillance duplex scanning in preventing VTE in trauma patients.[66]

A more recent study recommended that for patients presenting after fracture, mechanical and pharmacological prophylaxis should be initiated, and serum D-dimer should be evaluated if there is clinical suspicion for VTE. In those with a positive D-dimer, ultrasound duplex scanning is the first line for detecting the location of a DVT. CT contrast venography can also be used and has a higher sensitivity, but it is more invasive, more costly, and has contraindications in patients with renal insufficiency or contrast hypersensitivity. If confirmatory, therapeutic dose of enoxaparin should be given[64] at 1 mg/kg every 12 hours.[67]

In a 2017 prospective randomized controlled trial, thromboprophylaxis with rivaroxaban 10mg once daily prior to surgery was shown to effectively reduce the risk of preoperative DVT for patients with femoral neck fracture without increasing the risk of bleeding.[68] An alternative standard thromboprophylaxis medication is enoxaparin at a subcutaneous dose of either 30 mg every 12 hours or 40 mg once daily.[69]

The risk of postoperative VTE three months after hip surgery has an incidence ranging from 1-5%.[70,71] Postoperative

anticoagulation recommendations for patients who are otherwise at low risk for VTE is a prophylaxis with a minimum of 10 to 14 days of low-dose LMWH, fondaparinux, low dose unfractionated heparin (LDUH), adjusted-dose Vitamin K antagonist (VKA), aspirin (all Grade 1B recommendations), or an intermittent pneumatic compression device (IPCD) (Grade 1C).[71]

For patients on preoperative anticoagulation, there is a paucity of evidence for timing to resume therapeutic dosing with most practices resuming 24 hours after surgery with appropriate surgical hemostasis and absence of postoperative bleeding.[56] Direct oral anticoagulants (DOACs) are expected to achieve full therapeutic effect by 2-4 hours after the medications are resumed, while warfarin resumption may be indicated for a low molecular weight heparin bridge until the international normalized ratio (INR) returns to the therapeutic range, which could take up to 4 days.[56]

The most common indication for anticoagulation in geriatric orthopedic patients is atrial fibrillation, with an incidence of 7-10% in patients admitted with hip fractures.[56] The BRIDGE trial was a randomized, double-blind, placebo-controlled trial of 1884 patients with atrial fibrillation and acute hip fracture that were randomized to receive bridging anticoagulation or a placebo during warfarin interruption. There was no reduction in incidence of arterial thromboembolism with bridging therapy. It also showed a more than 2-fold increase in incidence of major bleeding in the group that underwent bridging therapy. The limitation of this study is that the average patient had a low CHADS2 score (average 2.3), thus results are not generalizable to those with high risk of thromboembolism.[72] Therefore, current recommendations for VKA therapy discontinuation are to only bridge anticoagulation if the patient has a history of VTE within the last three months, has atrial fibrillation with a CHADS2 >5, has a mechanical heart valve, or has a known genetic clotting disorder.[56,73]

If the patient is on warfarin or another VKA and does not have an increased risk of VTE, the anticoagulation can be reversed effectively using vitamin K with 3 mg IV (range 2 - 10 mg) upon admission to correct coagulopathy. Additionally, prothrombin complex remains a reliable and safe method for immediate reversal of VKA-induced coagulopathy in hip fracture surgery or failed vitamin K treatment reversal. Some literature recommends a preoperative INR <1.5, but the most recent literature indicates that low risk surgery (percutaneous pinning) is acceptable if the INR is under 3 and intermediate or higher risk hip fracture surgery is acceptable if the INR is under 2.[56,73] If surgery delay is expected, a prophylactic dose of LMWH should be used until the night before surgery.[73]

Indications for inferior vena cava filters has been controversial, and the American Society of Hematology 2019 guidelines recommend against their use due to high complication rate and limited evidence of benefit.[58] A 2012 retrospective cohort analysis concluded that patients undergoing early hip fracture surgery who are taking clopidogrel, aspirin, or warfarin are not at substantially increased risk for bleeding.[74] The literature suggests that surgery should not be delayed in patients on aspirin or clopidogrel, but spinal or regional anesthetic methods should be avoided in patients taking clopidogrel due to risk of spinal hematoma. However, evidence regarding the use of novel antiplatelet medications such as ticagrelor and DOACs remains a largely unexplored area in the context of hip fracture surgery.[73]

Table 7: Considerations for pre-operative cardiovascular evaluation and management echocardiography for patients with hip fractures

- 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force
  - Echocardiography and testing: pages 292-294

