

# Management of Hip Fractures in Older Adults

## Evidence-Based Clinical Practice Guideline

*Adopted by:*

The American Academy of Orthopaedic Surgeons Board of Directors  
December 3, 2021

*Endorsed by:*



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## SUMMARY OF RECOMMENDATIONS

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Recommendations are formed when there is sufficient evidence by which to create a directional statement. This is defined as evidence from two or more high quality studies (i.e., a strong recommendation), two or more moderate quality studies (i.e., a moderate recommendation), or statements resulting in a strong or moderate strength following Evidence to Decision Framework upgrading and/or downgrading.

### PREOPERATIVE TRACTION

**Preoperative traction should not routinely be used for patients with a hip fracture.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

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### SURGICAL TIMING

**Hip fracture surgery within 24-48 hours of admission may be associated with better outcomes.**

**Strength of Evidence:** Limited

**Strength of Recommendation:** Moderate ★★★★★ (Upgraded)

*Evidence from one or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention. Recommendation was upgraded based on EtD framework.*

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### VENOUS THROMBOEMBOLISM PROPHYLAXIS

**Venous thromboembolism (VTE) prophylaxis should be used in hip fracture patients.**

**Strength of Evidence:** Moderate

**Strength of Recommendation:** Strong ★★★★★ (Upgraded)

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention. Recommendation was upgraded based on EtD framework.*

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## **ANESTHESIA**

**Either spinal or general anesthesia is appropriate for patients with a hip fracture.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong 

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

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## **UNSTABLE FEMORAL NECK FRACTURES – Arthroplasty vs Fixation**

**In patients with unstable (displaced) femoral neck fractures, arthroplasty is recommended over fixation.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong 

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

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## **UNIPOLAR/BIPOLAR HEMIARTHROPLASTY**

**In patients with unstable (displaced) femoral neck fractures, unipolar or bipolar hemiarthroplasty can be equally beneficial.**

**Strength of Evidence:** Moderate

**Strength of Recommendation:** Moderate 

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.*

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## **UNSTABLE FEMORAL NECK FRACTURES - Total Arthroplasty vs Hemi Arthroplasty**

**In properly selected patients with unstable (displaced) femoral neck fractures, there may be a functional benefit to total hip arthroplasty over hemiarthroplasty at the risk of increasing complications.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Moderate  (Downgraded)

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention. Recommendation was downgraded based on EtD framework.*

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## **CEMENTED FEMORAL STEMS**

**In patients undergoing arthroplasty for femoral neck fractures, the use of cemented femoral stems is recommended.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

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## **SURGICAL APPROACH**

**In patients undergoing treatment of femoral neck fractures with hip arthroplasty, evidence does not show a favored surgical approach.**

**Strength of Evidence:** Moderate

**Strength of Recommendation:** Moderate ★★★★★

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.*

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## **CEPHALOMEDULLARY DEVICE – STABLE INTERTROCHANTERIC FRACTURES**

**In patients with stable intertrochanteric fractures, use of either a sliding hip screw or a cephalomedullary device is recommended.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

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## **CEPHALOMEDULLARY DEVICE – SUBTROCHANTERIC/REVERSE OBLIQUITY FRACTURES**

**In patients with subtrochanteric or reverse obliquity fractures a cephalomedullary device is recommended.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

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## **CEPHALOMEDULLARY DEVICE – UNSTABLE INTERTROCHANTERIC FRACTURES**

**Patients with unstable intertrochanteric fractures should be treated with a cephalomedullary device.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong 

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

---

## **TRANSFUSION**

**A blood transfusion threshold of no higher than 8g/dl is suggested in asymptomatic postoperative hip fracture patients.**

**Strength of Evidence:** Moderate

**Strength of Recommendation:** Moderate 

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.*

---

## **MULTIMODAL ANALGESIA**

**Multimodal analgesia incorporating preoperative nerve block is recommended to treat pain after hip fracture.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong 

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

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## **TRANEXAMIC ACID**

**Tranexamic acid should be administered to reduce blood loss and blood transfusion in patients with hip fractures.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong 

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

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## **INTERDISCIPLINARY CARE PROGRAMS**

**Interdisciplinary care programs should be used in the care of hip fracture patients to decrease complications and improve outcomes.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong 

*Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention.*

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## SUMMARY OF OPTIONS

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Options are formed when there is little or no evidence on a topic. This is defined as low quality evidence or a single moderate quality study (i.e., a limited strength option), no evidence or only conflicting evidence (i.e., a consensus option), or statements resulting in a limited or consensus strength following Evidence to Decision Framework upgrading and/or downgrading.

### **STABLE FEMORAL NECK FRACTURES**

**In patients with stable (impacted/non-displaced) femoral neck fractures, hemiarthroplasty, internal fixation or non-operative care may be considered.**

**Strength of Evidence:** Moderate

**Strength of Option:** Limited ★★☆☆ (Downgraded)

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.*

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### **CEPHALOMEDULLARY DEVICE – PERTROCHANTERIC FRACTURES**

**In patients with pertrochanteric femur fractures, short or long cephalomedullary nail may be considered.**

**Strength of Evidence:** Limited

**Strength of Option:** Limited ★★☆☆

*Evidence from one or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention.*

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### **WEIGHT BEARING**

**Following surgical treatment of hip fractures, immediate, full weight bearing to tolerance may be considered.**

**Strength of Evidence:** Limited

**Strength of Option:** Limited ★★☆☆

*Evidence from one or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention.*

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# INTRODUCTION

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## OVERVIEW

This clinical practice guideline is based on a systematic review of published studies examining the surgical treatment of hip fractures in adults age 55 years and older (older adults). It provides recommendations that will help practitioners to integrate the current evidence and clinical practice, and it highlights gaps in the literature in need of future research. This guideline is intended to be used by appropriately trained physicians and clinicians who manage the treatment of hip fractures in older adults. It also serves as an information resource for developers and applied users of clinical practice guidelines.

## GOALS AND RATIONALE

The purpose of this clinical practice guideline is to evaluate the current best evidence associated with treatment. Evidence-based medicine (EBM) standards advocate for use of empirical evidence by physicians in their clinical decision making. To assist with access to the large resources of information, a systematic review of the literature in publication was conducted between March 2020 and July 2021. It highlights where there is good evidence, where evidence is lacking, and what topics future research will need to target in order to help facilitate evidence-based decision making in the treatment of older adult patients with hip fracture. AAOS staff methodologists assisted the physician/clinician work group in evaluating the existing literature so that they could formulate the following recommendations based on a rigorous systematic process. Musculoskeletal care is provided in many different settings and by a variety of providers. We created this guideline as an educational tool to guide qualified physicians and clinicians in making treatment decisions that improve the quality and efficacy of care. This guideline should not be construed as including all possible methods of care or excluding acceptable interventions similarly directed at obtaining favorable outcomes. The final decision to use a specific procedure must be made after assessing all concerns presented by the patient and consideration of locality-specific resources.

## INTENDED USERS

This guideline is intended to be used by orthopaedic surgeons and other healthcare providers managing patients with hip fracture in older adults. This includes adult primary care physicians, geriatricians, hospital based adult medicine specialists, physical therapists, occupational therapists, nurse practitioners, physician assistants, emergency physicians, and other healthcare professionals who routinely see this type of patient in various practice settings. It serves as an information resource for medical practitioners. In general, individual practicing physicians and clinicians do not have the resources required to complete a project of comparable scope and duration involving the evaluation of an extensive literature base. In April 2019, the AAOS adopted the use of the GRADE Evidence-to-Decision Framework into its clinical practice guideline development methodology. This Framework enables work group members to incorporate additional factors into the strength of each recommendation and move away from the rigidity of previous AAOS recommendation language stems. The AAOS intends for this guideline to assist treatment providers not only in making shared clinical decisions with their patients, but also in describing to patients and their loved ones why a selected intervention represents the best available course of treatment. This guideline is not intended for use as a benefits determination document. It does not cover allocation of resources, business and ethical considerations, and other factors needed to determine the material value of orthopaedic care. Users of this guideline may also want to consider the appropriate use criteria (AUC) related to the treatment of hip fracture in older adult patients.

## **PATIENT POPULATION**

This guideline is intended for use with adults aged 65 years and older who have been diagnosed by a trained healthcare provider with hip fracture. (The lower limit for our patient population was set at 55 years of age but was also required to have an average age of 65 years).

## **SCOPE**

As defined by the scope of this CPG, prevention of primary or secondary hip fractures or post-hospital rehabilitation are not addressed in this document. These subjects remain critically important to the holistic care of the geriatric patient and those who have sustained a hip fracture. The reader is encouraged to view these external CPGs and references for further information.

References:

- Conley RB, Adib G, Adler RA, et al. Secondary Fracture Prevention: Consensus Clinical Recommendations from a Multistakeholder Coalition. *J Bone Miner Res.* 2020;35(1):36-52. doi:10.1002/jbmr.3877
- LeBlanc KE, Muncie HL Jr, LeBlanc LL. Hip fracture: diagnosis, treatment, and secondary prevention. *Am Fam Physician.* 2014;89(12):945-951.
- Camacho PM, Petak SM, Binkley N, et al. American Association Of Clinical Endocrinologists/American College Of Endocrinology Clinical Practice Guidelines For The Diagnosis And Treatment Of Postmenopausal Osteoporosis-2020 Update. *Endocr Pract.* 2020;26(Suppl 1):1-46. doi:10.4158/GL-2020-0524SUPPL;
- Shoback D, Rosen CJ, Black DM, Cheung AM, Murad MH, Eastell R. Pharmacological Management of Osteoporosis in Postmenopausal Women: An Endocrine Society Guideline Update. *J Clin Endocrinol Metab.* 2020;105(3):dga048. doi:10.1210/clinem/dga048
- Watts NB, Adler RA, Bilezikian JP, et al. Osteoporosis in men: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab.* 2012;97(6):1802-1822. doi:10.1210/jc.2011-3045
- Holick MF, Binkley NC, Bischoff-Ferrari HA, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline [published correction appears in *J Clin Endocrinol Metab.* 2011 Dec;96(12):3908]. *J Clin Endocrinol Metab.* 2011;96(7):1911-1930. doi:10.1210/jc.2011-0385
- McDonough CM, Harris-Hayes M, Kristensen MT, Overgaard JA, Herring TB, Kenny AM, Mangione KK. Physical Therapy Management of Older Adults With Hip Fracture. *J Orthop Sports Phys Ther.* 2021 Feb;51(2):CPG1-CPG81. doi: 10.2519/jospt.2021.0301. PMID: 33522384.

## **ETIOLOGY**

Hip fractures in older adults are most often the result of low energy trauma. These fractures are usually associated with osteoporosis or impaired bone strength. Other conditions, such as history of falls or frailty, may also predispose to hip fracture risk.

## **INCIDENCE AND PREVALENCE**

With increasing life expectancy, the number of older individuals at risk for hip fracture will increase over time.

## **RISK FACTORS**

Risk factors for an older adult sustaining a hip fracture include, but are not limited to, increasing age, low bone density, impaired balance, gait disturbance, poor vision, and hazardous living

environments (such as cluttered spaces, throw rugs, or a lack of grab bars where appropriate). Race and ethnicity are also non-modifiable risk factors that can play an important role in patient outcomes.

## **BURDEN OF DISEASE**

Although the age-standardized incidence of hip fracture is falling in many developed countries, the aging of the world population results in an increased overall number of hip fractures globally. Thus, the number of hip fractures in older adults that occur globally is expected to increase from 1.26 million in 1990 to 4.5 million by the year 2050 (Veronese).

Between 1986 and 2005, the annual mean number of hip fractures in the US was 957.3 per 100 000 (95% confidence interval [CI], 921.7-992.9) for women and 414.4 per 100 000 (95% CI, 401.6-427.3) for men. The majority of fractures in both men and women occurred among those aged 75-84 years. The overall mortality for hip fracture is 24% at one year. However, for some of the most vulnerable hip fracture patients (i.e., nursing home residents), the 6-month mortality is as high as 36% for all, and 46% for men (Brauer).

Older patients who sustain hip fractures are at risk for:

1. Increased rates of mortality (Guzon-Illescas).
2. Increased rates of morbidity (Veronese).
3. Decreased quality of life (Alexiou).
4. Increased rates of depression (Alexiou, Veronese).
5. Decreased levels of mobility and ambulation (Dyer).
6. Increased rates of subsequent fractures (Balasubramanian).
7. Increased need for enhanced level of care and supervision (Konda).

A typical older adult patient who has sustained a hip fracture will incur over \$50,000/year in medical costs (Adeyemi).

## **POTENTIAL BENEFITS, HARM, AND CONTRAINDICATIONS**

Hip fracture in an older adult patient is typically a life-altering event requiring surgical treatment with the associated risks. Recovery to pre-fracture level of function is often unsuccessful and may occur in less than 50% of patients, regardless of their previous level of function (Tang). The aim of treatment of hip fracture in the older adult is to provide pain relief and restoration of function. For the vast majority of fractures, surgical treatment is indicated and carries greater potential benefit than harm. While there are more hip fractures in women than men, there may be important sex and gender differences in hip fracture and this CPG does not explore or address such potential differences. Future research may result in a better understanding of how a patient's sex and gender alter treatment benefits and harms.

## **DIFFERENCES BETWEEN THE PRESENT AND PREVIOUS GUIDELINES**

This updated clinical practice guideline replaces the first edition that was completed in 2014, "Management of Hip Fractures in the Elderly 1st edition." This update considered the literature that was previously examined as well as the empirical evidence published since the 2014 guideline. Since this last edition, AAOS has updated their study appraisal methodology coinciding with updates to the Cochrane handbook and the ROBINS, QUADAS, and QUIPS tools (full methodology can be found on the AAOS website). Additionally, to align with GRADE methodology, all observational studies are now assigned a base appraisal of low-quality evidence. In April 2019, the AAOS also adopted the use of the GRADE Evidence-to-Decision

Framework into its clinical practice guideline development methodology. This Framework enables work group members to incorporate additional factors into the strength of each recommendation and move away from the rigidity of previous AAOS recommendation language stems. The current guideline also established new parameters for study inclusion, which mandated that in order to be included in our CPG, a study must have included at least 30 patients per comparison group, and that the average age of study participants must be at least 65 years, with the age of individual participants limited to  $\geq 55$  years. The complete listing of inclusion criteria for this guideline is detailed in the section, “Study Inclusion Criteria,” (eAppendix 1).



## METHODS

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The methods used to perform this systematic review were employed to minimize bias and enhance transparency in the selection, appraisal, and analysis of the available evidence. These processes are vital to the development of reliable, transparent, and accurate clinical recommendations. To view the full AAOS clinical practice guideline methodology please visit

<https://www.aaos.org/quality/research-resources/methodology/> .

This clinical practice guideline evaluates the management of hip fracture in older adult patient outcomes. The AAOS approach incorporates practicing physicians (clinical experts) and methodologists who are free of potential conflicts of interest relevant to the topic under study, as recommended by clinical practice guideline development experts.<sup>1</sup>

This clinical practice guideline was prepared by the AAOS Hip Fracture in Older Adults Guideline physician development group (clinical experts) with the assistance of the AAOS Clinical Quality and Value (CQV) Department (methodologists). To develop this clinical practice guideline, the clinical practice guideline development group held an introductory meeting on November 17, 2019 to establish the scope of the clinical practice guideline. As the physician experts, the clinical practice guideline development group defined the scope of the clinical practice guideline by creating PICO Questions (i.e. population, intervention, comparison, and outcome) that directed the literature search. The AAOS Medical Librarian created and executed the search (see Appendix III for search strategy).

### LITERATURE SEARCHES

The systematic review begins with a comprehensive search of the literature. Articles considered were published prior to the start date of the search in a minimum of

three electronic databases; PubMed, EMBASE, and the Cochrane Central Register of Controlled Trials. The medical librarian conducts the search using key terms determined from the guideline development group's PICO questions.

A CQV methodologist will review/include only primary literature but will supplement the electronic search with a manual search of the bibliographies of secondary literature sources, such as systematic reviews, as available. The methodologist will then evaluate all recalled articles for possible inclusion based on the study selection criteria and will summarize the evidence for the guideline work group who assist with reconciling possible errors and omissions. A study attrition diagram is provided in the appendix of each document that details the numbers of identified abstracts, recalled and selected studies, and excluded studies that were evaluated in the CPG. The search strategies used to identify the abstracts is also included in the appendix of each CPG document.

### DEFINING THE STRENGTH OF RECOMMENDATION

Judging the quality of evidence is only a steppingstone towards arriving at the strength of a CPG recommendation. The strength of recommendation also takes into account the quality, quantity, and the trade-off between the benefits and harms of a treatment, the magnitude of a treatment's effect, and whether data exists on critical outcomes.

Strength of recommendation expresses the degree of confidence one can have in a recommendation. As such, the strength expresses how possible it is that a recommendation will be overturned by future evidence. It is very difficult for future evidence to overturn a recommendation that is based on many high quality randomized controlled trials that show a large effect. It is much more likely that future evidence will overturn recommendations derived from a few small retrospective comparative studies.

Consequently, recommendations based on the former kind of evidence are given a “strong” strength of recommendation and statement based on the latter kind of evidence are presented as options to the practicing clinician, rather than a directional recommendation, with either a “limited” strength or, in the event of no supporting or only conflicting evidence, a “consensus” strength.





**VOTING ON THE RECOMMENDATIONS**

The recommendations and their strength were voted on by the guideline development group members during the final meeting. If

disagreement between the guideline development group occurred, there was further discussion to see whether the disagreement(s) could be resolved. Recommendations were approved and adopted in instances where a simple majority (60%) of the guideline development group voted to approve; however, the guideline development group had consensus (100% approval) when voting on every recommendation for this guideline. Any recommendation strength upgrade or downgrade based on the Evidence-to-Decision Framework requires a super majority (75%) approval of the work group.

**INTERPRETING THE STRENGTH OF EVIDENCE**

**Table I. Level of Evidence Descriptions**

Strength	Overall Strength of Evidence	Description of Evidence Quality	Strength Visual
<b>Strong</b>	Strong or Moderate	Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention. Or Rec is upgraded from Moderate using the EtD framework.	
<b>Moderate</b>	Strong, Moderate or Limited	Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention. Or Rec is upgraded or downgraded from Limited or Strong using the EtD framework.	
<b>Limited</b>	Limited or Moderate	Evidence from one or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention. Or Rec is downgraded from Strong or Moderate using the EtD Framework.	
<b>Consensus</b>	No Evidence	There is no supporting evidence, or higher quality evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.	

**Table II. Interpreting the Strength of a Recommendation or Option**

Strength of Recommendation	Patient Counseling (Time)	Decision Aids	Impact of Future Research
Strong	Least	Least Important, unless the evidence supports no difference between two alternative interventions	Not likely to change
Moderate	Less	Less Important	Less likely to change
Limited	More	Important	Change possible/anticipated
Consensus	Most	Most Important	Impact unknown

**REVIEW PERIOD**

Following the final meeting, the CPG draft undergoes a 3-week review period for additional input from external content experts. Written comments are provided on the structured review form. All reviewers are required to disclose their conflicts of interest.

Specialty societies relevant to the topic are solicited for nominations of individual reviewers approximately six weeks before the final meeting. The review period is announced as it approaches, and others interested are able to volunteer to review the draft. The chairs of the guideline work group review the draft of the guideline prior to dissemination.

