Evidence-based guidelines for the management of hip fractures in older persons: an update

Jenson C S Mak, Ian D Cameron and Lyn M March

ABSTRACT

Objective: To update evidence-based guidelines for the treatment of proximal femoral fractures published in the Journal in 2003.

Data sources: Systematic search of MEDLINE, CINAHL and EMBASE for articles published from October 2001 to June 2008, and the Cochrane Database of Systematic Reviews (most recent issue searched — Issue 2, 2008).

Study selection: Randomised controlled trials and meta-analyses of all aspects of acute-care hospital treatment and rehabilitation for proximal femoral fractures among participants aged 50 years or older with proximal femoral fractures not associated with metastatic disease or multiple trauma.

Data extraction: All studies were reviewed independently by two assessors, who recorded individual study results, and an assessment of study quality and treatment conclusions was made according to Cochrane Collaboration protocols. If necessary, a third review was performed to reach consensus.

Results: 128 new studies were identified and 81 met our inclusion criteria. Recommendations for time to surgery, thromboprophylaxis, anaesthesia, analgesia, prophylactic antibiotics, surgical fixation of fractures, nutritional status, mobilisation and rehabilitation have been updated. Also, recommendations regarding surgical wound closure, management of postoperative delirium, osteoporosis treatment and hip protectors have been added. The guidelines include the current National Health and Medical Research Council grades of recommendations for clinical guidelines.

Conclusions: Significant changes in recommendations have been made, particularly in relation to surgery, rehabilitation and tertiary prevention. Hip fracture should be treated according to the most up-to-date evidence to achieve the best possible outcomes and optimal use of limited resources.

MJA 2010; 192: 37–41

Hip fracture is a commonly encountered clinical problem[1] and is associated with high mortality rates.[2] One in three older people who survive a hip fracture return to their previous level of independence, 50% require long-term help with routine activities and cannot walk unaided, and 25% require full-time nursing-home care.[3]

Evidence-based clinical practice guidelines for the treatment of proximal femoral fractures were first published in the Journal in 1999[4] and were updated in 2003.[5] This article updates the 2003 guidelines and includes the current National Health and Medical Research Council (NHMRC) grades of recommendations for clinical guidelines.

METHODS

We identified randomised controlled trials (RCTs) and meta-analyses of interventions for hip fracture management that were published from October 2001 to June 2008 by searching electronic databases (MEDLINE, EMBASE and CINAHL). The Cochrane Database of Systematic Reviews was searched up to Issue 2, 2008. Search terms were "hip fractures" together with specific interventions, which had been identified in the review published in 2003.[5] Searches were limited to RCTs and meta-analyses, participants aged 50 years or older, and proximal hip fractures not related to metastatic disease. Primary studies which had already been included in Cochrane Collaboration reviews at the time of our literature search were not re-reviewed. In the absence of an RCT, we searched for large-scale observational studies.

All articles were read independently by two assessors (J C S M and I D C). Results and data on study quality were recorded on a proforma developed according to Cochrane Collaboration guidelines for assessment of study quality.[6] Disagreements were resolved by a third, independent assessor (L M M) and a consensus meeting. Where possible, studies were discussed with the relevant local experts in the field (eg, orthopaedics, pain medicine and anaesthesia) to ensure that the extracted information was relevant for clinical practice in Australia.

Individual study results and an assessment of the quality of each study's methods were summarised in a table format with author, year, number of participants, interventions tested, ranking of bias (low, moderate, high), adequate concealment of allocation of patients to groups, and summary of results with relative risk, 95% confidence intervals and conclusions regarding treatment.

These tables were then used to generate a summary for each intervention, which included the previous recommendation, a summary of the evidence provided by the new studies and any new recommendations.

Evidence-based guidelines were then developed, with current NHMRC grades of recommendations.[7]

RESULTS

We identified 128 new studies, of which 81 met our inclusion criteria. Twenty-seven studies were excluded for one of the following reasons: they were not RCTs (11 studies), they were not specific for hip fractures (5), they were primary prevention studies (6), and they were published in a language other than English or did not meet our other inclusion criteria (5). Twenty studies were not re-reviewed, as they were included in Cochrane Collaboration reviews at the time of searching.

Sixteen Cochrane Collaboration reviews and 65 additional relevant articles published from October 2001 to June 2008 were identified. No new RCTs or meta-analyses were found relating to the following interventions: preoperative traction, prevention of pressure sores, oxygen therapy, pressure-gradient stockings, surgical wound drains, postoperative blood transfusion, surgical swabs and urinary catheterisation.

Four new issues in hip fracture management — surgical wound closure, reducing postoperative delirium, osteoporosis treatment and hip protectors — were included in our review, because they are pertinent management issues that have not been included in previous reviews or because studies addressing these issues are now available.