Preoperative Cardiovascular Evaluation and Management

Preoperative echocardiography is used in hip fracture patients to investigate cardiac comorbidities, such as heart failure, valvular disease, and atrial fibrillation. The 2014 ACC/AHA guidelines recommend preoperative echocardiograms in patients who had a change in clinical status or who have congestive heart failure (CHF) or stable valvular heart disease and at least one year since their last echocardiogram. The guidelines suggest performing a preoperative echocardiogram in patients with dyspnea of unknown origin.[75] Commonly cited justifications for significant clinical status changes, which are not specified in the above guidelines, include new murmur, myocardial infarction, syncope, dyspnea, or atrial fibrillation.[76]

Preoperative echocardiography is an important tool for screening patients who meet the above guidelines, but the ACC/AHA do not recommend routine preoperative echocardiograms for several reasons.[77] Preoperative echocardiography is associated with increased surgical delay, postoperative length of stay (LOS), and total healthcare costs at one year; however, these outcomes may be attributed to selection bias as less healthy patients with more severe comorbidities may be indicated more frequently for echocardiography.[78,79] A level of evidence III retrospective review showed that cardiology consultation and transthoracic echocardiography (TTE) are frequently overused, even in situations that are against ACC/AHA guidelines. In the study, despite only 17.7% of patients meeting criteria, 44.4% received a cardiac consultation. Furthermore, only 33.8% of those consulted met criteria for receiving preoperative TTE, but 89.4% received a TTE, which added a mean of more than six hours before surgery.[80] Another retrospective study showed that in a group of 100 geriatric patients with hip

fracture, following ACC/AHA guidelines could have prevented the performance of TTE in 34% of the patients, without missing a single case of management-altering disease.[81] One way to improve these outcomes is for echocardiography to be considered an urgent test when ordered to prevent additional surgical delay. It is important for physicians to be judicious in performing advanced workup, using ACC/AHA clinical practice guidelines when deciding whether cardiac consultation and/or TTE is necessary.[82]

Geriatric patients undergoing hip fracture surgery are at risk for myocardial infarction and injury perioperatively due to blood loss and co-morbidities. One retrospective study from 2020 found a myocardial infarction incidence of 23% in 1854 patients admitted for hip fractures perioperatively, which aligned with previous reports ranging from 6% to 36%, based on the diagnostic criteria adopted.[83] The authors correlated elevated troponin levels to increased mortality.

Table 8: Considerations for peri-operative anemia in patients with hip fractures.

- Blood transfusion threshold of no higher than hemoglobin 8 g/dL in asymptomatic patients, AAOS Clinical Practice Guideline: Management of Hip Fractures in the Elderly, meta-analysis, Transfusion Trigger Trial for Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair (FOCUS)
- Tranexamic acid is safe and effective in reducing transfusion requirements in patients undergoing hip fracture surgery
- Pre-operative iron therapy has limited benefit in treating anemia in patients undergoing hip fracture surgery

Anemia

Prior to the 1980s, pRBC transfusion threshold was hemoglobin less than 10 g/dL and hematocrit less than 30%; however, blood-borne pathogen risks and costs of transfusion have prompted reconsideration.[84] Several randomized controlled trials in hip fracture patients have been performed to determine efficacy and superiority of liberal (transfusing if hemoglobin <10 g/dL) versus restrictive (symptomatic or <8 g/dL) transfusion approaches. While the earlier trials indicated liberal use could improve mortality, the more recent growing body of evidence, conglomerated by a 2019 meta-analysis, indicates that restrictive methods are non-inferior, and thus are recommended due to the decreased cost and chance of transfusion-related problems.[85]

The Transfusion Trigger Trial for Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair (FOCUS) trial[86] involved randomized allocation of 2,016 patients with pre-existing cardiovascular disease or cardiovascular risk factors to liberal or restrictive postoperative transfusion after hip fracture surgery. The restrictive transfusion group received a single unit transfusion only if they developed symptoms of anemia or, in the absence of symptoms, when the hemoglobin level fell below 8 g/dL. The liberal group received immediate transfusion of one pack of RBCs and any additional transfusions necessary to maintain the hemoglobin above 10 g/dL. The liberal strategy did not reduce death rates, inability to walk independently on 60-day follow-up, nor reduce in-hospital morbidity in elderly patients at high cardiovascular risk; accordingly, current guidelines indicate transfusion only if symptomatic or below 8 g/dL.[86] The COVID-19 pandemic has stressed availability and sufficiency of blood transfusions to meet patient needs, underscoring the importance of judicious blood product management.[87]

Adjunctive therapies have been investigated to reduce transfusion perioperatively. Tranexamic acid (TXA) was evaluated in a retrospective cohort study of 289 patients who received 15mg/kg TXA prior to surgery and 32 who received no TXA. The study concluded that TXA appears to be safe and effective for reducing blood loss, pRBC transfusion, and LOS in geriatric hip fracture patients undergoing hip hemiarthroplasty. DVT rates were comparable in both groups, as the TXA group had a 0.35% DVT rate (1 patient) and the control group had a 0.94% DVT rate (3 patients).[88] Preoperative IV iron therapy for all patients scheduled for major orthopedic surgery was evaluated in a systemic review and demonstrated limited benefit, and 0.5% of patients given IV iron experienced a non-life-threatening, self-resolving complement-mediated “pseudo-allergy” that resulted in arthralgia, myalgia, or flushing without cardiovascular or respiratory effects.[89]

