Effective Health Care Program

Future Research Needs Paper
Number 2

# Future Research Needs for the Treatment of Common Hip Fractures

Agency for Healthcare Research and Quality
Advancing Excellence in Health Care • www.ahrq.gov

This report is based on research conducted by the Minnesota Evidence-based Practice Center (EPC) under contract to the Agency for Healthcare Research and Quality (AHRQ), Rockville, MD (Contract No. 290-2007-10064-I). The findings and conclusions in this document are those of the author(s), who are responsible for its contents; the findings and conclusions do not necessarily represent the views of AHRQ. Therefore, no statement in this report should be construed as an official position of AHRQ or of the U.S. Department of Health and Human Services.

The information in this report is intended to help health care researchers and funders of research make well-informed decisions in designing and funding research and thereby improve the quality of health care services. This report is not intended to be a substitute for the application of scientific judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical research and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances.

This report may be used, in whole or in part, as the basis for research design or funding opportunity announcements. AHRQ or U.S. Department of Health and Human Services endorsement of such derivative products may not be stated or implied.

This information does not represent and should not be construed to represent a determination or policy of the Agency for Healthcare Research and Quality or the U.S. Department of Health and Human Services.

This project was funded under Contract No. 290-2007-10064-I from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services (HHS).

*Future Research Needs Paper*

**Number 2**

# Future Research Needs for the Treatment of Common Hip Fractures

## Identification of Future Research from Evidence Report No. 184

**Prepared for:**
Agency for Healthcare Research and Quality
U.S. Department of Health and Human Services
540 Gaither Road
Rockville, MD 20850
www.ahrq.gov

**Contract No. 290-2007-10064-I**

**Prepared by**:
**Minnesota Evidence-based Practice Center**
**Minneapolis, MN**

*Investigators*

Mary Butler, Ph.D., M.B.A.
Mary L. Forte, Ph.D., D.C.
Robert L. Kane, M.D.
Marc F. Swiontkowski, M.D.

**AHRQ Publication No. 10-EHC071-EF**
**September 2010**

None of the investigators has any affiliations or financial involvement that conflicts with the material presented in this report.

**Suggested citation:** Butler M, Forte ML, Kane RL, Swiontkowski MF. Future Research Needs for the Treatment of Common Hip Fractures. Future Research Needs Paper No. 2. (Prepared by the Minnesota Evidence-based Practice Center under Contract No. 290-2007-10064-I.) AHRQ Publication No. 10-EHC071-EF. Rockville, MD: Agency for Healthcare Research and Quality. September 2010. Available at: www.effectivehealthcare.ahrq.gov/reports/final.cfm.

# Preface

The Agency for Healthcare Research and Quality (AHRQ) conducts the Effective Health Care Program as part of its mission to organize knowledge and make it available to inform decisions about health care. As part of the Medicare Prescription Drug, Improvement, and Modernization Act of 2003, Congress directed AHRQ to conduct and support research on the comparative outcomes, clinical effectiveness, and appropriateness of pharmaceuticals, devices, and health care services to meet the needs of Medicare, Medicaid, and the Children's Health Insurance Program (CHIP).

AHRQ has an established network of Evidence-based Practice Centers (EPCs) that produce Evidence Reports/Technology Assessments to assist public- and private-sector organizations in their efforts to improve the quality of health care. The EPCs now lend their expertise to the Effective Health Care Program by conducting comparative effectiveness reviews (CERs) of medications, devices, and other relevant interventions, including strategies for how these items and services can best be organized, managed, and delivered.

Systematic reviews are the building blocks underlying evidence-based practice; they focus attention on the strength and limits of evidence from research studies about the effectiveness and safety of a clinical intervention. In the context of developing recommendations for practice, systematic reviews are useful because they define the strengths and limits of the evidence, clarifying whether assertions about the value of the intervention are based on strong evidence from clinical studies. For more information about systematic reviews, see http://effectivehealthcare.ahrq.gov/reference/purpose.cfm.

AHRQ expects that CERs will be helpful to health plans, providers, purchasers, government programs, and the health care system as a whole. In addition, AHRQ is committed to presenting information in different formats so that consumers who make decisions about their own and their family's health can benefit from the evidence.

As part of a new effort in 2010, AHRQ has supported EPCs to work with various stakeholders, including patients, to further develop and prioritize the future research needed by decisionmakers. The Future Research Needs products are intended to inform and support researchers and those who fund research to ultimately enhance the body of comparative effectiveness evidence so that it is useful for decisionmakers.

Transparency and stakeholder input are essential to the Effective Health Care Program. Please visit the Web site (www.effectivehealthcare.ahrq.gov) to see draft research questions and reports or to join an email list to learn about new program products and opportunities for input. Comparative effectiveness reviews will be updated regularly.

## Acknowledgments

We would like to thank Marilyn Eells for her help with editing and formatting.

### Stakeholders

Lauren Beaupre, P.T., Ph.D.
University of Alberta
Edmonton, AB, CANADA

Thomas Becker, M.D., M.B.A.
Care Management and Reimbursement
Medica Health Plans
Minnetonka, MN

Shamiram R, Feinglass, M.D., M.P.H.
Global Medical Affairs
Zimmer, Inc.
Warsaw, IN

Keith E. Folkert, M.D., M.H.A.
Health Management and Medical Policy
Blue Cross and Blue Shield of Minnesota
Eagan, MN

Evan Hadley, M.D.
Division of Geriatrics and Clinical Gerontology
National Institute on Aging
Bethesda, MD

Edward Harvey, M.D.C.M., M.Sc., F.R.C.S.C.
Orthopaedic Trauma
Montreal General Hospital
Montreal, QC, CANADA

Jane M. Jacob, Ph.D., C.C.R.P.
Clinical Affairs
DJO Surgical
Austin, TX

Lyndon Joseph, Ph.D.
Division of Geriatrics and Clinical Gerontology
National Institute on Aging, NIH, DHHS
Bethesda, MD

Kenneth J. Koval, M.D.
Dartmouth Hitchcock Medical Center
Wilmot, NH

Joseph Lane, M.D.
Metabolic Bone Disease Service
Hospital for Special Surgery
New York, NY

Jay Magaziner, Ph.D., M.S.Hyg.
Department of Epidemiology and Public Health
University of Maryland School of Medicine
Baltimore, MD

Elliot J. Roth, M.D.
Department of Physical Medicine and Rehabilitation
Northwestern University Feinberg School of Medicine
Rehabilitation Institute of Chicago
Chicago, IL

Charles M. Turkelson, Ph.D.
Research and Scientific Affairs Department
Academy of Orthopaedic Surgeons
Rosemont, IL

We would also like to thank eight stakeholders who preferred to remain anonymous.

## AHRQ Contacts

Carolyn M. Clancy, M.D.
Director
Agency for Healthcare Research and Quality

Jean Slutsky, P.A., M.S.P.H.
Director
Center for Outcomes and Evidence
Agency for Healthcare Research and Quality

Stephanie Chang, M.D., M.P.H.
Director
Evidence-based Practice Center Program
Agency for Healthcare Research and Quality

Karen Siegel, P.T. M.A.
Associate Director and Task Order Officer
Evidence-based Practice Center Program
Agency for Healthcare Research and Quality

# Contents



## Tables



## Figures

# Executive Summary

The Effective Health Care Program was initiated in 2005 to provide valid evidence about the comparative effectiveness of different medical interventions. The object is to help consumers, health care providers, and others in making informed choices among treatment alternatives. Through its comparative effectiveness reviews, the program supports systematic appraisals of existing scientific evidence regarding treatments for high-priority health conditions. It also promotes and generates new scientific evidence by identifying gaps in existing scientific evidence and supporting new research. The program puts special emphasis on translating findings into a variety of useful formats for different stakeholders, including consumers.

The full report and this summary are available at www.effectivehealthcare.ahrq.gov/reports/final.cfm.

## Background

The 2009 systematic literature review "Treatments of Common Hip Fractures" was conducted for the American Academy of Orthopaedic Surgeons to provide input for their development of clinical guidelines for surgical procedures for implantable devices. The nominator was interested in understanding the interaction between patient factors, types of hip fractures, types of surgical implantable devices, and outcomes. The subsequent systematic review conducted by the Minnesota Evidence-based Practice Center (EPC) was unable to fully address the research questions with the existing literature because of (a) the limited perspective of discipline-specific investigations (i.e. orthopaedic or epidemiology), which tended to use incomplete sets of important independent variables in study designs and models, and (b) the generally low quality of hip fracture outcome studies to date, where specific populations were poorly defined, and the use of inconsistent outcome variables and assessment tools prevented aggregating or even comparing results. The objective of this project was to work with stakeholder groups with an interest in improving hip fracture patient outcomes to examine, refine, and prioritize research questions and methodological approaches that would fill the existing research knowledge gaps in hip fracture treatment.

## Methods

We formed a 21-member stakeholder group with representation from orthopaedic surgeon-researchers, epidemiologists, professional organizations, Federal and foundation research funders, healthcare payors, and device industry representatives. We simultaneously performed a search to locate relevant, recently-completed and currently ongoing hip fracture outcomes studies that potentially addressed existing knowledge gaps. Search results were combined with the list of identified research gaps from the original 2009 systematic review to generate a list of specific hip fracture knowledge gaps for email distribution to the stakeholders. A conference call with 14 stakeholders was held to discuss the state of hip fracture research, solicit feedback on the consolidated list of research gap areas, and to refine the research questions. A summary of the conference call and one-page Revised Hip Fracture Research Agenda was sent out to stakeholders for comment by email. The revised agenda included two theme areas: measurement and study design.

We used stakeholder comments and the Revised Research Agenda to develop a two-part prioritization activity. A subgroup of 10 stakeholders, representing payors, device manufacturers,

and a diverse set of researchers, rated the importance of various research concepts, and ranked a list of hip fracture outcomes measurement issues. These questions were placed within the context of developing an agenda for a consensus conference as means to resolve fundamental measurement issues. They also ranked specific research questions and whether or not each could be addressed with a randomized controlled trial (RCT). Stakeholders were asked to suggest research topics for which registry-based investigations would be most useful. Prioritization activity results were tabulated and ranked based on mean scores. Finally, additional feedback was sought from all stakeholders on potential ways to disseminate recommendations to improve research quality among orthopaedic surgeons and epidemiologists/observational researchers, and how to best incentivize both orthopaedic and epidemiology researchers to improve study quality.

# Results

No research gap, either a methods issue or a research question, was fully addressed by identified ongoing studies or recently published trials.