Clinical practice guidelines for the management of proximal femoral fractures*

1. Time to surgery (C)[8,9]

Early surgery (within 24–36 h) is recommended for most patients once a medical assessment has been made and the patient's condition has been stabilised appropriately. *Undue delay to surgery (> 48 h) in older patients using antiplatelet agents may be associated with higher morbidity, which may indirectly affect mortality.*[10,11]

2. Preoperative traction (A)[12-14]

There is no evidence to support the routine use of preoperative traction. The routine use of preoperative skin and skeletal traction should be abandoned.

3. Prevention of pressure sores (A)[15,16]

All patients should be nursed on a pressure-relieving mattress rather than a standard hospital mattress. Patients at very high risk of pressure sores should ideally be nursed on a large-cell, alternating-pressure air mattress or similar device.

4. Oxygen therapy (B)[17,18]

Some evidence supports the routine use of oxygen therapy for the first 72 h after surgery. All patients should have oximetry assessment from the time of emergency admission to 48 h after surgery, and oxygen administered as necessary.

5. Thromboprophylaxis (A)[19]

The substantial majority of hip fracture patients should receive low molecular weight heparin. Mechanical devices should be used for patients in whom anticoagulants and antiplatelet agents are contraindicated.

6. Pressure gradient stockings (A)[20,21]

Patients should be wearing pressure gradient stockings as soon as possible after admission.

7. Type of anaesthesia

Regional anaesthesia is recommended for most patients, *and may reduce acute postoperative confusion (A).*[22] *For continuous spinal anaesthesia, the paramedian approach is associated with a better catheter insertion rate compared with the classic midline approach (B).*[23]

8. Type of analgesia

Adequate analgesia should be administered before and immediately after surgery. *Three-in-one femoral nerve block is an effective method of providing analgesia to patients with hip fracture in the emergency department (A),*[24] *and is useful for reducing postoperative pain (A).*[25] *Intrathecal morphine is a useful and safe technique for providing postoperative pain relief after hip fracture surgery (B).*[26]

9. Prophylactic antibiotics (A)[27]

Prophylactic intravenous antibiotics should be given at induction of anaesthesia. Prolonged antibiotic use is of no proven benefit for prophylaxis of wound infection. *There is no evidence to suggest that topical antibiotics reduce wound infection (C).*[28]

10. Type of surgery

Extracapsular (trochanteric) fractures (A) should be treated surgically. *A sliding hip screw appears to be superior to fixation with intramedullary nails, given the lower complication rate of the sliding hip screw (A).*[29-31] *Unstable intertrochanteric fractures reduced in a slightly valgus position may achieve a better position after fracture healing (B).*[32] *There is insufficient evidence from randomised trials to determine important differences in outcome between different designs of intramedullary nails,*[33] *or whether replacement arthroplasty has any advantage over internal fixation (A).*[34]

Undisplaced intracapsular fractures (A) should have internal fixation with a widely used method that is familiar to the surgeon (cancellous bone screws or compression screw and plate).[35]

Displaced intracapsular fractures (A) have no clearly superior surgical treatment. The options for surgical treatment of this fracture are internal fixation or arthroplasty. *Hemiarthroplasty (femoral head replacement) is associated with greater initial operative trauma but has a lower risk of implant failure requiring reoperation of the hip than internal fixation,*[36,37] *making it a cost-efficient treatment.*[38] At present the choice of treatment is best determined by patient factors (including age, presence of arthritis, availability and cost of the different types of treatment, surgeon experience and preference) (B).[39]

Subtrochanteric fractures (C) *(including reverse oblique and transverse intertrochanteric fractures) can be treated with an intramedullary nail (eg, proximal femoral nail), which appears to be superior to a sliding hip screw because of shorter duration of surgery, shorter hospital stay, fewer orthopaedic complications and less need for major reoperations.*[40]

11. Surgical wound drains (A)[41-44]

Surgical wound drains may not be required as often as currently used and early removal is advised (about 24 h after insertion).

12. Surgical wound closure (B)[45]

Superficial wound complication rates are higher for wounds closed with metallic staples compared to wounds closed with subcuticular vicryl.

13. Postoperative blood transfusion (B)[46]

Routine transfusion in asymptomatic patients with a haemoglobin level ⩾ 80 g/L may not be required.

14. Surgical swabs (B)[47]

Calcium alginate swabs should be considered in hip fracture surgery.

15. Urinary catheterisation (B)[48]

Avoid indwelling catheters (where possible). Intermittent catheterisation is preferable and has been shown not to increase the incidence of urinary tract infections.

The updated evidence-based guidelines are summarised in the Box.

DISCUSSION

The NHMRC recommends regular review of established guidelines.[7] Our study updates previously published guidelines for the treatment of proximal femoral fractures.[5]

We made very few changes to previous recommendations, but we identified significant additional information — particularly regarding anaesthesia, analgesia and rehabilitation. We updated recommendations regarding thromboprophylaxis, type of anaesthesia, type of analgesia, type of surgery (for displaced intracapsular and subtrochanteric fractures), nutritional status, mobilisation and rehabilitation, and we added recommendations regarding surgical wound closure, reducing postoperative delirium, osteoporosis treatment and hip protectors.