Congenital Heart Disease

In noncardiac surgical candidates with a history of congenital heart disease, the AHA/ACA recommends that the surgery be performed in a hospital with or in consultation with experts in adult congenital heart disease (ACHD). Factors associated with increased risk include cyanosis, CHF, poor general health, younger age, pulmonary HTN, and urgent/emergent procedures [90].

Table 9: Considerations for pre-operative cerebrovascular accident in patients with hip fractures.

- Patients should be fully evaluated before surgery and delay is warranted for circulatory volume restoration, correction of anemia, or electrolyte optimization; however, delaying surgery for unrealistic medical goals should not preclude mobilization enabled by surgery

Cerebrovascular Accident

Current literature provides limited guidance for patients who present with concomitant hip fracture and cerebrovascular accident (CVA). There is agreement that CVA evaluation must happen before surgery, but the extent of the workup and surgical delay is controversial [91]. Specifically, CVA guidelines

suggest non-cardiac, non-urgent surgery should be delayed for at least two weeks for cerebral autoregulation recovery.[92] A hip fracture is considered an urgent condition, but not cardiac, confounding the global application of stroke guidelines. Patients should be fully evaluated before surgery and delay is warranted for circulatory volume restoration, correction of anemia, or electrolyte optimization. However, delaying surgery for unrealistic medical goals should not preclude mobilization enabled by surgery.[93]

Hyponatremia

The Osteoporotic Fractures in Men Study (MrOS) demonstrated that patients with hyponatremia (serum Na <135 mEq/L) had an increased risk of hip fracture (Hazard Ratio 3.04; 95% CI: 1.37 to 6.75).[94] There are numerous causes of hyponatremia (e.g., GI losses, diuretics, cirrhosis, cardiac failure), with syndrome of inappropriate secretion of antidiuretic hormone (SIADH) being the most common etiology in hospitalized patients. A retrospective study of 1,001 hip fracture patients found significantly higher 30-day, 1 year, and overall mortality rates in 126 hyponatremic patients in comparison to 875 normonatremic patients. Further division of the hyponatremic patients into mild hyponatremia (sNa ≥130-135 mEq/L), moderate hyponatremia (sNa ≥125-130 mEq/L), and severe hyponatremia (sNa ≤125 mEq/L) demonstrated significantly higher complication rates of 33.5% in the moderate/severe hyponatremic groups, as opposed to 22.9% in the mild hyponatremic division.[95] Common complications of hyponatremia in orthopedic surgery cases include cardiovascular events, wound infection, and pneumonia.[96] These findings are further supported by a study of geriatric hip fracture patients conducted by Lizaur-Utrilla et al., which found that sNa <127 mEq/L in conjunction with low albumin and elevated PTH levels was associated with delayed surgery and accounted for 67% of the variance in 30-day postoperative mortality.[97]

Despite clear evidence of the negative effects of hyponatremia on postoperative outcomes, the degree to which hyponatremia should be managed in the perioperative period is evolving. Some authors recommend determining and treating the underlying cause of hyponatremia before nonemergent surgical procedures to reduce postoperative complications [98,99]. However, each of these reports has been retrospective in nature, with a primary aim to affirm the relationship between hyponatremia and negative outcomes in hip fracture patients. Due to a paucity of prospective studies or RCTs that assess if and to what extent correcting hyponatremia in the preoperative period improves hip fracture surgery outcomes, multiple researchers have called for such studies to be conducted.[98,100]

For correcting hyponatremia, Spasovski et al. established a CPG which emphasizes cause-specific treatment to address the etiology, rather than simply raising serum sodium levels.[101] As volume status and hyponatremia are often assessed in conjunction, it is critical to understand correction of hyponatremia in hypovolemic, hypervolemic, and euvolemic patients.[101,102]

For correction of hypovolemic hyponatremia, clinicians should provide careful fluid resuscitation with "IV infusion of 0.9% saline or a balanced crystalloid solution at 0.5-1.0 ml/kg/hr", while also addressing likely causes of dehydration (e.g., diuretics, diarrhea), and other electrolyte disturbances.[101,102]