Executive Summary Table 1 provides a summary of stakeholder rankings for consensus conference topics. All items related to measurement were rated as moderately (scores in the 6 to 7 range) to highly important (scores in the 8 to 9 range). High priority and high importance was placed on a broad set of measurement consistency issues that are more generally accepted as important to researchers across disciplines, such as priority outcomes to be reported across studies, and establishing definitions and the recommended use of pertinent predictor variables. Items that received lower priority scores are largely items which are associated with one specific discipline or another, be it a surgical view, a rehabilitation view, or an epidemiological view. The trending toward wider standard deviations among lower-ranked conference topics also highlights the wider variation in the stakeholder responses to these items.

**Executive Summary Table 1. Stakeholder ranking of consensus conference topics**

| Consensus Conference Item | Rank |
|---|---|
| How important is it to have established, consistent reporting of post-treatment outcomes (function, pain, living situation, mortality, quality of life)? | 1 |
| How important is it to have established, consistent definitions of the types of fracture? | 2 |
| How important is it to have a tool box of validated outcomes measures? | 3 |
| How important is it to have fracture classification system agreement for all fractures, such as the use of AO/OTA? | 4 |
| How important is it to have established, minimum set of reported patient factors (clinical, demographic)? | 5 |
| How important is it to have established, consistent recording of post-acute care, rehabilitation (site, amount, timing)? | 6 (tie) |
| How important is it to have fracture classification system agreement for stable/unstable intertrochanteric fractures? | 6 (tie) |
| How important is it to have established, consistent use of intermediate outcomes (complications, revisions)? | 8 |
| How important is it to have established, clinically meaningful measures sensitive to differences in implant classes? | 9 |
| How important is it to have established, consistent definitions of surgical quality (e.g., technical quality such as quality of reduction, implant position, cup placement? | 10 |
| How important is it to have established, consistent recording of family and social support items? | 11 |
| How important is it to include the use of anabolic agents? | 12 |
| How important is it to have an established, consistent set of surgeon factors (e.g., surgeon experience, board certification, fellowship training, case volume)? | 13 |

For rank: 1=high. Importance was rated using a scale of 1(not important) to 10 (very important)

The following items were also rated as highly important by stakeholders: the general concepts of using a comprehensive conceptual model upon which to base study design; capturing baseline comorbidities as separate predictive factors to determine possible interactions with treatment responses; capturing treatment trajectories over time; addressing the representativeness of patient samples; and addressing which research questions can be answered through the use of registry data. However, stakeholders assigned lower priority scores to linking hip fracture research design initiatives with other coordinated research efforts, such as the National Institutes of Health Patient-Reported Outcomes Measurement Information System (PROMIS) patient outcome measurement initiative.

Stakeholders then ranked hip fracture research question and theme area priorities. Executive Summary Table 2 provides the rankings for these research questions. Of the top seven ranked research questions, only three, treatments for frail elderly patients and the treatment of displaced femoral neck fractures and unstable intertrochanteric hip fractures, were rated by a strong majority as answerable by RCTs. The top three priority research questions, which were related to functional recovery trajectories and the impact of suboptimal surgical quality on function, were rated as not good candidates for RCT research.

**Executive Summary Table 2. Stakeholder ranking of research questions**

| Item | Rank |
|---|---|
| 1. Functional recovery trajectories | |
| _ What predicts short time-to-recovery after hip fracture? | 1 |
| _ What predicts functional outcomes after 1 year, especially 1-2 years after hip fracture? | 2 |
| _ What is the impact of suboptimal surgical quality on functional outcomes? | 3 |
| 2. Patient populations: | |
| _ What treatment approach works best for patients admitted from nursing homes vs. community? | 4 |
| _ Do certain procedures (e.g., internal fixation) work better than others for frail older patients? | 5 |
| _ Are most fragile patients more or less likely to have suboptimal fracture reduction/implant position than the most active, mobile patients (making them higher risk for implant failure?) | 6 (tie) |
| _ Which procedures are better for patients with dementia? | 10 |
| 3. Condition specific questions | |
| _ What is the optimal treatment for displaced femoral neck fractures? | 6 (tie) |
| _ What is the optimal treatment for “unstable” intertrochanteric hip fractures? | 8 |
| _ What is the optimal treatment for subtrochanteric hip fractures? | 9 |
| 4. Implant specific comparisons/head-to-head trials | |
| _ Between class comparisons (e.g., IM nail vs screws) | 11 |
| _ Within-class comparison of arthroplasty – cement vs not | 12 |
| _ Within-class comparison of number and placement of screws | 13 |
| _ Within-class comparison of plate length, position | 14 |
| _ Within-class comparison of nail length (IMN) | 15 |

Responses to the question “What are the top three research areas for which registry data would be most useful?” mirrored the results of the RCT ratings. The most frequently cited research areas included patient characteristics, fracture type and implant use, and outcomes, essentially to determine prognostic factors for functional recovery.

Stakeholders also provided feedback via email on potential ways to incentivize researchers to follow the research recommendations. Since it is essential that individual study results are comparable with other studies to maximize the research benefit of each RCT, consensus conference recommendations on topics such as general and condition-specific outcomes assessments to include with each study must be disseminated with sufficient clarity and impact to surgeons and researchers to ultimately improve research practices. Ultimately,

incentives will be needed to encourage researchers to adopt the principles espoused here. As such, the following consensus building mechanisms were endorsed by the stakeholders:

- Create a set of study design and outcome measurement recommendation, similar to CONsolidated Standards Of Reporting Trials (CONSORT), for journals to adopt as a mandatory publication requirement for hip fracture research. Simultaneously publish recommendations in top orthopaedic journals, such as the Journal of Bone & Joint Surgery, Clinical Orthopaedics and Related Research, the Journal of International Orthopaedics, and the Journal of Orthopaedic Trauma. This is the same approach that was used to disseminate CONSORT recommendations.[2]
- Podium presentations and symposia proposals for annual professional meetings of the Orthopaedic Trauma Association, and the American Academy of Orthopaedic Surgeons calling for adoption of the recommendations.
- Encourage research funders to use a similar set of recommendations in writing requests for proposals or scoring submitted research proposals.

# Conclusions

This pilot project engaged hip fracture experts, orthopaedic surgeon-researchers, professional organization and industry representatives, and funders, to indentify and prioritize critical hip fracture outcomes knowledge gaps, and the best approaches to resolving them. This project provided valuable information that can advance hip fracture outcomes to improve the quality of care for his high-risk patient population. Successively refined research gap documents evaluated by stakeholders, augmented with a conference call discussion, proved to be a workable way to obtain both information on gaps and the opinions of various entities regarding the prioritization of cutting-edge issues in the treatment of hip fracture patients.

Agreement on the need for improvement in research measurement and methods across all types of hip fracture investigators was high among this group of experts. Similarly, priority areas for investigation showed a high degree of agreement across stakeholders, suggesting areas of focus for future hip fracture research efforts.

Although our panel of stakeholders identified specific areas for research improvements, the comments were principally directed toward orthopaedic rather than non-orthopaedic researchers. Further refinements to research recommendations that are specific to orthopaedic surgeons or epidemiologists could readily be determined within a consensus conference setting. However, this pilot project could not determine whether the majority of orthopaedic surgeons who treat hip fracture patients or epidemiologists who evaluate hip fracture outcomes perceive a need for research or measurement improvements. Such a determination would be essential if improvements were to be implemented in the broader professional and research communities.

Although ideas were generated for incentivizing research improvements, little is known about ways to change surgeon-researcher behavior in the conduct of clinical studies. Incentives need to offset the challenges of conducting clinical outcomes studies. Higher standards or scores by funding bodies for optimally-designed and measured clinical studies was one mechanism that received stakeholder support. Ultimately, several approaches to target providers across multiple settings may encourage improved outcomes, although the optimal incentivizing mechanism remains unknown.

# Background

The systematic review "Treatments of Common Hip Fractures," completed in August 2009, was the result of a topic nomination made by the American Academy of Orthopaedic Surgeons, who were planning to formulate clinical guidelines for surgical procedures for implantable devices. The nominator was interested in understanding the interaction between patient factors, fracture types, types of surgical implants, and outcomes.

Following refinement, the key questions addressed were:

Key Question 1. What is the relationship between patient variables (e.g., demographic factors, comorbidities), the type of fracture (i.e., intertrochanteric, subtrochanteric, subcapital) and post-treatment outcomes (e.g., pain, mobility, mortality)?

Key Question 2. What is the relationship between the type of fracture (i.e., intertrochanteric, subtrochanteric, subcapital) and post-treatment outcomes (e.g., pain, mobility, mortality)?

Key Question 3. What is the relationship between implant variables (e.g., position, material, method, and design of implant) and patient post-treatment outcomes (e.g., pain, mobility, mortality)?

Key Question 4. What is the relationship between the type of intervention (e.g., internal fixation versus arthroplasty) and patient post-treatment outcomes (e.g., pain, mobility, mortality)?

The systematic review was unable to fully answer the research questions with the existing literature generally because of two main factors: (1) the limited perspective of discipline-specific investigations (i.e., orthopaedics or epidemiology), which tended to use incomplete sets of important independent variables in study designs and models, and (2) the generally low quality of hip fracture outcome studies to date, where specific populations were poorly defined, and the use of inconsistent outcome variables prevented aggregating or even comparing results. The latter problem of inconsistent outcomes measures is a general issue for most mobility literature.

Additionally, very little literature was available to provide evidence for the multitude of comparisons of device variables within a class of devices, i.e. number of screws or the specific design for sliding hip screw implants. With this inability to show either greater effectiveness or equivalency between device variables, or between devices within a class, aggregating the comparisons at the level of head to head comparisons of classes of devices becomes problematic.

## Research Gaps

A number of recommendations were made to improve future research to support developing useful guidelines for orthopaedic surgeons. Table 1, a reproduction of a table from the original report, summarizes the research recommendations, which were largely aimed at improving study design and conduct consistent with CONSORT quality recommendations.