One controversial issue is determining the correct timing for surgery. Early surgery (within 24–36 hours) is recommended for most patients once a medical assessment has been made and the patient's condition has been stabilised appropriately. In the largest systematic review to date (257 367 patients), increased odds for 30-day all-cause mortality and 1-year all-cause mortality were observed for delay to surgery beyond 48 hours (41% and 32%, respectively).[11] The main controversy is that delay to surgery may be a confounding factor affecting survival, rather than an independent factor affecting survival — patients for whom surgery was delayed could have been sicker on admission or may have required more preoperative examinations to stabilise their medical conditions. However, it was argued that the

Clinical practice guidelines for the management of proximal femoral fractures (continued)*

16. Nutritional status (B)

All patients should have a nutritional assessment, so that protein and energy supplements can be provided as needed. *The use of protein and energy feeds may reduce "unfavourable outcome" (combined outcome of mortality and survivors with medical complications), but has no effect on mortality.*[49-51] *The use of dietetic assistants to help improve nutritional intake may result in a slight reduction in mortality (B).*[52]

17. Reducing postoperative delirium (B)

Proactive geriatric consultation may reduce incidence and severity of delirium in patients undergoing surgery for hip fracture.[53,54] *Prophylactic low-dose haloperidol may reduce severity and duration of delirium episodes and shorten length of hospital admission for hip surgery.*[55]

18. Mobilisation

Early assisted ambulation (begun within 48 h of surgery) accelerates functional recovery and is associated with more direct discharges to home and less discharges to high-level care in previously community-dwelling individuals (B).[56] *No particular mobilisation strategies (including neuromuscular stimulation of the quadriceps) can be recommended over others (A).*[57-61] *Aerobic endurance exercise (upper body) may be integrated into standard rehabilitation to enhance patients' aerobic fitness and mobility after hip fracture surgery (B).*[62] *A weight-bearing home exercise program improves balance and functional ability among older people who have completed usual care after a hip fracture (B).*[63]

19. Rehabilitation (B)[64]

Patients with hip fracture should be offered a coordinated multidisciplinary rehabilitation program with the specific aim of regaining sufficient function to return to their prefracture living arrangements (B).[65] *Early multidisciplinary daily geriatric care reduces inhospital mortality and medical complications in older patients with hip fracture, but does not reduce length of stay or functional recovery (B).*[66,67] *A program of accelerated discharge and home-based rehabilitation may lead to functional improvement, greater confidence in avoiding subsequent falls, improvements in health-related quality of life and less caregiver burden (B).*[68-71] *Multidisciplinary programs — comprising early individualised occupational therapy during hospital admission, continuous rehabilitation as well as discharge planning (including a home visit and post-acute care coordination when appropriate) — improve physical outcomes, quality of life and self-care abilities, reduce readmission rates and depression, may reduce risk of falling and may be associated with cost savings (B).*[72-78] *Extended outpatient rehabilitation that includes progressive resistance training can also improve physical function and quality of life compared with home exercise alone (B).*[79]

20. Osteoporosis treatment

Vitamin D supplementation, injected or given orally, suppresses parathyroid hormone, increases bone mineral density and reduces falls after hip fracture in previously independent older women (B).[80] *Frail older people confined to institutions may sustain fewer hip and other non-vertebral fractures if given vitamin D with calcium supplements (A).*[81-84]

An annual infusion of zoledronic acid is associated with a reduction in rate of new clinical vertebral and non-vertebral fractures and may improve survival after a low-trauma hip fracture (B).[85] *Oral alendronate*[86] *and oral risedronate are associated with reductions in rates of vertebral and non-vertebral fractures (B).*[87,88] *In postmenopausal women with osteoporosis, strontium ranelate is associated with reductions in rates of vertebral and non-vertebral fractures, but reduced risk of hip fracture associated with strontium ranelate treatment has only been observed in women aged 74 years or older whose bone mineral density fits clinical criteria for osteoporosis (B).*[89,90] *Of these studies, only the zoledronic acid trial was conducted in a population of patients who had undergone repair of a hip fracture.*[85]

After hip fracture, the use of a case manager may help to increase the number of investigations (such as bone mineral density testing) performed and increase prescription rates of bone-protective agents (B).[91] *A perioperative inpatient intervention program, involving patient education and provision of a list of questions for the general practitioner, may increase appropriate therapeutic intervention by GPs.*[92]

21. Hip protectors (C)[93-95]

Hip protectors may reduce the risk of hip fracture in institutionalised patients, but not in community-dwelling older people. Patient acceptance of hip protectors and adherence to their use remain poor due to discomfort and practicality.

