Medical Complications and Outcomes After Hip Fracture Repair

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Background: Most evidence guiding perioperative medical risk management of patients undergoing hip fracture repair focuses on cardiac and thromboembolic risk. Little is known of the relative clinical importance of other complications.

Objective: To systematically map incidence and outcomes of a broad spectrum of medical complications after hip fracture repair.

Methods: Retrospective cohort study of patients 60 years or older in 20 academic, community, and Veterans Affairs hospitals. Data on complications and mortality were abstracted from medical records by trained abstractors using standardized, pretested forms or the National Death Index.

Results: Of 8930 patients, 1737 (19%) had postoperative medical complications. Cardiac and pulmonary complications were most frequent (8% and 4% of patients, respectively). Similar numbers of patients had serious cardiac or pulmonary complications (2% and 3%, respectively). Other complications were gastrointestinal tract bleeding (2%), combined cardiopulmonary complications (1%), venous thromboembolism (1%), and transient ischemic attack or stroke (1%). Renal failure and septic shock were rare. After the index complication, 416 patients had 587 additional complications. Mortality was similar for serious cardiac or pulmonary complications (30 day: 22% and 17%, respectively; 1 year: 36% and 44%, respectively) and highest for patients with multiple complications (30 day: 29%-38%; 1 year: 43%-62%). Complications and death occurred significantly earlier for serious cardiac than for serious pulmonary complications (1 vs 4 days, 2 vs 8 days, $P<.001$); length of stay for patients surviving these complications was similar.

Conclusions: Most patients had no medical complications after hip fracture repair. Serious cardiac and pulmonary complications were equally important in frequency, mortality, and survivors' length of stay. Patients with multiple complications had especially poor prognosis.

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HIP FRACTURES are an important cause of morbidity and mortality in elders, with more than 225000 hip fractures occurring annually in the United States in patients older than 50 years.[1,2] Internists are frequently asked to help with preoperative risk assessment and perioperative medical management. Effective risk management requires an understanding of the full clinical picture of postoperative medical complications, but most research on perioperative risk has focused on cardiac complications. Recent evidence suggests that pulmonary complications may be as clinically important, and, other than venous thromboembolism, we know little about the full spectrum and outcomes of medical complications after hip fracture repair.[3-5] Previous studies are small, methodologically flawed, or assess only a few complications.[6-53] We therefore analyzed a large cohort of 8930 patients having hip fracture repair to (1) specifically compare the incidence and outcomes of pulmonary and cardiac complications and (2) describe the incidence and outcomes of other postoperative medical complications.

PATIENTS AND METHODS

STUDY DESIGN AND PATIENT POPULATION

We performed a retrospective cohort study of consecutive patients 60 years or older with hip fracture undergoing surgical repair at 20 study hospitals between 1982 and 1993. Participating hospitals in New Jersey, Texas, Pennsylvania, and Virginia included 5 university-affiliated hospitals, 2 Veterans Affairs medical centers, 4 community teaching hospitals, and 9 community hospitals. The study was approved by the Institutional Review Boards at all participating facilities. The cohort has previously been described and excluded patients who refused blood transfusion; had metastatic cancer, multiple myeloma, multiple trauma, additional operation beside hip fracture repair, or above-the-knee amputation; or were paraplegic or quadriplegic.[54] We further excluded patients with acute preoperative medical complications and those with missing information on the date or type of postoperative complications.

OUTCOMES

Medical complications were defined by explicit, standardized criteria specifically designed for retrospective chart abstraction. Mortality during hospitalization, at 30 days, and at 1 year was determined by chart audit or the National Death Index. We assessed inpatient complications and length of hospital stay until death, discharge, or 30 days, whichever occurred first. Because 10% of patients underwent surgery 2 days or more after admission, length of stay was defined from the day of surgery until discharge. We defined the index complication as the first postoperative medical complication. If additional complications occurred within 24 hours, the index event was defined as one of multiple complications. Complications occurring later than 24 hours after the index event were defined as additional complications. For example, for a patient with pneumonia followed by a myocardial infarction 12 hours later, the index event was classified as a combined cardiopulmonary complication. In contrast, for a patient with pneumonia followed by a myocardial infarction 3 days later, the index event was classified as pneumonia and the myocardial infarction as an additional complication.

