ORTHOPAEDIC CARE OF THE OLDER PATIENT

INTRODUCTION

By the year 2020 about 20% or an estimated 60 million people will be over the age of 65years. Increasing age leads to increasing vulnerability in the musculoskeletal system through injury and disease. Approximately 80% of those older individuals will have musculoskeletal complaints.

Significant osteoarthritis of the hip or knee will be reported by 40-60% of older individuals. Disabling osteoarthritis of the weight bearing joints frequently leads to joint replacement surgery performed an average 648,000 times annually from 1993-1995 (Praemer, 1999). In 1996, 74 percent of the total knee replacements and 68% of total hip replacements were performed on patients 65 and older (Praemer, 1999). As the number of elders in the population increases, so will the need for joint replacement surgery. Joint arthroplasty is expected to increase by at least 80% by 2030. (Praemer, 1999)

Age-related changes in bone and soft tissue are frequently associated with disabling fractures. In the first five years following menopause, women lose up to 25% of their bone mass. Osteoporosis affects approximately 20 million Americans, and every year 1.3 million fractures are attributed to this condition. Muscle strength decreases on average by about one-third after the age of sixty, which can lead to difficulty maintaining balance and predispose to falls. By the age of 90 one-third of women and one-sixth of

men will experience a hip fracture. About two-thirds of those who fracture a hip do not return to their prefacture level of functioning. The cost of treating all osteoporotic fractures was estimated to be 13.8 billion in 1995 and is expected to double in the next 50 years. Most of this cost can be attributed to the treatment and postoperative care of hip fractures (Praemer, 1999).

NORMAL MUSCULOSKELETAL AGING / THE AGING ATHLETE

A comprehensive review of the literature did not find any studies identifying normal ranges of motion of the extremities in older individuals. No articles were found addressing the treatment of the otherwise healthy elderly patient that sustains a sports – related musculoskeletal injury. It is not currently known whether treatments recommended for younger patients with musculoskeletal injuries are applicable in part or at all to the older patient with a similar problem.

Research is needed to define normative and incidence data in preparation for an increasingly active and vigorous older population.

- **Level B: Observational studies are needed to define the normal range of motion of the extremities in older people without musculoskeletal disease. Such studies should also examine the range of motion necessary for ADLs and IADLs.**
- **Level C: Observational studies of older athletes are needed to define the incidence and nature of sports-related injuries in older athletes**

and to examine the utility of arthroscopy in treatment of knee and shoulder injuries.

FACTORS THAT INFLUENCE POSTOPERATIVE OUTCOME

Age alone does not appear to be a prognostic factor for outcome following orthopaedic surgical procedures. Pre-existing medical condition, however, plays a significant role in postoperative outcome. Medical comorbidities influence physiological reserve, postoperative complications and capacity for rehabilitation. Many patients require treatment of a medical condition prior to elective joint replacement surgery (Clelland et al, 1996).

Following hip fracture, host factors, not injury severity, are the primary determinants of long-term survival (VanderSluis, et al, 1997). One year mortality following hip fracture may be predicted on admission by the number of medical conditions: with no other medical conditions, mortality is 0%, with one or two, mortality is 14%, with three or more, the mortality is 24% (Svensson et al, 1996).

Malnutrition is common in older patients. The incidence of malnutrition among orthopaedic patients is thought to be 20%. Many studies have shown that weight loss in older persons is a major predictor of mortality. In addition, poor nutrition can lead to weakness, fatigue, and decreased muscle mass, muscle strength and bone mineral density. Poor nutrition is, therefore, a risk factor for poor outcome following surgery due to wound healing complications, delayed recovery and increased infection rate. Low

preoperative serum albumin has been correlated with decreased post fracture quality of life (Ponzer, 1999) and increased post fracture mortality rate (Burness et al 1996).

On the other hand, good nutrition is associated with decreased fracture risk. In cohort study of women aged 55-69, assessed with a food frequency questionnaire and followed up two to three years later, a reduced risk of hip fracture was shown in those with increased dietary protein consumption (Munger 1999).

The outcome of elderly patients who have undergone surgery for hip fracture (Tkatch et al. 1992, Sullivan et al 1998, Schurch et al. 1998, Koval et al 1999) and joint arthroplasty (Lavernia et al. 1999) improves with dietary supplementation. Older patients with a hip fracture demonstrate an increase in serum IGF-1 in response to increased dietary protein (Bonjour et al, 1996, Schurch 1998). Insulin-like growth factor-I, which normally decreases in the aging process, may be responsible for the improvement seen in bone quality and outcome following fracture. It may be difficult, however, to improve nutrition in those hospitalized with a hip fracture. Many hospitalized elderly patients receive inadequate calories during their hospital stay (Sullivan et al JAMA 1999). Even if adequate calories are provided in the postoperative period, the nutritional status of malnourished patients does not improve (Paillaud et al, 2000).

Pre and perioperative medical conditions and nutrition clearly influence long-term outcome, interventions to influence those outcomes is critical and should be examined in the following ways:

- **Level A: Observational and case control studies are needed to determine the elements of preoperative evaluation and treatment that are associated with reduction in mortality.**
- **Level A: Randomized controlled trials are needed to determine the type and duration of nutritional supplementation that improves outcome following hip fracture. Such studies should seek to define specific nutritional deficiencies that are important to surgical outcome and fracture healing (calcium, protein, etc.).**
- **Level A: Case-controlled studies are needed to compare the incidence of malnutrition among hip fracture patients to that in the general population of older adults. Databases examining risk factors for hip fracture should be expanded (when possible) to include detailed nutritional measures.**

DEGENERATIVE JOINT DISEASE

Osteoarthritis (OA, degenerative joint disease) is the most common articular disease among those 65 and older. It frequently leads to decreased function and loss of independence. While the joints of the hand are the most commonly affected, they are less likely to be symptomatic than the knee or hip.

Clinically, OA is diagnosed by pain that worsens with activity and lessens with rest. Joints may feel like they are locking or giving way. Older adults with OA demonstrate decreased flexibility (Messier et al. 1992) and decreased quadriceps strength (Slemenda 1998). Impairment in mobility frequently leads to difficulty with activities of daily

living. Painful ambulation and disturbances in gait, as are frequently seen in arthritic joints, may predispose to falling (Sudarsky 1990). A self-reported history of arthritis and painful or limited motion were predictive of recurrent nonsyncopal falls in older adults (King and Tinnetti, 1995). There are many other factors that contribute to falling including lower extremity muscle weakness, deficits in balance, impaired visual, proprioceptive and cognitive function, sedative medications, and comorbid medical conditions. The contribution of a single factor such as hip or knee OA to falling is difficult to estimate and should be a topic of further research (Ling and Bathon 1996).

Pharmacologic management of OA usually begins with acetaminophen, the recommended analgesic for symptomatic OA in adults. In cases where acetaminophen at full dosage (3000 – 4000 mg / day) does not control symptoms, nonsteroidal anti-inflammatory drugs (NSAIDs) may be used. These medications exert their anti-inflammatory and analgesic effects by inhibition of prostaglandin synthesis via inactivation of the COX enzymes. Reduction of prostaglandin synthesis can have a negative impact on the kidneys and stomach leading to renal impairment and gastric ulceration. These agents are also associated with sodium retention that can lead to hypertension or edema. The elderly taking NSAIDs are particularly vulnerable to these side effects, with 20-30% of all hospitalizations and deaths due to PUD in this age group attributable to NSAID therapy (American College of Rheumatology Guidelines for Medical Management of OA of the hip or knee, 2000).

Selective COX-2 inhibitors, celecoxib and rofecoxib, have been studied in patients with OA. Celecoxib has been found to be more effective than placebo and comparable in efficacy with naproxen in patients with hip or knee OA and rofecoxib has been shown to be comparable to ibuprofen and diclofenac in patients with hip or knee OA (American College of Rheumatology Guidelines for Medical Management of OA of the hip or knee, 2000). Endoscopic studies have demonstrated a lower incidence of gastroduodenal ulcers than conventional NSAID therapy and comparable to that of placebo (American College of Rheumatology Guidelines for Medical Management of OA of the hip or knee, 2000).

Local treatments include topical capsaicin and methylsalicylate creams as adjunctive agents. Intrarticular injections of cortisone may be effective when there are effusions or local inflammatory signs (Hochberg, et al 1995).