**Table 1. Treatment of common hip fractures report: future research recommendations[1]**

| Key Question | Results of Literature Review | Types of Studies Needed to Answer Question | Future Research Recommendation |
|---|---|---|---|
| 1. What is the relationship between patient variables, the type of fracture and post-treatment outcomes? | Age, gender, prefracture functioning, and cognitive impairment appear to be related to mortality and functional outcomes. | Comprehensive studies that include variables that describe salient patient characteristics, fracture type, and surgical factors | • Include nursing home or dementia patients and distinguish them in analysis.<br>• Include comprehensive set of predictor variables.<br>• Collaboration between epidemiology and surgeon investigators.<br>• Include stable/unstable intertrochanteric subtypes (AO/OTA classification) in analyses, as well as surgical treatments; does outcome depend more on reduction than implant? |
| 2. What is the relationship between the type of fracture and post-treatment outcomes? | Fracture type is not independently related to patient outcomes in observational literature, but the literature has not generally examined stable and unstable intertrochanteric fractures. | | |
| 3. What is the relationship between implant variables and patient post-treatment outcomes? | Few studies show dramatic effects on patient level outcomes. | Well-designed RCTs. Likely multicenter studies will be necessary to attain adequately powered sample sizes. | • Consistent use of validated outcome measures.<br>• Quantify and report quality of surgical technique.<br>• Reliable reporting of stable/unstable intertrochanteric fracture subtypes.<br>• More inclusive conceptual models.<br>• Data pooling.<br>• Collaborate with observational investigators. |
| 4. What is the relationship between the type of intervention and patient post-treatment outcomes? | | | |

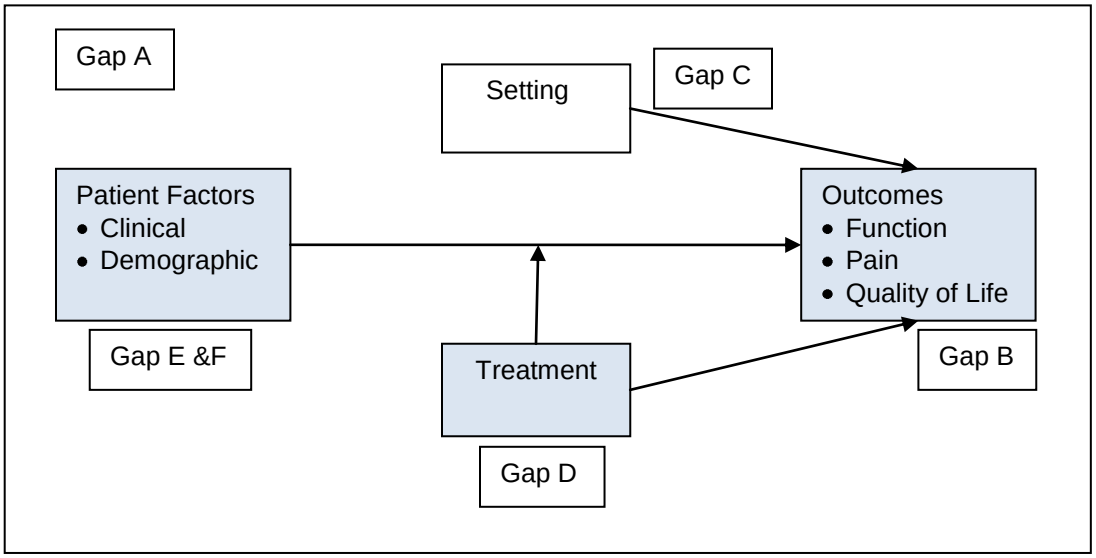
Figure 1 provides an illustration of the general conceptual model for important components in the surgical treatment of common hip fractures and their relationships to patient outcomes and the identified research gaps provided in Table 1 above. The highlighted factors are those which were explicitly addressed in the key questions, that is, patient demographic and clinical factors, including fracture type, type of treatment, and patient outcomes such as function, pain, and quality of life. The major research gaps identified in the original report can be categorized into the two main areas discussed earlier, e.g., discipline-specific study issues and studies of low quality, and located within this conceptual model.

**Discipline-specific studies.** There is one major gap in this category: Gap A. Gap A in Figure 1 refers to the lack of a comprehensive research view in the majority of hip fracture outcomes studies. Specifically, studies to date lack a broad set of predictor variables that sufficiently account for non-treatment factors, such as baseline patient status, clinical features, patient characteristics, and setting/contextual factors, that may affect patient outcomes. Surgeon investigators tend to exclude setting and patient factors, while observational researchers tend to omit condition and treatment-specific details. This problem is exacerbated by the lack of research collaboration between epidemiologic and orthopaedic surgeon investigators.

**Low quality outcome studies.** There are four major gaps in this category. Gap B, located with the patient outcomes in Figure 1, relates to the inconsistent use of validated outcome measures. Gap C relates to the incomplete reporting of treatment settings factors, such as hospital volume

and surgical variables, such as surgical technique or surgeon experience with each treatment/device. Gap D relates to the treatment-specific details, an omission in many observational studies. This is further complicated by a lack of head to head trials comparing various components of device characteristics to establish whether equivalency or improved effectiveness of specific components of devices can be demonstrated. Gap E relates to the inadequate classification of clinical patient factors, i.e. stable or unstable fractures and the type of fracture. Gap F addresses patient populations that are not well represented in the current literature, such as patients with cognitive impairments and dementia, or patients admitted from nursing homes and other institutional residences.

**Figure 1. Conceptual model**




The focus of the original systematic review was on patient-related outcomes, such as function, pain, and quality of life, in the recovery after hip fracture. In order to fully address these outcomes, the quality of research evidence for these outcomes will need to improve. Therefore, the goals of this hip fracture research needs project were:

1. To list, update, and prioritize research gap areas that need to be filled to advance hip fracture outcomes knowledge.
2. To identify specific treatment and outcome measurement issues which require resolution to advance the field in meaningful ways.
3. To suggest the best research method(s) to address specific knowledge gaps (RCT or other research design, consensus conference of experts, other), and
4. Where a consensus conference(s) is/are indicated, suggest ways to disseminate conference recommendations to the field (orthopaedics, epidemiology) so recommendations can be implemented in research.

# Methods

This section provides a brief overview of the methods employed for this project. Please refer to Appendixes A through C for more detailed project methods.

## Identifying Ongoing Studies

We performed a search to locate relevant, recently completed and currently ongoing hip fracture studies that potentially addressed existing knowledge gaps. Additionally, searches were carried out in Medline for recent publications that became available subsequent to the 2009 systematic review. ClinicalTrials.gov (http://clinicaltrials.gov), the WHO International Clinical Trials Registry Platform (ICTRP) (http://www.who.int/ictrp/en/), and the National Institutes of Health Research Portfolio Online Reporting Tool (RePORT) (http://projectreporter.nih.gov/reporter.cfm) web-based trial registries were searched for relevant ongoing studies. Studies were matched to the previously identified hip fracture research gaps and provided to stakeholders for comment.

## Engaging Stakeholders, Researchers, and Funders

We formed a 21-member stakeholder group with broad representation from orthopaedic surgeon-researchers, epidemiologists, professional organizations, federal and foundation research funders, healthcare payors, and device industry representatives. We sought stakeholders who were familiar with current hip fracture research practices and knowledge of research design since the identified research gaps were methodological in nature.

A conference call with 14 available stakeholders was held in June 2010, to discuss the state of hip fracture research, solicit feedback on the consolidated list of research gap areas, and to refine the research questions. Participating stakeholders were representative of the larger stakeholder group; no type of stakeholder was unrepresented on the call. All 21 stakeholders were provided the Executive Summary from the original systematic review to help set the context for the conference call. Identified ongoing studies were combined with the list of identified research gaps from the original 2009 systematic review to generate a table of specific hip fracture knowledge gaps. This table was also provided prior to the stakeholders prior to the conference call.

Email was used for all other stakeholder contact. All 21 stakeholders received a summary of the conference call, and a revised research agenda based on stakeholder input, and were asked to provide further comment or clarification if warranted. We conducted a prioritization activity by email to a subgroup of 10 stakeholders. We used stakeholder comments and the Revised Research Agenda to develop a two-part prioritization activity asking stakeholders to rate the importance of various research concepts, and rank a list of hip fracture outcomes measurement issues. A representative sub-group of seven non-government stakeholders, representing payors, device manufacturers, and a diverse set of researchers, and three government employees, participated in this activity. Additional feedback was sought from all stakeholders on potential ways to disseminate recommendations to improve research quality among orthopaedic surgeons and epidemiologists/observational researchers, and how to best incentivize all researchers to improve study quality.

## Handling Conflicts of Interest

Disclosure forms of conflicts of interests were collected from all stakeholders. While no one was prohibited from participating based on their disclosures, the forms would have allowed us to temper any stakeholder's contributions if the conversation topic warranted attention.

Multiple representatives of different device industry manufacturers participated. This was done in order to avoid the perception of undue influence by any one manufacturing firm.

Although the intention was to keep a fire-wall between funders and researchers, scheduling did not allow this option. However, this fact did not appear to inhibit participation. Since the conference call discussion remained at the general level of how the field needs to address the existing research gaps, rather than the development of specific research questions, any issues of unfair advantage for future research proposals appears very low. Stakeholder responses to ranking specific research questions on the prioritization activity were handled by email, thus researchers and funders were blind to the other's stated opinions.

## Determining Appropriate and Feasible Study Designs

Information regarding appropriate and feasible study designs was gathered during the stakeholder conference call and through the prioritization activity. The majority of the conference call was spent discussing the gap between ideal and current research design practices, and problematic measurement issues that limit the comparability of study results. Suggestions regarding the range of possible study designs (i.e., RCT, observational studies, and the use of registries), and opinions about issues in outcomes assessment were obtained. The prioritization activity asked whether or not each identified research question could be adequately addressed with an RCT. The activity also asked stakeholders to suggest topics for which research based on registries would be most useful.

## Prioritizing Research

We used stakeholder comments and a revised research agenda to develop a two-part email prioritization activity for a sub-group of stakeholders to complete. The stakeholders were asked to rate on a scale of 1 (least important) to 10 (most important) the relative importance of methods issues that could be resolved in a consensus conference. They were also asked to rank current hip fracture outcomes measurement issues that require resolution to advance the field, starting with 1 as the highest priority (most limiting) issue. Stakeholders were then asked to rank specific research questions, again starting with 1 as the highest priority question. Prioritization activity results were tabulated and ranked based on mean scores.

# Results

## Contribution of Ongoing Studies and Recent Publications

We did not find that any research gap was adequately addressed by recently completed studies. (See Appendix B) A few studies underway, specifically the FAITH and HEALTH trials have incorporated more complete conceptual models, are using validated outcomes assessment tools, and are collecting data to help understand the potential impact of factors such as the quality of surgical technique on patient outcomes.