Some specialty societies (both orthopaedic and non-orthopaedic) ask their evidence-based practice (EBP) committee to provide review of the guideline. The organization is responsible for coordinating the distribution of our materials and consolidating their comments onto one form. The chair of the external EBP committees provides disclosure of their conflicts of interest (COI) and manages the potential conflicts of their members.

Again, the AAOS asks for comments to be assembled into a single response form by the specialty society and for the individual submitting the review to provide disclosure of potentially conflicting interests. The review stage gives external stakeholders an opportunity to provide evidence-based direction for

modifications that they believe have been overlooked. Since the draft is subject to revisions until its approval by the AAOS Board of Directors as the final step in the guideline development process, confidentiality of all working drafts is essential.

The CPG is also provided to members of the AAOS Board of Directors (BOD), members of the Research and Quality Council (RQC), members of the Board of Councilors (BOC), and members of the Board of Specialty Societies (BOS) and members of the Committee on Evidence-Based Quality and Value (EBQV) for review and comment. The CPG is automatically forwarded to the AAOS BOD, RQC, and EBQV so that they may review it and provide comment prior to being asked to approve the document. Based on these bodies, over 200 commentators have the opportunity to provide input into each CPG.

The chairs of the guideline work group, the manager of the AAOS CQV unit, and the Director of AAOS CQV draft the initial responses to comments that address methodology. These responses are then reviewed by the chair and co-chair, who respond to questions concerning clinical practice and techniques. All comments received and the initial drafts of the responses are also reviewed by all members of the guideline development group. All proposed changes to recommendation language as a result of the review period are based on the evidence. Final revisions are summarized in a

report that is provided alongside the guideline document throughout the remainder of the approval processes and final publication.

The AAOS believes in the importance of demonstrating responsiveness to input received during the review process and welcomes the critiques of external specialty societies.

Following final approval of the guideline, all individual responses are posted on our website <http://www.aaos.org/quality> with a point-by-point reply to each non-editorial comment. Reviewers who wish to remain anonymous notify the AAOS to have their names de-identified; their comments, our responses, and their COI disclosures are still posted.

### **THE AAOS CPG APPROVAL PROCESS**

This final clinical practice guideline draft must be approved by the AAOS Committee on Evidence Based Quality and Value, and subsequently the AAOS Research and Quality Council, and the AAOS Board of Directors. These decision-making bodies are described in the Hip Fracture in Older Adults CPG eAppendix. Their charge is to approve or reject its publication by majority vote.

### **REVISION PLANS**

This clinical practice guideline represents a cross-sectional view of current treatment and may become outdated as new evidence

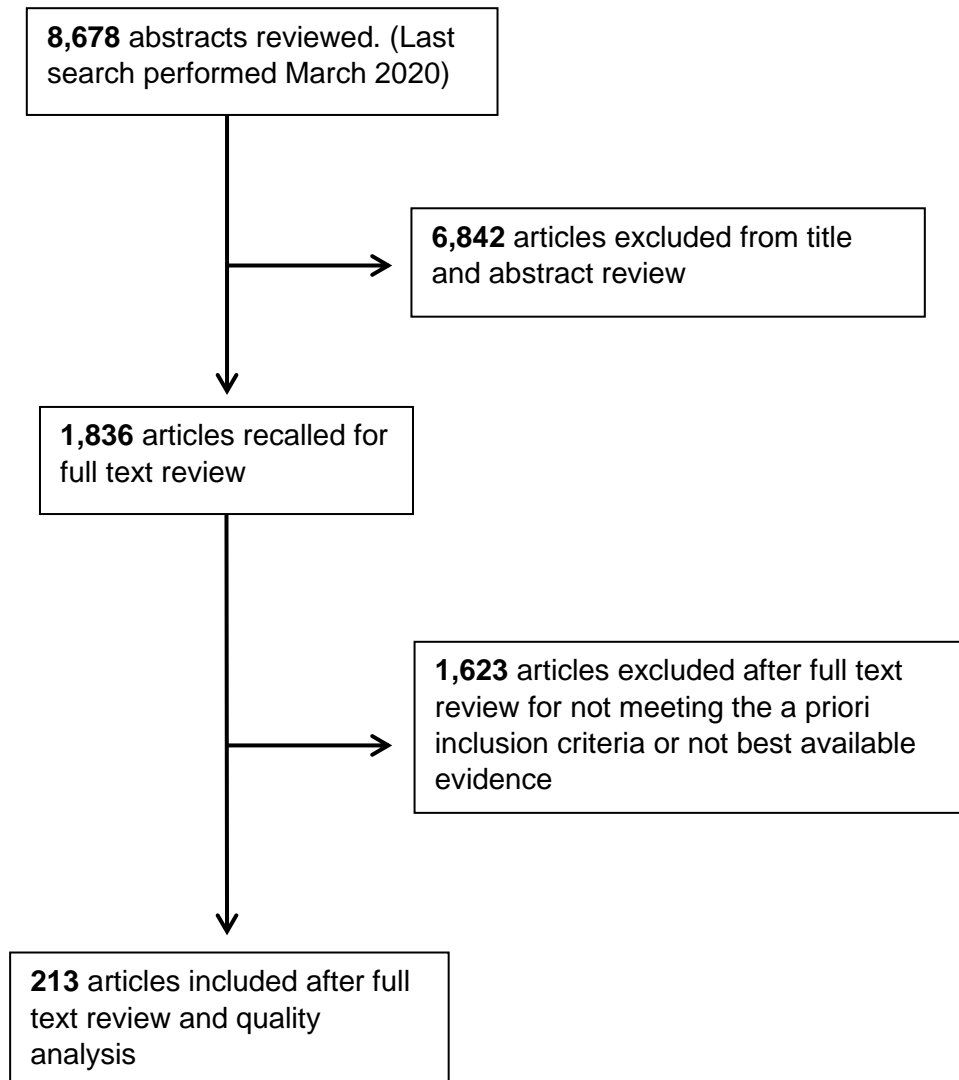
becomes available. This clinical practice guideline will be revised in accordance with new evidence, changing practice, rapidly emerging treatment options, and new technology. This clinical practice guideline will be updated or withdrawn in five years.

### **CPG DISSEMINATION PLANS**

The primary purpose of the present document is to provide interested readers with full documentation of the best available evidence for various procedures associated with the topic of this review. Publication of most clinical practice guidelines is announced by an Academy press release, articles authored by the clinical practice guideline development group and published in the *Journal of the American Academy of Orthopaedic Surgeons*, and articles published in *AAOS Now*. Most clinical practice guidelines are also distributed at the AAOS Annual Meeting in the Resource Center. The final guideline recommendations and their supporting rationales will be hosted on [www.OrthoGuidelines.org](http://www.OrthoGuidelines.org).

Selected clinical practice guidelines are disseminated by webinar, the AAOS Learning Management Systems (LMS), Media Briefings, and by distributing them at relevant Continuing Medical Education (CME) courses and at the AAOS Resource Center.

## STUDY ATTRITION FLOWCHART



## RECOMMENDATIONS

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Recommendations are formed when there is sufficient evidence by which to create a directional statement. This is defined as evidence from two or more high quality studies (i.e., a strong recommendation), two or more moderate quality studies (i.e., a moderate recommendation), or statements resulting in a strong or moderate strength following Evidence to Decision Framework upgrading and/or downgrading.

### PREOPERATIVE TRACTION

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**Preoperative traction should not routinely be used for patients with a hip fracture.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

#### **Rationale**

Overall, there were two high quality (Endo 2013, Rosen 2001) and six moderate studies (Needoff 1993, Resch 1998, Resch 2005, Saygi 2010, Tosun 2018, Yip 2002) addressing preoperative traction. Since 2012, one high (Endo 2013) and one moderate quality study (Tosun 2018) investigated preoperative traction. Tosun (2018) found that a position splint resulted in significant difference in immobilization comfort score (30.1/100) and pain compared to traction, whereas Endo found no differences in pain. Tosun (2018) also found that preoperative traction resulted in more pre-operative complications (constipation, pressure ulcers, adhesive plaster allergy, urinary tract infections, pulmonary complications, bleeding in the fractured joint) than a position splint applied for 1 day preoperatively, whereas Endo found no significant differences in complications between traction and no traction. These results are consistent with prior evidence and strengthen the body of evidence indicating that there are no benefits of preoperative traction. The recommendation reflects that there are some instances in which traction may be required (e.g., specific cases with peri-trochanteric fractures), however, in most cases pre-operative traction should not be used.

#### **Benefits/Harms of Implementation**

There are no known harms of implementing this recommendation. However, research is lacking regarding the potential harm of pre-operative traction as a form of tethering, which could trigger delirium, particularly in patients with dementia.

#### **Outcome Importance**

Complications, comfort, and pain are important outcomes related to hip fracture.

#### **Cost Effectiveness/Resource Utilization**

Not using preoperative traction may decrease cost/resource utilization compared to bedrest with positioning for comfort using pillows.

#### **Acceptability**

Use of alternatives to preoperative traction appeared to be acceptable to patients (Endo 2013, Tosun 2018).

***Feasibility***

Positioning with pillows is feasible.

***Future Research***

Future research regarding preoperative modalities to minimize patient pain should be continued to be investigated, including use of a position splint. Research should address possibility of delirium as a complication of pre-operative traction use.

## SURGICAL TIMING

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**Hip fracture surgery within 24-48 hours of admission may be associated with better outcomes.**

**Strength of Evidence:** Limited

**Strength of Recommendation:** Moderate  (Upgraded)

*Evidence from one or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention. Recommendation was upgraded based on EtD framework.*

### **Rationale**

Eight low strength studies (Elliot 2003, Moran 2005, Parker 1992, Siegmeth 2005, Orosz 2004, McGuire 2004, Novack 2007, Radcliff 2008) evaluated patient outcomes in relation to timing of hip fracture surgery. Potential confounding effects of patients with increased comorbidities also having delays to surgery was accounted for with statistical techniques (instrumental variable analysis, regression) and excluding patients delayed due to medical reasons.

The majority of studies favored improved outcomes in regard to pain, complications, and length of stay with decreased time to surgery. After controlling for patent comorbidities, the influence of delay to surgery on mortality was mixed but increased delay was in general associated with increased mortality. The studies varied on the optimal time frame from admission to surgery (24 hours to 4 days); however, the majority favored surgery within 24-48 hours.

### **Benefits/Harms of Implementation**

Benefits from numerous studies have been outlined. There is minimal harm in adopting early surgical timing of hip fractures. The evidence is limited partly due to the difficulty and potential ethical issues with performing a randomized controlled trial on this topic. The committee felt that the cited evidence, along with other lower quality studies supports this recommendation as there is potential patient harm with delay in surgery. Further, the potential benefit to patients is large enough that the committee voted it to be a moderate strength recommendation despite the limited level of evidence.

### **Cost Effectiveness/Resource Utilization**

Decreasing time to surgery decreases cost and health care resources.

### **Feasibility**

Intervention has been used extensively and has been proven feasible. However, it should be noted that these studies were performed predominantly at high volume, well-resourced, academic centers. While decreased time to surgery from admission should always be the goal, in some cases this target may not be met due to patient comorbidities, or factors related to the medical center (staffing, OR availability, surgeon availability, medical sub-specialist availability).

### **Future Research**

Future research improving controls for bias relating to increased medical severity of patients delayed for surgery is needed to better identify critical timing related issues regarding patient specific populations. Understanding which perioperative medical issues and co-morbidities are modifiable and can impact patient outcomes would help in optimizing surgical timing. Further, exploring whether race has an impact on timing to surgery could help decrease health disparities.



## VENOUS THROMBOEMBOLISM PROPHYLAXIS

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**Venous thromboembolism (VTE) prophylaxis should be used in hip fracture patients.**

**Strength of Evidence:** Moderate

**Strength of Recommendation:** Strong ★★★★★ (Upgraded)

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention. Recommendation was upgraded based on EtD framework.*

### **Rationale**

Six moderate quality studies (Eskeland 1966, Jorgensen 1992, Jorgensen 1998, Morris 1976, PEP Study 2000, Sasaki 2009) and four low quality studies (Cha Y H 2019, Goh E L 2020, Kulachote N 2015, Zhang C 2018) were identified comparing various pharmacological prophylaxis interventions in the setting of hip fracture. One moderate strength study (Stranks 1992) compared mechanical prophylaxis to a group that received no mechanical prophylaxis. These studies were an update of those utilized in the 2014 CPG guideline on the same topic, and excluded some previous studies judged to not meet current criteria for inclusion. Of these included studies, evidence shows the risk of DVT/VTE/PE complication is significantly less with VTE prophylaxis than control. Most general complications were not significantly different between treatment groups and there is some evidence that mortality is less with prophylaxis.

Given the significant established risk factors for VTE present in this patient population including age, presence of hip fracture, major surgery, delays to surgery, and the potential serious consequences of failure to provide prophylaxis in the hip fracture population, it is the recommendation of the workgroup that VTE prophylaxis be used.

With regard to mechanical prophylaxis, in the absence of a contraindication, this mechanical intervention can be applied with good efficacy for decreasing VTE, reasonable cost, and little risk to patient safety.

With regard to chemical prophylaxis, moderate quality evidence suggests that this may decrease patient risk of VTE/PE, with minimal risk of increased hemorrhagic consequences. There is however insufficient evidence to recommend a specific pharmacologic agent or duration of treatment. Patient specific factors should be considered when choosing an anticoagulated agent such as patient immobility, comorbidities, or bleeding risks.

### **Benefits/Harms of Implementation**

Patients with hip fracture are at high risk for deep venous thrombosis and pulmonary embolism. The consequences of symptomatic VTE are significant and include both increased morbidity and mortality. The harms associated with this recommendation include those associated with over or under treatment in the prevention of VTE/PE. Potential patient risks include thrombotic event, patient burden for administration route as well as risk of over treatment including hemorrhagic event. Given the potentially dire consequences of a VTE, and the relatively low risk of VTE prophylaxis, the committee voted to upgrade this to a strong recommendation despite the moderate evidence.

### **Cost Effectiveness/Resource Utilization**

Mechanical prophylaxis is available at most medical institutions in the United States and is typically an available adjunct without major cost or need for additional resources. Aspirin may be a cost-effective agent for appropriately selected patients and is able to be administered in an oral route, with little education, and low cost. Low Molecular Weight Heparin may also prove cost effective for appropriate patients, however, requires education on administration and patient compliance. This chemoprophylactic agent has no typical monitoring costs. Coumadin is a cost-effective means of anticoagulation for appropriately selected patients and is able to be administered in an oral route. This

however requires post discharge monitoring which may require system resources and additional patient education. NOAC/DOAC medication are an effective but more costly means of VTE prophylaxis for appropriately selected patients and are able to be administered in an oral route, with little education and no post discharge monitoring.

### ***Future Research***

The issue of VTE prophylaxis in patients who have sustained a hip fracture is complex. There are many unanswered questions that have the potential to have a significant impact on clinical outcomes for this patient population. A multi-armed randomized controlled study would be optimal. Such a study would potentially need to evaluate the comparative effectiveness of a multitude of chemical agents, at different dosages, with multiple time points (such as pre- and post-op), and include assorted durations of therapy, while utilizing contemporary diagnostic methodologies. Barriers to such a study include the low incidence of the complication implicating a requirement for a substantially large sample size. Furthermore, such a study carries ethical concerns given the potential risks associated with under-treatment. Potentially, well organized patient outcome registries may ultimately help improve our knowledge in this area and advances in large data-set machine learning algorithms may also help sort through the complexity of these mixed patient groups and their treatment needs.

## ANESTHESIA

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**Either spinal or general anesthesia is appropriate for patients with a hip fracture.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

Two high quality studies (Shin 2020, Tzimas 2018) and five moderate strength studies (Haghighi 2017, Parker 2015, McKenzie 1984, Davis 1981, Valentin 1986) compared mortality and complications among patients undergoing hip fracture surgery with spinal versus general anesthesia. One high quality study included in the prior guideline version was excluded due to low sample size (Casati); one study graded as high quality (Davis 1981) in the prior version was classified as moderate quality in the present guideline.

One high quality study (Shin 2020) and two moderate quality studies (Davis 1981, Valentin 1986) found no difference in mortality at up to 120 days for spinal versus general anesthesia. One moderate quality study (McKenzie 1984) found a decreased mortality rate at two weeks postoperatively in the spinal anesthesia group; however, this difference did not persist at two months. One moderate quality study (Parker 2015) found increased mortality with spinal versus general anesthesia at 1 year. One high quality study (Shin 2020) and one moderate quality study (Parker 2015) found no difference in in-hospital complications with spinal versus general anesthesia. One high quality study (Tzimas 2018) and two moderate quality studies (Parker 2015, McKenzie 1984) found no difference in length of stay by anesthesia type. One moderate quality study (Haghighi 2017) found lower postoperative pain scores with spinal versus general anesthesia.

### **Benefits/Harms of Implementation**

Spinal anesthesia and general anesthesia each have a longstanding record of use with established safety in appropriately selected patients. In patients undergoing anticoagulation, available external guidance should be consulted regarding the timing of block placement relative to anticoagulant dosing to limit potential harms for patients undergoing spinal anesthesia.

### **Outcome Importance**

Mortality and complications occur commonly after hip fracture surgery; therefore, identifying interventions to improve these outcomes represents an important public health priority.

### **Cost Effectiveness/Resource Utilization**

No data were identified to characterize the relative cost-effectiveness of spinal versus general anesthesia.

### **Acceptability**

Both spinal and general anesthesia may be acceptable to patients and providers. Acceptability of spinal versus general anesthesia for a given case may vary depending on patient preferences, provider experience, and case characteristics.

### **Feasibility**

Both spinal and general anesthesia are in widespread use in the United States.

### **Future Research**

Most identified randomized trials were small and may have lacked power to detect important differences between groups. Future research including appropriately randomized patients may provide more

information on risks and benefits of spinal anesthesia versus general anesthesia with regard to mortality, complications, and other important patient-centered outcomes such as delirium, functional outcomes, and discharge location.

## UNSTABLE FEMORAL NECK FRACTURES – ARTHROPLASTY VS FIXATION

---

**In patients with unstable (displaced) femoral neck fractures, arthroplasty is recommended over fixation.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

Six high quality (Frihagen 2007, Johansson 2001, Keating 2005, Lu 2017, Parker 2010, Stoen 2014) and 22 moderate quality studies (Bachrach-Lindstrom 2000, Calder 1995, Cao 2014, Chammout 2012, Davison 2001, Desteli 2015, Dolatowski 2019, El-Abed 2005, Johansson 2014, Johansson 2006, Johansson 2000, Jolly 2019, Mouzopoulos 2008, Parker 2002, Ravikumar 2000, Roden 2003, Shi 2018, Sikorski 1981, Skinner 1989, Stoen 2014, Tidermark 2003, Waaler 2012) directly compared arthroplasty (hemi- and/or total hip arthroplasty) to internal fixation for the treatment of unstable/displaced (Garden III and IV) femoral neck fractures. These studies consistently reported better outcomes (reoperation rate, pain scores, functional status, and/or complication rate) for patients in who were treated with arthroplasty. A decreased rate of reoperation among patients treated with arthroplasty was the most consistent finding across the studies. Composite analysis of these studies shows no statistically significant difference in mortality between arthroplasty and internal fixation.

### **Benefits/Harms of Implementation**

Implementing this recommendation does not result in additional harm to the patient beyond that conferred by usual surgical risk. Arthroplasty may be associated with somewhat higher initial charges compared with internal fixation due to more costly implants and higher procedural and professional fees, however this is likely offset by the decrease in reoperations expenses avoided by arthroplasty versus internal fixation.