* Recommendations that have changed or been added since publication of the review in 2003[5] are shown in italics, and current National Health and Medical Research Council grades of recommendations for clinical guidelines are included (A = body of evidence can be trusted to guide practice; B = body of evidence can be trusted to guide practice in most situations; C = body of evidence provides some support for recommendation[s] but care should be taken in its application; D = body of evidence is weak and recommendation must be applied with caution).[7] ◆

effect on mortality remains even after adjusting for confounding preoperative factors. In contrast, other studies have found no differences in short-term or long-term mortality because of delay to surgery.[9,10] However, these studies used different criteria for delay to surgery (>96 hours and >24 hours, respectively) than the large systematic review.[11] Furthermore, delay to surgery beyond 48 hours has been shown to be associated with more than twice the number of major postoperative complications, including bedsores, pneumonia, urinary tract infections, deep vein thrombosis and pulmonary embolism, compared with surgery within 48 hours.[96]

Our study has some limitations. It can be difficult to decide whether evidence from older populations without hip fracture can be applied to people with hip fracture. For example, although there is now extensive evidence to guide clinical practice for falls prevention, most of these studies have not been conducted for patients with a hip fracture. The Cochrane Collaboration review of falls prevention in the community[97] included only three of 111 studies of patients after hip fracture, but this review should be carefully considered for patients who remain at substantial risk of falls after hip fracture. Furthermore, although some of the recommendations are likely to lead to additional expenditure, they may lead to long-term resource savings owing to reduction in morbidity (eg, delirium) and possible reduction in mortality (in the case of zoledronic acid).

Guidelines date quickly and our update is up to mid 2008. In developing wide-ranging systematic reviews and guidelines, it inevitably takes considerable time to review the primary studies and formulate recommendations. Publishing in a peer-reviewed journal also adds to the time from literature search to date of publication. Summarising complex issues in a review, such as this, can also be difficult. Although guidelines provide a useful resource for clinicians, it is still unclear whether the use of evidence-based guidelines improves outcomes. However, a recent meta-analysis suggests that using evidence-based clinical pathways after a hip fracture can lower the odds of common inpatient complications.[98]

Our review has updated guidelines for the management of proximal femoral fractures that were originally published in 1999[4] and updated in 2003.[5] Significant changes in recommendations, particularly in relation to surgical treatment, rehabilitation and tertiary prevention, have been made. The common clinical problem of hip fracture should be treated according to the most up-to-date evidence to achieve the best possible outcomes and optimal use of limited resources.

ACKNOWLEDGEMENTS

We acknowledge the work of the authors of previous versions of these guidelines, including Michael Chilov. We also thank Val Yates (library assistant), Denise Vitalone (librarian) and Lynne Roberts (library manager) from Bankstown–Lidcombe Hospital Library for facilitating access to the research articles, as well as Professor Ian Harris, Dr Martin Laird, Dr Nicky Walsh, Dr Richard Halliwell and Michael Glynn, who provided valuable comments on the orthopaedic, pain medicine and anaesthesia sections of the guidelines, and all the junior orthopaedic staff who assisted with data extraction for the current version of the guidelines. Finally, we acknowledge all our patients with hip fractures (including our relatives), who we have had the pleasure to look after, as they have been our best teachers.

COMPETING INTERESTS

None identified.

AUTHOR DETAILS

Jenson C S Mak, MB BS, FRACP, FAFRM(RACP), Rehabilitation Medicine Physician,[1] Geriatrician and Orthogeriatrician,[2] and Clinical Research Fellow[3]

Ian D Cameron, MB BS, PhD, FAFRM(RACP), Rehabilitation Medicine Physician and Head[3]

Lyn M March, MB BS, PhD, FRACP, Rheumatologist[4]

1 Sacred Heart Rehabilitation Service, St Vincent's Hospital, Sydney, NSW.

2 Department of Geriatric Medicine, Gosford Hospital, Gosford, NSW.

3 Rehabilitation Studies Unit, Northern Clinical School, Faculty of Medicine, University of Sydney, Sydney, NSW.

4 Institute of Bone and Joint Research, Northern Clinical School, Faculty of Medicine, University of Sydney, Sydney, NSW.

Correspondence: jenson.mak@gmail.com

REFERENCES

1 Sanders KM, Nicholson GC, Ugoni AM, et al. Health burden of hip and other fractures in Australia beyond 2000. Projections based on the Geelong Osteoporosis Study. *Med J Aust* 1999; 170: 467-470.

2 Haleem S, Lutchman L, Mayahi R, et al. Mortality following hip fracture: trends and geographical variations over the last 40 years. *Injury* 2008; 39: 1157-1163.

3 Pasco JA, Sanders KM, Hoekstra FM, et al. The human cost of fracture. *Osteoporos Int* 2005; 16: 2046-2052.

4 March LM, Chamberlain AC, Cameron ID, et al. How best to fix a broken hip. Fractured Neck of Femur Health Outcomes Project Team. *Med J Aust* 1999; 170: 489-494.

5 Chilov MN, Cameron ID, March LM. Evidence-based guidelines for fixing broken hips: an update. *Med J Aust* 2003; 179: 489-493.