Far more common than hypovolemic hyponatremia is hypervolemic hyponatremia, which is initially managed with fluid restriction (1.5 L/day in mild hyponatremia, 1 L/day more severe hyponatremia) and discontinuation of diuretics. One idea that has received attention for the correction of hypervolemic hyponatremia is the use of vaptan agents, which work as arginine vasopressin receptor 2 (AVPR2) antagonists.[102] An RCT conducted by Palmer et al. treated 69 hypervolemic hyponatremic (sNa ≤130 mEq/L) patients with either 20 mg or 40 mg/day doses of conivaptan for 4 days. An average increase of serum sodium was noted in these patients (20 mg/day: 7.1±4.8 and 40 mg/day: 7.6±5.8) over the course of the study. However, eight patients were withdrawn before study completion due to overly rapid correction of sodium (sNa increase ≥12 mEq/L in under 24 hours).[103] This concern with overly rapid correction of sodium levels as seen in this study and several other reports, and its potential for osmotic demyelination syndrome (ODS), has led to recommendations against the use of vaptans in hypervolemic hyponatremic patients. Demococycline, which reduces AVPR2's response to vasopressin, is also contraindicated due to increased risk of AKI.[101]

Table 10: Considerations for peri-operative hyponatremia in patients with hip fractures.

- Hip fracture patients with hyponatremia have significantly higher 30-day, 1 year, and overall mortality rates
- Hypovolemic hyponatremia should be corrected with IV infusion of 0.9% saline or a balanced crystalloid solution at 0.5-1.0 ml/kg/hr, while also addressing likely causes of dehydration and other electrolyte disturbances
- Hypervolemic hyponatremia initially managed with fluid restriction (1.5 L/day in mild hyponatremia, 1 L/day more severe hyponatremia) and discontinuation of diuretics
- Euvolemic hyponatremia should be managed with fluid restriction as first-line treatment
    - Supplementation of urea (0.25-0.50 g/kg/day) or combined low-dose loop diuretics with oral sodium chloride are second-line options
        - Serum [Na] should not be raised more than 10 mEq/L within 24 h of treatment onset, and no more than 18 mEq/L within 48 h to reduce risk of osmotic demyelination syndrome

SIADH is a clinically euvolemic hyponatremic disorder and considered a diagnosis of exclusion. CPG recommends fluid restriction as first-line treatment of SIADH induced hyponatremia, with supplementation of "urea (0.25-0.50 g/kg/day) or combined low-dose loop diuretics with oral sodium chloride" serving as second-line options. Vaptans and demeclocycline are again contraindicated. To avoid ODS, sNa shoulder not be raised more than 10 mEq/L within 24 h of treatment onset, and no more than 18 mEq/L within 48 h.[101]

A prospective study conducted by Verghese et al. compared 18 chronic hyponatremia (sNa <135 mEq/L at time of admission) patients to 15 patients with new-onset hyponatremia (normonatremia upon admission, sNa <135 mEq/L postoperatively). All 15 new-onset hyponatremia patients had resolution of hyponatremia within 48 h of operation with sodium correction and monitoring, whereas chronic hyponatremia did not resolve.[96] Although this study did not describe how sNa levels were corrected, it does help physicians to set reasonable expectations for sNA levels for patients upon time of discharge.[104-106]

Diabetes Mellitus

Type 2 diabetes mellitus or non-insulin dependent diabetes mellitus (NIDDM), is the second most common comorbidity behind hypertension in geriatric hip fracture patients.[107] This is particularly concerning for surgical candidates, as surgery induces a stress response that increases blood glucose (BG) levels. Hyperglycemia has been associated with increased risk of both surgical site and periprosthetic infections, along with increased LOS and mortality.[108] To reduce the risk of these complications, guidelines for target blood glucose levels have been established in orthopedic surgery candidates, although these guidelines tend to differ between nations. For example, in the United Kingdom, the National Health Service (NHS) has set a target BG of 108-180 mg/dL, whereas the American Association of Endocrinologists (AACE) and the American Diabetes Association (ADA) jointly recommend a target "of <140 mg/dL and random BG less than 180 mg/dL". The NHS also offers BG of 72-216 md/dL as an acceptable range before orthopaedic procedures, although these ranges are not as clearly defined by the AACE/ADA.[109,110]

Insulin administration is the preferred method for managing BG levels in hospitalized patients.[110] It is also critical that providers monitor patients' BG levels in the perioperative period, specifically "before meals or every 4-6 hours in patients who are fasting."[108]

Table 11: Considerations for diabetes mellitus management in patients with hip fractures.