### **Future Research**

Future studies should help to identify patient populations who may benefit from less invasive treatment.

## UNIPOLAR/BIPOLAR HEMIARTHROPLASTY

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**In patients with unstable (displaced) femoral neck fractures, unipolar or bipolar hemiarthroplasty can be equally beneficial.**

**Strength of Evidence:** Moderate

**Strength of Recommendation:** Moderate 

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.*

### **Rationale**

Ten moderate quality studies (Calder 1995, Calder 1996, Davison 2001, Hedbeck 2011, Inngul 2013, Kanto 2014, Khan 2015, Parker 2020, Raia 2003, Stoffel 2013) and one low quality study (Kenzora 1998) included comparing outcomes of unipolar and bipolar hemiarthroplasty for treatment of displaced femoral neck fractures reported no significant differences in most of the outcome measures between the two groups. A meta-analysis of mortality at all time points showed no significant differences between these two groups.

### **Benefits/Harms of Implementation**

Unipolar and bipolar hemiarthroplasty pose similar risk of adverse events. Composite Quality of Life (QoL) and functional outcome measures are overall not significantly between the two groups, although isolated statistically significant outcome differences were noted in some outcome measures that favored the bipolar group.

### **Outcome Importance**

All outcome measures including QoL, function, adverse events, mortality, and pain are relevant to patients.

### **Cost Effectiveness/Resource Utilization**

Most studies acknowledge lower cost of unipolar heads (Note: cost of implant is dependent on implant pricing at institutions and may not be lower at a specific institution).

### **Acceptability**

No variation in acceptability between the two groups anticipated.

### **Feasibility**

Surgical centers may not have equal access/availability to both unipolar and bipolar heads.

### **Future Research**

Specific cost/resource utilization studies may be useful to compare these two groups.

## UNSTABLE FEMORAL NECK FRACTURES – TOTAL ARTHROPLASTY vs HEMI ARTHROPLASTY

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**In properly selected patients with unstable (displaced) femoral neck fractures, there may be a functional benefit to total hip arthroplasty over hemi arthroplasty at the risk of increasing complications.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Moderate  (Downgraded)

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention. Recommendation was downgraded based on EtD framework.*

### **Rationale**

Four high strength (Chammout 2019, Hedbeck 2011, Keating 2005, van den Bekerom 2010) and ten moderate strength studies (Blomfeldt 2005, Cadossi 2013, Health Investigators 2019, Iorio 2019, Li 2017, Parker 2019, Ren 2017, Sharma 2016, Ukaj 2019, Xu 2017) examined this question. The evidence demonstrates a small functional outcome benefit to patients who received total hip arthroplasty. Hemi arthroplasty was associated with a small decrease in dislocation and instability. Mortality rates were largely unaffected within the first 4 years after treatment.

The strength of the evidence is strong. However, the effect size is small, which led the expert panel to unanimously downgrade this recommendation to moderate. Patient exclusion criteria in some of these studies reflect the general bias amongst surgeons towards performing total hip arthroplasty in patients who are higher functioning and more likely to be independent community ambulators. Cautious decision making for lower functioning patients may be justified considering the bias and risk for complications.

### **Benefits/Harms of Implementation**

Implementing this recommendation does not result in additional harm to the patient beyond that conferred by usual surgical risk. The choice of appropriate treatment requires discussion of risk and benefit with patients and families (shared decision making). This may help determine which patients might benefit more from functional improvement or avoiding complications including those patients whose preoperative function does not justify a surgical procedure involving greater risks.

Implementing this recommendation is likely to lead to greater expenditure. Total hip arthroplasty implants are priced higher than implants for hemi arthroplasty. Procedural and professional fees are higher for total hip arthroplasty than for hemi arthroplasty. The slight increase in complications with total hip arthroplasty may also generate additional charges.

### **Future Research**

Further areas of investigation include whether potential delays in surgery occur when total hip arthroplasty is the chosen treatment, and whether this influences postoperative morbidity. Another important but unanswered question is whether the demand for total hip arthroplasty following fracture can be met by surgeons who currently employ hemi arthroplasty, or if the increasing use of total hip arthroplasty by less experienced surgeons will offset potential benefits seen in previous studies.

## CEMENTED FEMORAL STEMS

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**In patients undergoing arthroplasty for femoral neck fractures, the use of cemented femoral stems is recommended.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

Two high quality studies (Figved 2009, Taylor 2012) and eleven moderate quality studies (Movrin 2020, Parker 2020, Inngul 2015, Langslet 2014, Deangelis 2012, Santini 2005, Moerman 2017, Chammout 2016, Talsnes 2013, Vidovic 2013, Vidovic 2015) address the question of cemented or uncemented femoral stem arthroplasty for femoral neck fractures, many of them randomized controlled trials. Six studies comprised of one high quality (Taylor 2012) and five moderate quality (Vidovic 2013, Vidovic 2015, Moerman 2017, Inngul 2015, Santini 2005) support cemented femoral stems for short term improved patient reported outcomes. Two studies (Inngul 2015, Taylor 2012) suggested a higher periprosthetic fracture risk in cementless implants. Few studies have demonstrated clear superiority in regard to mortality or medical complications (Parker 2020, Deangelis 2012). Seven studies (Figved 2009, Morvin 2020, Langslet 2014, Chammout 2016, Talsnes 2013, Vidovic 2013, Vodovic 2015) reported higher surgical time and blood loss in cemented implants.

### **Benefits/Harms of Implementation**

Patients who undergo cemented femoral stems may benefit from lower periprosthetic fracture risk and improved short time outcomes while being at risk for increased surgical time and blood loss.

### **Outcome Importance**

Patients undergoing cemented femoral stems will have the benefits of higher short-term patient reported outcomes and lower periprosthetic fracture risk, but with increased surgical time and blood loss during the operation. Postoperative periprosthetic fracture is a serious complication often requiring additional surgery with attendant risks. Surgeon’s familiarity with surgical technique may guide which implant they choose which contributes to the overall variability.

### **Cost Effectiveness/Resource Utilization**

Implant cost varies widely depending on healthcare contracts and geographic location. In general, cemented implants cost less, but utilization may require more resources such as bone cement and cement preparation supplies, as well as operating room staff training.

### **Acceptability**

Acceptability may be variable. However, since 2012, and after the first guidelines of femoral stem fixation were released in 2014, cement fixation for femoral stems has been increasing in the US.

### **Future Research**

High quality, double blinded randomized controlled trials are needed comparing stem fixation in arthroplasty for femoral neck fractures to definitively determine risk of fracture, blood loss and patient outcomes.



## SURGICAL APPROACH

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**In patients undergoing treatment of femoral neck fractures with hip arthroplasty, evidence does not show a favored surgical approach.**

**Strength of Evidence:** Moderate

**Strength of Recommendation:** Moderate 

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.*

### **Rationale**

One high quality study (Ugland 2018), seven moderate quality studies (Jianbo 2019, Li 2017, Parker 2015, Repantis 2015, Saxer 2018, Ugland 2019, Verzellotti 2019) and two low quality studies (Biber 2012, Skoldenberg 2010) were included in the evidence for this recommendation.

The high quality study (Ugland 2019) compared hemiarthroplasty with the anterolateral approach to hemiarthroplasty with the direct lateral approach and reported that while there were elevated levels of serum creatine kinase (CK) observed in the anterolateral approach group, no correlation between CK levels and the Timed Up and Go test or the Trendelenburg sign at 3 months were found.

There were also 8 citations on the subject of surgical approach in the surgical treatment of femoral neck fractures with moderate evidence strength. Jianbo (2019) reported on a prospective, randomized study of 100 patients. They specifically compared the clinical outcomes and complications of using either the conventional posterior approach, or with using a minimally invasive (MIS) and muscle preserving approach (the Suprapath approach). There was less blood loss, and low transfusion rate in the MIS group. There was less pain, and better function within the first week in the minimally invasive group, but no differences between the groups at the 3-month interval. Repantis (2015) reported on the comparative results of a prospective, randomized study in 80 patients using either a MIS approach or in using the posterior approach. It was a single-surgeon series. There was less pain in the MIS group in the short term. There was no difference in any of the other outcomes or complications up to 4 years of follow up. In another comparative study, Saxer (2018) reported on the results of 190 patients using either a MIS or using the lateral approach. There was less pain, and faster ambulation in the first 3 weeks in the MIS group. There was no difference in any of the other outcomes, or in the complications between the groups. Verzellotti (2019) reported on the comparative results of using the direct anterior (DA) which is muscle preserving, or in using the posterior approach in 100 patients. There was less pain in the DA group in the first month after surgery. There was no difference in the other outcomes or complications between the groups. The operative time was longer in the DA group. Parker (2015) reported the comparative results of a multi-center, prospective, randomized study in 216 patients using either the posterior or the lateral approach. There was no difference in any of the outcome measures analyzed between the groups. In a prospective, randomized study in 150 patients, Ugland (2018) reported higher risk of post-surgery Trendelenburg gait when the arthroplasty was done using the lateral approach in contrast to using the anterolateral approach (more abductor muscle preserving). Two low strength articles (Biber 2012, Skoldenberg 2010) compared the posterior approach to the direct lateral approach for performing arthroplasty in the patients with femoral neck fractures. While neither of the included studies specifically addressed any functional outcomes, they both demonstrated statistically significant differences in dislocation rates, favoring the direct lateral approach.

The data in these newer studies show no difference in the dislocation rates between the different surgical approaches, including the posterior approach. This is in contrast to the earlier data in older publications which showed higher dislocation rate with the posterior approach in comparison to the lateral approach in particular.

***Benefits/Harms of Implementation***

While some studies showed less pain in the early postoperative period for less invasive surgical approaches, operative time may be longer with a less invasive approach and there was no clear difference in functional outcomes. This information should be considered in the context of both patient and surgeon specific factors when deciding on a surgical approach.

***Future Research***

The existing evidence does not support superiority of one surgical approach. Future well designed RCTs should include a comparison of the anterior approach with the posterior and the lateral approach. Any future studies related to surgical approach should also include pain and functional data associated with the approaches. This may have important implications for patient selection and recovery needs such as assistive devices or therapy needs.

## CEPHALOMEDULLARY DEVICE – STABLE INTERTROCHANTERIC FRACTURES

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**In patients with stable intertrochanteric fractures, use of either a sliding hip screw or a cephalomedullary device is recommended.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

Two high quality (Cai 2016, Varela 2009) and 6 moderate strength (Carulli 2017, Li 2018, Sanders 2017, Utrilla 2005, Wang 2019, Xu 2018) studies compared the use of an extramedullary sliding hip screw device with a cephalomedullary device for stable intertrochanteric fractures. Fixation with either an extramedullary or intramedullary implant show similar clinical outcomes. One moderate strength study (Utrilla 2005) found no difference in walking ability with either a sliding hip screw or cephalomedullary nail for the stable intertrochanteric fractures. While one study (Sanders 2017) did show improved walking ability in the cephalomedullary group, the high strength study (Varela 2009) found no difference in functional outcome, hospital stay, fracture collapse, or mortality between a cephalomedullary nail and an extramedullary sliding hip screw and plate device that offers two points of fixation into the femoral head. This recommendation includes stable peritrochanteric fractures, 31.A1 and 31.A2, that are stable after anatomical reduction.

### **Benefits/Harms of Implementation**

There are no known harms associated with implementing this recommendation.

### **Cost Effectiveness/Resource Utilization**

The cost of cephalomedullary devices is generally more than sliding hip screw fixation in most institutions. Cephalomedullary nail fixation had reduced length of hospital stay and fewer complications (Xu 2018) which can lead to overall decreased costs with cephalomedullary devices.

### **Future Research**

Randomized, prospective trials comparing modern cephalomedullary nails with extramedullary devices in a large cohort of patients with only stable intertrochanteric fractures (OTA 31.A1) should specifically assess pain, functional outcomes, radiographic parameters, complications, and cost. These studies should control for patient demographics as well as quality of fracture reduction and placement of fixation (tip-to-apex distance). The potential difficulty with conversion to total hip arthroplasty for failed fracture treatment also should be considered when comparing fixation methods.

## CEPHALOMEDULLARY DEVICE – SUBTROCHANTERIC/REVERSE OBLIQUITY FRACTURES

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**In patients with subtrochanteric or reverse obliquity fractures a cephalomedullary device is recommended.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

Reverse obliquity fractures are a subset of intertrochanteric/peritrochanteric fractures that are an unstable pattern. Though subtrochanteric fractures are more of a proximal femur fractures, they can be a component of an intertrochanteric fracture as well. There were 3 high (Miedel 2005, Schipper 2004, Zehir 2015), and 6 moderate quality (Aktselis 2014, Fernandez 2017, Griffin 2016, Hardy 1998, Reindl 2015, Tao 2013) studies evaluating the use of cephalomedullary devices in the treatment of unstable intertrochanteric and subtrochanteric fractures. Although many comparative studies have been done, the variability of fracture classification systems and implants used makes interpretation of the literature challenging; many orthopaedic surgeons use the terms intertrochanteric and peritrochanteric interchangeably. Evaluation of these studies shows an apparent treatment benefit with cephalomedullary devices for unstable peritrochanteric fractures compared to extramedullary devices.

One high strength comparative study (Schipper 2004) showed similar results and outcomes between different cephalomedullary devices in unstable fractures.

Another high strength study (Miedel 2005) demonstrated a lower complication rate with use of a cephalomedullary versus an extramedullary device in treatment of unstable intertrochanteric and subtrochanteric fractures. Another moderate strength study (Hardy 1998) showed improved mobility and decreased limb shortening in unstable intertrochanteric fractures treated with a cephalomedullary device versus a sliding hip screw.

### **Benefits/Harms of Implementation**

There are no known harms associated with implementing this recommendation.

### **Future Research**

Continued comparative studies between modern cephalomedullary and extramedullary devices in unstable subtrochanteric and reverse obliquity fractures (OTA 31.A3) which control for fracture reduction and implant position (specifically tip-to-apex distance) may further clarify the utility of cephalomedullary devices for this fracture cohort. TAD is important in all peritrochanteric and intertrochanteric fractures. Many use it in A3 fractures as well clinically.

## CEPHALOMEDULLARY DEVICE – UNSTABLE INTERTROCHANTERIC FRACTURES

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**Patients with unstable intertrochanteric fractures should be treated with a cephalomedullary device.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

Two high (Adams 2001, Zehir 2015) and 9 moderate quality studies, (Papasimos 2005, Utrilla 2005, Leung 1992, Aktseles 2014, Fernandez 2017, Griffin 2016, Reindl 2015, Tao 2013, Verettas 2010) evaluated the use of cephalomedullary devices in unstable intertrochanteric fractures with a separate lesser trochanteric fragment but no subtrochanteric involvement (OTA 31.A2). Although many studies have been done, the variability of the fracture classification systems and the diverse designs of the implants used makes interpretation of the literature challenging. Many orthopaedic surgeons use the terms intertrochanteric and peritrochanteric interchangeably. Evaluation of these studies shows strong evidence strength supporting the treatment benefit of using the cephalomedullary devices for unstable intertrochanteric fractures.

Two moderate strength studies (Utrilla 2005, Leung 1992) recommended a cephalomedullary device over sliding hip screw. Utrilla (2005) found improved postoperative walking ability and fewer blood transfusions in the cephalomedullary group. Leung (1992) showed no difference in the mortality or in the ultimate hip function but did show a shorter convalescence period in the cephalomedullary cohort. A moderate strength study (Verettas 2010) found no difference in pain and in the systemic physiologic responses (O<sub>2</sub> requirement, mental status, hematocrit) between the treatment groups with using either a sliding hip screw or using a cephalomedullary device. Papasimos (2005) conducted a moderate strength study evaluating treatment with using a sliding hip screw and using two different cephalomedullary devices. Their data showed no difference between the devices with respect to the ultimate fracture consolidation and the return to the pre-fracture level of function. Adams (2001) conducted a comparative study evaluating using a cephalomedullary device to using an extramedullary plate and screw in the treatment of 31.A1, 31.A2 and 31.A3 fractures. They found the use of an intramedullary device in the treatment of intertrochanteric hip fractures was associated with a higher but nonsignificant risk of postoperative complications. By controlling for tip-to-apex distance, there was no statistical difference between the types of the implants with regard to fracture reduction and the fracture stability during the healing phase.

### **Benefits/Harms of Implementation**

There are no known harms associated with implementing this recommendation

### **Future Research**

The current trend is for increasing use of cephalomedullary devices in the treatment of intertrochanteric fractures (Yli-Kyyny, 2012; Jeffery, Anglen 2008). Concerns regarding increased complication rates with conversion of failed cephalomedullary implants to total hip arthroplasty (Pui 2013) warrants caution and further investigation. High level trials comparing modern cephalomedullary devices with sliding hip screws in a large cohort of patients with intertrochanteric fractures classified as OTA 31.A2 should specifically assess pain, functional outcomes, radiographic outcomes, complications, and cost. These

studies should control for patient demographics, quality of fracture reduction, hardware placement (specifically tip-to-apex distance) and the changing experience of practicing surgeons.

**Additional References:**

1. Yli-Kyyny TT, Sund R, Juntunen M, Salo JJ, Kröger HP. Extra- and intramedullary implants for the treatment of pertrochanteric fractures -- results from a Finnish National Database Study of 14,915 patients. *Injury*. 2012;43(12):2156-2160. doi:10.1016/j.injury.2012.08.026
2. Anglen JO, Weinstein JN; American Board of Orthopaedic Surgery Research Committee. Nail or plate fixation of intertrochanteric hip fractures: changing pattern of practice. A review of the American Board of Orthopaedic Surgery Database. *J Bone Joint Surg Am*. 2008;90(4):700-707. doi:10.2106/JBJS.G.00517
3. Pui, C. M., Mathias, P. B., Geoffrey, H., W., William, M., Michael, A. M., Douglas, E. P. Increased Complication Rate Following Conversion Total Hip Arthroplasty After Cephalomedullary Fixation For Intertrochanteric Hip Fractures: A Multi-center Study. *JOA* 2013; 28(8): 45-47.

## TRANSFUSION

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**A blood transfusion threshold of no higher than 8g/dl is suggested in asymptomatic postoperative hip fracture patients.**

**Strength of Evidence:** Moderate

**Strength of Recommendation:** Moderate 

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.*

### **Rationale**

Several moderate strength studies (Carson 2015, Carson 2011, Gregersen 2015, Gruber-Baldini, 2013, Parker 2013) support this recommendation. Carson (2011) FOCUS trial is the largest (n=2016) and most robust study to address transfusion threshold in hip fracture patients. FOCUS considered patient-centered and clinically important outcomes in a prospective, randomized, multicenter, controlled trial. This study showed that a restrictive transfusion threshold of hemoglobin 8g/dl in asymptomatic hip fracture patients with cardiovascular disease or risk factors resulted in no significant difference in primary or secondary outcomes at 30- or 60-days including mortality, independent walking ability, residence, other functional outcomes, cardiovascular events, or length of stay. Symptoms or signs that were considered indicative of anemia appropriate for transfusion were chest pain that was deemed to be cardiac in origin, congestive heart failure, and unexplained tachycardia or hypotension unresponsive to fluid replacement. Gregersen’s (2015) study comparing 9.7g/dl vs. 11.3 g/dl also showed no significant difference in most of the primary or secondary outcomes.

Of note, in the Carson (2011) study, for patients in the restrictive-strategy group (8g/dl) and for patients in both groups in the Gregerson (2015) study, blood was transfused 1 unit at a time and the patient reassessed for presence of symptoms or signs after each transfusion.