## Recommended Research

Stakeholders identified fundamental outcomes measurement issues that require resolution among orthopaedic surgeons and other researchers to meaningfully advance hip fracture outcomes knowledge. The mechanism to resolve these interdisciplinary outcomes issues, recommended by the Minnesota EPC and endorsed by the stakeholders, was a consensus conference.

Table 2 provides a summary of stakeholder rankings for consensus conference topics. All items related to measurement were rated as moderately (scores in the 6 to 7 range) to highly important (scores in the 8 to 9 range). High priority and high importance was placed on a broad set of measurement consistency issues that are more generally accepted as important to researchers across disciplines. Such items included priority outcomes to be reported across studies, and establishing definitions and the recommended use of pertinent predictor variables. Items that received lower priority scores are largely items which are associated with one specific discipline or another, be it a surgical view, a rehabilitation view, or an epidemiological view. The trending toward wider standard deviations among lower-ranked conference topics also highlights the wider variation in the stakeholder responses to these items.

**Table 2. Stakeholder ranking of consensus conference topics**

| Consensus Conference Item | Rank | Importance Mean (SD) |
|---|---|---|
| How important is it to have established, consistent reporting of post-treatment outcomes (function, pain, living situation, mortality, quality of life) | 1 | 9.2 (1.3) |
| How important is it to have established, consistent definitions of the types of fracture | 2 | 8.7 (1.7) |
| How important is it to have a tool box of validated outcomes measures? | 3 | 8.5 (1.7) |
| How important is it to have fracture classification system agreement for all fractures, such as the use of AO/OTA? | 4 | 8.7 (2.0) |
| How important is it to have established, minimum set of reported patient factors (clinical, demographic) | 5 | 8.7 (1.7) |
| How important is it to have established, consistent recording of post-acute care, rehabilitation (site, amount, timing) | 6 (tie) | 8.2 (2.4) |
| How important is it to have fracture classification system agreement for stable/unstable intertrochanteric fractures? | 6 (tie) | 8.0 (2.1) |
| How important is it to have established, consistent use of intermediate outcomes (complications, revisions) | 8 | 8.2 (1.9) |
| How important is it to have established, clinically meaningful measures sensitive to differences in implant classes | 9 | 7.6 (1.9) |
| How important is it to have established, consistent definitions of surgical quality (e.g., technical quality such as quality of reduction, implant position, cup placement | 10 | 6.4 (3.2) |
| How important is it to have established, consistent recording of family and social support items | 11 | 6.9 (2.9) |
| How important is it to include the use of anabolic agents | 12 | 6.0 (2.4) |
| How important is it to have an established, consistent set of surgeon factors (e.g., surgeon experience, board certification, fellowship training, case volume) | 13 | 5.7 (2.4) |

For rank: 1=high. Importance was rated using a scale of 1(not important) to 10 (very important)

The following items were also rated as highly important by stakeholders: the general concepts of using a comprehensive conceptual model upon which to base study design (importance = 8.5, SD 1.5); capturing baseline comorbidities as separate predictive factors to determine possible interactions with treatment responses (importance = 8.3, SD 2.2); capturing treatment trajectories over time (importance = 8.0, SD 1.8); addressing the representativeness of patient samples (importance = 8.0, SD 1.9); and addressing which research questions can be answered through the use of registry data (importance = 8.2, SD 1.9). However, stakeholders assigned lower priority scores to linking hip fracture research design initiatives with other coordinated research efforts, such as the National Institutes of Health Patient-Reported Outcomes Measurement Information System (PROMIS) patient outcome measurement initiative (importance = 3.9, SD 2.9).

Assuming that critical measurement issues had been resolved through a consensus conference, stakeholders then ranked hip fracture research question and theme area priorities. Table 3 provides the rankings for these research questions. Of the top seven ranked research questions, only three, treatments for frail elderly patients and the treatment of displaced femoral neck fractures and unstable intertrochanteric hip fractures, were rated by a strong majority as answerable by RCTs. The top three priority research questions, which were related to functional recovery trajectories and the impact of suboptimal surgical quality on function, were rated as not good candidates for RCT research.

**Table 3. Stakeholder ranking of research questions**

| Item | Rank (1=high) | # Yes (Question is good RCT candidate) |
|---|---|---|
| 1. Functional recovery trajectories | | |
| _ What predicts short time-to-recovery after hip fracture? | 1 | 3 |
| _ What predicts functional outcomes after 1 year, especially 1-2 years after hip fracture? | 2 | 3 |
| _ What is the impact of suboptimal surgical quality on functional outcomes? | 3 | 0 |
| 2. Patient populations: | | |
| _ What treatment approach works best for patients admitted from nursing homes vs. community? | 4 | 5 |
| _ Do certain procedures (e.g., internal fixation) work better than others for frail older patients? | 5 | 7 |
| _ Are most fragile patients more or less likely to have suboptimal fracture reduction/implant position than the most active, mobile patients (making them higher risk for implant failure?) | 6 (tie) | 1 |
| _ Which procedures are better for patients with dementia? | 10 | 3 |
| 3. Condition specific questions | | |
| _ What is the optimal treatment for displaced femoral neck fractures? | 6 (tie) | 8 |
| _ What is the optimal treatment for "unstable" intertrochanteric hip fractures? | 8 | 8 |
| _ What is the optimal treatment for subtrochanteric hip fractures? | 9 | 6 |
| 4. Implant specific comparisons/head-to-head trials | | |
| _ Between class comparisons (e.g., IM nail vs screws) | 11 | 6 |
| _ Within-class comparison of arthroplasty – cement vs not | 12 | 5 |
| _ Within-class comparison of number and placement of screws | 13 | 4 |
| _ Within-class comparison of plate length, position | 14 | 4 |
| _ Within-class comparison of nail length (IMN) | 15 | 5 |

Responses to the question "what are the top three research areas for which registry data would be most useful" mirrored the results of the RCT ratings. The most frequently cited research areas included patient characteristics, fracture type and implant use, and outcomes, essentially to determine prognostic factors for functional recovery.

# Dissemination of Research Recommendations

Stakeholders provided feedback via email on potential ways to incentivize researchers to follow the research recommendations. Since it is essential that individual study results are comparable with other studies to maximize the research benefit of each RCT, consensus conference recommendations on topics such as general and condition-specific outcomes assessments to include with each study must be disseminated with sufficient clarity and impact to surgeons and researchers to ultimately improve research practices. Ultimately, incentives will be needed to encourage researchers to adopt the principles espoused here. As such, the following consensus building mechanisms were endorsed by the stakeholders:

- Create a set of study design and outcome measurement recommendations, similar to CONSORT, for journals to adopt as a mandatory publication requirement for hip fracture research. Simultaneous manuscript publications in top orthopaedic journals, such as the Journal of Bone & Joint Surgery, Clinical Orthopaedics and Related Research, Journal of International Orthopaedics, and the Journal of Orthopaedic Trauma, as well as placing the recommendations online for reference. This is the same approach that was used to disseminate CONSORT recommendations.[2]

- Podium presentations and symposia proposals for annual professional meetings of the Orthopaedic Trauma Association and the American Academy of Orthopaedic Surgeons calling for adoption of the recommendations.
- Encourage research funders to use a similar set of recommendations in writing requests for proposals, or scoring submitted research proposals.

# Discussion

A select group of hip fracture outcomes experts, professional organization representatives, funders, payors and industry representatives showed a high level of agreement in the identification and significance ranking of current hip fracture outcomes issues that remain unresolved.

The use of a consensus conference as means to resolve fundamental measurement issues that continue to handicap hip fracture outcomes investigations received unanimous support, along with strong agreement on the issues that require resolution by that mechanism. The larger standard deviations for lower ranked consensus conference items demonstrate a wider variance in perceptions among stakeholders. This variability can be interpreted as honest disagreement or as evidence of a lack of consensus on important research design issues, although the scope of this project was not intended to make that specification. Instead, we use the results as yet more evidence that a consensus conference, where ideas can be shared and debated, remains an essential task to be completed in order to advance the field.

The top three research questions ranked by stakeholders relate to the timing of functional recovery and the relationship between surgical quality and functional outcomes. These questions map to Gaps B-F identified in Figure 1, as understanding patient, setting, and treatment factors are necessary components to developing knowledge regarding predictors of functional recovery, which in turn require valid and reliable outcome measurements. Information on functional recovery trajectories, both early and late after hip fracture surgery, represent refinements of clinical investigations to date. Resolution of timing issues will enable better comparisons to be made of the value of one device class over another if the benefits are short-lived. Stakeholder rankings, combined with current orthopaedic clinical trials that include surgical quality assessments, suggest acknowledgement by surgeons that unlike pharmaceutical trials, variation in treatment quality may impact outcomes (Gap C). The association between surgical quality and outcomes appeared only minimally in the orthopaedic hip fracture literature 15-20 years ago, then essentially disappeared until recently.[1]

Two of three areas that ranked highest among stakeholders for RCT investigation reflect current high-visibility controversies in orthopaedics, including the optimal treatment for patients with displaced femoral neck fractures or unstable intertrochanteric hip fractures. Using the conceptual model in Figure 1 as guidance would lead to well-designed RCTs. The third area, the optimal treatments for frail elderly hip fracture patients, reflects the changing demographics of U.S. hip fracture patients, and the historically low involvement of the very old in hip fracture clinical trials to date, leaving a broad knowledge gap in the treatment of this growing and high-risk segment of the population (Gap A).

Although the experts who participated in this project were selected as representative of broader professional and research groups with hip outcomes interests, the prioritization activity was limited to a small subsample of the stakeholder group, and the results may not reflect the priorities of the general stakeholder population. The sample size was limited by the Paperwork Reduction Act and Information Collections Policy (44 USC 3501-3520), administered by the Office of Management and Budget.[3] The Act was designed to minimize the paperwork burden on the public, assure high quality data are obtained, and minimize costs. However, the approval process to allow greater than nine non-government participants exceeded the length of time available to complete the project. Instead, we sought to minimize the burden by using a small sample size and informal discussions via teleconference.

Fundamental concepts implicit in this project, including the assumption that orthopaedic surgeons collectively recognize that their clinical research would benefit from design and measurement improvements, and that the optimal outcomes to measure are patient, rather than complications-based, were not explicitly determined in this pilot project. Such potentially-delicate intraprofessional concepts may be better assessed from within by surgeon opinion leaders and professional organizations.