We screened for myocardial infarction in patients with (1) postoperative chest pain and at least 1 postoperative electrocardiogram (ECG); (2) cardiac enzymes and at least 1 postoperative ECG; or (3) at least 2 ECGs performed, with one during the postoperative period. In patients who met these criteria, up to 3 ECGs were interpreted by the ECG center at the University of Minnesota, Minneapolis, and myocardial infarction was defined by the criteria of the Atherosclerosis Risk in Communities Study.[55] Myocardial infarction was definite if any of the following criteria were met: (1) evolving diagnostic ECG; (2) diagnostic ECG and abnormal cardiac enzyme levels; or (3) chest pain, abnormal cardiac enzyme levels, and either evolving ST-T wave or equivocal changes on ECG. Myocardial infarction was considered probable for (1) chest pain and abnormal cardiac enzyme levels or (2) abnormal cardiac enzyme levels and evolving ST-T wave changes on ECG. Myocardial infarction was categorized as possible if the only abnormality was elevated cardiac enzyme levels.

We defined congestive heart failure by (1) physician diagnosis or chest radiography consistent with new congestive heart failure or pulmonary edema and (2) new or increased treatment with diuretics, digoxin, or afterload-reducing agents. Arrhythmia was defined as chart documentation (progress note, consultation note, or ECG) of ventricular fibrillation, ventricular tachycardia, atrial fibrillation, atrial flutter, supraventricular tachycardia, paroxysmal atrial tachycardia, or multifocal atrial tachycardia. The definition of conduction defect was chart documentation (progress note, consultation note, or ECG) of Mobitz type II block, second-degree heart block, complete heart block, third-degree heart block, sinus pause ($>$2 seconds), sinus arrest, sick sinus syndrome, or tachycardia-bradycardia syndrome. We defined emergency cardioversion, pacemaker placement, or cardiopulmonary resuscitation as chart documentation in progress notes or consultation notes.

Definite pneumonia was defined as antibiotics plus postoperative chest radiograph consistent with infiltrate or physician diagnosis of pneumonia. Pneumonia was defined as possible if any of the following criteria were met: positive chest radiograph, physician diagnosis, or antibiotic treatment. We defined respiratory failure as intubation maintained past midnight on the day of hip fracture repair or reintubation postoperatively.

Gastrointestinal tract bleeding was defined as chart documentation of hematemesis, coffee-ground emesis, blood per nasogastric tube, melena, or blood per rectum. Hypotension requiring vasopressors in association with other complications was considered secondary to the primary complication (eg, pneumonia, septic shock, or arrhythmia). We defined isolated hypotension requiring vasopressors as systolic blood pressure less than 90 mm Hg treated with vasopressor agents, excluding low-dose dopamine. Renal failure was defined as a decline in renal function requiring hemodialysis. Deep venous thrombosis or pulmonary embolism required positive duplex ultrasound or venogram, high-probability ventilation-perfusion scan, or positive pulmonary angiogram. We defined transient ischemic attack or cerebrovascular accident by physician diagnosis or evidence of new stroke on computed tomography or magnetic resonance imaging. Septic shock was defined by physician diagnosis.

To more accurately describe the epidemiology of postoperative cardiac and pulmonary complications, we categorized these complications as serious or not serious, using definitions determined by consensus of the investigators. The following cardiac and pulmonary complications were classified as serious: definite or probable myocardial infarction, emergency cardioversion, pacemaker insertion, ventricular fibrillation, respiratory failure, and pneumonia. In addition, other cardiac complications were explicitly considered serious if associated with any of the following indicators: cardioversion, pacemaker insertion, cardiopulmonary resuscitation, ventricular fibrillation, ventricular tachycardia, supraventricular tachycardia, sick sinus syndrome or other conduction defect, or hypotension requiring vasopressors.

DATA COLLECTION

Trained abstractors reviewed the entire medical record using standardized, pretested abstraction forms, an explicit abstraction process, centralized training of abstraction supervisors from the 4 study sites, and a systematic prospective data quality assurance process.[54] Data collected included demographic characteristics, medical comorbid conditions, smoking and alcohol use, medications used before admission and during hospitalization, preoperative physical examination, laboratory data, cointerventions (eg, thromboembolism prophylaxis, antibiotic prophylaxis, and physical therapy), variables for type of fracture and repair, intraoperative data, postoperative complications, and mortality.[54] Chart data to assess independence in activities of daily living were collected for a global assessment across all activities and for specific data regarding bed-to-chair transfer, walking or wheelchair use, feeding, and basic grooming.