### **Benefits/Harms of Implementation**

Implementation of this recommendation is likely to result in lower transfusion associated complications and cost. There is risk that cognitively impaired patients cannot report symptoms, so special attention to these individuals may be warranted; FOCUS automatically transfused significantly demented patients below hemoglobin 8mg/dl.

### **Future Research**

Confirmatory studies by other authors would strengthen evidence. Additional studies could further risk stratify and refine transfusion thresholds in subpopulations.



## MULTIMODAL ANALGESIA

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**Multimodal analgesia incorporating preoperative nerve block is recommended to treat pain after hip fracture.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

This recommendation combines and updates information contained in 2014 CPG recommendations on Preoperative Regional Anesthesia and Postoperative Multimodal Analgesia. We identified a total of 28 high- or moderate-quality studies (Aprato 2018, Clemmesen 2018, Ergenoglu 2015, Godoy-Monzon 2010, Gorodetskyi 2007, Kang 2013, Ma 2018, Moppett 2015, Morrison 2016, Parras 2016, Phruetthiphat 2021, Unneby 2017, Unneby 2020, Wennberg 2019, Wennberg 2019, Zhang 2020, Zhou 2019, Cooper 2019, Newman 2013, Nie 2015, Rowlands 2018, Temelkovska 2014, Uysal 2020, Unneby 2020, Xu 2020, Matot 2003, Mouzopoulos 2009, Zhang 2019) addressing diverse aspects of perioperative multimodal analgesia for hip fracture patients. Analgesic approaches, dosing regimens, comparators, and outcomes assessed varied markedly across available studies.

Ten high-quality studies (Wennberg 2019, Ma 2018, Wennberg 2019, Unneby 2017, Unneby 2020, Morrison 2016, Aprato 2018, Monzon 2010, Zhou 2019, Ergenoglu 2015) and nine moderate-quality studies (Mouzopoulos 2009, Xu 2020, Rowlands 2018, Zhang 2019, Unneby 2020, Uysal 2020, Cooper 2019, Newman 2013, Matot 2003) specifically assessed use of regional anesthesia before surgery as a component of a perioperative multimodal analgesic approach. 17 of 19 identified studies assessed either fascia iliaca compartment block (FICB) or femoral nerve block (FNB), with or without obturator nerve block; 1 moderate-quality study (Matot 2003) assessed continuous epidural analgesia. 1 high-quality study (Zhou 2019) and 2 moderate-quality studies compared preoperative FICB to preoperative FNB with or without obturator nerve block (Zhou 2019, Cooper 2019, Newman 2013); 1 high-quality study compared FICB to intra-articular hip injection (Aprato 2018). All other identified studies compared a preoperative regional block to routine opioid- and non-opioid based pain management, with or without performance of a sham nerve block procedure in the control arm.

Among studies comparing preoperative regional anesthesia (including FNB, FICB, or epidural) to non-regional anesthesia control, regional anesthesia was associated with decreased pain severity compared to control in 5 high-quality studies (Monzon 2010, Ma 2018, Wennberg 2019, Unneby 2017, Morrison 2016) and 4 moderate-quality studies (Rowlands 2018, Zhang 2019, Uysal 2020, Xu 2020). Regional anesthesia was associated with decreased requirements for parenteral analgesia versus control in one high-quality study (Morrison 2016). Results varied with regard to the association between regional anesthesia receipt and adverse outcomes; while some studies reported lower rates of delirium (Mouzopoulos 2009), cardiovascular events (Matot 2003), postoperative complications (Ma 2018) and severe opioid-related adverse events (Morrison 2016) with regional anesthesia, findings were inconsistent across studies reviewed, with some reporting no difference or worsened outcomes with regional anesthesia observed for these endpoints. One high-quality study (Morrison 2016) observed improved recovery of ambulation at post-operative day 3 and at 6 weeks with regional anesthesia. Among studies comparing FICB to FNB, one high-quality study (Zhou 2019) and one moderate-quality study (Newman 2013) found improved pain VAS score with preoperative FNB vs FICB. In one high-quality study (Zhou 2019), analgesic requirements and rates of nausea were lower with FNB vs FICB. One high-quality study (Aprato 2018) found better pain control and lower systemic analgesic requirements with intra-articular hip injection vs preoperative FICB.

Five high-quality studies (Kang 2013, Gorodetskyi 2007, Zhang 2020, Clemmesen 2018, Phruetthiphat 2021) and five moderate quality studies (Mouzopoulos 2009, Matot 2003, Temelkovska-Stevanovska



2014, Nie 2015, Ogilvie-Harris 1993) assessed aspects of multimodal analgesia for hip fracture patients other than preoperative regional anesthesia. Identified studies examined a range of approaches including: standardized pain treatment protocols; neurostimulation; pre- or intra-operative dexmedetomidine infusion; preoperative methylprednisolone; intra-operative or postoperative regional anesthetics; and postoperative periarticular anesthetic injections. Improved pain outcomes were observed for postoperative periarticular injections (Phruetthiphat 2021, Kang 2013), postoperative FNB (Temelkowska-Stevanovska 2014); and neurostimulation (Gorodetskyi 2007). Neither intraoperative dexmedetomidine (Zhang 2020) nor preoperative methylprednisolone (Clemmesen 2018) were associated with improved pain scores versus control. Association between adjunctive pain therapies and postoperative outcomes varied across modalities evaluated.

### ***Benefits/Harms of Implementation***

Risks associated with pain treatment approaches are likely to vary across modalities and should be interpreted with regard to the risks of alternative treatments, such as opioids. Certain techniques, such as epidural anesthesia, may be contraindicated in the presence of anticoagulant therapy or coagulopathy. Appropriate provider training in pain management techniques, adequate monitoring for potential procedure-related complications, and availability of rescue medications and other resources is essential to ensuring patient safety.

### ***Outcome Importance***

Treatment of pain represents a major priority for many hip fracture patients and their families; additional outcomes assessed in studies reviewed here, such as delirium and functional recovery, may also carry substantial importance to patients.

### ***Cost Effectiveness/Resource Utilization***

Identified studies did not assess cost-effectiveness or resource utilization; these are likely to vary according to the specific pain treatment modality under consideration.

### ***Acceptability***

Preoperative FNB and FICB both appear to be broadly acceptable to patients; limited information is available on the acceptability of other pain treatment modalities reviewed here.

### ***Feasibility***

FNB and FICB can be performed feasibly in emergency departments, perioperative care settings, and other hospital areas with appropriate provider training and access to necessary monitors and rescue treatments. Feasibility of other multimodal analgesic approaches may vary according to the modality evaluated.

### ***Future Research***

Future research on preoperative regional anesthesia for hip fracture patients may focus on impacts on complications and patient-centered end-outcomes, such as functional recovery after fracture. Additional research is needed to define optimal or preferred strategies for multimodal analgesia. Such research may examine outcomes for regimens that incorporate agents not evaluated in identified studies, such as gabapentin, and should evaluate impacts on complications and patient-centered end outcomes in addition to pain outcomes.

## TRANEXAMIC ACID

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**Tranexamic acid should be administered to reduce blood loss and blood transfusion in patients with hip fractures.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

16 studies address the question of use of tranexamic acid in older adult patients with hip fractures (Chen 2019, Tengberg 2016, Tian 2018, Watts 2017, Zufferey 2010, Drakos 2016, Lei 2017, Ma 2021, Zhou 2019, Ashkenazi 2020, Kwak 2019, Lee 2015, Maalouly 2020, Schiavone 2018, Virani 2016, Xie 2019). 5 high quality studies (Chen 2019, Watts 2017, Tian 2018, Tengberg 2016, Zufferey 2010) and 6 lower quality studies (Zhou 2019, Drakos 2016, Lei 2017, Schiavone 2018, Xie 2019, Ashkenazi 2020) reported significantly lower blood loss and 3 high quality studies (Chen 2019, Watts 2017, Tian 2018) and 7 lower quality studies (Drakos 2016, Lei 2017, Kwak 2019, Xie 2019, Lee 2015, Ashkenazi 2020, Maalouly 2020) reported trends towards lower blood transfusions with TXA. Tranexamic acid was not associated with higher incidence of mortality or symptomatic thromboembolic events.

### **Benefits/Harms of Implementation**

Use of tranexamic acid in hip fracture patients may result in lower blood loss and transfusion rates compared to placebo in a number of high quality studies. Studies were unable to detect any difference in adverse events with use of tranexamic acid such as infection, wound complication, DVT, CVA, PE or MI (Chen 2019). One study (Zuffrey 2010) noted slightly increased asymptomatic VTE events as noted in the mandatory ultrasound. Caution may be exercised in patients with strong thrombotic risk factors as many of the studies excluded patients with previous thrombotic events.

### **Outcome Importance**

Patients with hip fractures may benefit from TXA to reduce blood loss and subsequent transfusion.

### **Cost Effectiveness/Resource Utilization**

Additional use of tranexamic acid in orthopaedic surgery has been demonstrated to be very cost effective in other areas of orthopaedic surgery, especially hip and knee replacement. Several studies additionally cite the better cost-effective nature of TXA when compared to transfusion. This intervention of TXA may offer potential cost savings for institutions as a health care system as a whole.

### **Future Research**

Future research should determine which factors may place patients at higher risk for VTE or CVA, what is the optimal dose for tranexamic acid, and which mode of administration is best.

## INTERDISCIPLINARY CARE PROGRAMS

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**Interdisciplinary care programs should be used in the care of hip fracture patients to decrease complications and improve outcomes.**

**Strength of Evidence:** Strong

**Strength of Recommendation:** Strong ★★★★★

*Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.*

### **Rationale**

While the 2014 AAOS CPG on Interdisciplinary Care focused on patients with mild to moderate dementia, four high quality studies (Berggren 2008, Duncan 2006, Marcantonio 2001, Naglie 2002) and 15 moderate quality studies (Crotty 2019, Heltne 2017, Huusko 2000, Huusko 2002, Majumdar 2007, Olsson 2007, Prestmo 2015, Shyu 2008, Shyu 2010, Shyu 2013, Shyu 2013, Shyu 2013, Shyu 2016, Stenvall 2007, Vidan 2005) now provide strong evidence that interdisciplinary management of geriatric hip fractures improves overall outcomes in all geriatric fracture patients.

Interdisciplinary care refers to programs that involve providers from multiple disciplines working together to co-manage individuals with hip fracture. This may include geriatric and orthopaedic providers, and nursing, dietary, and rehabilitation providers such as occupational and physical therapists. Co-management often includes workup and initiation of therapy for osteoporosis, pain, functional, nutritional and medication management, and prevention of complications (e.g. falls, delirium, and constipation).

Although the outcomes delineated in the studies do not allow for head-to-head comparisons, certain critical themes have emerged from our updated analysis.

**Decreased mortality and complications:** One high quality study (Duncan 2006) and three moderate studies (Vidan 2005, Olsson 2006, Shyu 2016) found that early multidisciplinary daily geriatric care reduces in-hospital mortality and medical complications in older adult patients with hip fractures. One high quality study (Naglie 2002) and two moderate quality studies (Huusko 2000, Majumdar 2007) found no difference in mortality for intensive geriatric rehabilitation and case management respectively. However, the findings from these studies all trended toward benefit of intervention.

**Functional outcomes, reduction of falls, quality of life, and return to the community:** Two high quality studies (Berggren 2008, Naglie 2002) found no significant difference in falls, fractures and functional outcomes for interdisciplinary care. One moderate study (Vidan 2005) found no difference in functional recovery. However, the findings from these studies all trended toward benefit of intervention. While most authors reported a trend toward increased mobility, decreased falls and/or failure to lose mobility, significant improvements were noted in eight moderate studies (Crotty 2019, Prestmo 2015, Huusko 2002, Olsson 2007, Huusko 2000, Shyu 2016, Stenvall 2007, both a and b). There was evidence of benefits for reduction in falls and improved quality of life and return to the community. Three studies, Naglie (2002) Huusko (2000) and Stenvall (2007) found improvements in functional outcomes for subgroups with mild to moderate cognitive impairment or dementia.

**Initiation of Osteoporosis Management:** Only Majumdar (2007) compared case management focused on evidence-based osteoporosis treatment with usual care. They found that the intervention group had substantially higher proportion of appropriate care (bone mineral density testing, bisphosphonate therapy). The average intervention cost was \$50.00 per patient.

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Nutritional outcomes: Duncan (2006) noted that Dietetic assistant supported patients had higher energy intake and decreased in-hospital and 4-month post-operative mortalities. Stenvall (2007) found fewer nutritional problems for postoperative geriatric assessment and rehabilitation intervention compared to conventional care.

Delirium: Marcantonio (2001) found that cumulative incidence was significantly lower for delirium and severe delirium in the group who had geriatric consultation compared to the usual care group. Both groups experienced a similar drop in prevalence so that there was no significant difference by discharge. Stenvall (2007a) found significantly better outcomes for postoperative delirium and number of days of delirium for the postoperative geriatric assessment and rehabilitation intervention compared to conventional care. There was also no difference between groups in the number days of delirium per episode. Crotty (2019) found that the control group was favored at 4 weeks, but at 12 weeks there was no difference.

Cognitive status: Whereas one high quality study (Berggren 2008) found no difference in Mini-Mental State Exam (MMSE) between intervention and control groups, two high quality studies found significant differences in favor of interdisciplinary care. Prestmo (2015) found significant improvement in MMSE and Clinical Dementia Rating scale for comprehensive geriatric care compared to orthopaedic trauma ward care. Shyu (2013) found a non-significant outcome for general mental health as measured by the SF-36 Mental Component Summary score for interdisciplinary comprehensive compared to usual care.

Depression: Berggren (2008) found that the Geriatric Depression scale scores favored conventional orthopaedic care group compared to multi-disciplinary multi-factorial care at 4 and 12 months after hospitalization. Prestmo (2015) found significant difference in depression symptoms in favor for comprehensive geriatric care. Shyu and colleagues (2008, 2010, 2013, 2013, 2013, 2016) followed 2 cohorts of hip fracture patients recruited in 2001-2003 and 2005-2010, respectively. The team tracked interdisciplinary versus usual care in the first cohort and noted reduction of depression in those treated with interdisciplinary care. They then added comprehensive care for their second cohort which included depression management and reduced depression even further.

Improved medical care: This issue was particularly addressed by Heltne (2017) who conducted a secondary analysis of the Trondheim Hip Fracture Trial, which compared acute inpatient comprehensive geriatric care (CGC) with traditional orthopaedic care. They found that at discharge the group had more prescribed medications, related to the treatment of conditions related to the fracture (e.g., pain, constipation, osteoporosis). In addition, the CGC group had more drugs withdrawn, such as cardiovascular and CNS-active drugs.

Length of stay: Results on hospital length of stay varied. Whereas Vidan (2005) found that early multidisciplinary daily geriatric care reduces in-hospital mortality and medical complications in older adult patients with hip fractures, there was no significant effect on length of hospital stay or functional recovery. Two studies also found no significant difference in length of stay between intervention and control groups (Marcantonio 2001, Duncan 2006). Moreover, while Prestmo (2015) found improved mobility, activities of daily living, and more frequent direct discharge home at 12 months for comprehensive geriatric care compared with usual orthopaedic care, they also found increased hospital length of stay. However, between 4 and 12 months, the comprehensive care group required fewer short-term nursing home stays. There was no difference between groups in hospital readmissions or permanent nursing home stay during the 4-12-month period. Similarly, Stenvall (2007 a and b) found shorter length of stay for the intervention group. Huusko (2000) conducted a secondary analysis of a RCT of intensive geriatric rehabilitation compared to usual care for 2 groups of patients with mild and

moderate dementia. For both groups, the intervention resulted in substantially shorter length of hospital stay and a higher percent of patients returning to living in the community.

### ***Benefits/Harms of Implementation***

Interdisciplinary care programs for patients with hip fracture have a longstanding record of use with few identified safety risks. Relative benefits and harms of specific program elements should be considered individually to guide design and implementation.

### ***Cost Effectiveness/Resource Utilization***

Available studies provide limited information on the cost-effectiveness of interdisciplinary care programs overall or aspects of specific programs that may increase or decrease their cost effectiveness.

### ***Acceptability***

Dedicated care programs are likely to be acceptable to patients and providers, although acceptability may vary depending on specific components.

### ***Feasibility***

Available studies demonstrate feasibility of program implementation overall across diverse settings; feasibility of implementation/use is likely to vary depending on program eligibility criteria and the specific components.

### ***Future Research***

Future research should compare the relative advantages of different intervention components and their timing, intensity, frequency, and duration. Additional research is needed to characterize the cost-effectiveness of interdisciplinary hip fracture programs from the perspective of different stakeholders (e.g., patient/family, hospital, payer, society).

## OPTIONS

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Low quality evidence, no evidence, or conflicting supporting evidence have resulted in the following statements for patient interventions to be listed as options for the specified condition. Future research may eventually cause these statements to be upgraded to strong or moderate recommendations for treatment.

### STABLE FEMORAL NECK FRACTURES

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**In patients with stable (impacted/non-displaced) femoral neck fractures, hemiarthroplasty, internal fixation or non-operative care may be considered.**

**Strength of Evidence:** Moderate

**Strength of Option:** Limited ★★☆☆

*Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.*

#### **Rationale**

Strong evidence from one prospective clinical trial comparing 3 groups of patients randomized to non-operative care, internal fixation and hemiarthroplasty. Strong evidence is in favor of hemiarthroplasty group for composite QoL/Function outcome measures-Harris Hip Score (1m,3m and 6m) and EQ-5D (1m and 3m) but not at other time points, or other outcome measures including adverse events, length of stay or mortality.

There is strong evidence of equipoise between the non-operative care, internal fixation and hemiarthroplasty groups in the Wei (2020) study on all outcomes. However, there were significant differences in a few individual outcomes. For example, patients in the hemiarthroplasty group had better functional outcomes compared to the non-surgical group, whereas the outcomes between non-surgical and internal fixation groups were similar. Therefore, the overall strength of evidence was downgraded using EtDF to Limited.

Wei (2020) showed statistically significant and clinically meaningful short-term and intermediate-term pain, function and QoL outcome differences favoring the hemiarthroplasty group over the non-surgical group. However, these outcomes were similar in the long-term. All other outcome measures including pain, function, QoL as well as adverse events, complications, hospital stay, and mortality were similar between the 3 groups at all other time points. Therefore, hemiarthroplasty may be considered for short term improvement of function, QOL and mortality. Individual patient factors should be considered when determining appropriate intervention.

#### **Benefits/Harms of Implementation**

No differences in adverse events in two groups (hemiarthroplasty vs. non-operative), but better outcomes in hemiarthroplasty group at least in short and intermediate terms.

#### **Outcome Importance**

Composite QoL and Function outcomes are important and relevant (patient reported) to patient.

#### **Acceptability**

Patients may have variable acceptability of operative vs. non-operative recommendations.

#### **Feasibility**

Hemiarthroplasty may not be available in all centers.

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***Future Research***

Replication of Wei's study in other populations and health care systems is important.

## CEPHALOMEDULLARY DEVICE – PERTROCHANTERIC FRACTURES

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**In patients with pertrochanteric femur fractures, short or long cephalomedullary nail may be considered.**

**Strength of Evidence:** Limited

**Strength of Option:** Limited ★★☆☆

*Evidence from one or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention.*

### **Rationale**

One moderate quality study (Shannon 2019) and multiple low quality studies reported lower surgical OR time, lower intraoperative blood loss (Frisch 2017, Horner 2017, Liu 2018), lower transfusion rate (Guo 2015), and less fluoroscopy (Frisch 2017, Horner 2017, Liu 2018) with short nail use. Multiple comparison studies reported no difference in adverse events (Bovbjerg 2020, Frisch 2017, Guo 2015, Horner 2017, Liu 2018, Rai 2020) nor patient reported outcomes (Rai 2020) in short versus long cephalomedullary nails. One low quality study (Frisch 2017) reported a higher incidence of periprosthetic fractures with short nails, but other studies did not find such findings (Guo 2015). Overall, both short or long cephalomedullary nails are acceptable options in pertrochanteric femur fractures.