We found strong agreement on mechanisms for the dissemination of consensus conference recommendations for improved research designs, study quality and outcomes measurement among stakeholders. However, the more challenging issues of incentivizing surgeons and epidemiologists to improve study quality received less-definitive recommendations. Orthopaedic and orthopaedic research opinion leaders can lead by example in future clinical outcomes studies, since suggestions to improve research practices may be best heard when delivered by opinion leaders within the professions, rather than by outside entities. Varied approaches may be the most successful. Closely following that, funding agencies, including Foundations, would benefit the processes greatly by adopting a set of standards for the conduct of RCTs with the goal of comparability across studies to maximize outcome information.

# Conclusions

This pilot project engaged hip fracture experts, orthopaedic surgeon-researchers, professional organization and industry representatives, and funders, to indentify and prioritize critical hip fracture outcomes knowledge gaps, and the best approaches to resolving them. This project provided valuable information that can advance hip fracture outcomes to improve the quality of care for his high-risk patient population. Successively refined research gap documents evaluated by stakeholders, augmented with a conference call discussion, proved to be a workable way to obtain both information on gaps, and the opinions of various entities regarding the prioritization of cutting-edge issues in the treatment of hip fracture patients.

Agreement on the need for improvement in research measurement and methods across all types of hip fracture investigators was high among this group of experts. Similarly, priority areas for investigation showed a high-degree of agreement across stakeholders, suggesting areas of focus for future hip fracture research efforts.

Although our panel of stakeholders identified specific areas for research improvements, the comments were principally directed toward orthopaedic rather than non-orthopaedic researchers. Further refinements to research recommendations that are specific to orthopaedic surgeons or epidemiologists could readily be determined within a consensus conference setting. However, this pilot project could not determine whether the majority of orthopaedic surgeons who treat hip fracture patients, or epidemiologists who evaluate hip fracture outcomes, perceive a need for research or measurement improvements. Such a determination would be essential if improvements were to be implemented in the broader professional and research communities.

Although ideas were generated for incentivizing research improvements, little is known about ways to change surgeon-researcher behavior in the conduct of clinical studies. Incentives need to offset challenges of conducting clinical outcomes studies. Higher standards or scores by funding bodies for optimally-designed and measured clinical studies was one mechanism that received stakeholder support. Ultimately, several approaches to target providers across multiple settings may encourage improved outcomes, although the optimal incentivizing mechanism remains unknown.

# References

# Abbreviations

| | |
|---|---|
| EPC | Evidence-based Practice Center |
| RCT | Randomized controlled trial |

# Appendixes

Appendix A. Search Strategy for Recently Published and Ongoing Studies
Appendix B. List of Ongoing and Recently Published Studies
Appendix C. Prioritization Methods and Tools

# Appendix A. Search Strategy for Recently Published and Ongoing Studies

Medline was searched from 2008-present (July, 2010) for randomized clinical trials, systematic reviews, meta-analyses, and observational studies, to determine if publications subsequent to the 2009 Minnesota EPC report partially filled the previously-identified knowledge gaps. The search strategy used in the original report was replicated. This search included a list of terms intended to identify all research publications associated with intertrochanteric/subtrochanteric and subcapital hip fractures. Searches for trials were further limited by terms to identify types of surgical implant interventions. We also manually searched reference lists from relevant systematic reviews. Publications were assessed for relevance through dual review at the title/abstract level; applicable studies were retrieved, reviewed, and matched to one or more existing research gap areas.

We also searched ClinicalTrials.gov (http://clinicaltrials.gov), the WHO International Clinical Trials Registery platform (ICTRP) (http://www.who.int/ictrp/en/), and the NIH Research Portfolio Online Reporting Tool (RePORT) (http://projectreporter.nih.gov/reporter.cfm) web-based trial registries for relevant ongoing studies. Searches were conducted using simple search terms such as "hip fracture." Trial records were reviewed for relevance based on patient population, age 50 and older with a nonpathologic fracture that resulted from low energy trauma, and fracture type. All types of femoral neck or intracapsular fractures were included. Applicable studies were reviewed and matched to one or more existing research gap area.

# Appendix B. List of Ongoing and Recently Published Studies

**Table B-1. List of identified relevant studies from trial registries**

| Trial # (Registry) | Trial Name | Investigators Study Sponsor Collaborators |
|---|---|---|
| NCT01051830 (ClinicalTrials.gov) | Care model for hip fractured elderly persons with diabetes mellitus | (none listed)<br>Chang Gung Memorial Hospital<br>National Health Research Institutes, Taiwan |
| NCT00556842 (ClinicalTrials.gov) | Comparing total hip arthroplasty and hemi-arthroplasty on revision surgery and quality of life in adults with displaced hips fractures (HEALTH) | M. Bhandari, TA Eihnorn, MJ Heetveld<br>NIAMS<br>Hamilton Health Sciences, ZonMw: Netherlands, CIHR: Canada |
| NCT00557167 (ClinicalTrials.gov) | Evaluation of surgical fixation using alternative implants for the treatment of hip fractures (FAITH) | M Bhandari<br>Canadian Institutes of Health Research<br>NIH, Stichting Nuts Ohra |
| NCT00323232 (ClinicalTrials.gov) | Comparison of treatment outcomes in hip fractures surgiacally fixed with either a two or four hole device | PJ O'Brien<br>University of British Columbia |
| NCT00491673 (ClinicalTrials.gov) | A prospective randomized trial of uncemented versus cemented hemiarthroplasty for displaced femoral neck fractures (HEMI04) (completed) | W Figved<br>Ullevaal University Hospital<br>Asker & Baerum Hospital |
| NCT00859378 (ClinicalTrials.gov) | Cemented vs non-cemented semiendoprosthesis in the treatment of proximal femoral fractures | (none listed)<br>Kuopio University Hospital<br>Finnish Foundation of Orthopedics and Traumatology |
| NCT00800124 (ClinicalTrials.gov) | Prospective randomized study on cemented versus non-cemented hemiarthroplasty in elderly with hip fractures | O Talsnes<br>Sykehuset Innlandet HF<br>Rikshospitalet University Hospital, Sykehuset Buskerud |
| NCT00306917 (ClinicalTrials.gov) | Prospective, randomized study of Summit Porocoat vs Summit DuoFix HA in cementless total hip arthroplasty | DA Fisher, JW Mesko, P Perona, SB Lowe, DL Pomeroy, N Reddy<br>DePuy Orthopaedics |
| NCT00736684 (ClinicalTrials.gov) | Proximan femoral nail antirotation (PFNA) vs Gamma Nail 3 (Gamma3) for intramedullary nailing of unstable trochanteric fractures (PROGAINT-ES) | J Vaquero Martin<br>AO Clinical Investigation and Documentation<br>Synthes Inc. |
| NCT00595634 (ClinicalTrials.gov) | Intramedullary nailing for treatment of unstable intertrochanteric hip fracture outcome study (INTUIT) | G Brown<br>Smith & Nephew Recon |
| NCT00621088 (ClinicalTrials.gov) | A prospective randomized multicenter study comparing the sliding hip screw and the InterTAN nail in trochanteric and subtrochanteric femoral fractures | K Matre<br>Haukeland University Hospital |
| NCT00597779 (ClinicalTrials.gov) | Extramedullary vs intramedullary devices in the treatment of unstable intertrochanteric hip fractures | R Reindl<br>McGill University Health Center<br>Orthopaedic Trauma Association |
| NCT00664950 (ClinicalTrials.gov) | InterTAN IM nail versus sliding hip screw in geriatric fractures | D Sanders, D Bryant<br>Lawson Health Research Institute<br>Orthopaedic Research Foundation |
| NCT00829725 (ClinicalTrials.gov) | Comparison study of 3-4 screws internal fixation with multi-screw system Targon FN for femoral neck fracture | (none listed)<br>Sheba Medical Center |
| NCT00555945 (ClinicalTrials.gov) | Re-evaluation of Gamma3 intramedullary nails in intertrochanteric hip fracture (REGAIN) | M Bhandari<br>Hamilton Health Sciences<br>Stryker Orthopaedics |

| Trial # (Registry) | Trial Name | Investigators Study Sponsor Collaborators |
|---|---|---|
| NCT00317837 (ClinicalTrials.gov) | Bi-polar vs unipolar hemiarthroplasty for patients aged 70 years or above with a dislocated medial femoral neck fracture | M Lamm<br>Northern Orthopaedic Division, Denmark |
| NCT00764153 (ClinicalTrials.gov) | Hemiarthroplasty or internal fixation for displaced femoral neck fractures—5 years follow up | JE Madsen<br>Ullevaal University Hospital<br>Norwegian Foundation for Health and Rehabilitation, Research Council of Norway |
| ACTRN12609000367246 (WHO Portal) | A randomized clinical trial of pain and mobility following cemented vs uncemented hemiarthroplasy in elderly patients with hip fracture | F Taylor<br>Accident Compensation Corporation |
| ACTRN12608000162314 (WHO Portal) | Prospective randomized pilot study comparing the dynamic hip screw and intramedullary gamma nail regarding the treatment of intertrochanteric hip fracture | R. Molnar<br>Unfunded |
| 3R37AG009901-14S1 (RePORTER) | Sequelae of hip fracture in men: an epidemiologic study | J Magaziner<br>University of Baltimore<br>NIA |
| 5R01AG029315-04 (RePORTER) | The epidemiology of bone strength and muscle composition after hip fracture in men | J Magaziner<br>University of Baltimore<br>NIA |