ANALYSIS

Complication and mortality rates were calculated with 95% confidence intervals. Time in days (from surgery to complication and from complication to death or discharge) was calculated with median values and interquartile ranges. Statistical comparisons of complication rates, mortality, and time to complication, death, and discharge were limited to the largest patient groups: all and serious cardiac complications; all and serious pulmonary complications, gastrointestinal tract bleeding; and combined cardiopulmonary complications. We used an analysis of variance approach with χ^2 (categorical data) or Kruskal-Wallis (continuous data) tests for independence; if results were statistically significant, we proceeded to selected pairwise comparisons.

RESULTS

There were 9598 patients potentially eligible for the study. After 637 patients (6.6%) with preoperative medical complications and 31 patients with missing data were excluded, the final cohort comprised 8930 patients (**Table 1**). The study population was elderly (mean age, 80.2±8.7 years), primarily female (79%), white (87%), and living at home at the time of the fracture (73%). Patients had significant chronic disease as suggested by mul-

Table 1. Demographic Characteristics of Cohort

Characteristic	No. (%)
Age, y	
60-69	1197 (13)
70-79	2653 (30)
80-89	3833 (43)
≥90	1247 (14)
Female sex	7088 (79)
Race/ethnicity	
White	7750 (87)
Black	635 (7)
Hispanic	485 (5)
Other	39 (0.5)
Preadmission residence	
Home	6556 (73)
Retirement home	475 (5)
Nursing home	1767 (20)
Independence in activities of daily living	
Independent	5117 (58)
Needing some help	2457 (28)
Dependent	1313 (15)
Medical comorbidity	
Ischemic heart disease	3528 (40)
Congestive heart failure	1407 (16)
Atherosclerotic cerebrovascular disease	1718 (19)
Hypertension	4203 (47)
Asthma or chronic obstructive lung disease	1325 (15)
Confusion or dementia	2582 (29)
Charlson Comorbidity Index score[56]	
0	4365 (49)
1	2851 (32)
2	1126 (13)
≥3	588 (7)
ASA category*	
I or II	2576 (29)
III	5480 (61)
IV or V	874 (10)

*ASA indicates American Society of Anesthesiologists.

Table 2. Patient-Specific Index Complications and Mortality in 8930 Patients Undergoing Hip Fracture Repair*

Index Complication	No. of Patients (% of Total)	30-d Mortality, % (95% CI)	1-y Mortality, % (95% CI)
All patients, with and without complications	**8930 (100)**	4 (3.6-4.4)	16 (15-17)
No complications	7193 (81)	1.7 (1.4-2)	12 (11.5-13)
Any complication	1737 (19)	14 (12-15)	34 (32-36)
Any cardiac	720 (8)	11 (9-13)	31 (27-34)
Any pulmonary	344 (4)	14 (11-19)†	41 (36-46)†
Serious cardiac	178 (2)	22 (17-29)	36 (28-46)
Serious pulmonary	229 (2.6)	17 (12-23)‡	44 (38-51)‡
Combined cardiopulmonary	117 (1)	33 (25-43)§	58 (48-67)§
Gastrointestinal bleeding	195 (2)	8 (4-12)	26 (20-33)
DVT/PE	89 (1)	4 (1-11)	11 (6-20)
TIA/CVA	85 (1)	18 (10-27)	39 (28-50)
Hypotension requiring vasopressors, no other complication	85 (1)	9 (4-18)	18 (10-27)
2 Complications, not cardiopulmonary	65 (0.7)	29 (19-42)	43 (31-56)
≥3 Complications	24 (0.3)	38 (19-59)	62 (41-81)
Renal failure	8 (0.09)	38 (8-76)	62 (24-92)
Septic shock	5 (0.06)	0	40 (5-85)

*CI indicates confidence interval; DVT, deep venous thrombosis; PE, pulmonary embolism; TIA, transient ischemic attack; and CVA, cerebrovascular accident.

†P=.08 and .001 for 30-day and 1-year mortality, respectively, for any pulmonary complication compared with any cardiac complication.

‡P=.17 and .10 for 30-day and 1-year mortality, respectively, for serious pulmonary compared with serious cardiac complications.

§P<.001 for 30-day and 1-year mortality for cardiopulmonary complications vs cardiac or pulmonary complications alone.

tiple markers of comorbidity (individual diseases, number of prescribed medications, Charlson Comorbidity Index score, and American Society of Anesthesiologists category). A minority (15%) of patients were dependent in activities of daily living.