### **Benefits/ Harms of Implementation**

Benefits of implementation include shorter patient operative time and lower blood loss. There is risk that patients may suffer periprosthetic femur fractures with short nails.

### **Outcome Importance**

The consequences of using a short versus long cephalomedullary nail is unaffected for adverse events such as implant cut out, infection or implant failure. A short nail may result in less operative time and lower blood loss, and possibly lower transfusion rate.

### **Cost Effectiveness/Resource Utilization**

Shorter cephalomedullary nails generally have lower implant costs compared to long cephalomedullary nails. Additionally, shorter operative time and lower blood loss may have intangible healthcare related savings.

### **Acceptability**

There are likely a large number of surgeons who are dogmatic about the use of long cephalomedullary nails, especially in the use of unstable fracture patterns such as reverse obliquity or subtrochanteric extension fractures. Additionally, studies have not looked specifically at use of short cephalomedullary nails in these fracture patterns.

### **Feasibility**

No feasibility nor barriers foreseen

### **Future Research**

Future research with high quality studies should help elucidate short versus long in unstable intertrochanteric fracture patterns and periprosthetic fracture risk factors.



## WEIGHT BEARING

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**Following surgical treatment of hip fractures, immediate, full weight bearing to tolerance may be considered.**

**Strength of Evidence:** Limited

**Strength of Option:** Limited ★★☆☆

*Evidence from one or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention.*

### **Rationale**

Two low level retrospective studies (Atzmon 2021, Otteson 2018) compared weight-bearing as tolerated to weight bearing restrictions (partial or non-weight bearing) following intra and extra-capsular hip fractures. Both studies found higher mortality in the non-weight bearing group. Otteson (2018) performed a review of 4918 patients through the NSQIP database of over 600 US centers and found that 75% of patients were allowed to weight-bear as tolerated. They reported that 30-day mortality, length of stay, post-operative delirium, infection, transfusion rates, pneumonia, and adverse events were lower in the weight bearing as tolerated cohort with no difference between groups with return to the operating room within 30 days. However, in the study by Atzmon (2021) weight-bearing restrictions were applied based on the surgeon or therapist’s judgement of patient inability to fully bear weight due to prior functional or cognitive limitations, inadequate fixation or bone quality, or high pain level. Otteson (2018) lacked information on the surgeon’s reason for imposing restrictions, the duration for which these restrictions were imposed, or the surgeon’s criteria that were used to lift the restrictions later in the recovery. Therefore, the results are subject to substantial risk of bias by indication.

### **Benefits/ Harms of Implementation**

No studies reported adverse events and this recommendation has been adopted by ~75% of US orthopedic surgeons based on 2018 NSQIP report. Potential benefits include improved functioning and independence and reduced adverse outcomes.

### **Outcome Importance**

Patient functioning, cost of care, adverse outcomes, and mortality may be improved by further adoption of early, unrestricted weight bearing.

### **Cost Effectiveness/Resource Utilization**

Weight-bearing as tolerated does not require increased resources or costs.

### **Acceptability**

Approximately 25% of patients receive weight-bearing restrictions, indicating lack of acceptability for a substantial proportion of providers and/or patients.

### **Feasibility**

Evidence that 75% of patients are allowed to weight-bear as tolerated supports feasibility.

### **Future Research**

Inconsistent adoption highlights the need for larger, prospective, multi-institutional longitudinal studies. Future research should endeavor to specify the reasons for weight-bearing restrictions, and investigate patients’ ability to comply, as well as the relationship between restrictions and lower extremity strength, power, functional mobility.

View background material via the HipFx CPG eAppendix 1

View data summaries via the HipFx CPG eAppendix 2

# APPENDICES

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## Appendix I: References

### Introduction References

1. Tang VL, Sudore R, Cenzer IS, et al. Rates of Recovery to Pre-Fracture Function in Older Persons with Hip Fracture: an Observational Study. *J Gen Intern Med.* 2017;32(2):153-158. doi:10.1007/s11606-016-3848-2
2. Adeyemi A, Delhougne G. Incidence and Economic Burden of Intertrochanteric Fracture: A Medicare Claims Database Analysis. *JB JS Open Access.* 2019 Feb 27;4(1):e0045. doi: 10.2106/JBJS.OA.18.00045. PMID: 31161153; PMCID: PMC6510469.
3. Guzon-Illescas O, Perez Fernandez E, Crespí Villarias N, Quirós Donate FJ, Peña M, Alonso-Blas C, García-Vadillo A, Mazzucchelli R. Mortality after osteoporotic hip fracture: incidence, trends, and associated factors. *J Orthop Surg Res.* 2019 Jul 4;14(1):203. doi: 10.1186/s13018-019-1226-6. PMID: 31272470; PMCID: PMC6610901.
4. Veronese N, Maggi S. Epidemiology and social costs of hip fracture. *Injury.* 2018 Aug;49(8):1458-1460. doi: 10.1016/j.injury.2018.04.015. Epub 2018 Apr 20. PMID: 29699731.
5. Dyer SM, Crotty M, Fairhall N, Magaziner J, Beaupre LA, Cameron ID, Sherrington C; Fragility Fracture Network (FFN) Rehabilitation Research Special Interest Group. A critical review of the long-term disability outcomes following hip fracture. *BMC Geriatr.* 2016 Sep 2;16(1):158. doi: 10.1186/s12877-016-0332-0. PMID: 27590604; PMCID: PMC5010762.
6. Alexiou KI, Roushias A, Varitimidis SE, Malizos KN. Quality of life and psychological consequences in elderly patients after a hip fracture: a review. *Clin Interv Aging.* 2018 Jan 24;13:143-150. doi: 10.2147/CIA.S150067. PMID: 29416322; PMCID: PMC5790076.
7. Balasubramanian A, Zhang J, Chen L, Wenkert D, Daigle SG, Grauer A, Curtis JR. Risk of subsequent fracture after prior fracture among older women. *Osteoporos Int.* 2019 Jan;30(1):79-92. doi: 10.1007/s00198-018-4732-1. Epub 2018 Nov 19. PMID: 30456571; PMCID: PMC6332293.
8. Konda SR, Dedhia N, Ranson RA, Tong Y, Ganta A, Egol KA. Loss of Ambulatory Level and Activities of Daily Living at 1 Year Following Hip Fracture: Can We Identify Patients at Risk? *Geriatr Orthop Surg Rehabil.* 2021 Mar 31;12:21514593211002158. doi: 10.1177/21514593211002158. PMID: 33868763

## Included Literature References

1. Adams, C. I., Robinson, C. M., Court-Brown, C. M., McQueen, M. M. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for intertrochanteric fractures of the femur. *Journal of Orthopaedic Trauma* 2001; 6: 394-400
2. Aktselis, I., Kokoroghiannis, C., Fragkomichalos, E., Koundis, G., Deligeorgis, A., Daskalakis, E., Vlamis, J., Papaioannou, N. Prospective randomised controlled trial of an intramedullary nail versus a sliding hip screw for intertrochanteric fractures of the femur. *International Orthopaedics* 2014; 1: 155-61
3. Aprato, A., Audisio, A., Santoro, A., Grosso, E., Devivo, S., Berardino, M., Masse, A. Fascia-iliaca compartment block vs intra-articular hip injection for preoperative pain management in intracapsular hip fractures: A blind, randomized, controlled trial. *Injury* 2018; 12: 2203-2208
4. Ashkenazi, I., Schermann, H., Gold, A., Lin, R., Pardo, I., Steinberg, E., Sternheim, A., Snir, N. Tranexamic acid in hip hemiarthroplasty. *Injury* 2020; 11: 2658-2662
5. Atzmon, R., Drexler, M., Ohana, N., Nyska, M., Palmanovich, E., Dubin, J. The effect of postoperative weight-bearing status on mortality rate following proximal femoral fractures surgery. *Archives of Orthopaedic & Trauma Surgery* 2021; 0: 08
6. Bachrach-Lindström, M., Johansson, T., Unosson, M., Ek, A. C., Wahlström, O. Nutritional status and functional capacity after femoral neck fractures: a prospective randomized one-year follow-up study. *Aging (Milano)* 2000; 5: 366-74
7. Berggren, M., Stenvall, M., Olofsson, B., Gustafson, Y. Evaluation of a fall-prevention program in older people after femoral neck fracture: a one-year follow-up. *Osteoporosis International* 2008; 6: 801-9
8. Biber, R., Brem, M., Singler, K., Moellers, M., Sieber, C., Bail, H. J. Dorsal versus transgluteal approach for hip hemiarthroplasty: an analysis of early complications in seven hundred and four consecutive cases. *International Orthopaedics* 2012; 11: 2219-23
9. Blomfeldt, R., Törnkvist, H., Ponzer, S., Söderqvist, A., Tidermark, J. Internal fixation versus hemiarthroplasty for displaced fractures of the femoral neck in elderly patients with severe cognitive impairment. *Journal of Bone & Joint Surgery - British Volume* 2005; 4: 523-9
10. Bovbjerg, P. E., Larsen, M. S., Madsen, C. F., SchÄ,nnemann, J. Failure of short versus long cephalomedullary nail after intertrochanteric fractures. 2020; 0: 209-212
11. Cadossi, M., Chiarello, E., Savarino, L., Tedesco, G., Baldini, N., Faldini, C., Giannini, S. Erratum: A comparison of hemiarthroplasty with a novel polycarbonate- urethane acetabular component for displaced intracapsular fractures of the femoral neck: A randomised controlled trial in elderly patients (Bone and Joint Journal (2013) 95-B (609-615)). *Bone and joint journal* 2013; 11: 1582
12. Cai, L., Wang, T., Di, L., Hu, W., Wang, J. Comparison of intramedullary and extramedullary fixation of stable intertrochanteric fractures in the elderly: a prospective randomised controlled trial exploring hidden perioperative blood loss. *BMC Musculoskeletal Disorders* 2016; 1: 475
13. Calder, S. J., Anderson, G. H., Harper, W. M., Jagger, C., Gregg, P. J. A subjective health indicator for follow-up. A randomised trial after treatment of displaced intracapsular hip fractures. *Journal of Bone & Joint Surgery - British Volume* 1995; 3: 494-6
14. Calder, S. J., Anderson, G. H., Jagger, C., Harper, W. M., Gregg, P. J. Unipolar or bipolar prosthesis for displaced intracapsular hip fracture in octogenarians: a randomised prospective study. *Journal of Bone & Joint Surgery - British Volume* 1996; 3: 391-4
15. Cao, L., Wang, B., Li, M., Song, S., Weng, W., Li, H., Su, J. Closed reduction and internal fixation versus total hip arthroplasty for displaced femoral neck fracture. *Chinese Journal of Traumatology* 2014; 2: 63-8
16. Carson, J. L., Sieber, F., Cook, D. R., Hoover, D. R., Noveck, H., Chaitman, B. R., Fleisher, L., Beaupre, L., Macaulay, W., Rhoads, G. G., Paris, B., Zagorin, A., Sanders, D. W., Zakriya, K. J., Magaziner, J. Liberal versus restrictive blood transfusion strategy: 3-year survival and cause of death results from the FOCUS randomised controlled trial. *Lancet* 2015; 9974: 1183-9

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View data summaries via the HipFx CPG eAppendix 2

17. Carson, J. L., Terrin, M. L., Noveck, H., Sanders, D. W., Chaitman, B. R., Rhoads, G. G., Nemo, G., Dragert, K., Beaupre, L., Hildebrand, K., Macaulay, W., Lewis, C., Cook, D. R., Dobbin, G., Zakriya, K. J., Apple, F. S., Horney, R. A., Magaziner, J. Liberal or restrictive transfusion in high-risk patients after hip surgery. *New England Journal of Medicine* 2011; 26: 2453-62
18. Carulli, C., Piacentini, F., Paoli, T., Civinini, R., Innocenti, M. A comparison of two fixation methods for femoral trochanteric fractures: A new generation intramedullary system vs sliding hip screw. *Clinical cases in mineral and bone metabolism* 2017; 1: 40-47
19. Cha, Y. H., Lee, Y. K., Koo, K. H., Wi, C., Lee, K. H. Difference in Mortality Rate by Type of Anticoagulant in Elderly Patients with Cardiovascular Disease after Hip Fractures. *Clinics in Orthopedic Surgery* 2019; 1: 15-20
20. Chammout, G. K., Mukka, S. S., Carlsson, T., Neander, G. F., Stark, A. W., Skoldenberg, O. G. Total hip replacement versus open reduction and internal fixation of displaced femoral neck fractures: a randomized long-term follow-up study. *Journal of Bone & Joint Surgery - American Volume* 2012; 21: 1921-8
21. Chammout, G., Kelly-Pettersson, P., Hedbeck, C. J., Stark, A., Mukka, S., Skoldenberg, O. HOPE-Trial: Hemiarthroplasty Compared with Total Hip Arthroplasty for Displaced Femoral Neck Fractures in Octogenarians: A Randomized Controlled Trial. *JB & JS Open Access* 2019; 2: e0059
22. Chammout, G., Muren, O., Laurencikas, E., Bodens, H., Kelly-Pettersson, P., Sjo, H., Stark, A., Skoldenberg, O. More complications with uncemented than cemented femoral stems in total hip replacement for displaced femoral neck fractures in the elderly: a single-blinded, randomized controlled trial with 69 patients. *Acta Orthopaedica* 2016; 0: 1â?çek7
23. Chechik, O., Amar, E., Khashan, M., Kadar, A., Rosenblatt, Y., Maman, E. In support of early surgery for hip fractures sustained by elderly patients taking clopidogrel: a retrospective study. *Drugs & Aging* 2012; 1: 63-8
24. Chen, F., Jiang, Z., Li, M., Zhu, X. Efficacy and safety of perioperative tranexamic acid in elderly patients undergoing trochanteric fracture surgery: a randomised controlled trial. *Hong Kong Medical Journal* 2019; 2: 120-126
25. Clemmesen, C. G., Lunn, T. H., Kristensen, M. T., Palm, H., Foss, N. B. Effect of a single pre-operative 125 mg dose of methylprednisolone on postoperative delirium in hip fracture patients; a randomised, double-blind, placebo-controlled trial. *Anaesthesia* 2018; 11: 1353-1360
26. Cooper, A. L., Nagree, Y., Goudie, A., Watson, P. R., Arendts, G. Ultrasound-guided femoral nerve blocks are not superior to ultrasound-guided fascia iliaca blocks for fractured neck of femur. 2019; 3: 393-398
27. Crotty, M., Killington, M., Liu, E., Cameron, I. D., Kurrle, S., Kaambwa, B., Davies, O., Miller, M., Chehade, M., Ratcliffe, J. Should we provide outreach rehabilitation to very old people living in Nursing Care Facilities after a hip fracture? A randomised controlled trial. *Age & Ageing* 2019; 3: 373-380
28. Davis, F. M., Laurenson, V. G. Spinal anaesthesia or general anaesthesia for emergency hip surgery in elderly patients. *Anaesth Intensive Care* 1981; 4: 352-8
29. Davison, J. N., Calder, S. J., Anderson, G. H., Ward, G., Jagger, C., Harper, W. M., Gregg, P. J. Treatment for displaced intracapsular fracture of the proximal femur. A prospective, randomised trial in patients aged 65 to 79 years. *Journal of Bone & Joint Surgery - British Volume* 2001; 2: 206-12
30. Deangelis, J. P., Ademi, A., Staff, I., Lewis, C. G. Cemented versus uncemented hemiarthroplasty for displaced femoral neck fractures: a prospective randomized trial with early follow-up. *Journal of Orthopaedic Trauma* 2012; 3: 135-40
31. Desteli, E. E., Imren, Y., Erdogan, M., Aydagun, O. Quality of Life Following Treatment of Trochanteric Fractures with Proximal Femoral Nail versus Cementless Bipolar Hemiarthroplasty in Elderly. *Clinical & Investigative Medicine - Medecine Clinique et Experimentale* 2015; 2: E63-72
32. Dolatowski, F. C., Frihagen, F., Bartels, S., Opland, V., Saltyte Benth, J., Talsnes, O., Hoelsbrekken, S. E., Utvag, S. E. Screw Fixation Versus Hemiarthroplasty for Nondisplaced Femoral Neck Fractures in Elderly Patients: A Multicenter Randomized Controlled Trial. *Journal of Bone & Joint Surgery - American Volume* 2019; 2: 136-144

33. Drakos, A., Raoulis, V., Karatzios, K., Doxariotis, N., Kontogeorgakos, V., Malizos, K., Varitimidis, S. E. Efficacy of Local Administration of Tranexamic Acid for Blood Salvage in Patients Undergoing Intertrochanteric Fracture Surgery. *Journal of Orthopaedic Trauma* 2016; 8: 409-14
34. Duncan, D. G., Beck, S. J., Hood, K., Johansen, A. Using dietetic assistants to improve the outcome of hip fracture: a randomised controlled trial of nutritional support in an acute trauma ward. *Age & Ageing* 2006; 2: 148-53
35. El-Abed, K., McGuinness, A., Brunner, J., DalloVedova, P., O'Connor, P., Kennedy, J. G. Comparison of outcomes following uncemented hemiarthroplasty and dynamic hip screw in the treatment of displaced subcapital hip fractures in patients aged greater than 70 years. *Acta Orthopaedica Belgica* 2005; 1: 48-54
36. Elliott, J., Beringer, T., Kee, F., Marsh, D., Willis, C., Stevenson, M. Predicting survival after treatment for fracture of the proximal femur and the effect of delays to surgery. *Journal of Clinical Epidemiology* 2003; 8: 788-95
37. Endo, J., Yamaguchi, S., Saito, M., Itabashi, T., Kita, K., Koizumi, W., Kawaguchi, Y., Asaka, T., Saegusa, O. Efficacy of preoperative skin traction for hip fractures: a single-institution prospective randomized controlled trial of skin traction versus no traction. *Journal of Orthopaedic Science* 2013; 2: 250-5
38. Ergenoglu, P., Akin, S., Bali, C., Eker, H. E., Yalcin Cok, O., Aribogan, A. Effect of low dose dexmedetomidine premedication on propofol consumption in geriatric end stage renal disease patients. *Brazilian Journal of Anesthesiology* 2015; 5: 326-32
39. Eskeland, G., Solheim, K., Skjörten, F. Anticoagulant prophylaxis, thromboembolism and mortality in elderly patients with hip fractures. A controlled clinical trial. *Acta Chir Scand* 1966; 1: 16-29
40. Fernandez, M. A., Aquilina, A., Achten, J., Parsons, N., Costa, M. L., Griffin, X. L. The tip-apex distance in the X-Bolt dynamic plating system. 2017; 4: 204-207
41. Figved, W., Opland, V., Frihagen, F., Jervidal, T., Madsen, J. E., Nordsletten, L. Cemented versus uncemented hemiarthroplasty for displaced femoral neck fractures. 2009; 9: 2426-35
42. Frihagen, F., Nordsletten, L., Madsen, J. E. Hemiarthroplasty or internal fixation for intracapsular displaced femoral neck fractures: randomised controlled trial. *BMJ* 2007; 7632: 1251-4
43. Frisch, N. B., Nahm, N. J., Khalil, J. G., Les, C. M., Guthrie, S. T., Charters, M. A. Short Versus Long Cephalomedullary Nails for Pertrochanteric Hip Fracture. *Orthopedics* 2017; 2: 83-88
44. Godoy Monzón, D., Vazquez, J., Jauregui, J. R., Iserson, K. V. Pain treatment in post-traumatic hip fracture in the elderly: regional block vs. systemic non-steroidal analgesics. *Int J Emerg Med* 2010; 4: 321-5
45. Goh, E. L., Gurung, P. K., Ma, S., Pilpel, T., Dale, J. H., Kannan, A., Anand, S. Direct Oral Anticoagulants in the Prevention of Venous Thromboembolism Following Surgery for Hip Fracture in Older Adults: A Population-Based Cohort Study. *Geriatric Orthopaedic Surgery & Rehabilitation* 2020; 0: 2151459319897520
46. Gorodetskiy, I. G., Gorodnichenko, A. I., Tursin, P. S., Reshetnyak, V. K., Uskov, O. N. Non-invasive interactive neurostimulation in the post-operative recovery of patients with a trochanteric fracture of the femur. A randomised, controlled trial. *Journal of Bone & Joint Surgery - British Volume* 2007; 11: 1488-94
47. Gregersen, M. Postoperative red blood cell transfusion strategy in frail anemic elderly with hip fracture. A randomized controlled trial. *Danish Medical Journal* 2016; 4:
48. Gregersen, M., Borris, L. C., Damsgaard, E. M. Blood transfusion and overall quality of life after hip fracture in frail elderly patients--the transfusion requirements in frail elderly randomized controlled trial. *Journal of the American Medical Directors Association* 2015; 9: 762-6
49. Griffin, X. L., Parsons, N., McArthur, J., Achten, J., Costa, M. L. The Warwick Hip Trauma Evaluation One: a randomised pilot trial comparing the X-Bolt Dynamic Hip Plating System with sliding hip screw fixation in complex extracapsular hip fractures: WHiTE (One). *Bone & Joint Journal* 2016; 5: 686-9
50. Gruber-Baldini, A. L., Marcantonio, E., Orwig, D., Magaziner, J., Terrin, M., Barr, E., Brown, J. P., Paris, B., Zagorin, A., Roffey, D. M., Zakriya, K., Blute, M. R., Hebel, J. R., Carson, J. L. Delirium