Intrarticular injections of hyaluronan and hylan are now being used frequently for the treatment of symptomatic knee osteoarthrosis. A randomized controlled clinical trial of three (hylan) or five (hyaluronate) weekly, Intrarticular injections provided sustained pain relief and improved function, at least as effectively as continuous treatment with NSAIDs, with fewer side effects (Adams, 1995, Altman and Moskowitz, 1998). It is not currently known how this substance exerts its therapeutic effect.

Exercise benefits the elderly, improving symptoms in those with arthritis and preventing hip fracture by increasing bone density (Nelson et al 1994), and muscle strength (Butler et al 1998) and thereby decreasing falling (Province, et al 1995). Other studies have

shown that resistance training in older adults increases muscle mass (Evans 1995) and improves neural coordination and strength (Tseng et al 1995).

Osteoarthristis is a common and morbid problem in later life and painful arthritis of the hip or knee is a risk factor for falls. Further research is needed to define the importance of OA of the knee or hip as an independent risk factor for falls and to examine the risks and benefits of surgical and non-surgical therapies on risk reduction.

- **Level B: Basic studies are needed to determine the mechanism of action of viscosupplements in providing long-term pain relief from knee arthritis. Additional clinical studies are needed to examine the long-term effect on cartilage during repeated courses of treatment.**
- **Level C: A randomized clinical trial is needed to examine if viscosupplements will delay or reduce the likelihood of TKA in elderly patients.**
- **Level B: Existing databases should be examined (or expanded) in an effort to determine the independent contribution that hip or knee osteoarthritis holds as a risk factor for falls in older people.**
- **Level B: Databases examining the effects of joint replacement surgery should assess baseline and postoperative rates of falling to determine the effects of replacement on falls risk.**
- **Level B: Further laboratory and clinical studies of COX-2 inhibitors should examine the effects of these agents on fracture healing, tissue healing (e.g. after rotator cuff injury) and on bony ingrowth (into joint replacements).**

SURGICAL TREATMENT OF DEGENERATIVE JOINT DISEASE

Older patients may be more vulnerable to joint disease because of age-related changes in the musculoskeletal system. For the most part, surgical management of joint disease is predominantly joint replacement. Joint replacement surgery can significantly improve the health and well being of patients. Following hip or knee replacement, an outcome study found those patients 75 years of age and older had improved their preoperative SF-36 scores, becoming similar to population norms for this age group (March et al. 1999). A review of 99 consecutive elective hip and knee arthroplasties in patients 80 years of age and older found significantly improved postoperative knee and hip scores, with no increased complication rate when compared to a younger otherwise matched control group (Brander et al 1997). Postoperative outcome has been demonstrated to be predominantly dependent on preoperative function (Fortin et al, 1999) and not age. Surgical management of joint disease can improve physical function, which could positively influence comorbities, improve strength and balance, and reduce the rate of injurious falls.

DEGENERATIVE DISEASE OF THE HIP

Surgical treatment of osteoarthritis of the hip in the older patient is limited to total joint arthroplasty. Advanced age alone does not appear to be a contraindication to joint reconstruction. Poor outcomes appear to be related to comorbidities rather than age. The best outcomes for total hip arthroplasty have, however, been shown in those younger than 75 (Young et al. 1998). Total hip replacement in patients 80 and older results in more

complications than in younger patients, including increased rate of dislocation and femoral fractures (Newington et al, 1990). However, total hip replacement improves pain and physical activity (Brodie and Sloman, 1998) and increases independence and function (Boettcher 1992).

Fixation of the components in total hip arthroplasty is a topic of considerable debate. A cementless acetabular component is most frequently used. Concern about the increased cost of porous coated implants and the ability for bony ingrowth in the older patient have generally led to the use of a cemented femoral stem in the older patient. However , Konstantoulakis in 1999 reviewed hip arthroplasties in patients 65 and older and found that uncemented hip arthroplasties in this age group showed no signs of subsidence or osteolysis after four years of follow up. An autopsy study by Lester et al 1998 of cementless femoral components, with an average time in situ of 22 months, in patients with an average age of 87 years, found that the implants were well fixed and stable. It would seem from the literature that age has no bearing on the success of different fixation methods, cement vs bony ingrowth. Cost, however, may be a significant issue.

Wear debris may lead to implant loosening. The atrophy of bone and muscle may also be a contributing factor in implant loosening. However, pelvic osteolysis, which can result from polyethylene wear debris, was not found in patients older than 70 years of age followed for a minimum of 5 years (Maloney et al 1999). The influence of age on cellular response to wear debris, is something that has not been studied. Aging affects

cell number and most likely affects cellular response. This is potentially an interesting area of study.

When implants become loose, they often become painful, necessitating revision surgery. Revision hip surgery in patients over age 75 has been found to improve function and relieve pain although the complication rate (death 13.3% and dislocation 20%) was higher than in patients younger than 75 (Radcliffe et al 1999).

The incidence of dislocation of total hip components is 1-2%. The most common causes of recurrent dislocation, reported in a study conducted by Joshi et al 1998, were component malposition (58%) and failure of the abductor mechanism (42%). Ekelund et al 1992 found a higher dislocation rate for total hip replacements performed for complications from proximal femoral fractures. Treatment may consist of revision surgery or repair of the abductor mechanism if possible. Revision of a total hip replacement to bipolar arthroplasty (large head with no acetabular component) has been shown to be helpful as a salvage treatment for instability of the hip (Parvizi and Morrey 2000).

Hip disease is a problem that limits the quality of life and functional independence of older persons. Advances will depend on studies to address areas of uncertainty in treatment such as optimal techniques for fixation, outcomes after hip revision, the effect of age on wear debris and prevention of periprosthetic fracture.

- **Level A: Case control studies should examine the surgical and functional outcome for various methods of fixation and various surgical approaches in total**

hip replacement. Such studies should examine the outcomes for cementless components in osteoporotic bone.

- **Level B: Observational studies are needed to define the outcome of revision hip surgery in elderly patients. Careful reporting of factors associated with outcome would help define future Level A studies to further define the optimal approach to this problem.**
- **Level C: Basis laboratory studies are needed to define the influence of age on the cellular response to wear debris.**
- **Level B: Observational studies are needed to define the type of hip procedure (cemented or uncemented) that is associated with the lowest incidence of periprosthetic fractures in elderly patients. Additional observational studies are needed to generate information on the outcomes of various treatments for periprosthetic fractures in preparation for hypothesis testing in case-controlled studies.**

DEGENERATIVE DISEASE OF THE KNEE

Surgical options for the arthritic knee include arthroscopy and arthroplasty. Arthroscopic debridement of the arthritic knee has been shown to improve function, decrease pain and decrease need for total joint replacement (McGinley et al 1999). However, patients with angular malalignment of the knee do poorly following arthroscopic debridement (Salisbury et al 1985 and Harwin, 1999), and this is a more significant factor in outcome than age (Harwin, 1999). Resent results of randomized controlled clinical trial have

shown no difference in outcome between placebo and arthroscopic debridement and arthroscopic lavage of osteoarthritic knees (Moseley et al. 2002).

End stage osteoarthritis of the knee is generally treated with total knee arthroplasty that reliably provides significant and persistent relief of pain and improved physical function. Age does not appear to have a negative impact on patient outcomes (Hawker et al 1998). Patients over the age of 80 followed for 12 months after total knee replacement demonstrated improved pain, emotional reaction, sleep and physical mobility (Birdsall et al 1999). Those older than 85 had significant improvement in pain and function after total knee replacement, although most still required the use of a cane for walking outdoors (Dickstein, 1998, Laskin, 1999). Successful knee replacement surgery has been demonstrated in patients 90 and older. While no surgical complications occurred in this age group, there were several nonsurgical complications including confusion, urinary retention, atrial fibrillation, atrial flutter, gallstone retention and gastrointestinal bleeding (Belmar et al, 1999).

All total knee components are generally cemented especially in the elderly. Cemented, all-polyethylene tibial components have been recommended for patients older than 75 because the component is less expensive (Gioe and Bowman 2000) and studies have shown a high rate of survivorship without the need for revision surgery and without symptomatic loosening (Pagnano, et al 1999). In recent years, patellar resurfacing has been controversial. Recent studies have shown, however, that patellar resurfacing results

in better stair climbing ability and improved overall function (Schroeder-Boersch et al, 1998).