6 Higgins JPT, Green S, editors. Cochrane handbook for systematic reviews of interventions. Version 5.0.2 [updated September 2009]. Oxford: Cochrane Collaboration, 2008. http://www.cochrane-handbook.org (accessed Dec 2009).

7 NHMRC additional levels of evidence and grades for recommendations for developers of guidelines. Stage 2 consultation. Early 2008 – end June 2009. http://www.nhmrc.gov.au/_files_nhmrc/file/guidelines/Stage%202%20Consultation%20Levels%20and%20Grades.pdf (accessed Dec 2009).

8 Stoddart J, Horne G, Devane P. Influence of preoperative medical status and delay to surgery on death following a hip fracture. *ANZ J Surg* 2002; 72: 405-407.

9 Grimes JP, Gregory PM, Noveck H, et al. The effects of time-to-surgery on mortality and morbidity in patients following hip fracture. *Am J Med* 2002; 112: 702-709.

10 Harty JA, McKenna P, Moloney D, et al. Antiplatelet agents and surgical delay in elderly patients with hip fractures. *J Orthop Surg (Hong Kong)* 2007; 15: 270-272.

11 Shiga T, Wajima Z, Ohe Y. Is operative delay associated with increased mortality of hip fracture patients? Systematic review, meta-analysis, and meta-regression. *Can J Anaesth* 2008; 55: 146-154.

12 Parker MJ, Handoll HHG. Pre-operative traction for fractures of the proximal femur in adults. *Cochrane Database Syst Rev* 2006; (3): CD000168.

13 Resch S, Bjarnetoft B, Thorngren KG. Preoperative skin traction or pillow nursing in hip fractures: a prospective, randomized study in 123 patients. *Disabil Rehabil* 2005; 27: 1191-1195.

14 Yip DK, Chan CF, Chiu PK, et al. Why are we still using pre-operative skin traction for hip fractures? *Int Orthop* 2002; 26: 361-364.

15 McInnes E, Bell-Syer SEM, Dumville JC, et al. Support surfaces for pressure ulcer prevention. *Cochrane Database Syst Rev* 2008; (4): CD001735.

16 Gunningberg L, Lindholm C, Carlsson M, Sjoden PO. Reduced incidence of pressure ulcers in patients with hip fractures: a 2-year follow-up of quality indicators. *Int J Qual Health Care* 2001; 13: 399-407.

17 Brown AG, Visram AR, Jones RD, et al. Pre-operative and post-operative oxygen saturation in the elderly following spinal or general anaesthesia — an audit of current practice. *Anaesth Intensive Care* 1994; 22: 150-154.

18 Fugere F, Owen H, Ilsley A, et al. Changes in oxygen saturation in the 72 hours after hip surgery: the effect of oxygen therapy. *Anaesth Intensive Care* 1994; 22: 724-728.

19 Handoll HHG, Farrar MJ, McBirnie J, et al. Heparin, low molecular weight heparin and physical methods for preventing deep vein thrombosis and pulmonary embolism following surgery for hip fractures. *Cochrane Database Syst Rev* 2002; (4): CD000305.

20 Agu O, Hamilton G, Baker D. Graduated compression stockings in the prevention of venous thromboembolism. *Br J Surg* 1999; 86: 992-1004.

21 Amaragiri SV, Lees TA. Elastic compression stockings for prevention of deep vein thrombosis. *Cochrane Database Syst Rev* 2000; (1): CD001484.

22 Parker MJ, Handoll HHG, Griffiths R. Anaesthesia for hip fracture surgery in adults. *Cochrane Database Syst Rev* 2004; (4): CD000521.

23 Rabinowitz A, Bourdet B, Minville V, et al. The paramedian technique: a superior initial approach to continuous spinal anesthesia in the elderly. *Anesth Analg* 2007; 105: 1855-1857.

24 Fletcher AK, Rigby AS, Heyes FL. Three-in-one femoral nerve block as analgesia for fractured neck of femur in the emergency department: a randomized, controlled trial. *Ann Emerg Med* 2003; 41: 227-233.

25 Parker MJ, Griffiths R, Appadu BN. Nerve blocks (subcostal, lateral cutaneous, femoral, triple, psoas) for hip fractures. *Cochrane Database Syst Rev* 2002; (1): CD001159.

26 Kwan ASK, Lee BB, Brake T. Intrathecal morphine for post-operative analgesia in patients with fractured hips. *Hong Kong Med J* 1997; 3: 250-255.

27 Gillespie WJ, Walenkamp G. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures. *Cochrane Database Syst Rev* 2001; (1): CD000244.

28 Kamath S, Sinha S, Shaari E, et al. Role of topical antibiotics in hip surgery. A prospective randomised study. *Injury* 2005; 36: 783-787.

29 Parker MJ, Handoll HHG. Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults. *Cochrane Database Syst Rev* 2008; (3): CD000093.

30 Saudan M, Lubbeke A, Sadowski C, et al. Pertrochanteric fractures: is there an advantage to an intramedullary nail?: a randomized, prospective study of 206 patients comparing the dynamic hip screw and proximal femoral nail. *J Orthop Trauma* 2002; 16: 386-393.