- outcomes in a randomized trial of blood transfusion thresholds in hospitalized older adults with hip fracture. *Journal of the American Geriatrics Society* 2013; 8: 1286-95
51. Guo, X. F., Zhang, K. M., Fu, H. B., Cao, W., Dong, Q. A comparative study of the therapeutic effect between long and short intramedullary nails in the treatment of intertrochanteric femur fractures in the elderly. *Chinese Journal of Traumatology* 2015; 6: 332-5
  52. Haghghi, M., Sedighinejad, A., Nabi, B. N., Mardani-Kivi, M., Tehran, S. G., Mirfazli, S. A., Mirbolook, A., Saheli, N. A. Is Spinal Anesthesia with Low Dose Lidocaine Better than Sevoflurane Anesthesia in Patients Undergoing Hip Fracture Surgery. 2017; 4: 226-230
  53. Hardy, D. C., Descamps, P. Y., Krallis, P., Fabeck, L., Smets, P., Bertens, C. L., Delince, P. E. Use of an intramedullary hip-screw compared with a compression hip-screw with a plate for intertrochanteric femoral fractures. A prospective, randomized study of one hundred patients. *Journal of Bone & Joint Surgery - American Volume* 1998; 5: 618-30
  54. Health Investigators, Bhandari, M., Einhorn, T. A., Guyatt, G., Schemitsch, E. H., Zura, R. D., Sprague, S., Frihagen, F., Guerra-Farfan, E., Kleinlugtenbelt, Y. V., Poolman, R. W., Rangan, A., Bzovsky, S., Heels-Ansdell, D., Thabane, L., Walter, S. D., Devereaux, P. J. Total Hip Arthroplasty or Hemiarthroplasty for Hip Fracture. *New England Journal of Medicine* 2019; 23: 2199-2208
  55. Hedbeck, C. J., Blomfeldt, R., Lapidus, G., Törnkvist, H., Ponzer, S., Tidermark, J. Unipolar hemiarthroplasty versus bipolar hemiarthroplasty in the most elderly patients with displaced femoral neck fractures: a randomised, controlled trial. *International Orthopaedics* 2011; 11: 1703-11
  56. Hedbeck, C. J., Enocson, A., Lapidus, G., Blomfeldt, R., Törnkvist, H., Ponzer, S., Tidermark, J. Comparison of bipolar hemiarthroplasty with total hip arthroplasty for displaced femoral neck fractures: a concise four-year follow-up of a randomized trial. *Journal of Bone & Joint Surgery - American Volume* 2011; 5: 445-50
  57. Heltne, M., Saltvedt, I., Lydersen, S., Prestmo, A., Sletvold, O., Spigset, O. Patterns of drug prescriptions in an orthogeriatric ward as compared to orthopaedic ward: results from the Trondheim Hip Fracture Trial-a randomised clinical trial. *European Journal of Clinical Pharmacology* 2017; 8: 937-947
  58. Horner, N. S., Samuelsson, K., Solyom, J., Bjorgul, K., Ayeni, O. R., Ostman, B. Implant-Related Complications and Mortality After Use of Short or Long Gamma Nail for Intertrochanteric and Subtrochanteric Fractures: A Prospective Study with Minimum 13-Year Follow-up. *JB & JS Open Access* 2017; 3: e0026
  59. Hossain, F. S., Rambani, R., Ribee, H., Koch, L. Is discontinuation of clopidogrel necessary for intracapsular hip fracture surgery? Analysis of 102 hemiarthroplasties. *Journal of Orthopaedics & Traumatology* 2013; 3: 171-7
  60. Huusko, T. M., Karppi, P., Avikainen, V., Kautiainen, H., Sulkava, R. Intensive geriatric rehabilitation of hip fracture patients: a randomized, controlled trial. *Acta Orthop Scand* 2002; 4: 425-31
  61. Huusko, T. M., Karppi, P., Avikainen, V., Kautiainen, H., Sulkava, R. Randomised, clinically controlled trial of intensive geriatric rehabilitation in patients with hip fracture: subgroup analysis of patients with dementia. *BMJ* 2000; 7269: 1107-11
  62. Inngul, C., Blomfeldt, R., Ponzer, S., Enocson, A. Cemented versus uncemented arthroplasty in patients with a displaced fracture of the femoral neck: a randomised controlled trial. *Bone & Joint Journal* 2015; 11: 1475-80
  63. Inngul, C., Hedbeck, C. J., Blomfeldt, R., Lapidus, G., Ponzer, S., Enocson, A. Unipolar hemiarthroplasty versus bipolar hemiarthroplasty in patients with displaced femoral neck fractures: a four-year follow-up of a randomised controlled trial. *International Orthopaedics* 2013; 12: 2457-64
  64. Iorio, R., Iannotti, F., Mazza, D., Speranza, A., Massafra, C., Guzzini, M., D'Arrigo, C., Ferretti, A. Is dual cup mobility better than hemiarthroplasty in patients with dementia and femoral neck fracture? A randomized controlled trial. *Sicotj* 2019; 0: 38
  65. Jianbo, J., Ying, J., Xinxin, L., Lianghao, W., Baoqing, Y., Rongguang, A. Hip hemiarthroplasty for senile femoral neck fractures: Minimally invasive SuperPath approach versus traditional posterior approach. *Injury* 2019; 8: 1452-1459

66. Johansson, T. Internal fixation compared with total hip replacement for displaced femoral neck fractures: a minimum fifteen-year follow-up study of a previously reported randomized trial. *Journal of Bone & Joint Surgery - American Volume* 2014; 6: e46
67. Johansson, T., Bachrach-Lindström, M., Aspenberg, P., Jonsson, D., Wahlström, O. The total costs of a displaced femoral neck fracture: comparison of internal fixation and total hip replacement. A randomised study of 146 hips. *International Orthopaedics* 2006; 1: 1-6
68. Johansson, T., Jacobsson, S. A., Ivarsson, I., Knutsson, A., Wahlström, O. Internal fixation versus total hip arthroplasty in the treatment of displaced femoral neck fractures: a prospective randomized study of 100 hips. *Acta Orthop Scand* 2000; 6: 597-602
69. Johansson, T., Risto, O., Knutsson, A., Wahlström, O. Heterotopic ossification following internal fixation or arthroplasty for displaced femoral neck fractures: a prospective randomized study. *International Orthopaedics* 2001; 4: 223-5
70. Jolly, A., Bansal, R., More, A. R., Pagadala, M. B. Comparison of complications and functional results of unstable intertrochanteric fractures of femur treated with proximal femur nails and cemented hemiarthroplasty. 2019; 2: 296-301
71. Jørgensen, P. S., Knudsen, J. B., Broeng, L., Josephsen, L., Bjerregaard, P., Hagen, K., Jørgensen, P. K., Tørholm, C. The thromboprophylactic effect of a low-molecular-weight heparin (Fragmin) in hip fracture surgery. A placebo-controlled study. 1992; 278: 95-100
72. Jørgensen, Per Seest, Strandberg, Charlotte, Wille-Jørgensen, Peer, Tørholm, Carsten, Neergaard, Kirsten, Paaske, Birgit P., Rasmussen, Søren W., Christensen, Steen W., Mantoni, Margit, Thamsen, Hanne Early Preoperative Thromboprophylaxis with Klexane® in Hip Fracture Surgery: A Placebo-Controlled Study. *Clinical and Applied Thrombosis/Hemostasis* 1998; 2: 140-142
73. Kang, H., Ha, Y. C., Kim, J. Y., Woo, Y. C., Lee, J. S., Jang, E. C. Effectiveness of multimodal pain management after bipolar hemiarthroplasty for hip fracture: a randomized, controlled study. *Journal of Bone & Joint Surgery - American Volume* 2013; 4: 291-6
74. Kanto, K., Sihvonen, R., Eskelinen, A., Laitinen, M. Uni- and bipolar hemiarthroplasty with a modern cemented femoral component provides elderly patients with displaced femoral neck fractures with equal functional outcome and survivorship at medium-term follow-up. *Archives of Orthopaedic & Trauma Surgery* 2014; 9: 1251-9
75. Keating, J. F., Grant, A., Masson, M., Scott, N. W., Forbes, J. F. Displaced intracapsular hip fractures in fit, older people: a randomised comparison of reduction and fixation, bipolar hemiarthroplasty and total hip arthroplasty. *Health Technology Assessment (Winchester, England)* 2005; 41: iii-iv, ix-x, 1-65
76. Kenzora, J. E., Magaziner, J., Hudson, J., Hebel, J. R., Young, Y., Hawkes, W., Felsenthal, G., Zimmerman, S. I., Provenzano, G. Outcome after hemiarthroplasty for femoral neck fractures in the elderly. 1998; 348: 51-8
77. Khan, A. M., Anwar, S. F., Hafeez, S. Clinical outcome of cemented bipolar hemiarthroplasty versus Austin Moore hemiarthroplasty for displaced intracapsular fractures of hip in terms of anterior thigh pain in elderly. *JPMA - Journal of the Pakistan Medical Association* 2015; 11: S49-51
78. Kulachote, N., Sa-Ngasoongsong, P., Sirisreetreerux, N., Wongsak, S., Suphachatwong, C., Wajanavisit, W., Kawinwonggowit, V. The Impacts of Early Hip Surgery in High-Risk Elderly Taking Antithrombotic Agents and Afflicted with Intertrochanteric Fracture. *Journal of the Medical Association of Thailand* 2015; 0: S76-81
79. Kwak, D. K., Jang, C. Y., Kim, D. H., Rhyu, S. H., Hwang, J. H., Yoo, J. H. Topical tranexamic acid in elderly patients with femoral neck fractures treated with hemiarthroplasty: efficacy and safety? - a case-control study. *BMC Musculoskeletal Disorders* 2019; 1: 228
80. Langslet, E., Frihagen, F., Opland, V., Madsen, J. E., Nordsletten, L., Figved, W. Cemented versus uncemented hemiarthroplasty for displaced femoral neck fractures: 5-year followup of a randomized trial. *Clinical Orthopaedics & Related Research* 2014; 4: 1291-9
81. Lee, C., Freeman, R., Edmondson, M., Rogers, B. A. The efficacy of tranexamic acid in hip hemiarthroplasty surgery: an observational cohort study. *Injury* 2015; 10: 1978-82
82. Lei, J., Zhang, B., Cong, Y., Zhuang, Y., Wei, X., Fu, Y., Wei, W., Wang, P., Wen, S., Huang, H., Wang, H., Han, S., Liu, S., Zhang, K. Tranexamic acid reduces hidden blood loss in the treatment of

- intertrochanteric fractures with PFNA: a single-center randomized controlled trial. *Journal of Orthopaedic Surgery* 2017; 1: 124
83. Leung, K. S., So, W. S., Shen, W. Y., Hui, P. W. Gamma nails and dynamic hip screws for peritrochanteric fractures. A randomised prospective study in elderly patients. *Journal of Bone & Joint Surgery - British Volume* 1992; 3: 345-51
  84. Li, H., Wang, Q., Dai, G. G., Peng, H. PFNA vs. DHS helical blade for elderly patients with osteoporotic femoral intertrochanteric fractures. *European Review for Medical & Pharmacological Sciences* 2018; 1: 1-7
  85. Li, J., Xiao, J., Zhang, Z., Jia, F., Wu, Z. A Novel Fast Mobile-Window Small Incision Technique for Hip Arthroplasty in the Elderly and Comparison with Conventional Incision. *Medical Science Monitor* 2017; 0: 3303-3310
  86. Liu, J., Frisch, N. B., Mehran, N., Qatu, M., Guthrie, S. T. Short-term Medical Complications Following Short Versus Long Cephalomedullary Nails. *Orthopedics* 2018; 5: e636-e642
  87. Lu, Q., Tang, G., Zhao, X., Guo, S., Cai, B., Li, Q. Hemiarthroplasty versus internal fixation in super-aged patients with undisplaced femoral neck fractures: a 5-year follow-up of randomized controlled trial. *Archives of Orthopaedic & Trauma Surgery* 2017; 1: 27-35
  88. Ma, H., Wang, H., Long, X., Xu, Z., Chen, X., Li, M., He, T., Wang, W., Liu, L., Liu, X. Early intravenous tranexamic acid intervention reduces post-traumatic hidden blood loss in elderly patients with intertrochanteric fracture: a randomized controlled trial. *Journal of Orthopaedic Surgery* 2021; 1: 106
  89. Ma, Y., Wu, J., Xue, J., Lan, F., Wang, T. Ultrasound-guided continuous fascia iliaca compartment block for pre-operative pain control in very elderly patients with hip fracture: A randomized controlled trial. *Experimental & Therapeutic Medicine* 2018; 3: 1944-1952
  90. Maalouly, J., Tawk, A., Ayoubi, R., Al Rahbani, G. K., Metri, A., Saidy, E., El-Hajj, G., Nehme, A. Efficacy of the Combined Administration of Systemic and Intra-Articular Tranexamic Acid in Total Hip Arthroplasty Secondary to Femoral Neck Fracture: A Retrospective Study. *Advances in Orthopedics* 2020; 0:
  91. Maheshwari, R., Acharya, M., Monda, M., Pandey, R. Factors influencing mortality in patients on antiplatelet agents presenting with proximal femoral fractures. 2011; 3: 314-6
  92. Majumdar, S. R., Beaupre, L. A., Harley, C. H., Hanley, D. A., Lier, D. A., Jubly, A. G., Maksymowych, W. P., Cinats, J. G., Bell, N. R., Morrish, D. W. Use of a case manager to improve osteoporosis treatment after hip fracture: results of a randomized controlled trial. *Archives of Internal Medicine* 2007; 19: 2110-5
  93. Manning, B. J., O'Brien, N., Aravindan, S., Cahill, R. A., McGreal, G., Redmond, H. P. The effect of aspirin on blood loss and transfusion requirements in patients with femoral neck fractures. *Injury* 2004; 2: 121-4
  94. Marcantonio, E. R., Flacker, J. M., Wright, R. J., Resnick, N. M. Reducing delirium after hip fracture: a randomized trial. *Journal of the American Geriatrics Society* 2001; 5: 516-22
  95. Matot, I., Oppenheim-Eden, A., Ratrot, R., Baranova, J., Davidson, E., Eylon, S., Peyser, A., Liebergall, M. Preoperative cardiac events in elderly patients with hip fracture randomized to epidural or conventional analgesia. *Anesthesiology* 2003; 1: 156-63
  96. McGuire, K. J., Bernstein, J., Polsky, D., Silber, J. H. The 2004 Marshall Urist award: delays until surgery after hip fracture increases mortality. 2004; 428: 294-301
  97. McKenzie, P. J., Wishart, H. Y., Smith, G. Long-term outcome after repair of fractured neck of femur. Comparison of subarachnoid and general anaesthesia. *British Journal of Anaesthesia* 1984; 6: 581-5
  98. Miedel, R., Ponzer, S., Törnkvist, H., Söderqvist, A., Tidermark, J. The standard Gamma nail or the Medoff sliding plate for unstable trochanteric and subtrochanteric fractures. A randomised, controlled trial. *Journal of Bone & Joint Surgery - British Volume* 2005; 1: 68-75
  99. Moerman, S., Mathijssen, N. M. C., Niesten, D. D., Riedijk, R., Rijnberg, W. J., Koeter, S., Kremers van de Hei, K., Tuinebreijer, W. E., Molenaar, T. L., Nelissen, Rghh, Vochteloo, A. J. H. More complications in uncemented compared to cemented hemiarthroplasty for displaced femoral neck