**Table B-2. Randomized clinical trials published May 2008 to July 2010**

| Author, Year, Country | Comparison | Fracture Pattern, Patient Population | Patient N | Randomization Scheme | Outcomes | Results |
|---|---|---|---|---|---|---|
| **Femoral Neck: Displaced/Not Displaced** | | | | | | |
| Leonardsson, 2010[1] Sweden | Arthroplasty vs. IF: results at 10 years follow-up<br><br>*2 year results published by Rogmark et al. in 2002 (JBJS-Br) | displaced femoral neck fractures: Garden 3 or 4; age 70+, 1995-97<br><br>Exclude: confused, bed-ridden, RA, not community, fracture older than 2 days | N=450 IF: 217 arthro: 192 | 41 patients excluded for various reasons after randomization "by sealed, numbered opaque envelopes" | Mortality, device failure, and a "standardized questionnaire that assessed social and medical factors, as well as walking ability" 5 years: by mail. 10 years: 53/96 had exam and x-rays | Failures: 45.6% in IF vs. 8.8% in replacement. Most common reasons for "salvage revision" in IF group were nonunion and AVN. Mortality same: 75% at 10 yrs. Pt-reported pain and function similar in both groups at 5, 10 yrs. |
| Figved, 2009[2] Norway | Cemented vs. uncemented hemiarthroplasty (both bipolar) | displaced femoral neck fractures, age 70+ | N=220 c: 112 un:108 | Two sites randomized separately using a computer random number generator with permuted blocks of five | HHS, Barthel Index, EQ-5D | Barthel index and EQ-5D scores were similar across groups. Rates of complications and mortality similar. |
| Macaulay, 2008[3] USA | hemiarthroplasty vs. THA (DFACTO) | displaced femoral neck fractures, previously independent | n=40 | "..opaque sealed envelope technique". Blocked randomization, 5 sites | 6, 12, 24 mo: SF-36, WOMAC, HHS, timed up & go | At 24 months, THA had significantly less pain on SF36 and scored better on SF-36 MH subscale. THA had superior WOMAC. |
| **Extracapsular/Stable and Unstable Intertrochanteric and Subtrochanteric** | | | | | | |
| Barton, 2010[4] UK | Long Gamma Nail vs. Sliding Hip Screw (4-hole plate) | AO/OTA 31-A2 (Intertrochanteric), Ages 42-99. Half of patients had "reduced mental capacity" by Mini-mental score <10<br><br>Exclude: prior or pathologic, reverse oblique, surgeon decided not to enroll | N=210; LGN:100 SHS:110 | "Randomization was carried out with the use of sealed envelopes generated by a medical statistician. One envelope was selected and opened at daily trauma meeting". Sample size est. was 220; 300 envelopes were generated but only 210 enrolled: groups were unbalanced on mental status | Primary: reoperation by 1 year; secondary: EuroQoL 5D; mobility and residence (at admit and 1 year) used 5 point scale | No significant differences in reoperation at 1 year or EQ-5D, any secondary outcomes. No differences in mortality after correction for the mini-mental score (more LGN patients had reduced mental scores-see randomization). Third generation LGN (current) |

DHS=Dynamic hip screw, IF=Internal fixation, IMN=Intramedullary nail, NR=Not reported, RCT=Randomized controlled trial, SHS=Sliding hip screw, THA=Total hips arthroplasty

**References for Table B-2**

1. Leonardsson O, Sernbo I, Carlsson A, et al. Long-term follow-up of replacement compared with internal fixation for displaced femoral neck fractures: results at ten years in a randomised study of 450 patients. J Bone Joint Surg Br 2010 Mar;92(3):406-412.

2. Figved W, Opland V, Frihagen F, et al. Cemented versus uncemented hemiarthroplasty for displaced femoral neck fractures. Clin Orthop Relat Res 2009 Sep;467(9):2426-2435.

3. Macaulay W, Nellans KW, Garvin KL, et al. Prospective randomized clinical trial comparing hemiarthroplasty to total hip arthroplasty in the treatment of displaced femoral neck fractures: winner of the Dorr Award. J Arthroplasty 2008 Sep;23(6 Suppl 1):2-8.

4. Barton TM, Gleeson R, Topliss C, et al. A comparison of the long gamma nail with the sliding hip screw for the treatment of AO/OTA 31-A2 fractures of the proximal part of the femur: a prospective randomized trial. J Bone Joint Surg Am 2010 Apr;92(4):792-798.

**Table B-3. Observational trials published May 2008 to July 2010**

| Author Year country | Study Aim | Patient N follow-up | Patient population, fracture type | Outcomes | Surgical treatment | Site | Results |
|---|---|---|---|---|---|---|---|
| Samuelsson, 2009[1] Sweden | Analyze outcomes after hip fracture with respect to gender and cognitive function | N=2,134 2 years | consecutive patients in 2003. All nonpathologic fractures age 25-103 (12% of patients were < age 69)<br><br>intra- vs. extracapsular fractures, no subtypes | By gender and cognitive status: Mortality, residence, walking ability and activities of daily living (ADLs) were analyzed at baseline, 4 and 24 months. Assessed by phone or postal questionnaire; mortality by proxy or hospital register | internal fixation or prosthesis | 4 university hospitals in Stockholm | Women were older, more often living alone and had poorer walking ability at baseline. Women with intracapsular fractures were significantly more often treated with arthroplasty. Men had higher risk for losing walking ability and death only among men with cognitive impairment. Cognitive function was the most important factor in regaining prefracture function and returning to own home |

**References for Table B-3**

1. Samuelsson B, Hedstrom MI, Ponzer S, et al. Gender differences and cognitive aspects on functional outcome after hip fracture--a 2 years' follow-up of 2,134 patients. Age Ageing 2009 Nov;38(6):686-692.

**Table B-4. Systematic reviews and meta-analyses published May 2008 to July 2010**

| First Author, Year | Title Fracture Pattern Patient Population | # of Studies Patient N Hip N | Devices | Outcomes Addressed | Reported Results |
|---|---|---|---|---|---|
| **Femoral Neck: Displaced/Not Displaced** | | | | | |
| Hopley 2010[1]<br><br>Searched 1966 to March 2010 | Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review.<br><br>Patient age > 60 years | 4 RCTs, 3 quasirandomized trials, 8 retrospective cohort studies N=1890 | THA vs. hemiarthroplasty | Reoperations, mortality, complications, function, QoL | THA may lead to lower reoperation rates and better functional outcomes compared with hemiarthroplasty. However, reoperation effect was mainly driven by studies without concealed treatment allocation. Study heterogeneity precluded definitive statements; further research was recommended. |
| Goh 2009[2]<br><br>Searched 1966 to February 2006 | Meta-analysis comparing total hip arthroplasty with hemi-arthroplasty in the treatment of displaced neck of femur fracture | 3 RCTs N=407 | THA vs. hemiarthroplasty | Primary: revision hip surgery. Secondary: mortality, pain, hip function and mobility | No significant differences mortality at any time point (1, 2, 3 and 13 years). THA had significantly less pain at 1 year but not at 2 years. No significant differences in dislocation at any time point. |
| Wang 2009[3]<br><br>Searched 1979 to May 2008 | Arthroplasty or internal fixation for displaced femoral neck fractures: which is the optimal alternative for elderly patients? A meta-analysis<br><br>Garden 3 or 4 | 20 RCTs and quasirandomized trials (N=3,109). 10 RCTs (N=1,477) had complications at 2 years. 2 RCTs had complications at 5 years (N=380) | All types of internal fixation versus arthroplasty (THA or hemi, including uni- and bipolar) | Mortality, pain, revision surgery, surgical and medical complications | No significant differences mortality at any time point. No differences in pain at 1 year. Arthroplasty had higher risk of deep infection, and that was associated with the need for reoperation. Arthroplasty had significantly fewer reoperations at 1, 2 and 5 years. |
| **Extracapsular/Stable and Unstable Intertrochanteric and Subtrochanteric** | | | | | |

| First Author, Year | Title<br>Fracture Pattern<br>Patient Population | # of Studies<br>Patient N<br>Hip N | Devices | Outcomes Addressed | Reported Results |
|---|---|---|---|---|---|
| Bhandari, 2009[5]<br><br>Searched 1969 to January 2006 | Gamma nails revisited: Gamma nails versus compression hip screws in the management of intertrochanteric fractures of the hip: a meta-analysis | 20 RCTs<br>N=3,464 | Gamma nail vs. sliding hip screw | Femoral shaft fracture | Risk of femoral shaft fracture related to Gamma nails appears to be decreasing over time. Based on 352 patients from 2005, authors concluded that risk was no longer significant compared with sliding hip screw procedures. |
| Parker 2008[6]<br><br>Searched 1966 to June 2007 | Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults. | 36 RCTs and quasi<br>N=<br>(22 compared GN vs. SHS in 3,871 patients) | intramedullary nails versus extramedullary implants, multiple types | Operative details, fracture fixation complications, post-op complications, anatomical restoration, mortality, pain, mobility, failure to return to pre-fracture residential status | Update of 2005. Sliding hip screw superior for trochanteric fractures compared to IMN due to lower device complication rates. Functional outcomes, mortality and postoperative complications were similar. Further research required if intramedullary nails have advantages for other fracture types (example: subtrochanteric) or if different IMNs produce similar results. |
| Kuzyk, 2009[7]<br><br>Searched through June 2007 | Minimally Invasive Hip Fracture Surgery: Are Outcomes Better?<br><br>intertrochanteric fractures | 14 RCTs N=not stated<br>(Table 1 total is 2,099) | Minimally-invasive plating, nailing or external fixation vs. SHS; many implants | Mortality, fixation failure, transfusion need, operative time | Transfusion was significantly lower in minimally-invasive group. No significant differences for other outcomes, including mortality. |
| Panesar, 2008[8]<br><br>Searched 1995-2006 | The percutaneous compression plate versus the dynamic hip screw: a meta-analysis<br><br>head to head trials (1995-2006) | ? | PCCP versus DHS | Primary: mortality at one year. Secondary: perioperative factors | Decreased trend in early mortality in PCCp group (p=0.51). “Similar trends found for other outcomes.” |

| First Author, Year | Title Fracture Pattern Patient Population | # of Studies Patient N Hip N | Devices | Outcomes Addressed | Reported Results |
|---|---|---|---|---|---|
| Jiang 2008[4]<br><br>Searched ? | No advantages of Gamma nail over sliding hip screw in the management of peritrochancteric hip fractures: a meta-analysis of randomized controlled trials | 11 RCTs N=1,344 | Gamma nail vs. sliding hip screw | Mortality, cut-out, non-union, re-operation, wound infection, intra-operative fractures of femur, blood loss or surgical time | There were no significant differences between groups on any outcomes. Authors concluded there were no obvious advantages of Gamma nails over sliding hip screw fixation. |
| **Subtrochanteric** | | | | | |
| Kuzyk, 2009[9]<br><br>Searched through June 2007 | Intramedullary versus extramedullary fixation for subtrochanteric femur fractures<br><br>Included intertroch with subtroch extension. | 12 studies: N=NR (Table 1 total = 691) Three level I studies were used to calculate a pooled relative risk for failure of fixation | | Fixation failure, operative time, blood loss, intraoperative complications, postoperative medical complications, transfusion need, wound complications, nonunion, length of hospital stay, and functional recovery | Grade B evidence that operative time and fixation failure are reduced with the use of intramedullary implants for subtrochanteric fractures. "Studies rarely provided information on preoperative medical or functional status." Only one level 1 study reported significantly better walking ability at 4 weeks in the IMN group, but no difference at 4 or 12 months. |

DHS=Dynamic hip screw, IF=Internal fixation, IMN=Intramedullary nail, NR=Not reported, RCT=Randomized controlled trial, SHS=Sliding hip screw, THA=Total hips arthroplasty

**References for Table B-4**


1. Hopley C, Stengel D, Ekkernkamp A, et al. Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review. BMJ 2010;340:c2332.
2. Goh SK, Samuel M, Su DH, et al. Meta-analysis comparing total hip arthroplasty with hemiarthroplasty in the treatment of displaced neck of femur fracture. J Arthroplasty 2009 Apr;24(3):400-406.
3. Wang J, Jiang B, Marshall RJ, et al. Arthroplasty or internal fixation for displaced femoral neck fractures: which is the optimal alternative for elderly patients? A meta-analysis. Int Orthop 2009 Oct;33(5):1179-1187.
4. Jiang SD, Jiang LS, Zhao CQ, et al. No advantages of Gamma nail over sliding hip screw in the management of peritrochanteric hip fractures: a meta-analysis of randomized controlled trials. Disabil Rehabil 2008;30(7):493-497.