31 Papasimos S, Koutsojannis CM, Panagopoulos A, et al. A randomised comparison of AMBI, TGN and PFN for treatment of unstable trochanteric fractures. *Arch Orthop Trauma Surg* 2005; 125: 462-468.

32 Pajarinen J, Lindahl J, Savolainen V, et al. Femoral shaft medialisation and neck-shaft angle in unstable pertrochanteric femoral fractures. *Int Orthop* 2004; 28: 347-353.

33 Parker MJ, Handoll HHG. Intramedullary nails for extracapsular hip fractures in adults. *Cochrane Database Syst Rev* 2006; (3): CD004961.

34 Parker MJ, Handoll HHG. Replacement arthroplasty versus internal fixation for extracapsular hip fractures in adults. *Cochrane Database Syst Rev* 2006; (2): CD000086.

35 Parker MJ, Stockton G, Gurusamy KS. Internal fixation implants for intracapsular proximal femoral fractures in adults. *Cochrane Database Syst Rev* 2001; (4): CD001467.

36 Parker MJ, Gurusamy K. Internal fixation versus arthroplasty for intracapsular proximal femoral fractures in adults. *Cochrane Database Syst Rev* 2006; (4): CD001708.

37 Rogmark C, Johnell O. Primary arthroplasty is better than internal fixation of displaced femoral neck fractures: a meta-analysis of 14 randomized studies with 2,289 patients. *Acta Orthop* 2006; 77: 359-367.

38 Rogmark C, Carlsson A, Johnell O, Sembo I. Costs of internal fixation and arthroplasty for displaced femoral neck fractures: a randomized study of 68 patients. *Acta Orthop Scand* 2003; 74: 293-298.

39 Keating JF, Grant A, Masson M, et al. Randomized comparison of reduction and fixation, bipolar hemiarthroplasty, and total hip arthroplasty. Treatment of displaced intracapsular hip fractures in healthy older patients. *J Bone Joint Surg (Am)* 2006; 88: 249-260.

40 Sadowski C, Lubbeke A, Saudan M, et al. Treatment of reverse oblique and transverse intertrochanteric fractures with use of an intramedullary nail or a 95 degrees screw-plate: a prospective, randomized study. *J Bone Joint Surg (Am)* 2002; 84: 372-381.

41 Parker MJ, Livingstone V, Clifton R, McKee A. Closed suction surgical wound drainage after orthopaedic surgery. *Cochrane Database Syst Rev* 2007; (3): CD001825.