Interestingly, after total knee arthroplasty, bone mineral density of the proximal femur improves (Ishii et al, 2000). This increase in bone density may be related to an increase in loading of the proximal femur as a result of improved mobility. This improvement in bone density could prevent or lessen the likelihood of an injurious fall.

Arthroscopy of osteoarthric knees has been shown to be unsuccessful in the management of symptoms. The role of knee arthroscopy in the older patient with knee pain is unclear. While the potential benefits of knee replacement are clear, there remain several unanswered issues. These relate to patient selection for various procedures, issues of optimal hardware and the outcomes related to gait and balance

- **[What are the indications for arthroscopic debridement of the osteoarthritic knee?] Will this change?**
- **[What are the criteria for arthroscopic meniscectomy in the elderly patient?] Will this change?**
- **Level B: Observational studies are needed to identify patients at risk for less than optimal outcome after TKA, e.g. those with peripheral vascular disease or neuropathy.**
- **Level B: Additional observational studies focused on patients over 85 years who undergo TKA should identify risk factors for post-operative morbidity and begin to define interventional strategies to reduce that risk.**

- **Level C: Case controlled studies are needed to determine whether metal-backed or all-polyethylene tibial components should be used in arthroplasty for elderly patients and whether there are indications for each.**
- **Level B: Observational studies of patients undergoing treatment for comminuted distal femur fractures are needed to examine the possible utility of TKA as a reconstructive procedure in this setting.**
- **Level C: Observational studies should help to further define those benefits of TKA (ROM, increased strength, decreased pain, etc), which serve to improve gait and balance. Ultimately such studies may begin to determine whether or not TKA helps to reduce the risk of hip fracture.**

DEGENERATIVE DISEASE OF THE SHOULDER

Degenerative disease of the shoulder is fairly common. Out of 100 randomly chosen people age 65 and older, 34% were found to have significant shoulder pain and 30% had disability related to decreased shoulder movement (Chakaravarty and Webley, 1990). Rotator cuff disease is the major cause of shoulder disability. The degenerative change in the rotator cuff that occurs as a result of overuse can lead to a tear with minimal trauma. Large tears in the rotator cuff are more frequent in the older population (Hattrup, 1995). Tears of the rotator cuff may result in the loss of the primary stabilizers of the glenohumeral joint leading to articular wear and arthritis.

Treatment of rotator cuff disease generally begins with rotator cuff strengthening exercises and antiinflammatory medication. In a review of 124 patients with rotator cuff tears treated conservatively, those with well-preserved motion and strength did well with nonoperative treatment, in contrast to those with limited motion and strength on first evaluation (Itoi and Tabata 1992). Patients who experience significant sleep loss due to shoulder pain are unlikely to be satisfied with nonoperative treatment (Hawkins, Dunlap 1995).

Rotator cuff repair is usually associated with an acromioplasty and occasionally a distal clavicle resection. Surgery is often performed in an open manner through a standard approach, with the deltoid removed from the acromion and distal clavicle.

In general, the larger the rotator cuff tear, the poorer the results (Hattrup, 1995, Motycka et al, 2001). A follow up study nearly 7 years after open rotator cuff repair in 72 patients, found that age was not a factor in functional outcome (Motycka et al, 2001). Retrospective reviews of 92 patients, age 62 and older (Grondel et al, 2001) and 69 patients, age 75 and older, (Worland et al, 1999) found, with standardized scoring, improved function, decreased pain and satisfactory results more than 2 years following open rotator cuff repair.

Rehabilitation after rotator cuff surgery is important. The greatest improvement in strength occurs in the first six months after surgery but strength continues to improve 12

months after surgery (Rokito et al, 1996) and can ultimately equal that of the nonoperative shoulder (Hartsell, 1993).

Symptomatic, failed repairs of massive rotator cuff tears can be managed with muscle transfer as a salvage procedure. The latissimus dorsi (Miniaci and Macleod, 1999) or central quadriceps tendon can be used as a free tendon graft. Harvest of the central quadriceps tendon in elderly patients was associated with significant reduction in knee reliability and function (Comley and Krishnan 1999).

Significant degenerative change of the glenohumeral joint is initially treated with antiinflammatory medication and function-maintaining exercise. Surgical management may consist of total shoulder arthroplasty, hemiarthroplasty or bipolar hemiarthroplasty.

Shoulder arthroplasty is frequently performed for end-stage glenohumeral arthritis. Total shoulder arthroplasty involves resurfacing of the glenoid in addition to replacement of the humeral head. The indications for resurfacing the glenoid have not been clearly defined, but generally resurfacing is reserved for cases with an intact rotator cuff. Total shoulder arthroplasty demonstrated significantly greater pain relief and improved internal rotation than hemiarthroplasty (Gartsman et al, 2000). Hemiarthroplasty is frequently utilized to eliminate the problem of glenoid loosening which can occur in total shoulder arthroplasty as a result of proximal humeral migration due to a torn rotator cuff. Improvement in function and comfort has been demonstrated following hemiarthroplasty performed in patients with massive rotator cuff tearing (Worland et al, 1997 and Zuckerman et al,

2000). Bipolar hemiarthroplasty is also used to treat glenohumeral arthritis associated with rotator cuff tearing. It has been theorized that the oversized humeral head would increase the stability of the joint, increase the abductor lever arm and power and prevent impingement of the tuberosities. Concerns have been raised regarding the potential for overstuffing the glenohumeral joint and the generation of polyethylene wear debris. A review of the literature did not find any reports comparing bipolar hemiarthroplasty with standard hemiarthroplasty in the rotator cuff deficient shoulder.

While shoulder disease is common and disabling much remains to be learned on its optimal surgical management. Changes in the aging shoulder and in potential tissue donor sites will likely influence possible surgical approaches. While the goals for improved function from TKA are readily identified, range and function goals for the shoulder may be more subtle.

- **Level A: Case-controlled studies are needed comparing functional outcomes in older people with shoulder disease who are undergo rotator cuff surgery hemiarthroplasty or total shoulder replacement versus those who do not undergo surgery. Key outcomes for comparison include improved function and decreased pain. Such studies should address how the desired outcomes may change with age from the young 65-75 years to the very old (over 90 years).**
- **Level B: Studies of surgical methods to address tissue deficiency in the elderly patient with a chronic rotator cuff tear are needed.**

COMPLICATIONS OF JOINT REPLACEMENT SURGERY

THROMBOEMBOLISM

Venous thromboembolism occurs in 40-70% of patients who undergo hip or knee replacement without postoperative thromboprophylaxis. Patients who have total knee arthroplasty are 3.2 times more likely to have deep venous thrombosis develop than patients who have total hip arthroplasty (Fujita et al, 2000). Patients 65 and older that had total hip arthroplasty, and an increased body mass index have an increased risk of rehospitalization for thromboembolic events (White et al., 2000).

With thromboprophylaxis, the incidence of DVT is 15% in those having hip replacement and 30% in those with knee replacements (Leclerc et al. 1998). The risk for thromboembolism continues for at least one month postoperatively (Dahl et al. 2000), with the rate of proximal DVT 2.4% one week after surgery and increasing to 8.2% one month after surgery (Caprini et al. 1999). The risk of fatal PE after total knee arthroplasty without thromboprophylaxis is 0.4% (Ansari et al, 1997).

Those with hip fractures demonstrate a high rate of DVT, and, if surgery is delayed more than 48 hours, 62% of patients have venographic evidence of DVT (Zahn et al.1999). Autopsies performed on patients with surgically treated hip fractures demonstrate that the incidence of fatal PE is between 0.37% and 3.3% (Bergqvist and Fredin, 1991).

A variety of medications and mechanisms has been proposed to decrease the rate of thromboembolism. The safest and most efficacious method of prophylaxis remains controversial. Mechanical modalities include external pneumatic compression sleeves and foot pumps. These work by decreasing stasis in the gastroc-soleus complex, by improving venous return and also by increasing fibrinolysis. They are placed on the patient prior to and worn throughout surgery. It is recommended that the sleeves be discontinued when the patient is more ambulatory. Pneumatic compression has been shown to be effective after total hip arthroplasty only in patients with body mass index (wt in kg / height in meters^2) of less than 25 (White et al. 2000). The arteriovenous impulse system has been shown to be effective in reducing thromboembolic events after hemiarthroplasty of the hip (Kennedy et al. 2000) and comparable to enoxaparin in prevention of DVT following total hip replacement (Warwick et al, 1998).