- American Association of Endocrinologists (AACE) and the American Diabetes Association (ADA) jointly recommend a blood glucose target <140 mg/dL and random < 180 mg/dL before elective procedures
  - Insulin administration is the preferred method for managing blood glucose levels in hospitalized patients
- In the UK, National Health Service (NHS) has set a target blood glucose of 108-180 mg/dL and 72-216 md/dL considered an acceptable range before orthopaedic procedures
- Hyperglycemia has been associated with increased risk of both surgical site and peri-prosthetic infections, along with increased length of hospital stay and mortality

End-Stage Renal Disease

Patients with end-stage renal disease (ESRD) may require dialysis to compensate for impaired renal function. ESRD has been associated with decreased bone density and patients on dialysis have a relative risk of hip fractures 4.4 times that of age-matched controls.[111] Not only are patients on dialysis more likely to experience a hip fracture, but they are also at significantly greater risk for mortality and surgical complications.[112] For example, Ding et al. compared 28 femoral neck fracture patients with ESRD on dialysis to 31 control patients with the same fracture and chronic kidney disease (CKD), but no dialysis. After treatment by hip hemiarthroplasty and a mean postoperative follow up of 39 months, seven dialysis patients showed radiographic evidence of implant loosening as opposed to just one patient in the control group (p-value = 0.02).[113]

The management of ESRD dialysis patients involves multiple considerations preoperatively, including cardiovascular diagnostic workup. It is also critical that patients receive hemodialysis the day before surgery, with elective surgeries taking place at least 6 h after dialysis with heparin to minimize risk of perioperative bleeding.[114]

Table 12: Considerations for end-stage renal disease in patients with hip fractures.

- Dialysis patients have a relative risk of hip fracture 4.4 times that of healthy, age-matched controls
- Associated with increased risk for post-operative implant loosening
- In chronic renal failure, 45% mortality at 2 years postoperatively
- Perioperative management of patients with end-stage renal disease
  - Consent: inform patients of increased risk of complications and mortality
  - Cardiovascular diagnostic workup
  - Hemodialysis the day before surgery
  - Elective surgeries taking place at least 6 h after dialysis with heparin to minimize risk of perioperative bleeding
  - Blood pressure: predialysis <140/90 mmHg, postdialysis <130/80 mmHg
  - Hemoglobin: 9.0-10.0 g/dL; hematocrit: ≥30% otherwise transfuse or EPO
  - HbA1c: 6.0-8.0%

Table 13: Considerations for osteoporosis in patients with hip fractures.

- Medical therapy
  - Vitamin D (800 IU/day)
  - Calcium (1200 mg/day)
  - Treatment naïve patients may receive oral bisphosphonates (e.g., Alendronate, Risedronate) in the hospital, or at least as part of patient discharge orders.
  - IV bisphosphonates (e.g., Zoledronic acid), and subcutaneous (e.g., Denosumab) injections should not be used until two weeks postoperatively
  - Patients with typical fragility (e.g., femoral neck, intertrochanteric) fractures should continue with bisphosphonate therapy
- Atypical femoral fractures (subtrochanteric, femoral shaft) are rare and may be caused by chronic bisphosphonate therapy
  - The decision to continue or discontinue BPs in these patients is controversial, including a "drug holiday" to allow for bone turnover and promote healing, although no current CPGs support this practice

Osteoporosis

There are approximately 2 million osteoporotic fractures in the U.S. each year, with hip fractures constituting 14%.[115] Recent studies have indicated that osteoporosis-related fracture rates have plateaued or even potentially increased.[116] Hip fractures that occur from "low energy" trauma, such as a "fall from a standing height or less" are referred to as fragility fractures, with reduced bone density being a major risk factor for these events.[117] Bone densitometry is not required before treating hip fractures but can be used to prospectively assess response to treatment.[118-120] CT scans performed perioperatively can be extrapolated to diagnosis osteoporosis.[121]

In addition to supplementation with vitamin D (800 IU/day) and calcium (1200 mg/day) for osteoporotic hip fracture patients, pharmacologic therapy is indicated as well. The administration of pharmacologic therapy in patients who have suffered from hip fracture may be divided into treatment naïve group and those already taking bisphosphonates (BPs). For treatment naïve patients, oral BPs (e.g., Alendronate, Risedronate) may begin in the hospital, or at least as part of patient discharge orders. However, IV (e.g., Zoledronic acid), and subcutaneous (e.g., Denosumab) injections should not be used until two weeks postoperatively.[122]

For patients who are currently on a BP regimen, it is important to consider whether a patient has suffered a typical (e.g., femoral neck, intertrochanteric) hip fracture, or an atypical (e.g., subtrochanteric, femoral shaft) fracture. Patients with typical fragility fractures should continue with pharmacological therapy [122]. Although concerns have arisen that BP inhibition of osteoclasts may negatively impact bone remodeling and union, a report by Nixon et al. found that BPs did not interfere with bone healing in fragility fractures managed surgically.[123] Atypical femoral fractures, however, may be the consequence of chronic BP therapy. Although rare and accounting for just 1.1% of femur fractures, prolonged BP use can suppress bone turnover to the point of causing microdamage and skeletal fragility, ultimately resulting in fracture. One area of controversy is the continued use of BPs as patients recover from an atypical fragility fracture. In theory, BPs may impede bone union and healing after a fracture, and some physicians have suggested a 'drug holiday', where patients go a brief period without BPs to minimize the effects of long-term BP exposure. However, there are no current clinical guidelines that support this practice, and physicians must consider the ability of BPs to decrease risk of fractures, prevent hospitalizations, and reduce disability. More research is needed to determine how the continued use of BPs in patients after an atypical hip fracture affects treatment outcomes.[124]