- fractures: a randomized controlled trial of 201 patients, with one year follow-up. *BMC Musculoskeletal Disorders* 2017; 1: 169
100. Moppett, I. K., Rowlands, M., Mannings, A., Moran, C. G., Wiles, M. D., Notts Investigators LiDCO-based fluid management in patients undergoing hip fracture surgery under spinal anaesthesia: a randomized trial and systematic review. *British Journal of Anaesthesia* 2015; 3: 444-59
  101. Moran, C. G., Wenn, R. T., Sikand, M., Taylor, A. M. Early mortality after hip fracture: is delay before surgery important?. *Journal of Bone & Joint Surgery - American Volume* 2005; 3: 483-9
  102. Morris, G. K., Mitchell, J. R. Warfarin sodium in prevention of deep venous thrombosis and pulmonary embolism in patients with fractured neck of femur. *Lancet* 1976; 7991: 869-72
  103. Morrison, R. S., Dickman, E., Hwang, U., Akhtar, S., Ferguson, T., Huang, J., Jeng, C. L., Nelson, B. P., Rosenblatt, M. A., Silverstein, J. H., Strayer, R. J., Torrillo, T. M., Todd, K. H. Regional Nerve Blocks Improve Pain and Functional Outcomes in Hip Fracture: A Randomized Controlled Trial. *Journal of the American Geriatrics Society* 2016; 12: 2433-2439
  104. Mouzopoulos, G., Stamatakos, M., Arabatzi, H., Vasiliadis, G., Batanis, G., Tsembeli, A., Tzurbakis, M., Safioleas, M. The four-year functional result after a displaced subcapital hip fracture treated with three different surgical options. *International Orthopaedics* 2008; 3: 367-73
  105. Mouzopoulos, G., Vasiliadis, G., Lasanianos, N., Nikolaras, G., Morakis, E., Kaminaris, M. Fascia iliaca block prophylaxis for hip fracture patients at risk for delirium: a randomized placebo-controlled study. *J Orthop Traumatol* 2009; 3: 127-33
  106. Movrin, I. Cemented versus uncemented hemiarthroplasty for displaced femoral neck fractures: A randomized controlled trial with two years follow-up. *Acta Orthopaedica et Traumatologica Turcica* 2020; 1: 83-88
  107. Naglie, G., Tansey, C., Kirkland, J. L., Ogilvie-Harris, D. J., Detsky, A. S., Etchells, E., Tomlinson, G., O'Rourke, K., Goldlist, B. Interdisciplinary inpatient care for elderly people with hip fracture: A randomized controlled trial. 2002; 1: 25-32
  108. Needoff, M., Radford, P., Langstaff, R. Preoperative traction for hip fractures in the elderly: a clinical trial. *Injury* 1993; 5: 317-8
  109. Newman, B., McCarthy, L., Thomas, P. W., May, P., Layzell, M., Horn, K. A comparison of preoperative nerve stimulator-guided femoral nerve block and fascia iliaca compartment block in patients with a femoral neck fracture. *Anaesthesia* 2013; 9: 899-903
  110. Nie, H., Yang, Y. X., Wang, Y., Liu, Y., Zhao, B., Luan, B. Effects of continuous fascia iliaca compartment blocks for postoperative analgesia in patients with hip fracture. *Pain Research & Management* 2015; 4: 210-2
  111. Novack, V., Jotkowitz, A., Etzion, O., Porath, A. Does delay in surgery after hip fracture lead to worse outcomes? A multicenter survey. *International Journal for Quality in Health Care* 2007; 3: 170-6
  112. Olsson, L. E., Karlsson, J., Ekman, I. Effects of nursing interventions within an integrated care pathway for patients with hip fracture. *Journal of Advanced Nursing* 2007; 2: 116-125
  113. Orosz, G. M., Magaziner, J., Hannan, E. L., Morrison, R. S., Koval, K., Gilbert, M., McLaughlin, M., Halm, E. A., Wang, J. J., Litke, A., Silberzweig, S. B., Siu, A. L. Association of timing of surgery for hip fracture and patient outcomes. *JAMA* 2004; 14: 1738-43
  114. Ottesen, T. D., McLynn, R. P., Galivanche, A. R., Bagi, P. S., Zogg, C. K., Rubin, L. E., Grauer, J. N. Increased complications in geriatric patients with a fracture of the hip whose postoperative weight-bearing is restricted: an analysis of 4918 patients. *Bone & Joint Journal* 2018; 10: 1377-1384
  115. Papisimos, S., Koutsojannis, C. M., Panagopoulos, A., Megas, P., Lambiris, E. A randomised comparison of AMBI, TGN and PFN for treatment of unstable trochanteric fractures. *Archives of Orthopaedic & Trauma Surgery* 2005; 7: 462-8
  116. Parker, M. J. Lateral versus posterior approach for insertion of hemiarthroplasties for hip fractures: A randomised trial of 216 patients. *Injury* 2015; 6: 1023-7
  117. Parker, M. J. Randomised trial of blood transfusion versus a restrictive transfusion policy after hip fracture surgery. *Injury* 2013; 12: 1916-8
  118. Parker, M. J., Cawley, S. Cemented or uncemented hemiarthroplasty for displaced intracapsular fractures of the hip: a randomized trial of 400 patients. *Bone & Joint Journal* 2020; 1: 11-16

119. Parker, M. J., Cawley, S. Treatment of the displaced intracapsular fracture for the 'fitter' elderly patients: A randomised trial of total hip arthroplasty versus hemiarthroplasty for 105 patients. *Injury* 2019; 11: 2009-2013
120. Parker, M. J., Griffiths, R. General versus regional anaesthesia for hip fractures. A pilot randomised controlled trial of 322 patients. *Injury* 2015; 8: 1562-6
121. Parker, M. J., Khan, R. J., Crawford, J., Pryor, G. A. Hemiarthroplasty versus internal fixation for displaced intracapsular hip fractures in the elderly. A randomised trial of 455 patients. *Journal of Bone & Joint Surgery - British Volume* 2002; 8: 1150-5
122. Parker, M. J., Pryor, G. A. The timing of surgery for proximal femoral fractures. *Journal of Bone & Joint Surgery - British Volume* 1992; 2: 203-5
123. Parker, M. J., Pryor, G., Gurusamy, K. Hemiarthroplasty versus internal fixation for displaced intracapsular hip fractures: a long-term follow-up of a randomised trial. *Injury* 2010; 4: 370-3
124. Parras, T., Blanco, R. Randomised trial comparing the transversus abdominis plane block posterior approach or quadratus lumborum block type I with femoral block for postoperative analgesia in femoral neck fracture, both ultrasound-guided. *Revista Espanola de Anestesiologia y Reanimacion* 2016; 3: 141-8
125. Phruetthiphat, O. A., Lawanprasert, A., Khuangsirikul, S., Heebtamai, D., Chotanaphuti, T. Effectiveness of Periarticular Injection After Bipolar Hemiarthroplasty for Displaced Femoral Neck Fracture in Elderly Patients: A Double Blinded Randomized, Controlled Study. *Journal of Arthroplasty* 2021; 0: 16
126. Prestmo, A., Hagen, G., Sletvold, O., Helbostad, J. L., Thingstad, P., Taraldsen, K., Lydersen, S., Halsteinli, V., Saltnes, T., Lamb, S. E., Johnsen, L. G., Saltvedt, I. Comprehensive geriatric care for patients with hip fractures: a prospective, randomised, controlled trial. *Lancet* 2015; 9978: 1623-33
127. Prevention of pulmonary embolism and deep vein thrombosis with low dose aspirin: Pulmonary Embolism Prevention (PEP) trial. *Lancet* 2000; 9212: 1295-302
128. Radcliff, T. A., Henderson, W. G., Stoner, T. J., Khuri, S. F., Dohm, M., Hutt, E. Patient risk factors, operative care, and outcomes among older community-dwelling male veterans with hip fracture. *Journal of Bone & Joint Surgery - American Volume* 2008; 1: 34-42
129. Rai, S., Gupta, T. P., Kashid, M., Nath, S. K., Shaki, O. DO VARIOUS LENGTHS of PROXIMAL FEMORAL NAIL HAVE ANY EFFECT on FRACTURE UNION in A TROCHANTERIC FRACTURE in ELDERLY?. *Journal of Musculoskeletal Research* 2020; 0:
130. Raia, F. J., Chapman, C. B., Herrera, M. F., Schweppe, M. W., Michelsen, C. B., Rosenwasser, M. P. Unipolar or bipolar hemiarthroplasty for femoral neck fractures in the elderly?. *Clinical orthopaedics and related research* 2003; 414: 259-265
131. Raval, P., Ramasamy, A., Raza, H., Khan, K., Awan, N. Comparison of short vs long anti-rotation in treating trochanteric fractures. *Malaysian Orthopaedic Journal* 2016; 1: 22-28
132. Ravikumar, K. J., Marsh, G. Internal fixation versus hemiarthroplasty versus total hip arthroplasty for displaced subcapital fractures of femur--13 year results of a prospective randomised study. *Injury* 2000; 10: 793-7
133. Reindl, R., Harvey, E. J., Berry, G. K., Rahme, E., Canadian Orthopaedic Trauma, Society Intramedullary Versus Extramedullary Fixation for Unstable Intertrochanteric Fractures: A Prospective Randomized Controlled Trial. *Journal of Bone & Joint Surgery - American Volume* 2015; 23: 1905-12
134. Ren, C., Guo, J., Gao, Y. Comparison of total hip arthroplasty and hemiarthroplasty in elderly patients with femoral neck fracture. *Biomedical research (india)* 2017; 16: 7127-7130
135. Repantis, T., Bouras, T., Korovessis, P. Comparison of minimally invasive approach versus conventional anterolateral approach for total hip arthroplasty: a randomized controlled trial. *European journal of orthopaedic surgery & traumatologie* 2015; 1: 111-6
136. Resch, S., Bjärnetoft, B., Thorngren, K. G. Preoperative skin traction or pillow nursing in hip fractures: a prospective, randomized study in 123 patients. *Disability & Rehabilitation* 2005; 18: 1191-5

137. Resch, S., Thorngren, K. G. Preoperative traction for hip fracture: a randomized comparison between skin and skeletal traction in 78 patients. *Acta Orthop Scand* 1998; 3: 277-9
138. Rödén, M., Schön, M., Fredin, H. Treatment of displaced femoral neck fractures: a randomized minimum 5-year follow-up study of screws and bipolar hemiprostheses in 100 patients. *Acta Orthop Scand* 2003; 1: 42-4
139. Rogmark, C., Carlsson, A., Johnell, O., Sernbo, I. A prospective randomised trial of internal fixation versus arthroplasty for displaced fractures of the neck of the femur. Functional outcome for 450 patients at two years. *Journal of Bone & Joint Surgery - British Volume* 2002; 2: 183-8
140. Rosen, J. E., Chen, F. S., Hiebert, R., Koval, K. J. Efficacy of preoperative skin traction in hip fracture patients: a prospective, randomized study. *Journal of Orthopaedic Trauma* 2001; 2: 81-5
141. Rowlands, M., Walt, G. V., Bradley, J., Mannings, A., Armstrong, S., Bedford, N., Moppett, I. K., Sahota, O. Femoral Nerve Block Intervention in Neck of Femur Fracture (FINOF): a randomised controlled trial. *BMJ Open* 2018; 4: e019650
142. Sanders, D., Bryant, D., Tieszer, C., Lawendy, A. R., MacLeod, M., Papp, S., Liew, A., Viskontas, D., Coles, C., Gurr, K., Carey, T., Gofton, W., Bailey, C., Bartley, D., Trenholm, A., Stone, T., Leighton, R., Foxall, J., Zomar, M., Trask, K. A Multicenter Randomized Control Trial Comparing a Novel Intramedullary Device (InterTAN) Versus Conventional Treatment (Sliding Hip Screw) of Geriatric Hip Fractures. *Journal of Orthopaedic Trauma* 2017; 1: 1-8
143. Santini, S., Rebecato, A., Bolgan, I., Turi, G. Hip fractures in elderly patients treated with bipolar hemiarthroplasty: comparison between cemented and cementless implants. *Journal of Orthopaedics and Traumatology* 2005; 2: 80-87
144. Sasaki, S., Miyakoshi, N., Matsuura, H., Saitoh, H., Kudoh, D., Shimada, Y. Prospective randomized controlled trial on the effect of fondaparinux sodium for prevention of venous thromboembolism after hip fracture surgery. *Journal of Orthopaedic Science* 2009; 5: 491-6
145. Saxer, F., Studer, P., Jakob, M., Suhm, N., Rosenthal, R., Dell-Kuster, S., Vach, W., Bless, N. Minimally invasive anterior muscle-sparing versus a transgluteal approach for hemiarthroplasty in femoral neck fractures-a prospective randomised controlled trial including 190 elderly patients. *BMC Geriatrics* 2018; 1: 222
146. Saygi, B., Ozkan, K., Eceviz, E., Tetik, C., Sen, C. Skin traction and placebo effect in the preoperative pain control of patients with collum and intertrochanteric femur fractures. *Bull NYU Hosp Jt Dis* 2010; 1: 15-7
147. Schiavone, A., Bisaccia, M., Inkov, I., Rinonapoli, G., Manni, M., Rollo, G., Meccariello, L., Vicente, C. I., Ceccarini, P., Ruggiero, C., Caraffa, A. Tranexamic Acid in Pterochanteric Femoral Fracture: Is it a Safe Drug or Not?. 2018; 1: 67-78
148. Schipper, I. B., Steyerberg, E. W., Castelein, R. M., van der Heijden, F. H., den Hoed, P. T., Kerver, A. J., van Vugt, A. B. Treatment of unstable trochanteric fractures. Randomised comparison of the gamma nail and the proximal femoral nail. *Journal of Bone & Joint Surgery - British Volume* 2004; 1: 86-94
149. Shannon, S. F., Yuan, B. J., Cross, W. W., Barlow, J. D., Torchia, M. E., Holte, P. K., Sems, S. A. Short Versus Long Cephalomedullary Nails for Pterochanteric Hip Fractures: A Randomized Prospective Study. *Journal of Orthopaedic Trauma* 2019; 10: 480-486
150. Sharma, V., Awasthi, B., Kumar, K., Kohli, N., Katoch, P. Outcome Analysis of Hemiarthroplasty vs. Total Hip Replacement in Displaced Femoral Neck Fractures in the Elderly. *Journal of Clinical and Diagnostic Research JCDR* 2016; 5: RC11-3
151. Shi, H., Xiao, L., Wang, Z. Curative effect of artificial femoral head replacement and its effect on hip joint function and complications of senile patients with femoral intertrochanteric fracture. *Experimental & Therapeutic Medicine* 2018; 2: 623-628
152. Shin, S., Kim, S. H., Park, K. K., Kim, S. J., Bae, J. C., Choi, Y. S. Effects of Anesthesia Techniques on Outcomes after Hip Fracture Surgery in Elderly Patients: A Prospective, Randomized, Controlled Trial. *Journal of Clinical Medicine* 2020; 6: 26
153. Shyu, Y. I., Liang, J., Tseng, M. Y., Li, H. J., Wu, C. C., Cheng, H. S., Chou, S. W., Chen, C. Y., Yang, C. T. Comprehensive and subacute care interventions improve health-related quality of life for

- older patients after surgery for hip fracture: a randomised controlled trial. *International Journal of Nursing Studies* 2013; 8: 1013-24
154. Shyu, Y. I., Liang, J., Tseng, M. Y., Li, H. J., Wu, C. C., Cheng, H. S., Chou, S. W., Chen, C. Y., Yang, C. T. Enhanced interdisciplinary care improves self-care ability and decreases emergency department visits for older Taiwanese patients over 2 years after hip-fracture surgery: A randomised controlled trial. *International Journal of Nursing Studies* 2016; 0: 54-62
  155. Shyu, Y. I., Liang, J., Tseng, M. Y., Li, H. J., Wu, C. C., Cheng, H. S., Yang, C. T., Chou, S. W., Chen, C. Y. Comprehensive care improves health outcomes among elderly Taiwanese patients with hip fracture. *Journals of Gerontology Series A-Biological Sciences & Medical Sciences* 2013; 2: 188-97
  156. Shyu, Y. I., Liang, J., Wu, C. C., Su, J. Y., Cheng, H. S., Chou, S. W., Chen, M. C., Yang, C. T. Interdisciplinary intervention for hip fracture in older Taiwanese: benefits last for 1 year. *Journals of Gerontology Series A-Biological Sciences & Medical Sciences* 2008; 1: 92-7
  157. Shyu, Y. I., Liang, J., Wu, C. C., Su, J. Y., Cheng, H. S., Chou, S. W., Chen, M. C., Yang, C. T., Tseng, M. Y. Two-year effects of interdisciplinary intervention for hip fracture in older Taiwanese. *Journal of the American Geriatrics Society* 2010; 6: 1081-9
  158. Shyu, Y. I., Tseng, M. Y., Liang, J., Tsai, W. C., Wu, C. C., Cheng, H. S. Interdisciplinary intervention decreases cognitive impairment for older Taiwanese with hip fracture: 2-year follow-up. *International Journal of Geriatric Psychiatry* 2013; 12: 1222-31
  159. Siegmeth, A. W., Gurusamy, K., Parker, M. J. Delay to surgery prolongs hospital stay in patients with fractures of the proximal femur. *Journal of Bone & Joint Surgery - British Volume* 2005; 8: 1123-6
  160. Sikorski, J. M., Barrington, R. Internal fixation versus hemiarthroplasty for the displaced subcapital fracture of the femur. A prospective randomised study. *Journal of Bone & Joint Surgery - British Volume* 1981; 3: 357-61
  161. Skinner, P., Riley, D., Ellery, J., Beaumont, A., Coumine, R., Shafighian, B. Displaced subcapital fractures of the femur: a prospective randomized comparison of internal fixation, hemiarthroplasty and total hip replacement. *Injury* 1989; 5: 291-3
  162. Sköldenberg, O., Ekman, A., Salemyr, M., Bodén, H. Reduced dislocation rate after hip arthroplasty for femoral neck fractures when changing from posterolateral to anterolateral approach. *Acta Orthopaedica* 2010; 5: 583-7
  163. StÅ, en, R. O., Lofthus, C. M., Nordsletten, L., Madsen, J. E., Frihagen, F. Randomized trial of hemiarthroplasty versus internal fixation for femoral neck fractures: No differences at 6 years hip. *Clinical orthopaedics and related research* 2014; 1: 360-367
  164. Stenvall, M., Olofsson, B., Lundström, M., Englund, U., Borssén, B., Svensson, O., Nyberg, L., Gustafson, Y. A multidisciplinary, multifactorial intervention program reduces postoperative falls and injuries after femoral neck fracture. *Osteoporosis International* 2007; 2: 167-75
  165. Stenvall, M., Olofsson, B., Nyberg, L., Lundström, M., Gustafson, Y. Improved performance in activities of daily living and mobility after a multidisciplinary postoperative rehabilitation in older people with femoral neck fracture: a randomized controlled trial with 1-year follow-up. *Journal of Rehabilitation Medicine* 2007; 3: 232-8
  166. Stoen, R. O., Lofthus, C. M., Nordsletten, L., Madsen, J. E., Frihagen, F. Randomized trial of hemiarthroplasty versus internal fixation for femoral neck fractures: no differences at 6 years. *Clinical Orthopaedics & Related Research* 2014; 1: 360-7
  167. Stoffel, K. K., Nivbrant, B., Headford, J., Nicholls, R. L., Yates, P. J. Does a bipolar hemiprosthesis offer advantages for elderly patients with neck of femur fracture? A clinical trial with 261 patients. *ANZ Journal of Surgery* 2013; 4: 249-54
  168. Stranks, G. J., MacKenzie, N. A., Grover, M. L., Fail, T. The A-V Impulse System reduces deep-vein thrombosis and swelling after hemiarthroplasty for hip fracture. *Journal of Bone & Joint Surgery - British Volume* 1992; 5: 775-8
  169. Talsnes, O., Hjelmstedt, F., Pripp, A. H., Reikeras, O., Dahl, O. E. No difference in mortality between cemented and uncemented hemiprosthesis for elderly patients with cervical hip fracture. A