Aspirin has long been used for thromboprophylaxis. In the PEP trial (Lancet 2000), 17,444 randomized patients undergoing surgery for hip fracture or elective arthroplasty received 160 mg of aspirin daily for 35 days post surgery. The study concluded that this regimen reduced PE 43% and symptomatic DVT 29%. In this study, thromboembolic events were not recorded if they were not symptomatic. Using this protocol there was no significant increase in bleeding complications. Aspirin has been shown to effective for thromboprophylaxis in doses of 160 mg (PEP, Lancet 2000) and 375 mg (Kennedy et al, 2000).

Warfarin has been shown to be protective against DVT after total hip and knee arthroplasty. The goal is to keep the INR between 2 and 3. Warfarin used in combination with pneumatic compression results in a prevalence of DVT of 5% and a prevalence of bleeding complications of 0.9% (Woolson et al, 1998). A meta-analysis of thromboembolic prophylaxis following elective total hip arthroplasty (Freedman et al, 2000) found that warfarin and pneumatic compression were the best prophylactic agents in terms of safety and efficacy. Sensitivity to anticoagulant effects is enhanced by age 80 years or greater, hip fracture fixation and weight greater than 180 pounds (Messich et al, 1999).

Enoxaparin, a low molecular weight heparin (LMWH), is frequently used for thromboprophylaxis. In elderly patients with hip fracture, a 40 mg once daily dose of enoxaparin was found to be effective in prevention of DVT without major bleeding complications (Barsotti et al, 1990). The rate of thromboembolic event during and after prophylaxis with enoxaparin has been reported to be 2% and the rate of major hemorrhage 2.9% (Leclerc, et al, 1998). Individuals over the age of 65 receiving enoxaparin report bleeding complications of 23.7% compared to 16.5% in controls (Shaieb et al 1999) resulting in a lower hemoglobin and a higher transfusion rate in the enoxaparin group. The complication rate was lower if the first dose of enoxaparin was given more than 10 hours postoperatively. A meta-analysis, revealed that LMWH may be more protective against thromboembolic following total joint arthroplasty but that there was a slightly greater risk of clinically important bleeding (Imperiale and Speroff 1994). In a study of 263 patients who had undergone total knee arthroplasty, there was

an 11.3% incidence of bleeding complications in those patients using enoxaparin compared to a 4.6% incidence in patients using warfarin, with no significant difference in the rate of DVT between the groups (Stern et al, 2000). The bleeding complications reported with the LMWHs may be attributed to the fact that these medications are cleared by renal excretion. Those with decreased renal function may develop accumulation of the drug and hemorrhagic problems (Fairweather, 1999).

There are several effective therapies for the prevention of thromboembolism in older patients who have undergone hip and knee procedures. Most of these are associated with some risk of bleeding and some residual risk of thromboembolism. The optimal regimen for older patients and for specific procedures remains to be determined.

- **Level A: Randomized controlled clinical trials are needed of the various preventive regimens (alone or in combination) are needed to identify the optimally safe and effective treatment strategy. Such studies should also address how long DVT prophylaxis should continue in elderly patients with recent total joint replacements and hip fracture.**

PERIPROSTHETIC FRACTURE

Periprosthetic femur fractures have been estimated to occur in 2.5% of patients following THA (Kyle and Crickard, 1998). The cause is usually loosening of the implant due to osteoporosis (Wu et al 1999) or osteolysis secondary to wear debris (Younger et al, 1998). The incidence of these fractures is likely to increase the longer the implant is in place. Treatment can consist of plate fixation if the implant is stable or stem revision

with or without cerclage wiring and bone strut grafts if the initial stem is loose (Jukkala-Partio et al 1998, Siegmeth et al 1998, Incavo 1998)

Fracture around a total knee arthroplasty generally occurs around the femoral component. Treatment may consist of open reduction and internal fixation (Weber 1999) or intramedullary rodding (Weber, et al, 2000), placing the rod in the intercondylar notch, between the medial and lateral femoral condyles of the femoral component. If the fracture is comminuted treatment is difficult. Tani et al, 1998 as a means for reconstructing large segmental defects, have described Intramedullary fibular grafting.

Risk factors for periprosthetic fractures resemble those for osteoporotic fracture (old age/poor bone quality). Development and risk for these fractures is also likely influenced by the site (hip or knee) and possibly by the nature of fixation for the device (cemented/noncemented). Further research is needed to understand causes and to design and test preventive strategies.

- **Level B: Further retrospective studies are needed to examine risk factors for periprosthetic fractures beyond age and poor bone quality. Case controlled studies could possibly suggest protective factors such as the nature of the implant (cemented or uncemented) and the use of antiresorptive therapies.**
- **Level A: Randomized trials would be needed to determine with certainty whether specific prostheses and or anti-resorptive therapies would be effective at minimizing the risk of periprosthetic fracture.**

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INFECTION

Infection of a joint after total hip or knee arthroplasty may be the result of hematogenous seeding. Treatment is generally removal of the implant and placement of a block of cement that has been mixed with antibiotics to act as a cement spacer. A relatively new technique is to cement total joint components loosely in place with antibiotic impregnated cement as an "articulating spacer". Treatment with debridement and retention of joint components and antibiotic therapy is usually successful if caught within 2 weeks of symptoms (Crockarell et al 1998). The success of these techniques in the older patient has not been established.

- **Level B: Observational studies and subgroup analyses are needed to determine if features of periprosthetic infections are different in elderly patients and to examine differences in outcome for the elderly using established and emerging approaches to this problem.**

DEGENERATIVE SPINE DISEASE

Degenerative disease of the spine (spondylosis) includes spondylolisthesis, which is characterized by the forward displacement of one vertebral body on another, disc herniation or degeneration, facet joint degeneration, osteophytes, foraminal stenosis, and radiculopathy. Degenerative spondylosis and radiculopathy may occur in the cervical or lumbar spine. These conditions are usually managed conservatively.

Surgical intervention is reserved for those with progressive neurological deficit or severe functional incapacitation. Surgical decompression in cervical spondylotic myelopathy is

usually anterior decompression and fusion in those with three or fewer levels or in patients with kyphosis, and a posterior decompression in those with more extensive disease (Orr and Zdeblick, 1999).

The elderly can benefit from decompression (Taylor, et al. 1991,Kohno et al, 1997, Tanaka et al, 1999) however incomplete recovery is more likely in patients older than 70, and outcome was found to be related more to the clinical picture and the duration of the symptoms than age (Tanaka et al, 1999).

Surgical treatment of lumbar spinal stenosis generally consists of decompressive laminectomy plus fusion with or without instrumentation. Patients 65 and older have outcomes as good as younger patients (Sanderson and Wood, 1993). The complication rate may be higher for patients 75 and older (Deyo, et al, 1992) and has been reported to be 6% (Kalbarczyk et al, 1998) to 10% (Vitaz et al, 1999). After four years of follow up, patients over the age of 60 years that had surgical treatment for spinal stenosis had better outcomes than those that had nonsurgical treatment (Atlas et al, 2000). In a meta-analysis, patients suffering from degenerative spinal stenosis for up to 8 years responded best to decompression without fusion while those with symptoms of 15 years or more, had better results with decompression and fusion with instrumentation (Niggemeyer 1997). These studies suggest that earlier intervention is more successful, possibly due to better overall health and functional reserve and fewer medical comorbidities in younger patients. This is supported by the finding which the most powerful predictor of a good outcome was the patient's report of good or excellent health before surgery (Katz et al, 1999). Shorter duration of symptoms may be associated with less nerve degeneration and

atrophy. This is supported by the results of a study which revealed the outcome following surgically treated lumbar spinal stenosis was better when there was a shorter preoperative duration of symptoms (Jonsson et al 1997). A 10-year follow-up study found that more than half of patients evaluated their post-surgical results as excellent or good (Iguchi et al 2000).