Table 2 shows the patient-based incidence of index complications and associated mortality. Of 8930 patients, 81% (7193) had no postoperative medical complications. In the 1737 patients with complications, 1531 (17%) had 1, 182 (2%) had 2, and 24 (0.3%) had 3 or more complications as their index event. Cardiac and pulmonary complications were most frequent (8% and 4% of patients, respectively). However, most cardiac complications were not serious; the incidences of serious cardiac and serious pulmonary complications were similar (2% and 2.6%, respectively). Other index complications included combined cardiopulmonary (1.3% of patients), gastrointestinal tract bleeding (2% of patients), and venous thromboembolism, transient ischemic attack or cerebrovascular accident, isolated hypotension, and multiple complications (in about 1% of patients for each). Renal failure requiring dialysis and septic shock were both rare.

Of the 1737 patients with complications, 206 (12%) had multiple complications as their index event. In 416 patients (24% of those with complications), an additional 587 complications occurred more than 24 hours after the index event. Among additional complications, cardiac and pulmonary remained most frequent, with 212 and 200 complications, respectively.

Overall inpatient mortality was 3.3% (292/8930). Patients without complications had a much lower inpatient mortality rate than patients with any complications (0.5% vs 15%). Similarly, mortality at 30 days and at 1 year was significantly lower for patients without complications (Table 2; P<.001 for both). Patients with multiple complications and renal failure had the highest mortality rates (29%-38%). Cardiac, pulmonary, and cerebrovascular complications were associated with higher mortality rates than were gastrointestinal tract bleeding, venous thromboembolism, and unexplained hypotension.

Patients with both, or combined, cardiac and pulmonary complications as their index event had higher 30-day and 1-year mortality than patients with either cardiac or pulmonary complications alone (P<.001). Overall, mortality was higher for patients with pulmonary than cardiac complications, but was similar for patients with serious cardiac and pulmonary complications.

Cardiac complications occurred significantly earlier postoperatively than pulmonary complications (1 vs 4 days; P<.001 for both all and serious complications). For patients who survived, length of stay was similar (13 and 12 days) after cardiac or pulmonary complications. However, for those who died, death occurred signifi-

cantly earlier after serious cardiac than serious pulmonary complications (2 vs 8 days; $P<.001$). For other complications, median days between surgery and the index complications were variable and time to death after the index complication was often protracted.

Respiratory failure was classified as a pulmonary complication regardless of its association with other complications. The 116 index cases of respiratory failure were distributed as follows: 38 isolated, or primary, cases; 3 cases with pneumonia; 33 cases with cardiac complications; 19 cases with pneumonia plus cardiac complications; 11 cases with noncardiac complications; and 12 cases associated with noncardiac complications combined with other cardiac or pulmonary complications. If the 33 patients with respiratory failure and cardiac complications were reclassified as patients whose index complication was cardiac, the number of serious pulmonary and serious cardiac complications would remain similar (196 pulmonary vs 211 cardiac instead of 229 pulmonary vs 178 cardiac).

COMMENT

We systematically evaluated the spectrum, incidence, and clinical outcomes of medical complications after hip fracture repair. Most patients (81%) had no postoperative complications and their mortality was relatively low. For those with complications, most had only one, but a substantial minority (12%) had multiple complications as their index event. Mortality was substantially higher in patients with postoperative complications and was especially high for those with multiple complications.

Overall, the number of patients with cardiac complications was twice the number with pulmonary complications, consistent with the common perception that cardiac events are the most frequent postoperative medical complication.[57] However, the higher frequency of cardiac complications was entirely explained by nonserious complications. For serious pulmonary and cardiac complications, incidence and mortality were quite similar. For those who survived these complications, length of hospital stay was also similar. Among those who died, serious cardiac complications and subsequent death occurred significantly earlier postoperatively than did serious pulmonary complications.

We searched MEDLINE for studies of mortality or medical complications after hip fracture repair published since 1966 and found 48 with potentially relevant data.[6-53] Sex and age characteristics of these studies were similar to those of our large cohort, but the largest involved only 723 patients and mean size was only 222.[6-53] Among studies published since 1990 with at least 100 patients and mortality data, mortality rates were 7% to 11% in hospital, 3% to 13% at 30 days, 10% to 28% at 3 months, and 17% to 43% at 1 year after surgery.* Our 30-day and 1-year mortality rates were at the low end of these ranges, at 4% and 16.4%, respectively.