42 Tjeenk RM, Peeters MP, van den Ende E, et al. Wound drainage versus non-drainage for proximal femoral fractures. A prospective randomised study. *Injury* 2005; 36: 100-104.
43 Cobb JP. Why use drains? *J Bone Joint Surg Br* 1990; 72: 993-995.
44 Varley GW, Milner SA. Wound drains in proximal femoral fracture surgery: a randomized prospective trial of 177 patients. *J R Coll Surg Edinb* 1995; 40: 416-418.
45 Shetty AA, Kumar VS, Morgan-Hough C, et al. Comparing wound complication rates following closure of hip wounds with metallic skin staples or subcuticular vicryl suture: a prospective randomised trial. *J Orthop Surg (Hong Kong)* 2004; 12: 191-193.
46 Carson JL, Terrin ML, Barton FB, et al. A pilot randomized trial comparing symptomatic vs. hemoglobin-level-driven red blood cell transfusions following hip fracture. *Transfusion* 1998; 38: 522-529.
47 Davies MS, Flannery MC, McCollum CN. Calcium alginate as haemostatic swabs in hip fracture surgery. *J R Coll Surg Edinb* 1997; 42: 31-32.
48 Skelly JM, Guyatt GH, Kalbfleisch R, et al. Management of urinary retention after surgical repair of hip fracture. *CMAJ* 1992; 146: 1185-1189.
49 Avenell A, Handoll HHG. Nutritional supplementation for hip fracture aftercare in older people. *Cochrane Database Syst Rev* 2006; (4): CD001880.
50 Eneroth M, Olsson UB, Thorngren KG. Nutritional supplementation decreases hip fracture-related complications. *Clin Orthop Relat Res* 2006; 451: 212-217.
51 Eneroth M, Olsson UB, Thorngren KG. Insufficient fluid and energy intake in hospitalised patients with hip fracture. A prospective randomised study of 80 patients. *Clin Nutr* 2005; 24: 297-303.
52 Duncan DG, Beck SJ, Hood K, Johansen A. Using dietetic assistants to improve the outcome of hip fracture: a randomised controlled trial of nutritional support in an acute trauma ward. *Age Ageing* 2006; 35: 148-153.
53 Siddiqi N, Stockdale R, Britton AM, Holmes J. Interventions for preventing delirium in hospitalised patients. *Cochrane Database Syst Rev* 2007; (2): CD005563.
54 Marcantonio ER, Flacker JM, Wright RJ, Resnick NM. Reducing delirium after hip fracture: a randomized trial. *J Am Geriatr Soc* 2001; 49: 516-522.
55 Kalisvaart KJ, de Jonghe JF, Bogaards MJ, et al. Haloperidol prophylaxis for elderly hip-surgery patients at risk for delirium: a randomized placebo-controlled study. *J Am Geriatr Soc* 2005; 53: 1658-1666.
56 Oldmeadow LB, Edwards ER, Kimmel LA, et al. No rest for the wounded: early ambulation after hip surgery accelerates recovery. *ANZ J Surg* 2006; 76: 607-611.
57 Handoll HHG, Sherrington C. Mobilisation strategies after hip fracture surgery in adults. *Cochrane Database Syst Rev* 2007; (1): CD001704.
58 Lamb SE, Oldham JA, Morse RE, Evans JG. Neuromuscular stimulation of the quadriceps muscle after hip fracture: a randomized controlled trial. *Arch Phys Med Rehabil* 2002; 83: 1087-1092.
59 Lauridsen UB, de la Cour BB, Gottschalck L, Svensson BH. Intensive physical therapy after hip fracture. A randomised clinical trial. *Dan Med Bull* 2002; 49: 70-72.
60 Sherrington C, Lord SR, Herbert RD. A randomised trial of weight-bearing versus non-weight-bearing exercise for improving physical ability in inpatients after hip fracture. *Aust J Physiother* 2003; 49: 15-22.
61 Hauer K, Specht N, Schuler M, et al. Intensive physical training in geriatric patients after severe falls and hip surgery. *Age Ageing* 2002; 31: 49-57.
62 Mendelsohn ME, Overend TJ, Connelly DM, Petrella RJ. Improvement in aerobic fitness during rehabilitation after hip fracture. *Arch Phys Med Rehabil* 2008; 89: 609-617.
63 Sherrington C, Lord SR, Herbert RD. A randomized controlled trial of weight-bearing versus non-weight-bearing exercise for improving physical ability after usual care for hip fracture. *Arch Phys Med Rehabil* 2004; 85: 710-716.
64 Cameron ID, Handoll HHG, Finnegan TP, et al. Coordinated multidisciplinary approaches for inpatient rehabilitation of older patients with proximal femoral fractures. *Cochrane Database Syst Rev* 2001; (3): CD000106.
65 Cameron ID. Coordinated multidisciplinary rehabilitation after hip fracture. *Disabil Rehabil* 2005; 27: 1081-1090.
66 Vidan M, Serra JA, Moreno C, et al. Efficacy of a comprehensive geriatric intervention in older patients hospitalized for hip fracture: a randomized, controlled trial. *J Am Geriatr Soc* 2005; 53: 1476-1482.
67 Naglie G, Tansey C, Kirkland JL, et al. Interdisciplinary inpatient care for elderly people with hip fracture: a randomized controlled trial. *CMAJ* 2002; 167: 25-32.
68 Crotty M, Whitehead CH, Gray S, Finucane PM. Early discharge and home rehabilitation after hip fracture achieves functional improvements: a randomized controlled trial. *Clin Rehabil* 2002; 16: 406-413.
69 Kuisma R. A randomized, controlled comparison of home versus institutional rehabilitation of patients with hip fracture. *Clin Rehabil* 2002; 16: 553-561.
70 Tsauo JY, Leu WS, Chen YT, Yang RS. Effects on function and quality of life of postoperative home-based physical therapy for patients with hip fracture. *Arch Phys Med Rehabil* 2005; 86: 1953-1957.
71 Crotty M, Whitehead C, Miller M, Gray S. Patient and caregiver outcomes 12 months after home-based therapy for hip fracture: a randomized controlled trial. *Arch Phys Med Rehabil* 2003; 84: 1237-1239.