Stenosis can recur within a few years following decompression and has been reported to be from 18% to 27% (Jonsson, et al., 1997, Katz et al, 1996, Caputy and Luessenhop, 1992). This may be attributed to vertebral levels that had unrecognized stenosis and were, therefore, not decompressed or stabilized in the initial surgery. Bone regrowth has also been demonstrated following decompression (Postacchini and Cinotti, 1992). Bone regrowth may be associated with postoperative spinal instability (Guigui et al. 1999).

Fusion with instrumentation is associated with a better outcome than fusion without instrumentation if there is instability after surgical decompression (Yone et al, 1996). Instrumentation in an osteoporotic spine can, however, be difficult. Larger screws can be used in the pedicle, but these can cause the pedicle to fracture. The pedicle can fracture if the screw diameter is greater than 70% of the outer diameter of the pedicle in cases were bone mineral density is low (Hirano et al, 1998).

Patients with osteoporosis have less bone to harvest for fusion and the bone is frequently of poor structural quality. Decreased number of osteoprogenitor cells in the autogenous

bone graft frequently necessitates supplemental material to encourage osteoinduction and osteoconduction.

Advanced age does not appear to preclude benefit from cervical-spine decompressive surgery although recovery of neurological function may be less complete than in younger patients. Available studies suggest that a longer duration of symptoms prior to surgery reduces the eventual degree of recovery. Benefit is also seen from lumbar surgery although at the risk of higher complication rates. Osteoporosis makes surgery more difficult and reduces the quality of bone harvested for grafts. These issues raise several significant research problems.

Level A: Case-controlled studies are needed to refine understanding of which patients benefit (in terms of symptom control and function) most from spinal decompression versus conservative management. Important co-variates include duration of symptoms and degree of neurological defecits and perhaps the degree of osteoporosis. Such studies should attempt to clarify when elderly patients should be referred for spinal decompression in order to experience maximum benefit.

Level B: Observational studies are needed to examine the impact of aging on bone fusion or fracture healing and to begin examining strategies to augment the bone healing response after fusion or fracture. Candidate strategies include growth factors.

DEGENERATIVE DISEASE OF THE FOOT AND ANKLE

There is a high incidence of foot problems in the elderly. If older individuals are to remain ambulatory, foot care is essential. Foot deformity, due to aging or degenerative disease, can lead to gait and balance disturbance. A comprehensive review of the literature found very few articles addressing foot-related issues in the elderly.

Shoe wear is an important factor in maintaining balance. A randomized controlled trial of twenty-five patients, to evaluate balance while barefoot and in different types of shoe wear, determined that bare feet and walking shoes maximize balance while high-heels create a balance hazard (Lord and Bashford, 1996).

Onychomycosis is a common problem affecting 2-13% of individuals. Treatment is oral antifungal agents. Efficacy and side effects of these medications in the elderly have not been well established. A review of the literature did not find any articles pertaining exclusively to the elderly.

Posterior tibial tendon insufficiency and hallux valgus often lead to severe deformity of the foot. Treatment can range from conservative care with shoe wear modifications and orthotics to extensive reconstruction and fusion. A review of the literature, however, found no articles evaluating reconstruction in the older patient.

Fractures of the ankle are relatively common. Of all ankle fractures, 20-30% occur in the elderly (Salai et al, 2000). A study, comparing operatively treated and non-operatively treated ankle fractures in patients older than 65, found better outcomes in the nonoperatively treated group (Salai et al, 2000).

Treatment of ankle arthritis is either fusion or total ankle arthroplasty. The results of ankle fusion can deteriorate over time as a result of transverse tarsal or subtalar degenerative joint disease. The elderly are thought to be good candidates for total joint replacement because there are most likely degenerative changes in other areas of the foot and because they may be less active. A review of the literature found no articles dealing with this procedure in the elderly exclusively.

There is relatively little known about the effect of foot and ankle problems on gait and balance in older people whereas these would appear to be important outcomes when assessing the utility of surgery for such disorders in this population. Research needs to define indications for surgery and orthotics in treatment of disorders of the foot and ankle.

Level A: Observational studies examining how foot and ankle deformity influence gait and balance are needed. Those deformities that are associated with significant gait problems should be the focus of research on surgical and non-surgical approaches to these conditions. Appropriate outcome measures (healing, gait improvement etc.) from specific techniques of foot and ankle reconstruction need to

be defined. In addition more study is needed to identify characteristics of footwear that maximizes balance.

Level C: Controlled trials are needed to identify safe and effective treatment for fungal disease of the foot.

BONE INSUFFICIENCY AND FALLS

Bone loss is frequently associated with aging. Significant bone loss, which results in skeletal fragility, is termed osteoporosis. Osteoporosis is a major health problem, affecting 10 million people in the United States. Another 18 million are at risk for developing the disease (NIH Consensus Statement, JAMA,2001). Low bone mineral density predicts fracture risk but cannot identify individuals who will have a fracture. Therefore, an understanding of the factors that result in a fall and the subsequent fracture is essential. At least 30% of individuals fall at least once in their life. Only 5% of falls result in fracture. Most fractures occur in the home (Aharanoff et al, 1998). The nature of the fall determines the type of fracture, while bone density and factors that increase or attenuate the force determine whether a fracture will occur (Nevitt and Cummings, 1993). A prospective case-controlled study demonstrated that a fall to the side, decreased bone density in the hip and impaired mobility were all-important risk factors for hip fracture (Greenspan et al, 1998). Neuromuscular and visual impairments, as well as femoral neck bone mineral density, are significant and independent predictors of hip fracture in elderly, mobile women (Dargent –Molina et al, 1996, Ivers et al, 1998, Klein et al, 1998). Balance is a prerequisite for mobility and ADL function (Era, et al 1997), and is affected

by medical comorbidities. Herndon et al, 1997 reported on chronic medical conditions in patients 65 and older, finding that a self -reported history of anemia or stroke increased risk of a fall. *For fall risk factors and stratagies that reduce falls see Tinetti NEJM January 2, 2003 and the Cochrane database review. Alternatively see AGS/BGS/AAOS guideline on falls* http://www.americangeriatrics.org/products/positionpapers/Falls.pdf

Nursing home residents are at particular risk for injurious falls. Institutionalized fallers have low serum 25-hydroxyvitamin D and high serum parathyroid hormone levels (Stein et al, 1999). Minimal trauma fractures are common, usually with no clear precipitating factors other than severely impaired mobility (Kane et al, 1995). Extreme weight loss and poor health have been shown to increase the risk of hip fracture (Langlois et al, 1998 and Meyer et al, 1998).

With aging there is frequently decreased muscle strength and impaired coordination, which results in an increased likelihood of falling and a decreased ability to break the fall. Physical activity throughout life has been found to reduce the risk of falling (Grisso 1997, Graafmans,et al 1996, Tinetti, 1988, Sorock, 1992).

Fractures of the hip, wrist and spine are a significant cause of morbidity and mortality among the elderly. The cost of treating these fractures is 14 billion dollars annually and this is expected to increase to 60 billion by the year 2020 (Praemer, 1999).

Fractures occur in osteopenic bone, but osteoporosis does not predict who will fracture. Falls are the result of cumulative risk factors and there is good data proving strategies

that reduce falls in community dwelling old folks that have fallen. Whether those same stratagies reduce fractures has not been determined (sample size indaquately powered).

Fractures occur in osteopenic bone, but osteoporosis does not predict who will fracture. Falls are the result of cumulative risk factors and there is good data proving strategies that reduce falls in community dwelling older people that have fallen. Whether those same strategies reduce fractures has not been determined (sample sizes inadequately powered). Risk factors for minimal-trauma fractures are being developed although intervention studies have not been undertaken. Studies are generally lacking on the best surgical approaches to such things as: using joint replacement for fractures that occur close to a joint and; techniques or materials that provide the best fixation in osteopenic bone.

Level A: Adequately powered clinical trials are needed to determine if fall-prevention strategies will translate into fracture reduction for treated patients.
Level C: Observational studies are needed that describe the functional recovery of patients whose fractures occur close to a joint and who are treated with either total joint replacement or standard care.
Level B: Methodological studies are needed describing outcomes with various approaches to fixation in osteopenic bone.