Respiratory Conditions: COVID-19 and chronic obstructive pulmonary disease

The perioperative management of hip fracture patients with respiratory conditions such as chronic obstructive pulmonary disease (COPD) and COVID-19 can be challenging, particularly for the anesthesiologists who are responsible for intraoperative respiratory function. A consensus statement from a multinational working group found significant reductions in postoperative pulmonary complications when comparing neuraxial anesthesia and general anesthesia for elective primary THA, resulting in a recommendation for neuraxial as the standard approach in the absence of contraindications to neuraxial techniques. This recommendation could be generalized to appropriate hip fracture patients, as one institution reported for the anesthetic management of treating patients with COVID-19 and hip fractures[125-127]. Current smoking and surgical delays were significant modifiable risk factors for mortality in COPD patients with hip fractures [126]. The use of regional anesthesia for hip fracture surgery in general is still controversial, but even in the general population (not just respiratory compromised patients), nerve blocks have been associated with decreased length of stay and health system costs.[128]

Multiple studies have reported that COPD increases risk for mortality in hip fracture patients, potentially by as much as 60-70%.[129,130] The severity of COPD is an important consideration, as severe-to-very severe COPD is associated with 1.65-fold increased postoperative mortality at 1 year when compared to hip fracture patients with mild-moderate COPD.[129] Patients with severe COPD are significantly more likely than non-COPD patients to develop postoperative

Table 14: Predictors of mortality and morbidity following hip fracture surgery

- Pre-injury mobility is the most significant determinant for post-operative survival
  - The Short Portable Mental Status Questionnaire score can be used in predicting mortality and activities of daily living and is recommended for use in the care of elderly patients with a hip fracture
  - Pre-injury mobility to be the most significant determinant for post-operative survival
- ASA classification (ASA III and IV increases mortality)
  - Amongst patients under the age of 85, those with ASA classifications of 3 or 4 have significant excess mortality following hip fracture that persists up to 2 years after injury
- Co-management
  - Reductions in long-term mortality have been observed in orthogeriatric models, in which hip fracture patients are comanaged by an orthopedic surgeon and geriatrician

complications such as pneumonia (9.4% to 5.5%), wound infections (3.3% to 2.4%), and sepsis (2.8% to 1.4%).[126] Additionally, an epidemiological report has indicated that COPD may be an independent risk factor for the occurrence of hip fractures (adjusted HR=1.57).[131]

History of Bariatric Surgery

Bariatric surgery (BS), specifically Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG) have been associated with decreased bone mineral density (BMD) and increased risk of hip fracture, likely due to decreased vitamin D and calcium absorption.[132-134] There is a paucity of data regarding surgical outcomes for hip fracture patients with a history of BS, but a meta-analysis conducted by Li et al. did find decreased short-term complications and LOS for total joint arthroplasty procedures in this group when compared to morbidly obese non-BS patients.[135] However, more research is needed to better understand the impact of BS on hip fracture surgery outcomes.

There is a paucity of data on treated hip fracture outcomes in patients with a history of bariatric surgery. Trials of vitamin D supplementation or BP pharmacotherapy have been conducted to prevent BMD from declining in BS patients, but with minimal success.[136-138] Given the ineffectiveness of standard pharmacotherapy in this population, the management of BS-induced osteoporotic hip fracture patients remains particularly challenging. More studies will need to be conducted to further guide clinicians' treatment of BS hip fracture patients.

Mortality and Predictors of Morbidity and Mortality

After femoral neck fracture, there is a 6% mortality rate during hospitalization, greater in men (10.2%) than women (4.7%).[139] Chronic renal failure, CHF, and atrial fibrillation were among independent risk factor for acute inpatient mortality after orthopaedic surgery.[140] Thirty-day mortality is 5.2% in women and 9.3% in men and 90-day mortality has an average of 16% in both men and women combined.[141,142] 180-day mortality is 1.3% in women and 22.9% in men [141]. One-year mortality rate is between 14-36%, with the highest risk within the first six months.[62,139,143]