5. Bhandari M, Schemitsch E, Jonsson A, et al. Gamma nails revisited: gamma nails versus compression hip screws in the management of intertrochanteric fractures of the hip: a meta-analysis. J Orthop Trauma 2009 Jul;23(6):460-464.
6. Parker MJ, Handoll HH. Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults. Cochrane Database Syst Rev 2008(3):CD000093.
7. Kuzyk PR, Guy P, Kreder HJ, et al. Minimally invasive hip fracture surgery: are outcomes better? J Orthop Trauma 2009 Jul;23(6):447-453.
8. Panesar SS, Mirza S, Bharadwaj G, et al. The percutaneous compression plate versus the dynamic hip screw: a meta-analysis. Acta Orthop Belg 2008 Feb;74(1):38-48.
9. Kuzyk PR, Bhandari M, McKee MD, et al. Intramedullary versus extramedullary fixation for subtrochanteric femur fractures. J Orthop Trauma 2009 Jul;23(6):465-470.

# Appendix C. Prioritization Methods and Tools

## Specific Methods

*1. We formed stakeholder groups with representation from orthopaedic surgeon-researchers, epidemiologists, professional organizations, federal and foundation research funders, payors and device industry representatives.*

We sought stakeholders who were familiar with current hip fracture research practices and knowledge of research design since the identified research gaps were methodological in nature. We first constructed a general list of the types of care providers, researchers, professionals and funders that represent various stakeholder groups and perspectives who hold an interest in hip fracture outcomes. The specific list of stakeholders was then constructed. The Technical Expert Panel (TEP) members from the 2009 project were included (orthopedic and epidemiologic researchers, plus a representative from the topic requestor, the American Academy of Orthopedic Surgeons (AAOS)). Additional researchers with broad hip fracture outcomes and rehabilitation interests were added, including physical therapy, an international orthopaedic researcher and epidemiologic researchers. We included representatives from the major orthopaedic and aging outcomes funding agencies (government, orthopaedic associations and foundations). In addition to the AAOS, several professional organizations were included: the Orthopaedic Trauma Association (OTA) and the American Academy of Physical Medicine and Rehabilitation (AAPM&R). Finally, we listed large payors of hip fracture services, a Medicare advisory group, and industry representatives (device manufacturers). Where additional contacts were needed, prior TEP members were consulted for individual suggestions to generate a comprehensive stakeholder lost to encompass broad hip fracture treatment perspectives. This process resulted in a 21 member stakeholder group including orthopaedic surgeon-researchers, epidemiologists, professional organizations, federal and foundation research funders, healthcare payors, and device industry representatives.

The list of research gaps identified in the August 2009 report served as the starting point for this project based on the four key questions that were the focus of the 2009 report. A more detailed table of research gaps was then constructed by the MN EPC faculty from the Discussion within the 2009 report, and used as the basis for a stakeholder conference call. Table C-1 provides a summary table of the research gaps that was provided to the stakeholders. Column 1 lists the key questions (1-4) from the 2009 hip fracture report, plus additional knowledge gap areas that are not specifically identified within the key questions. Column 2 lists the hip fracture research gap areas that were identified in the report, with additional specificity regarding research gaps. Column 3 has specific population needs that the MN EPC has identified.

*2. We simultaneously performed a search to locate relevant, recently-completed and currently on-going hip fracture outcomes studies that potentially addressed existing knowledge gaps. (See Appendix A for more search details.)*

Search results were combined with the list of identified research gaps from the original systematic review to generate a list of specific hip fracture knowledge gaps for email distribution to the stakeholders prior to the stakeholder conference call. Column 4 in Table C-1 lists ongoing studies that may address some of the identified gaps, and was generated from ClinicalTrails.gov.

**Table C-1. Research gaps table prepared for stakeholder conference call discussion**

| Key Question/Cross-cutting Issues | Research knowledge gaps | Under-studied populations | Ongoing studies that may address knowledge gaps |
|---|---|---|---|
| Interdisciplinary research | Lack of inclusive conceptual models which incorporate comprehensive set of predictor variables that sufficiently account for non-treatment factors that may influence outcomes | All patients | |
| Outcomes measurement | Consistent use of validated quality of life and outcome assessment tools<br>-crosswalk studies for each measure<br>-consensus conference for minimum outcome measurement set | All patients | |
| Fracture classifications | Consensus for:<br>-stable/unstable intertrochanteric fractures<br>-crosswalk of fracture classifications for comparability across studies | All patients | |
| 1. What is the relationship between **patient variables**, the **type of fracture** and patient post-treatment **outcomes**, such as pain and functioning?<br><br>*how patient factors, including fracture type, relate to patient outcomes* | A. Relationship between baseline *patient covariates* and post-treatment *outcomes*<br><br>B. Relationship between *type of fracture*, and post-treatment *outcomes*, given the patient covariates (see Q2, A)<br>a. how outcomes are modified by: inferior surgical quality, and/or using surgeon characteristics as proxy surgical quality<br>b. subgroup differences in fracture types?<br><br>C. How functional recovery trajectories differ by patient factors and fracture type, controlling for treatment<br>What predicts short time-to-recovery after hip fracture?<br><br>D. Functional trajectories after 1 year, especially 1-2 years after hip fracture<br>Factors associated with functional declines beyond 1 year after hip fracture | Outcomes and treatment differences:<br><br>a. patients admitted from nursing homes vs. community<br>b. cognitively-impaired patients from any setting<br>c. by race/ethnicity (changing U.S. demographics)<br>d. by physiologic vs. chronologic age (active elderly)<br>e. obese elderly<br>f. nutritionally-depleted vs. sarcopenic vs. frail elderly<br><br>-Isolated low energy hip fractures in older individuals (homogeneous clinical trial populations)<br><br>- In which patients is the risk/benefit ratio too great for surgical treatment of a hip fracture? | NCT01051830 Care model for hip fracture patient with diabetes (Taiwan) |

| Key Question/Cross-cutting Issues | Research knowledge gaps | Under-studied populations | Ongoing studies that may address knowledge gaps |
|---|---|---|---|
| 2. What is the relationship between the **type of fracture** and patient post-treatment **outcomes?**<br><br>*controlling for patient factors* | A. Relationship between *type of fracture*, and post-treatment *outcomes*, controlling for patient covariates<br><br>B. What is the optimal treatment for displaced femoral neck fractures?<br><br>C. What is the optimal treatment for 'unstable' intertrochanteric hip fractures?<br><br>D. Which AO/OTA 31-A fracture patterns should be treated as unstable fractures?<br><br>E. Subtrochanteric fractures | All patients<br><br>Subgroups: see 1B(b)<br>a. patients admitted from nursing homes vs. community<br>b. cognitively-impaired patients from any setting<br>c. by race/ethnicity (changing U.S. demographics) | NCT00556842. HEALTH: hemiarthroplasty vs. THA<br>NCT00557167. FAITH: internal fixation: pins vs. plate/screws |
| 3. What is the relationship between **implant variables** and patient post-treatment **outcomes?**<br><br>*implant-specific* | Incomplete sets of head-to-head trials.<br><br>A. What is the optimal treatment for displaced femoral neck fractures?<br><br>B. What is the optimal treatment for 'unstable' intertrochanteric hip fractures?<br><br>C. Within-class device comparisons:<br>-number and placement of screws<br>-plate length, position<br>-nail length (IMN)<br>-arthroplasty- cement versus not<br><br>D. how outcomes are modified by:<br>-inferior surgical quality, regardless of device.<br>Are some devices less forgiving of suboptimal surgical technique? | All patients, including specific high-risk subgroups | C: NCT00323232. SHS with 2 vs. 4 holes for 2 to 4 part IT fracture<br>NCT00491673 (completed) cement vs. uncemented hemi for displaced FN fracture<br>NCT00859378 cement vs. uncemented for FN<br>NCT00800124. Cement vs. uncemented hemi for dislocated FN<br>NCT00306917 (Trauma or elective?)<br>NCT00736684 PFNA vs. Gamma3 nail for unstable IT<br>NCT00546429? ATN Nail outcome study<br>NCT00595634? INTUIT. InterTAN for unstable IT outcome study |

| Key Question/Cross-cutting Issues | Research knowledge gaps | Under-studied populations | Ongoing studies that may address knowledge gaps |
|---|---|---|---|
| 4. What is the relationship between the **type of intervention** and patient **post-treatment outcomes?**<br><br>*device class comparisons*<br><br>*-how outcomes are modified by:*<br>** inferior surgical quality, and/or*<br>**using surgeon characteristics as a proxy for surgical quality* | Incomplete sets of head-to-head trials.<br><br>A. Timing of functional recovery by device: does one class of device afford earlier return to function?<br><br>B. What is the optimal treatment for displaced femoral neck fractures?<br><br>C. What is the optimal treatment for 'unstable' intertrochanteric hip fractures?<br><br>D. How to best treat 75-85 year old femoral neck fracture patients<br><br>E. how outcomes are modified by:<br>-inferior surgical quality, regardless of device. Are some devices less forgiving of suboptimal surgical technique? | All patients, including specific high-risk subgroups:<br>a. is optimal technique more important to outcomes in some patient groups?<br>b. Are most fragile patients more or less likely to have suboptimal fracture reduction/implant position than the most active, mobile patients? | NCT00556842. HEALTH: hemiarthroplasty vs. THA<br><br>NCT00557167. FAITH: internal fixation: pins vs. plate/screws<br><br>NCT00621088 possible. Subtroch SHS vs. Intertran Nail<br>NCT00597779 TFN vs. SHS for unstable IT<br>NCT00664950. InterTAN Nail vs. SHS for IT<br>NCT00829725 Parallel screws vs. TARGON implant for FN.<br>NCT00555945. Gamma3 Nail vs. SHS for IT (REGAIN)<br>NCT00317837. Bi vs. Uni-hemi for displaced FN<br>NCT00764153. Hemi vs. Internal fix for displaced FN (also NCT00464230) |

*3. A conference call with stakeholders was held to solicit feedback on the consolidated list of research gap areas and to refine the research questions*.