FRACTURES OF THE HIP

The number of elderly persons with hip fractures will double to 2.6 million by the year 2025 (Gullberg et al 1997). The lifetime risk of hip fracture is 11.1% for men and 22.7% for women (Oden et al, 1998). Almost half of all hip fractures occur in patients over the age of 80. An estimated 18-28% of older hip fracture patients die within 1 year of their fracture (Oden et al, 1998).

There are many determinants of hip fractures. The two main factors are falls and decreased bone density. Increased fracture risk has been demonstrated with lifestyle factors, such as weight loss or low body weight (Meyer, et al, 1998, Langlois, et al, 1998, Ensrud, et al, 1997, Farahmand et al, 2000 (JEpid), decreased physical activity (Gregg, et al 2000, Farahmand et al, 2000), increased tobacco use (Hoidrup et al, 2000, Stewart et al, 2000), and poor socioeconomic status (Bacon and Hadden 2000). Increased fracture risk has also been found to be associated with medical co-morbidities such as stroke (Ramnemark, et al, 2000), end-stage renal disease (Alem et al, 2000, Coco and Rush, 2000) and visual impairment (Ivers, et al, 2000).

There has been considerable debate in the past as to which came first, the fall or the fracture. Most studies report that the fall precedes the fracture. In fact, over 90% of all fractures are the result of falling, (Hayes, et al 1993,Cummings and Nevitt 1989, Cumming and Klineberg, 1994, Lauritzen, 1996, Parkkari, et al, 1999). Hip fractures typically result from falls which result in direct impact on the hip, typically a fall to the side. External hip protectors have been found to prevent hip fractures (Lauritzen et al

1993, 1997). A controlled study (Ekman, et al 1997) and a randomized, controlled clinical trial (Kannus et al., 2000) found the rate of hip fracture was significantly lower when hip protectors were worn. However, one study found only 44% compliance in wearing the device (Ekman, et al 1997). Reasons cited for not wearing the protector included skin irritation and being bed ridden.

For all but the very sick, operative treatment of hip fractures is recommended. Six-month mortality rates following nonoperative treatment for hip fractures has been found to be as high as 61% (Lyon et al, 1987). The timing of surgery following hip fracture is critical. The sooner the better, but, medical stabilization before surgery is required. Once medically stable, surgery is recommended, if possible within 24 hours. Operative delay more than 2 calendar days was associated with higher mortality within one year in patients who were independent, cognitively intact and able to walk prior to fracture (Zuckerman et al, 1995). There is a significant increase in mortality in those patients whose surgery was delayed more than 24 hours (Beringer et al, 1996 and Hamlet et al. 1997). The choice of regional or general anesthesia does not influence outcome (Koval et al, 1999).

Fractures of the hip include intertrochanteric fractures and femoral neck fractures. There may be some differences in the patients that sustain each type of fracture. In a prospective study of elderly patients admitted for hip fracture, patients with intertrochanteric fractures were slightly older, sicker and had longer hospital stays and were less likely at 2 months post-fracture to have recovered ADLs than patients with a femoral neck fracture (Fox et

al, 1999). Recovery at one year following hip fracture did not differ between fracture types. Patients with an intertrochanteric hip fracture had higher mortality rates at 2 and 6 months after fracture than those with a femoral neck fracture.

The basic tenet of treating hip fractures is secure fracture fixation to promote healing and early mobilization. Intertrochanteric hip fractures are generally treated by open reduction and internal fixation. A sliding hip screw / plate construct (compression hip screw) or a cephalomedullary nail (Gamma nail) may be used for treatment. Although there has been shown to be less femoral shortening with the Gamma Nail (Bess and Jolly, 1997), no difference between the two treatments with respect to functional recovery has been found (Baumgaertner et al 1998). An increased complication rate has been shown with the Gamma nail (Baumgaertner et al 1998). The Gamma nail may, however, be a more versatile implant, used to treat a variety of fracture patterns (Chevalley and Gamba, 1997). As there is currently no literature to suggest that use of this device improves outcome in routine intertrochanteric hip fractures, the sliding hip screw is felt to be the implant of choice for treatment of intertrochanteric hip fractures. For peritrochanteric fractures or fractures with subtrochanteric extension, the Gamma nail is superior in stability and decreases operative blood loss (Difiore, et al, 1993,Park et al, 1998, Habernek, et al, 2000), and complications can be minimized by attention to surgical technique (Lyddon, 1996).

Hemiarthroplasty has been proposed for treatment of unstable intertrochanteric hip fractures in debilitated elderly patients (Vahl et al, 1994 and Chan and Gill, 2000).

Hemiarthroplasty can also be used to salvage an intertrochanteric hip fracture that has had a failure of internal fixation (Stoffelen, 1994).

Femoral neck fractures may be fixed with internal fixation if non-displaced. However, Hudson et al, 1998 found a higher revision rate and mortality rate in patients who had internal fixation than hemiarthroplasty for femoral neck fracture. Internal fixation for femoral neck fracture has been associated with greater readmission and reoperation than hemiarthroplasty, without improvement in function (Pareker and Pryor, 2000). In a review of 312 community ambulators admitted for femoral neck fracture the choice of hemiarthroplasty or internal fixation also had no impact on physical ADL or instrumental ADL recovery (Young et al, 1997).

Hemiarthroplasty is performed when femoral neck fractures are displaced and/or the quality of the bone is poor. Cement may be used as a grout to improve stem fixation. There is no difference between the use of a bipolar or unipolar hemiarthroplasty for the treatment of femoral neck fractures (Wathne et al, 1995, Cornell et al, 1998 , Calder 1996). Furthermore, the bipolar prosthesis has been shown to have increased polyethylene wear due to impingement of the metal shell notching the femoral component (Incavo et al. 1993). Patients with cemented implants have been found to have a higher perioperative mortality than those in which no cement was used (Lennox, et al, 1993). However, in a randomized, prospective trial comparing cemented and uncemented bipolar hemiarthroplasties in 53 patients with femoral neck fracture,

cemented stems fared better with less pain and need for fewer walking aids than uncemented stems and there was no difference in complications (Emery et al, 1991).

Total hip arthroplasty may also be used to treat femoral neck fractures. Following femoral neck fracture, better outcome has been reported with total hip arthroplasty (THA) than hemiarthroplasty (Squires and Bannister, 1999) or internal fixation (Neander et al 1997, Johansson et al, 2000). Revision rates have been shown to be lower for THA (2.2%) than for cemented hemiarthroplasty (7.9%) and uncemented hemiarthroplasty (13%) (Gebhard et al, 1992). An increased rate of operative complications (17%) (Lee et al, 1998), dislocations (12%) (Johansson et al, 2000) and implant loosening (Broos, 1999) has been shown if total hip arthroplasty was performed for femoral neck fractures than if the replacement was done for osteoarthritis.

Immediate postoperative weight bearing to tolerance following hip fracture fixation has not been shown to result in hardware failure or loss of fixation (Koval et a, 1998).

Delirium is a common problem following operative treatment of hip fractures. Stromberg et al. 1999 in a randomized clinical trial found a 13% incidence of delirium postoperatively in patients with hip fractures. Postoperative delirium is more likely to occur in patients 80 and older, those with prefracture cognitive impairment, ADL functional impairment or high medical comorbidity, and if the delirium persists more than one month following hip fracture there is poor functional recovery (Marcantonio, et

al, 2000). Patients with dementia, delirium or depression are more likely to remain in the hospital longer following hip fracture (Holmes and House, 2000).

Bone mineral density decreases in the operative side following femoral neck fracture (Neander et al, 1997). A decline in bone mineral density has also been demonstrated in the contralateral hip in the year following hip fracture (Zerhan et al, 1998, Dirschl et al, 1997). Bone mineral density does, however, increase in the following 5 years, in most cases replacing the loss from the first year. Those patients who do not regain bone density in the contralateral hip are at risk for a second hip fracture (Dirschl et al 2000). Patients with a history of hip fracture have a greater risk for developing another hip fracture. A review of orthopaedists and internists found that neither specialty adequately addresses the prevention of a second hip fracture (Kamel et al, 2000).