- prospective randomized study on 334 patients over 75 years. *Archives of Orthopaedic & Trauma Surgery* 2013; 6: 805-9
170. Tao, R., Lu, Y., Xu, H., Zhou, Z. Y., Wang, Y. H., Liu, F. Internal fixation of intertrochanteric hip fractures: a clinical comparison of two implant designs. *The scientific world journal* 2013; 0: 834825
  171. Taylor, F., Wright, M., Zhu, M. Hemiarthroplasty of the hip with and without cement: a randomized clinical trial. *Journal of Bone & Joint Surgery - American Volume* 2012; 7: 577-83
  172. Temelkovska-Stevanovska, M., Durnev, V., Jovanovski-Srceva, M., Mojsova-Mijovska, M., Trpeski, S. Continuous femoral nerve block versus fascia iliaca compartment block as postoperative analgesia in patients with hip fracture. *Prilozi Makedonska Akademija Na Naukite I Umetnostite Oddelenie Za Medicinski Nauki* 2014; 2: 85-93
  173. Tengberg, P. T., Foss, N. B., Palm, H., Kallemose, T., Troelsen, A. Tranexamic acid reduces blood loss in patients with extracapsular fractures of the hip: results of a randomised controlled trial. *Bone & Joint Journal* 2016; 6: 747-53
  174. Thaler, H. W., Frisee, F., Korninger, C. Platelet aggregation inhibitors, platelet function testing, and blood loss in hip fracture surgery. *Journal of Trauma-Injury Infection & Critical Care* 2010; 5: 1217-20; discussion 1221
  175. Tian, S., Shen, Z., Liu, Y., Zhang, Y., Peng, A. The effect of tranexamic acid on hidden bleeding in older intertrochanteric fracture patients treated with PFNA. *Injury* 2018; 3: 680-684
  176. Tidermark, J., Ponzer, S., Svensson, O., Söderqvist, A., Törnkvist, H. Internal fixation compared with total hip replacement for displaced femoral neck fractures in the elderly. A randomised, controlled trial. *Journal of Bone & Joint Surgery - British Volume* 2003; 3: 380-8
  177. Tosun, B., Aslan, O., Tunay, S. Preoperative position splint versus skin traction in patients with hip fracture: An experimental study. *International Journal of Orthopaedic and Trauma Nursing* 2018; 0: 8-15
  178. Tzimas, P., Samara, E., Petrou, A., Korompilias, A., Chalkias, A., Papadopoulos, G. The influence of anesthetic techniques on postoperative cognitive function in elderly patients undergoing hip fracture surgery: General vs spinal anesthesia. *Injury* 2018; 12: 2221-2226
  179. Ugland, T. O., Haugeberg, G., Svenningsen, S., Ugland, S. H., Berg, O. H., Pripp, A. H., Nordsletten, L. Biomarkers of muscle damage increased in anterolateral compared to direct lateral approach to the hip in hemiarthroplasty: no correlation with clinical outcome : Short-term analysis of secondary outcomes from a randomized clinical trial in patients with a displaced femoral neck fracture. *Osteoporosis International* 2018; 8: 1853-1860
  180. Ugland, T. O., Haugeberg, G., Svenningsen, S., Ugland, S. H., Berg, O. H., Pripp, A. H., Nordsletten, L. High risk of positive Trendelenburg test after using the direct lateral approach to the hip compared with the anterolateral approach: a single-centre, randomized trial in patients with femoral neck fracture. *Bone & Joint Journal* 2019; 7: 793-799
  181. Ukaj, S., Zhuri, O., Ukaj, F., Podvorica, V., Grezda, K., Caton, J., Prudhon, J. L., Krasniqi, S. Dual Mobility Acetabular Cup Versus Hemiarthroplasty in Treatment of Displaced Femoral Neck Fractures in Elderly Patients: Comparative Study and Results at Minimum 3-Year Follow-up. *Geriatric Orthopaedic Surgery & Rehabilitation* 2019; 0: 2151459319848610
  182. Unneby, A., Svensson, O., Gustafson, Y., Olofsson, B. Femoral nerve block in a representative sample of elderly people with hip fracture: A randomised controlled trial. *Injury* 2017; 7: 1542-1549
  183. Unneby, A., Svensson, P. O., Gustafson, P. Y., Lindgren, A. P. B. M., Bergström, U., Olofsson, P. B. Complications with focus on delirium during hospital stay related to femoral nerve block compared to conventional pain management among patients with hip fracture â?? A randomised controlled trial. *Injury* 2020; 0:
  184. Unneby, A., Svensson, P. O., Gustafson, P. Y., Lindgren, A. P. B. M., Bergström, U., Olofsson, P. B. Complications with focus on delirium during hospital stay related to femoral nerve block compared to conventional pain management among patients with hip fracture â?? A randomised controlled trial. *Injury* 2020; 0:
  185. Utrilla, A. L., Reig, J. S., Muñoz, F. M., Tufanisco, C. B. Trochanteric gamma nail and compression hip screw for trochanteric fractures: a randomized, prospective, comparative study in 210 elderly patients with a new design of the gamma nail. *Journal of Orthopaedic Trauma* 2005; 4: 229-33

186. Uysal, A. I., Altiparmak, B., Yasar, E., Turan, M., Canbek, U., Yilmaz, N., Gumus Demirbilek, S. The effects of early femoral nerve block intervention on preoperative pain management and incidence of postoperative delirium geriatric patients undergoing trochanteric femur fracture surgery: A randomized controlled trial. *Ulusal Travma ve Acil Cerrahi Dergisi = Turkish Journal of Trauma & Emergency Surgery: TJTES* 2020; 1: 109-114
187. Valentin, N., Lomholt, B., Jensen, J. S., Hejgaard, N., Kreiner, S. Spinal or general anaesthesia for surgery of the fractured hip? A prospective study of mortality in 578 patients. *British Journal of Anaesthesia* 1986; 3: 284-91
188. van den Bekerom, M. P., Hilverdink, E. F., Sierevelt, I. N., Reuling, E. M., Schnater, J. M., Bonke, H., Goslings, J. C., van Dijk, C. N., Raaymakers, E. L. A comparison of hemiarthroplasty with total hip replacement for displaced intracapsular fracture of the femoral neck: a randomised controlled multicentre trial in patients aged 70 years and over. *Journal of Bone & Joint Surgery - British Volume* 2010; 10: 1422-8
189. Varela-Egocheaga, J. R., Iglesias-Colao, R., Suárez-Suárez, M. A., Fernández-Villán, M., González-Sastre, V., Murcia-Mazón, A. Minimally invasive osteosynthesis in stable trochanteric fractures: a comparative study between Gotfried percutaneous compression plate and Gamma 3 intramedullary nail. *Archives of Orthopaedic & Trauma Surgery* 2009; 10: 1401-7
190. Verettas, D. A., Ifantidis, P., Chatzipapas, C. N., Drosos, G. I., Xarchas, K. C., Chloropoulou, P., Kazakos, K. I., Trypsianis, G., Ververidis, A. Systematic effects of surgical treatment of hip fractures: gliding screw-plating vs intramedullary nailing. *Injury* 2010; 3: 279-84
191. Verzellotti, S., Candrian, C., Molina, M., Filardo, G., Alberio, R., Grassi, F. A. Direct anterior versus posterolateral approach for bipolar hip hemiarthroplasty in femoral neck fractures: a prospective randomised study. *Hip International* 2019; 0: 1120700019872117
192. Vidán, M., Serra, J. A., Moreno, C., Riquelme, G., Ortiz, J. Efficacy of a comprehensive geriatric intervention in older patients hospitalized for hip fracture: A randomized, controlled trial. *Journal of the American Geriatrics Society* 2005; 9: 1476-1482
193. Vidovic, D., Matejic, A., Punda, M., Ivica, M., Tomljenovic, M., Bekavac-Beslin, M., Mijic, A., Bakota, B. Periprosthetic bone loss following hemiarthroplasty: a comparison between cemented and cementless hip prosthesis. *Injury* 2013; 0: S62-6
194. Vidovic, D., Punda, M., Darabos, N., Bekavac-Beslin, M., Bakota, B., Matejic, A. Regional bone loss following femoral neck fracture: A comparison between cemented and cementless hemiarthroplasty. *Injury* 2015; 0: S52-6
195. Virani, S. R., Dahapute, A. A., Panda, I., Bava, S. S. Role of Local Infiltration of Tranexamic Acid in Reducing Blood Loss in Peritrochanteric Fracture Surgery in the Elderly Population. *Malaysian Orthopaedic Journal* 2016; 3: 26-30
196. Waaler Bjørnelv, G. M., Frihagen, F., Madsen, J. E., Nordsletten, L., Aas, E. Hemiarthroplasty compared to internal fixation with percutaneous cannulated screws as treatment of displaced femoral neck fractures in the elderly: cost-utility analysis performed alongside a randomized, controlled trial. *Osteoporosis International* 2012; 6: 1711-9
197. Wang, B., Liu, Q., Liu, Y., Jiang, R. Comparison of Proximal Femoral Nail Antirotation and Dynamic Hip Screw Internal Fixation on Serum Markers in Elderly Patients with Intertrochanteric Fractures. *Jcpssp, Journal of the College of Physicians & Surgeons - Pakistan* 2019; 7: 644-648
198. Watts, C. D., Houdek, M. T., Sems, S. A., Cross, W. W., Pagnano, M. W. Tranexamic Acid Safely Reduced Blood Loss in Hemi- and Total Hip Arthroplasty for Acute Femoral Neck Fracture: A Randomized Clinical Trial. *Journal of Orthopaedic Trauma* 2017; 7: 345-351
199. Wei, P., Xu, Y., Gu, Y., Geng, D., Yao, Q., Wang, L. Conservative vs Surgical Treatment of Impacted Femoral Neck Fracture in Patients 75 Years and Older. *Journal of the American Geriatrics Society* 2020; 0:
200. Wennberg, P., Moller, M., Herlitz, J., Kenne Sarenmalm, E. Fascia iliaca compartment block as a preoperative analgesic in elderly patients with hip fractures - effects on cognition. *BMC Geriatrics* 2019; 1: 252

201. Wennberg, P., Norlin, R., Herlitz, J., Sarenmalm, E. K., Moller, M. Pre-operative pain management with nerve block in patients with hip fractures: a randomized, controlled trial. *International Journal of Orthopaedic and Trauma Nursing* 2019; 0: 35-43
202. Xie, J., Hu, Q., Huang, Q., Chen, G., Zhou, Z., Pei, F. Efficacy and safety of tranexamic acid in geriatric hip fracture with hemiarthroplasty: a retrospective cohort study. *BMC Musculoskeletal Disorders* 2019; 1: 304
203. Xu, F., Ke, R., Gu, Y., Qi, W. Bipolar hemiarthroplasty vs. total hip replacement in elderly. *International journal of clinical and experimental medicine* 2017; 5: 7911-7920
204. Xu, L., Luo, F., Lei, E., Zhu, X., Huang, H., Li, Q., Wan, H. The effect of the fascia iliaca compartment block combined with laryngeal mask general anesthesia on the internal fixation of senile femoral neck fracture. *International journal of clinical and experimental medicine* 2020; 2: 634-643
205. Xu, R., Ru, J., Ji, F., Liu, J., Ji, Y., Wu, Z., Shi, D. Comparison of efficacy, complications and TGF-beta2 expression between DHS and PFNA in elderly patients with osteoporotic femoral intertrochanteric fracture. *Experimental & Therapeutic Medicine* 2018; 1: 394-399
206. Yip, D. K., Chan, C. F., Chiu, P. K., Wong, J. W., Kong, J. K. Why are we still using pre-operative skin traction for hip fractures?. *International Orthopaedics* 2002; 6: 361-4
207. Zehir, S., Zehir, R., Zehir, S., Azboy, I., Haykir, N. Proximal femoral nail antirotation against dynamic hip screw for unstable trochanteric fractures; a prospective randomized comparison. *European Journal of Trauma & Emergency Surgery* 2015; 4: 393-400
208. Zhang, C., Xu, B., Liang, G., Zeng, X., Yang, C., Zhang, F., Wan, Z., Yu, W., Chen, D., Ge, Z., Zhang, X. Rivaroxaban versus nadroparin for preventing deep venous thrombosis after total hip arthroplasty following femoral neck fractures: A retrospective comparative study. *Journal of International Medical Research* 2018; 5: 1936-1946
209. Zhang, J., Zhang, X., Wang, T., Nie, S., Pan, X., Tang, Y., Tang, L. Femoral nerve block relieves preoperative pain in elderly patients with femoral neck fracture. *Journal of International Translational Medicine* 2019; 4: 138-141
210. Zhang, W., Wang, T., Wang, G., Yang, M., Zhou, Y., Yuan, Y. Effects of Dexmedetomidine on Postoperative Delirium and Expression of IL-1beta, IL-6, and TNF-alpha in Elderly Patients After Hip Fracture Operation. *Frontiers in Pharmacology* 2020; 0: 678
211. Zhou, X. D., Zhang, Y., Jiang, L. F., Zhang, J. J., Zhou, D., Wu, L. D., Huang, Y., Xu, N. W. Efficacy and Safety of Tranexamic Acid in Intertrochanteric Fractures: A Single-Blind Randomized Controlled Trial. *Orthopaedic Audio-Synopsis Continuing Medical Education [Sound Recording]* 2019; 4: 635-642
212. Zhou, Y., Zhang, W. C., Chong, H., Xi, Y., Zheng, S. Q., Wang, G., Wu, X. B. A Prospective Study to Compare Analgesia from Femoral Obturator Nerve Block with Fascia Iliaca Compartment Block for Acute Preoperative Pain in Elderly Patients with Hip Fracture. *Medical Science Monitor* 2019; 0: 8562-8570
213. Zufferey, P. J., Miquet, M., Quenet, S., Martin, P., Adam, P., Albaladejo, P., Mismetti, P., Molliex, S., tranexamic acid in hip-fracture surgery, study Tranexamic acid in hip fracture surgery: a randomized controlled trial. *British Journal of Anaesthesia* 2010; 1: 23-30

## Appendix II: PICO Questions and Inclusion Criteria Used to Define Literature Search

1. In elderly patients who are treated for hip fracture, does the use of pre-operative traction result in beneficial patient outcomes? (Updated search limited to RCTs)
2. In elderly patients with hips fracture, what surgical timing results in optimal patient outcomes. (Updated search limited to RCTs)
3. In elderly patients with hip fracture, what is the recommended post-operative VTE prophylaxis and duration? (PICO maintained 2014 comparison format; mechanical vs pharmacological vs none vs both)
4. In elderly patients being treated for hip fracture, what operative anesthesia administration results in better patient outcomes?
5. In elderly patients being treated for stable hip fracture of the femoral neck, is surgery indicated?
6. In elderly patients with unstable femoral neck fracture, which surgical procedure results in better patient outcomes? (Updated search limited to RCTs)
7. In elderly patients with unstable (displaced) femoral neck fractures undergoing hemiarthroplasty, does unipolar or bipolar hemiarthroplasty result in better patient outcomes? (Updated search limited to RCTs)
8. In elderly patients with femoral neck fractures undergoing arthroplasty, what surgical procedure results in better patient outcomes?
9. In elderly patients with femoral neck fractures, what type of stem fixation results in better patient outcomes?
10. In elderly patients with femoral neck fractures, is there a specific surgical approach result in better patient outcomes?
11. In elderly patients do sliding hip screws or cephalomedullary devices result in better patient outcomes? (Updated search limited to RCTs)
12. In elderly patients with unstable intertrochanteric/pertrochanteric/subtrochanteric/basicervical fractures does the use of cephalomedullary devices result in better patient outcomes? (Updated search limited to RCTs)
13. In elderly patients with low-energy proximal femur fractures receiving a cephalomedullary device does the use of long or short cephalomedullary devices result in better patient outcomes? \*
14. In elderly patients with hip fracture, what hemoglobin level should trigger administering a transfusion? (Updated search limited to RCTs)
15. In elderly patients with hip fracture, what pain management modalities are most effective? \*
16. In patients with hip fracture, does administering fibrinolysis inhibitors improve patients' outcomes? \*
17. Is a hip fracture service beneficial in changing outcomes for geriatric hip fractures? \*
18. Does immediate weight bearing to tolerance following operative treatment for hip fracture impact outcomes? \*Denotes a PICO question new to the 2021 CPG



## **Study Inclusion Criteria**

- Study must be of **elderly patients with hip fractures**
- Article must be a full article report of a clinical study.
  - Retrospective non-comparative case series, medical records review, meeting abstracts, historical articles, editorials, letters, and commentaries are **excluded**.
  - Case series studies that give patients the treatment of interest AND another treatment are **excluded**.
  - Case series studies that have non-consecutive enrollment of patients are **excluded**.
  - Controlled trials in which patients were not stochastically assigned to groups AND in which there was either a difference in patient characteristics or outcomes at baseline AND where the authors did not statistically adjust for these differences when analyzing the results are **excluded**.
  - All studies of “Very Weak” strength of evidence are **excluded**.
  - All studies evaluated as Level V will be **excluded**.
  - **Unvalidated** Composite measures or outcomes are **excluded** even if they are patient-oriented.
- Study must appear in a peer-reviewed publication
- Study should have **30 or more patients per group**
- Study must be of humans
- Study must be published in English
- Study must be published in or after **2013 (last search from previous CPG), new PICOs - 1995**
- Study results must be quantitatively presented
- All study follow up durations are included
- For any given follow-up time point in any included study, there **must be ≥ 50% patient follow-up** (*if the follow-up is >50% but <80%, the study quality will be downgraded by one Level*)
- For any included study that uses “paper-and-pencil” outcome measures (e.g., SF-36), only those outcome measures that have been validated will be included
- Study must not be an in vitro study
- Study must not be a biomechanical study
- Study must not have been performed on cadavers

### **Patient population: Elderly ≥ 65**

- Inclusion: Enrolled patients  $\geq 50$  and mean  $\geq 65$
- low-energy proximal femur fractures (subcapital fractures, subtrochanteric fractures, peritrochanteric fractures, intertrochanteric fractures, femoral neck fractures (fractured neck of femur), basicervical fractures, midcervical fractures)

**Exclude:** >10%: Acetabular/pelvic fractures, oncological fractures (malignancies and tumor processes) atypical fractures, periprosthetic fractures, high-energy fractures (low-energy=equivalent to fall from standing height), avascular necrosis

We will only evaluate surrogate outcomes when no patient-oriented outcomes are available.

### **Best Available Evidence**

When examining primary studies, we will analyze the best available evidence regardless of study design. We will first consider randomized controlled trials identified by the search strategy. In the absence of two or more RCTs, we will sequentially search for prospective controlled trials, prospective comparative studies, retrospective comparative studies, and prospective case-series studies. Only studies of the highest level of available evidence are included, assuming that there were 2 or more studies of that higher level. For example, if there are two Level II studies that address the recommendation, Level III and IV studies are not included.

## **Appendix III: Guideline Development Group Disclosures**

### **Julie A Switzer, MD, FAAOS**

Submitted on: 02/02/2021

AAOS: Board or committee member (\$0) Workgroup AAOS Clinical Practice Guideline on Hip Fxs in Elderly Patients (Self)

American Orthopaedic Association: Board or committee member (\$0) Own the Bone Steering Committee (Self)

DePuy Synthes: Other financial or material support (\$18,000) Support to institution for Geriatric Trauma Symposium,

Dr. Switzer was course chairman (Self)

GOS&R: Editorial or governing board (\$0) Editorial Board member (Self)

IGFS International Geriatric Fracture Society: Board or committee member (\$0) Board Member (Self)

### **Mary Irene O'Connor, MD, FAAOS**

Submitted on: 08/06/2021

BoneSupport, Inc.: Paid consultant (\$24,000) BoneSupport, Inc. (Self)

Cohere Health: Paid consultant (\$3,000) Cohere Health (Self)

Cohere Health: Stock or stock Options Number of Shares: 2,000 Cohere Health (Self)

Mayo Clinic Press: Publishing royalties, financial or material support (\$2,500) Mayo Clinic Press (Self)

Vori Health: Employee (\$250,000) Vori Health (Self)

Vori Health: Stock or stock Options Number of Shares: 20,000 Vori Health (Self)

Zimmer: Paid consultant (\$35,000) N/A(Self)

### **Daniel Ari Mendelson, MD, MS, FACP, AGSF**

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American Journal of Physical Medicine & Rehabilitation: Editorial or governing board (\$0) Associate Editor-Editorial Board Member (Self)

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