Preparatory materials including the Executive Summary from the original systematic review, Table C-1, directions for reading the table, and the Minnesota EPC follow-up plan for the subsequent ranking exercise were distributed to all 21 stakeholders prior to the conference call. Fourteen stakeholders, representing all major types of stakeholders, were available and participated in the conference call. Following the 1 hour conference call, convened by the Minnesota EPC, stakeholder feedback was used to refine a one-page Revised Hip Fracture Research Agenda. The revised research agenda was sent out to all 21 stakeholders for comment along with a summary of the call; it included two theme areas: measurement and design issues. This agenda is provided Table C-2.

**Table C-2. Revised hip fracture research agenda**

| | |
|---|---|
| **Measurement Issues** | 1. Need to operationalize each element<br>▪ Intervention/procedure (including technical quality such as quality of reduction, implant position, cup placement)<br>▪ Type of fracture<br>▪ Patient factors (clinical, demographic)<br>▪ Surgeon factors (measures of surgeon quality, e.g. quality of initial reduction, placement of implants, appropriate sizing of femoral head endoprostheses)<br>▪ Outcomes<br>• Post-treatment: function, pain, living situation, mortality quality of life<br>• Intermediate: complications, revisions<br>• Sensitivity to differences in implant classes but still meaningful<br>▪ Use of anabolic agents<br>▪ Role of post-acute care, rehabilitation (site, amount, timing)<br>▪ Role of family support/Social support<br>2. Toolbox of approved, validated measures<br>3. Classification system for fractures (AO/OTA)<br>▪ stable/unstable intertrochanteric fractures<br>4. Within-class device comparisons:<br>▪ number and placement of screws<br>▪ plate length, position<br>▪ nail length (IMN)<br>▪ arthroplasty- cement versus not<br>5. Linkage with other ongoing efforts (e.g., PROMIS) |
| **Design Issues** | 6. Lack of inclusive conceptual models that incorporate comprehensive set of predictor variables (reflecting clinical and epidemiological perspectives) in study analyses that sufficiently account for factors that may influence outcomes (see attached model)<br>7. Capture baseline comorbidities as separate predictive factors and for interactions with treatment<br>8. Examine clinical trajectories. How long should benefits persist?<br>▪ Frequency and timing of follow-ups<br>9. Head-to-head trials<br>▪ Within-class comparisons (e.g., features of sliding hip screws)<br>▪ Between class comparisons (e.g., IM nail vs. screws)<br>10. Sampling issues (representativeness)<br>11. Role of registries |

*4. We used stakeholder comments and the Revised Research Agenda to develop a two-part prioritization activity for stakeholders to rate and rank 1.) hip fracture outcomes measurement issues and the best way to resolve them, and 2.) specific research questions and whether or not each could be addressed with a randomized clinical trial (RCT).*

Research prioritization by stakeholders was accomplished with a two-part activity. The first part listed a set of potential consensus conference research agenda items. Stakeholders were asked to rate the importance of each issue on a 1 to 10 scale, with 10 being most important, and then rank the priority of each of 13-items with 1 being most important and 13 being of least importance. The second part of the activity listed a set of potential hip fracture research questions. Stakeholders were asked to rank the research questions, and indicate whether an RCT would be a good candidate research design to answer the question. The activity is shown in Figure C-1 below:

We explored various means of setting criteria for the prioritization exercise. We initially intended to use the Effective Health Care selection criteria. However, this proved to be off-target for this form of methods related research needs. Instead, the prioritization activity, as can be seen in Figure C-1, attempted to contextualize the activity by asking participants to think about a possible agenda for an invitation-only consensus conference on hip fracture research.

**Figure C-1. Research prioritization activity for hip fracture outcomes stakeholders and experts**

**Common Hip Fractures Research Agenda**

**We are asking you to make several ratings about various items. Please rate all the elements in the shaded boxes.**

1. Thinking about a possible agenda for an invitation-only **consensus conference** on hip fracture research, please answer the following set of questions.

A. Please **rate** importance as **1 (not important) to 10 (very important) based on**:

- Variation: Addressing the issue would contribute to solving important variation in research or clinical care, or controversy in what constitutes optimal clinical care.
- Uncertainty: Addressing the issue would contribute to solving important uncertainty for decision makers.

B. Please **rank** your enthusiasm from **1 (highest rank) to 19 (lowest rank)** based on:

- Would addressing the item at a consensus conference be a reasonable use of conference time?
- Would addressing the item at a consensus conference be feasible, i.e., likely to result in a useful outcome?

**Please complete all shaded areas.**

| Item | Importance | Enthusiasm for Consensus Conference |
|---|---|---|
| 1. In terms of **measurement**, how important is it to include each of the following factors in research design? | | |
| • established, minimum set of reported patient factors (clinical, demographic) | | |
| • established, consistent definitions of the types of fracture | | |
| • established, consistent definitions of surgical quality (e.g., technical quality such as quality of reduction, implant position, cup placement | | |
| • established, consistent set of surgeon factors (e.g., surgeon experience, board certification, fellowship training, case volume) | | |
| • established, consistent reporting of post-treatment outcomes (function, pain, living situation, mortality, quality of life) | | |
| • established, consistent use of intermediate outcomes (complications, revisions) | | |
| • established, clinically meaningful measures sensitive to differences in implant classes | | |
| • the use of anabolic agents | | |
| • established, consistent recording of post-acute care, rehabilitation (site, amount, timing) | | |
| • established, consistent recording of family and social support items | | |
| 2. How important is it to have a tool box of validated outcomes measures? | | |
| 3. How important is it to have fracture classification system agreement | | |
| • for all fractures, such as the use of AO/OTA? | | |
| • for stable/unstable intertrochanteric fractures? | | |

| **For the next set of items please provide a single overall importance rating using a 1-10 scale where 1 is most important.** | **Importance** |
|---|---|
| 4. How important is it to link hip fracture research design and conduct with other ongoing coordinated research efforts (e.g., the NIH Patient Reported Outcomes Measurement Information System (PROMIS))? | |
| 5. In terms of design issues, for each study, how important is it to use a conceptual model that includes a comprehensive set of predictor variables (reflecting clinical and epidemiological perspectives)? | |
| 6. How important is it to capture baseline comorbidities as separate predictive factors, and assess them for interactions with treatment? | |
| 7. How important is it to examine clinical trajectories (suggest frequency and timing of follow-ups)? | |
| 8. How important is it to address the representativeness of patient samples? | |
| 9. How important is it to decide which research questions can be addressed by registry data? | |

What are the top three research areas for which registries would be most useful?

1.

2.

3.

2. Assuming that consensus and operational definitions were established for:

- Specific interventions
- Patient factors to collect
- Fracture classification/aggregation (stable/unstable by AO/OTA definitions)
- Surgical quality:
  - reduction parameters
  - optimal implant position (internal fixation, arthroplasty components)
- Outcomes:
  - maximal recovery: function, pain, QoL, living site/situation
  - intermediate: complications, revisions
  - minimum validated generic and condition-specific tools to use per study
- Post-acute care quantification,

Please **rank** the following research questions: There are 15 items. Please give the most important item a 1, and so on through 15. Then indicate which of these questions could realistically be answered by an RCT.

| **Item** | **Rank (1 = most important)** | **RCT Candidate (Y/N)** |
|---|---|---|
| 1. Functional recovery trajectories | | |
| • What is the impact of suboptimal surgical quality on functional outcomes? | | |
| • What predicts short time-to-recovery after hip fracture? | | |
| • What predicts functional outcomes after 1 year, especially 1-2 years after hip fracture? | | |
| 2. Patient populations: | | |
| • What treatment approach works best for patients admitted from nursing homes vs. community? | | |
| • Are most fragile patients more or less likely to have suboptimal fracture reduction/implant position than the most active, mobile patients (making them higher risk for implant failure?) | | |
| • Do certain procedures (e.g., internal fixation) work better than others for frail older patients? | | |
| • Which procedures are better for patients with dementia? | | |
| 3. Condition specific questions | | |
| • What is the optimal treatment for displaced femoral neck | | |

| | | |
|---|---|---|
| fractures? | | |
| • What is the optimal treatment for “unstable” intertrochanteric hip fractures? | | |
| • What is the optimal treatment for subtrochanteric hip fractures? | | |
| 4. Implant specific comparisons/head-to-head trials | | |
| • Within-class comparison of number and placement of screws | | |
| • Within-class comparison of plate length, position | | |
| • Within-class comparison of nail length (IMN) | | |
| • Within-class comparison of arthroplasty – cement vs. not | | |
| • Between class comparisons (e.g., IM nail vs. screws) | | |

*5. Activity results were tabulated; means and standard deviations are reported for X, Y and Z.*

Prioritization activity results were tabulated and rank was calculated based on mean scores. Ties in rankings were allowed. Nonresponders were sent reminder emails. If another stakeholder was invited to participate in place of a nonresponder, the nonresponder was notified that his or her participation in the prioritization exercise was not required. At total of seven non-government stakeholders, and three government employees, responded to the activity.

*6. Stakeholder feedback was solicited on ways to incentivize surgeons and researchers to adopt research recommendations, including future consensus conference results.*

An email was distributed to all stakeholders asking for advice on how to incentivize researchers to improve study design quality. We provided a list of possible options that were generated by the investigators, based in part on stakeholder comments during general discussions on the stakeholder conference call. Stakeholders were asked to respond by email whether they agreed, dissented, or comments regarding the three options. They were also invited to make any other suggestions for incentivizing the field toward change.

The possible options listed were:

- Create a set of study design and outcome measurement recommendations, similar to CONSORT, for journals to adopt as a mandatory publication requirement,
- Encourage research funders to use a similar set of recommendations in writing RFPs, or scoring (bonus points?) submissions,
- Podium presentations by opinion leaders calling for adopting recommendations.