The primary determinants of long-term survival following hip fracture are host factors and not injury severity (VanderSluis, et al, 1997). The mortality following hip fracture has been found to be predictable on admission by the number of medical conditions; with no other diagnosis mortality is 0%, with one or two mortality is 14%, and with three or more the mortality is 24% (Svensson et al, 1996). Following a hip fracture, medically ill and functionally impaired patients demonstrate an immediate increase in mortality, while those with no comorbidities and few impairments have a gradual increase in mortality that continues for 5 years post fracture (Magaziner et al, 1997). Increased mortality has also been demonstrated in those with mental impairment (Van Dortmont et al, 2000 and Holmes and House, 2000) and decreased postoperative ambulatory level (Imura et al,

2000). Age at the time of fracture is also predictive of mortality (Schroder and Erlandsen, 1993). The one-year mortality of nonagenarians is 46% (Jennings and deBoer, 1999) and centenarians is 56% (Forster and Calthorpe, 2000). Men, in general appear to have a higher mortality rate after hip fracture than women (Schroder and Erlandsen, 1993, Diamond et al, 1997). Poor et al, 1995 attributed this to interaction of the fracture with serious underlying medical conditions.

Following hip fracture there is a dramatic decline in physical function at two years, independent of the effects of increasing age, pre-existing medical conditions and disabilities (Norton et al, 2000). Prefracture mobility was the most significant factor in predicting continued ability to live at home (Parker and Palmer, 1995). By one year, only 41% of hip fracture patients are back to their prefracture ambulatory ability, 40% of those ambulating require assistive devices, 12% go from community ambulation to household ambulation and 8% become nonfunctional ambulators (Koval et al, 1995). Patients 85 and older who live independently and alone prefracture are at high risk for nonrecovery of ADLs and IADLs. Recovery of ADLs occurs in only 73% and only 48% recover instrumental ADLs (Koval et al, 1998). The chance of a patient with a hip fracture making any further recovery after 4 months is minimal and that recovery is directly influenced by increasing age, coexisting diseases and complications (Koots et al, 2000). Of the institutionalized elderly only 17% regain their overall functional ability and only 13% return to their pre-injury ambulatory status.

Hip fracture is a disorder of late life and one that is too often associated with substantial long-term disability. While surgical techniques have progressed and pre and perioperative care improved, long-term outcomes have failed to keep pace. Surgical advances included improved devices for fixation, better understanding of the importance of timing (best if in the first 24 hours), and weight bearing as tolerated for most repairs. Further advances can be expected as other key questions are addressed related to: whether or not cement should be used with hemiarthroplasty; in comparing available techniques for repair of intertrochanteric fracture to identify the optimal approach; and developing techniques or interventions to reduce hardware failure. Reducing one and two year mortality and improving long-term functional outcomes for patients is a more daunting task and will likely require approaches to reduce perioperative delirium, to improve continuity between care settings (hospital, rehab setting and home), to optimally manage medical co-morbidities (including osteoporosis), and to provide effective (perhaps extended) rehabilitation and nutritional support services.

- **Level A: Controlled trials are needed to examine outcomes using cement and non-cemented hardware for hemiarthroplasty. Additional controlled trials comparing techniques for repair of intertrochanteric hip fractures.**
- **Level B: Observational studies are needed to examine the effect of shortening on gait and balance.**
- **Level C: Can modalities such as electrical stimulation or ultrasound speed the fracture healing response in the older patient and therefore decrease fracture collapse or hardware failure?**

- **Level A: Methodological studies are needed to identify high-risk elderly patients with hip fracture and to devise clinical pathways for their care. Database analyses of the pre-hospital, in-hospital, and rehabilitative periods of elderly orthopaedic patients should be performed to identify clinical management strategies that result in decreased morbidity and improved functional recovery.**
- **Level B: Research should also include the expansion of current clinical databases to include long-term and functional outcomes of older orthopaedic surgical patients recovering from hip fracture.**

FRACTURES OF THE WRIST

Wrist fractures are a common consequence of osteoporosis. Wrist fractures are more likely to occur in women with low bone mineral density who are healthy and active and have good neuromuscular function as the hand is put out to break the fall (Kelsey et al, 1992). As common as distal radius fractures are in the elderly there is a paucity of research regarding treatment and outcome. The consensus of expert opinion seems to be that most of these fractures do well in the elderly regardless of treatment. However, this has not been well studied. Fractures may require either closed manipulation and immobilization or surgical treatment.

Older patients with low levels of activity have been found to be satisfied with wrist fractures treated nonoperatively, with 88% able to return to their prefracture activities

(Young and Rayan, 2000). Up to 30 degrees of dorsal angulation and 5mm of radial shortening have been found to be acceptable in elderly patients (Kelly et al. 1997).

More active individuals may be candidates for operative stabilization. Surgical treatment may consist of closed reduction and pinning, open reduction and pinning, open reduction and internal fixation with plate and screws, external fixation alone or in combination with wiring or plating. Percutaneous pinning is simple and has been shown to give results superior to manipulation and casting alone (Board et al, 1999). If the fracture is extensively comminuted, however, reduction may be lost.

Plate fixation (Rikli and Regazzoni et al,1996 and Ring, et al. 1997) is advantageous because it may be used in combination with bone grafting to restore structural integrity, and plate fixation allows for earlier motion. Plates are frequently placed on the dorsal aspect of the wrist and as a result can interfere with extensor tendon activity.

External fixation is frequently used to address the concern of radial shortening and comminution. This procedure uses an external device that applies pins proximal and distal to the fracture and applies traction to keep the fracture out to length. Bone grafting of the fracture site is frequently carried out to supplement the fixation (Herrera et al, 1999). Unfortunately, because the fracture is at the end of the bone, the external fixator needs to span the wrist joint, which can result in wrist stiffness. Also because the distal pins are placed in the metacarpal, and this bone is small, fractures can result. Frame loosening can occur as a result of pins being placed in osteoporotic bone. Bone graft or

bone substitute is frequently used for filling in the void after an impacted fracture is brought back out to length. Options for bone void filler include autograft, allograft and bone void fillers. Autograft is frequently not a good choice in the elderly patient as the number of mesenchymal cells in the host bone may be limited. In addition, because many of these patients are osteoporotic the structural integrity of the graft material is not adequate. Allograft bone is frequently used instead. Additionally, there are many bone substitutes. An injectable, remodellable, bone cement has been developed but not specifically studied in the elderly. It has been shown however, by Sanchez-Sotelo et al, 2000 to provide good results compared to conservative treatment.

Outcome ten years following distal radius fracture, was shown by Warwick et al, 1993 to be satisfactory. Radial shortening and finger stiffness significantly correlated with final result.

Wrist fracture is common in older women and while not well studied, it appears that most patients have a good outcome. However, for those fractures requiring operative intervention issues of osteoporosis and autograft versus allograft require further study.

- **Level C: Observational studies are needed to compare operative with nonoperative management to determine which method improves outcome (time to union and function) following wrist fracture.**
- **Level D: Descriptive studies are needed to determine the range of motion and strength of the wrist necessary for good ADL function.**

- **Level C: Controlled trials of various graft materials are needed to determine the best graft material to supplement wrist fracture internal fixation.**
- **Level D: Case series describing outcomes with various fixation methods are needed to determine the best fixation method for wrist fractures.**

FRACTURES OF THE SPINE

Osteoporotic vertebral compression fractures are very common, affecting 25% of women 70 years of age and older and 40% of women 80 and older (Lyles, 1999). Vertebral fractures are associated with significant performance impairments in physical, functional and psychosocial domains (Lyles, et al, 1993) and increased risk of mortality (Kado et al, 1999) and hospitalization (Ensrud, et al. 2000).

Vertebral fractures typically occur in the lumbar and thoracic region and result in loss of normal alignment of the spine. Kyphosis can cause severely deformed posture, which frequently leads to a reduction in pulmonary capacity (Schlaich, et al, 1998) and decreased physical mobility (Ryan and Fried, 1997 and Cortet et al, 1999). These fractures typically result from very minimal trauma such as sneezing, lifting, bending or coughing. Conservative treatment is generally indicated. Rest, physical therapy and occasionally bracing are used for treatment. Nasal calcitonin has been reported to have an analgesic effect when used following compression fractures (Lyritis, et al, 1997).