72 Hagsten B, Svensson O, Gardulf A. Health-related quality of life and self-reported ability concerning ADL and IADL after hip fracture: a randomized trial. *Acta Orthop* 2006; 77: 114-119.
73 Di Monaco M, Vallero F, De Toma E, et al. A single home visit by an occupational therapist reduces the risk of falling after hip fracture in elderly women: a quasi-randomized controlled trial. *J Rehabil Med* 2008; 40: 446-450.
74 Shyu YI, Liang J, Wu CC, et al. A pilot investigation of the short-term effects of an interdisciplinary intervention program on elderly patients with hip fracture in Taiwan. *J Am Geriatr Soc* 2005; 53: 811-818.
75 Huang TT, Liang SH. A randomized clinical trial of the effectiveness of a discharge planning intervention in hospitalized elders with hip fracture due to falling. *J Clin Nurs* 2005; 14: 1193-1201.
76 Huusko TM, Karppi P, Avikainen V, et al. Intensive geriatric rehabilitation of hip fracture patients: a randomized, controlled trial. *Acta Orthop Scand* 2002; 73: 425-431.
77 Krichbaum K. GAPN postacute care coordination improves hip fracture outcomes. *West J Nurs Res* 2007; 29: 523-544.
78 Ruchlin HS, Elkin EB, Allegrante JP. The economic impact of a multifactorial intervention to improve postoperative rehabilitation of hip fracture patients. *Arthritis Rheum* 2001; 45: 446-452.
79 Binder EF, Brown M, Sinacore DR, et al. Effects of extended outpatient rehabilitation after hip fracture: a randomized controlled trial. *JAMA* 2004; 292: 837-846.
80 Harwood RH, Sahota O, Gaynor K, et al. A randomised, controlled comparison of different calcium and vitamin D supplementation regimens in elderly women after hip fracture: the Nottingham Neck of Femur (NONOF) study. *Age Ageing* 2004; 33: 45-51.
81 Avenell A, Gillespie WJ, Gillespie LD, O'Connell DL. Vitamin D and vitamin D analogues for preventing fractures associated with involutional and post-menopausal osteoporosis. *Cochrane Database Syst Rev* 2005; (3): CD000227.
82 Boonen S, Lips P, Bouillon R, et al. Need for additional calcium to reduce the risk of hip fracture with vitamin D supplementation: evidence from a comparative metaanalysis of randomized controlled trials. *J Clin Endocrinol Metab* 2007; 92: 1415-1423.
83 Chapuy MC, Pamphile R, Paris E, et al. Combined calcium and vitamin D3 supplementation in elderly women: confirmation of reversal of secondary hyperparathyroidism and hip fracture risk: the Decalyos II study. *Osteoporos Int* 2002; 13: 257-264.
84 Lilliu H, Pamphile R, Chapuy MC, et al. Calcium–vitamin D3 supplementation is cost-effective in hip fractures prevention. *Maturitas* 2003; 44: 299-305.
85 Lyles KW, Colon-Emeric CS, Magaziner JS, et al; HORIZON Recurrent Fracture Trial. Zoledronic acid and clinical fractures and mortality after hip fracture. *N Engl J Med* 2007; 357: 1799-1809.
86 Wells GA, Cranney A, Peterson J, et al. Alendronate for the primary and secondary prevention of osteoporotic fractures in postmenopausal women. *Cochrane Database Syst Rev* 2008; (1): CD001155.
87 Wells GA, Cranney A, Peterson J, et al. Risedronate for the primary and secondary prevention of osteoporotic fractures in postmenopausal women. *Cochrane Database Syst Rev* 2008; (1): CD004523.
88 McClung MR, Geusens P, Miller PD, et al; Hip Intervention Program Study Group. Effect of risedronate on the risk of hip fracture in elderly women. *N Engl J Med* 2001; 344: 333-340.
89 Reginster JY, Felsenberg D, Boonen S, et al. Effects of long-term strontium ranelate treatment on the risk of nonvertebral and vertebral fractures in postmenopausal osteoporosis: results of a five-year, randomized, placebo-controlled trial. *Arthritis Rheum* 2008; 58: 1687-1695.
90 Seeman E, Vellas B, Benhamou C, et al. Strontium ranelate reduces the risk of vertebral and nonvertebral fractures in women eighty years of age and older. *J Bone Miner Res* 2006; 21: 1113-1120.
91 Majumdar SR, Beaupre LA, Harley CH, et al. Use of a case manager to improve osteoporosis treatment after hip fracture: results of a randomized controlled trial. *Arch Intern Med* 2007; 167: 2110-2115.
92 Gardner MJ, Brophy RH, Demetrakopoulos D, et al. Interventions to improve osteoporosis treatment following hip fracture. A prospective, randomized trial. *J Bone Joint Surg Am* 2005; 87: 3-7.
93 Parker MJ, Gillespie WJ, Gillespie LD. Hip protectors for preventing hip fractures in older people. *Cochrane Database Syst Rev* 2005; (3): CD001255.
94 Birks YF, Porthouse J, Addie C, et al; Primary Care Hip Protector Trial Group. Randomized controlled trial of hip protectors among women living in the community. *Osteoporos Int* 2004; 15: 701-706.
95 Birks YF, Hildreth R, Campbell P, et al. Randomised controlled trial of hip protectors for the prevention of second hip fractures. *Age Ageing* 2003; 32: 442-424.
96 Sircar P, Godkar D, Mahgerefteh S, et al. Morbidity and mortality among patients with hip fractures surgically repaired within and after 48 hours. *Am J Ther* 2007; 14: 508-513.
97 Gillespie LD, Robertson MC, Gillespie WJ, et al. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev* 2009; (2): CD007146.
98 Neuman MD, Archan S, Karlawish JH, et al. The relationship between short-term mortality and quality of care for hip fracture: a meta-analysis of clinical pathways for hip fracture. *J Am Geriatr Soc* 2009; 57: 2046-2054.

(Received 4 Mar 2009, accepted 17 Sep 2009) ❑