There are many characteristics of a patient, both pre-injury and postoperatively, that can predict outcomes of mortality and functionality. The Short Portable Mental Status Questionnaire score can be used in predicting mortality and activities of daily living and is recommended for use in the care of elderly patients with a hip fracture.[144] A prospective study of 1000 patients with femoral neck fractures found pre-injury mobility to be the most significant determinant for postoperative survival.[145] The type of hip fracture matters as well, with six-month mortality lowest for patients with nondisplaced femoral neck fractures (5.7%) and highest for patients with displaced femoral neck fractures (15.8%).[146] Amongst patients under the age of 85, those with ASA classifications of 3 or 4 had significantly increased mortality following hip fracture that persisted up to two years after injury.[147] Underlying comorbidities increased mortality, such as chronic renal failure, which has been shown to have a 45% mortality rate at two years postoperatively.[140]. Perioperative comorbidities, such as acute renal failure, pulmonary embolus, and CVA, were also associated with increased mortality.[148]

A timed up and go test has been shown to have high intertester reliability to predict need for a walking aid at two years, with an optimal threshold of fifty-eight seconds at four days postoperatively and twenty-six seconds at three weeks.[149,150] Improvement of more than 6.2 seconds for a patient who used 20 seconds at baseline indicates real change in functional mobility.[150] Walking >5 feet by 72 hours postoperatively has been associated with decreased likelihood of myocardial infarction, pneumonia, intensive care unit admission, and death or hospice transfer.[151]

DISCUSSION

Surgical Timing and Comorbidity Management

We recommend a practical approach, in which surgery is indicated as soon as possible, with prioritization of <24 hours, while being careful to consider medical comorbidities and proper preoperative evaluation with anesthesia, internal medicine, and geriatrics. Hip fracture surgery within 24-48 hours of admission may be associated with better outcomes.[152] Some studies demonstrated superiority or equivalence in postoperative complications for surgery within 24 hours from presentation.[18,153] Other studies demonstrated better outcomes among patients undergoing surgery within 48 hours from presentation.[9-11,154]

Financial Considerations

There is a paucity of data showing the financial ramifications of surgical timing; however, the studies available provide insight into the potential impact of accelerated surgical intervention. Most notably, the HIP ATTACK trial showed patients who were accelerated to surgery before medical optimization were at a lower risk of postoperative delirium, UTI, and pain. These patients were also faster to mobilize by a median difference of 21 hours ($p<0.0001$) and be discharged with an absolute mean difference of 1 day ($p<0.0001$). Each of these benefits resulted in cost savings to the hospitals.[19] A Level I trauma center in El Paso, TX implemented early surgical intervention for hip fractures and their average cost of inpatient episode-of-care (EOC) over the next three years was an 89% reduction from the baseline per EOC ($15,885 vs. $1,703). This strategy not only saved money, but also cut 30-day readmission rates from 7% to an average of 4%, and reduced ED-to-surgery wait time by an average of 47% from the comparative baseline.[155] Therefore, it is financially beneficial to have a treatment algorithm that enables hospital systems to expedite surgical intervention for hip fractures, while still optimizing outcomes through appropriate management of patient comorbidities.

Some facilities have successfully moved to an orthogeriatric model, in which hip fracture patients are comanaged by an orthopedic surgeon and geriatrician to streamline treatment and possibly accelerate surgery. A systematic review of 18 studies published between 1988 and 2015 showed that elderly patients with hip fractures admitted early into any orthogeriatric services had reduced long-term mortality.[156] In addition to the mortality benefit, at least two cohort studies have shown the orthogeriatric model can decrease hospital stay in patients presenting with frailty hip fractures.[157,158] The estimated total annual economic savings to the hospital with an integrated orthogeriatric care approach amounted to €1,017,084 ($1,391,629).[157] These models strive to accelerate surgery within 24 hours for patients not requiring preoperative medical intervention and deliver appropriate interventions for patients with acutely modifiable risk factors.[83]

Limitations

This literature review has limitations. First, the studies selected are a mixture of RCTs, case series, cohort studies, retrospective and prospective studies, and reviews, limiting direct comparisons among reports. Second, referenced studies were selected for emphasis on management of patients with geriatric hip fractures, and some studies expanded their populations to other fragility fractures. Third, guidelines for hip fracture management may vary among specialties. Fourth, for simplicity each comorbidity is discussed individually, but in clinical practice patients often present with multiple comorbidities. This review does not provide guidance as to which comorbidities should be prioritized, or how management is changed when clinicians must treat multiple comorbidities in the same patient.

CONCLUSION

Hip fractures are among the most common orthopaedic injuries in the geriatric population and come with significant morbidity and mortality. The current evidence suggests that these patients should be surgically managed 24-48 hours from injury in accordance with patient preferences and medical risk stratification. Doing so is likely to improve postoperative outcomes and save both patients and hospital systems considerable financial resources. After proper history and physical examination, imaging with plain radiographs is recommended, with T(1)-weighted coronal MRI being indicated in occult fractures. There are numerous cardiovascular, cognitive, and endocrinologic comorbidities that may delay or impact surgical treatment of hip fracture patients; recommendations regarding these comorbidities are provided in this report. A proper understanding of how these conditions affect hip fracture patients may help orthopaedic surgeons to expedite surgery safely and effectively and may also serve as a framework in the management of other fragility fractures in patients with comorbidities.