In situations where there are persistent neurologic symptoms, surgical treatment may be indicated. Lee and Yip, 1996 evaluated 497 patients with compression fractures and

found a 2% incidence of spinal cord compression. Treatment consisted of anterior decompression and iliac crest bone graft. The authors found incomplete recovery but in general the results were satisfactory. Vertebroplasty is a relatively new technique involving percutaneous administration, under fluoroscopic guidance, of polymethylmethacrylate (PMMA) into the vertebral body. Improvement in symptoms following treatment has been reported by up to 90% of patients (Jensen, et al, 1997, Barr, et al, 2000). Of those with compression fractures due to metastatic disease, only half of those treated with vertebroplasty report good relief of symptoms (Barr, et al, 2000).

Complications of vertebroplasty have been reported in 6% of cases. Cortet, et al, 1999 found no adverse effect from the procedure, and at 6 months, no vertebral fracture had occurred. With open or surgically controlled placement of the PMMA under fluoroscopic guidance, the potential risk of chemical, compressive or thermal effects of cement leakage on the neural structures is eliminated (Wenger and Markwalder, 1999). Fractures adjacent to vertebrae augmented with cement has been shown as a late complication (Grados et al, 2000).

Vertebral fractures are common and frequently cause severe acute and chronic pain. Surgical therapy is reserved for those with neurological deficits. Vertebroplasty is a relatively new and promising therapy for the pain of fracture, but much remains to be learned about its indications, the timing of the procedure and its benefits and complications.

- **Level A: Case-controlled and cohort studies are needed to examine the long-term effects, complications, benefits and indications (acute and or chronic pain) for vertebroplasty. Such studies should also examine the effects on adjacent vertebrae following vertebroplasty (fracture, deformity).**

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FRACTURES OF THE PROXIMAL HUMERUS

The proximal humerus frequently fractures when there is a fall directly onto the shoulder in cases where bone quality is poor. The proximal humerus may fracture into two, three or four parts. Treatment includes a sling with range of motion started when the patient is comfortable, internal fixation or humeral head replacement. Nonoperative treatment of 3 and 4 part proximal humerus fractures has shown good results. In a 10 year follow up of nonoperatively treated 3 and 4 part proximal humerus fractures, despite poor reduction and decreased range of motion, most patients were satisfied with their outcome (Zyto, 1998). A randomized controlled trial demonstrated that patients treated with ORIF had no better outcome than patients treated nonoperatively (Zyto et al 1999). The complication rate was higher in the operatively treated patients.

Operative treatment of proximal humerus fractures is considered when the reduction is poor. The indications for open reduction and internal fixation have generally been limited to two- and three-part fractures and some types of 4-part fractures if the bone quality is adequate. Plate fixation and indirect reduction have been associated with a low rate of avascular necrosis and nonunion (Hessmann et al, 1998). The valgus-impacted

four-part proximal humerus fracture has been treated with open reduction and internal fixation with 74% of those treated satisfied with their result (Jakob et al, 1991). Complications of open reduction and internal fixation include nonunion, malunion, subacromial impingement and adhesive capsulitis.

Hemiarthroplasty has been the mainstay of treatment for significantly displaced three- and four-part proximal humerus fractures in older patients. Better results are seen if the decision to perform hemiarthroplasty is made early after the fracture (Bosch et al, 1998). After hemiarthroplasty performed for three-and four-part proximal humerus fractures, several authors have noted in their patients decreased range of motion but good pain relief (Hawkins and Switlyk, 1993, Goldman et al, 1995 and Wretenberg and Ekelund, 1997). Others have found their patients to have decreased range of motion and continued pain (Zyto et al, 1998 and Movin et al, 1998). Complications of hemiarthroplasty include infection, nerve injury, intraoperative fractures, instability and tuberosity nonunion.

The results of operative repair for three and four-part proximal humeral fracture are conflicting. Results for non-operatively treated patients are probably not worse than those undergoing surgical repair, yet there are substantial limitations in shoulder range and functional abilities. Substantial additional study is needed on this topic.

- **Level A: Controlled studies are needed comparing operative to non-operative repair of proximal humerus fractures.**
- **Level A: Controlled studies are needed comparing various operative repairs for proximal humerus fractures.**

- **Level B: Observational studies are needed to more clearly define what constitutes a good outcome following a proximal humerus fracture.**

CONCLUSION

The morbidity related to musculoskeletal disorders in the elderly is significant. Degenerative joint disease and fractures of the spine and extremities have a tremendous impact on function especially in the oldest of individuals. Research is needed in many areas particularly in ways to decrease the amount of fall-related trauma, to improve implant fixation in osteoporotic bone, to enhance fracture healing in the aged and to optimize outcomes following fracture. Outcome studies should be performed to evaluate treatment, but what defines a successful outcome remains to be established in this age group.

OrthoSurg1. How can the amount of fall-related trauma be reduced?

Hypothesis-generating research should include expansion of clinical databases related to falls reduction to include a sufficient number of subjects to examine the effects on fracture rates and to examine risk factors for fractures that occur in spite of effective fall reduction. Observational studies and database analysis should focus on refinement of risk factors for fall related trauma. Methodological studies investigating techniques to reduce trauma during falls (hip protectors etc.) and to suggest methods of identifying and improving adherence for patients most likely to benefit from such devices.

Hypothesis-testing research studies to address this question would be

aimed at defining the benefits of risk factor intervention in older patients. Randomized trials of elderly patients treated with specific interventions and devices are needed to clarify the role of interventions on reducing injury, and improving survival and quality of life.

OrthoSurg2. How can implant fixation in osteoporotic bone be improved?

Hypothesis-generating research studies should focus on the technical aspects of specific fixation techniques (cemented, non-cemented implants) and post-operative care (e.g., antiresorptive agents, calcium, vitamin D, exercise). Database analyses and observational studies of specific implants currently used in operations on elderly patients should elucidate risk factors (e.g. degree of osteoporosis) and technical contributions to implant fixation. Further hypothesis-generating research should focus on the development of widely acceptable measures and timeframes for healing and fixation to be used as benchmarks in the evaluation of elderly patients after implant fixation.

Hypothesis-testing research may include randomized trials of specific implants alone or in combination with specific therapies to treat the underlying bone disease. Cohort studies to compare fixation rates according to implant type are needed. Multivariate analyses for such studies may clarify the role of device characteristics versus the presence of specific diseases in predicting successful fixation in older patients.

OrthoSurg3. How can fracture healing in the aged be enhanced?

Hypothesis-generating research should include studies to identify risk factors for poor healing and the effects on healing of commonly prescribed therapies for

osteoporosis. Basic research needs to examine growth factors and other modalities that may enhance healing for future clinical trials. Further hypothesis-generating research should focus on the development of widely acceptable measures and timeframes for healing to be used as benchmarks in the evaluation of elderly patients afterfracture.

Hypothesis-testing research may include randomized trials of specific therapies to enhance fracture healing. Cohort studies should compare healing rates under different strategies for fracture management. Multivariate analyses from such studies may clarify the role of patient level characteristics versus the management of specific fractures in predicting optimal healing in older patients.

OrthoSurg4. How can the outcomes after fracture be optimized?

Hypothesis-generating research should include methodological studies to identify high-risk elderly patients and devise clinical pathways for their care. Database analyses of the pre-hospital, in-hospital, and rehabilitative periods of elderly orthopaedic patients should be performed to identify clinical management strategies that result in decreased morbidity and improved functional recovery.

Hypothesis-generating research should also include the expansion of current clinical databases to include long-term and functional outcomes of older orthopaedic surgical patients. Observational studies and database analysis should focus on refinement of risk factors for poor outcome in elderly surgically versus non-surgically treated patients (e.g., humerus, wrist, vertebral fractures) and describe outcomes in various settings (acute rehab, SNF, home)

and with various approaches (e.g., organized fracture service, weight bearing as tolerated after hip repair) used to manage specific high priority fractures (e.g. hip).

Hypothesis-testing research studies to address this question would be aimed at defining the benefits of specific interventions in older patients. Randomized trials of elderly patients treated for specific fractures (e.g., vertebrae, wrist, humerus) are needed to clarify the role of operative therapy in improving function and quality of life. Case-control or randomized studies of clinical pathways to elucidate the benefit of pathways in obtaining better functional outcomes and reducing in-hospital adverse events and optimizing long-term recovery are needed. The aim of these studies would also be to identify treatment strategies that reduce the incidence of perioperative complications, wound-related problems, and deep venous thrombosis, which are especially prevalent in older orthopaedic patients.

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