Evidence Based Note Template: Geriatric Hip Fracture Initial Consult: Format and shortcuts for EPIC EMR

Chief Complaint: {left/right/bilateral} hip pain
Date of Injury: **
Mechanism of Injury: {ground level fall/fall down stairs/fall from bed/**}

History of Present Illness: ** year-old {male/female} sustained a @mechanism of injury@ on @date of injury@ and presented on @TODAY@ for evaluation and treatment. Endorses pain in {left/right/bilateral} {sacrum/buttock/hip/thigh/knee/leg/ankle/foot/**}. {Able/Unable} to ambulate after the injury. There was {no delay/delay of XX days prior to presentation due to**}.
Endorses {left/right/bilateral} upper extremity pain following injury.

Prior ambulation status:
Home: {wheelchair/walker/cane/without assistive devices/**}
Community: {wheelchair/walker/cane/without assistive devices/**}

Prior activity level:
{Sedentary/low demand/recreational} with activities including **

Antecedent hip pain:
{Endorses/Denies} antecedent pain in {left/right/bilateral} hips.

Previous insufficiency fractures:
{vertebrae/sacrum/hip/pubic rami/distal radius/**} on ** and treated with **

Past Medical History:
@PMH@
Past Surgical History:
@PSH@
Medications:
@MEDS@
Allergies:
@ALG@
Social History:
Tobacco:
Alcohol:
Illicit Drugs:
Lives {alone/with family/in supervised home/**}
Medical power of attorney: ** and phone number **
Family History:
@FAMHXNH@

Review of Systems:
CONSTITUTIONAL: Normal except as in HPI
EYES: Normal except as in HPI
HEENT: Normal except as in HPI
RESPIRATORY: Normal except as in HPI
CARDIOVASCULAR: Normal except as in HPI
GASTROINTESTINAL: Normal except as in HPI
GENITOURINARY: Normal except as in HPI
SKIN: Normal except as in HPI
HEMATOLOGIC/LYMPHATIC: Normal except as in HPI
ALLERGIC/IMMUNOLOGIC: Normal except as in HPI
ENDOCRINE: Normal except as in HPI
MUSCULOSKELETAL: Positive per HPI
NEUROLOGICAL: Normal except as in HPI
BEHAVIOR/PSYCH: Normal except as in HPI

Physical Exam:
Vitals:
@VS@
General:

No acute distress
Cardiovascular:
Regular rate and rhythm, warm and well perfused extremities
Pulmonary:
Non-labored breathing

{RIGHT/LEFT} Upper Extremity:
No lacerations, abrasions, or ecchymoses***
Tender to palpation ***
Compartments soft, compressible***
Range of motion: ***
No pain with passive motion of the fingers***
Able to abduct shoulder, flex and extend elbow, wrist, fingers, and thumb, finger abduction and adduction.
SILT axillary, musculocutaneous, median, radial, and ulnar nerve distributions
2+ radial pulse, brisk cap refill <2s

{RIGHT/LEFT} Lower Extremity:
Shortened, externally rotate lower extremity
No lacerations, abrasions, or ecchymoses***
Tender to palpation ***
Compartments soft, compressible ***
No pain with passive motion of the toes
No pain with short arcs
Range of motion: ***
Able to flex and extend hip and knee, plantarflex, dorsiflex, invert, and evert ankle, flex and extend toes
Able to perform straight leg raise
SILT superficial peroneal, deep peroneal, sural, saphenous, and tibial nerve distributions
2+ dorsalis pedis and posterior tibial pulses, brisk cap refill <2s

Gait: {unable/with assistance/independent}

Laboratory:
@BRIEFLAB(HGB,WBC,MONOPERCENT,PLT,CA,BUN,CREAT,GLU,HGBA1C,ALB,CK,INR,APTT,ESR,CRP)@

Imaging:
X-ray:
{pelvis/hip/femur/knee}

CT: (As indicated)

MRI: (As indicated)

Duplex Scanning: (As indicated)

Assessment:
@NAME@ is a @AGE@ @SEX@ who presents with ***

Plan:
- Admit to ***.
- Plan for OR (date***) for operative fixation of {left/right} hip
- Informed consent obtained by {patient/medical power of attorney}; risks, benefits, and alternatives discussed
- Additional work-up:
  - CBC, BMP, type and screen, PT/INR/PTT
  - EKG, CXR
- Activity: bedrest***; NWB***
- Foley ***
- VTE prophylaxis
- NPO for above
- Anesthesia consult for preoperative risk stratification

Medical Management of Common Comorbidities in Elderly Patients with Proximal Femur Fractures:

Review and Evidence Based Note Template

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