Few recent studies with at least 100 patients have reported specific medical complications after hip fracture repair.[29,41,42,46,48] Among these, incidence was 7% for

*References 1, 6, 12, 21, 29, 41-43, 45, 46, 48.

cardiac complications, 12% for cardiac failure (one study, 317 patients), and 6% to 10% for pneumonia (3 studies, 100-317 patients).[29,41,42,48] Rates from our study are similar but somewhat lower for serious pulmonary and cardiac complications.

This study had a number of strengths and was designed to address limitations in previous research. It is the largest study in a single surgical setting comprehensively evaluated for postoperative complications and their outcomes. We systematically reviewed medical records using a detailed abstraction instrument and explicit criteria for index complications and their severity.

This study's primary limitation is its retrospective chart audit design. Our ascertainment strategy targeted clinically apparent events and so may have underestimated incidence of some complications. For example, not all patients had routine postoperative ECGs, and screening for myocardial infarctions using cardiac enzymes was rarely performed. We detected fewer thromboembolic events than have prophylaxis trials in which routine surveillance was performed, although our results represent clinically recognized events.[58] In addition, the age of our data (1982-1993) may be a limitation. However, cohort studies large enough to accurately evaluate rates of complications will necessarily span a number of years and/or multiple sites and the data's age is similar to that of other recently published studies in leading journals.[59-61] Changes in rates of complications since these data were collected may include fewer myocardial infarctions because of increasing use of perioperative β-antagonists, less venous thromboembolism with more aggressive prophylaxis, and possibly less pneumonia with earlier ambulation. Such trends are unlikely to change the important finding of this study that serious cardiac and pulmonary complications are similar in frequency and outcomes.

In contrast to other studies of elective surgery, this study tackles the urgent setting of hip fracture repair with (1) the largest cohort to date and (2) expanded outcome assessment of complication severity, length of stay stratified by time of complication and survival status, and mortality at several time points. These results indicate that most elderly patients have an uncomplicated course after hip fracture repair. Of those with complications, most have only one. Few patients have multiple complications, but these patients have the worst prognosis and little is known about risk management for them.[3,61]

Most intervention research has focused on perioperative cardiac risk reduction. This study indicates that serious pulmonary and cardiac complications are equally clinically important in incidence, mortality, and length of stay after hip fracture repair and corroborate results from a previous study of abdominal surgery.[3] The evidence base for pulmonary operative risk lags behind that for cardiac risk, especially regarding identification of reliable risk factors and risk reduction strategies.[52,53,62,63]

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REFERENCES

1. Zuckerman JD. Hip fracture. *N Engl J Med*. 1996;334:1519-1525.
2. Morrison RS, Chassin MR, Siu AL. The medical consultant's role in caring for patients with hip fracture. *Ann Intern Med*. 1998;128:1010-1020.
3. Lawrence VA, Hilsenbeck SG, Mulrow CD, Dhanda R, Sapp J, Page CP. Incidence and hospital stay for cardiac and pulmonary complications after abdominal surgery. *J Gen Intern Med*. 1995;10:671-678.
4. Smetana GW. Preoperative pulmonary evaluation. *N Engl J Med*. 1999;340:937-944.
5. Arozullah AM, Daley J, Henderson WG, Khuri SF, for the National Veterans Administration Surgical Quality Program. Multifactorial risk index for predicting postoperative respiratory failure in men after major noncardiac surgery. *Ann Surg*. 2000;232:242-253.
6. van Dortmont LM, Douw CM, van Breukelen AM, et al. Outcome after hemiarthroplasty for displaced intracapsular femoral neck fracture related to mental state. *Injury*. 2000;31:327-331.
7. McCown PL, Miller WA. Long-term follow-up of hip fractures. *South Med J*. 1976;69:1540-1542.
8. Miller CW. Survival and ambulation following hip fracture. *J Bone Joint Surg Am*. 1978;60:930-934.
9. Davidson TI, Bodey WN. Factors influencing survival following fractures of the upper end of the femur. *Injury*. 1986;17:12-14.
10. Sarmiento A. Avoidance of complications of internal fixation of intertrochanteric fractures. *Clin Orthop Rel Res*. 1967;53:47-59.
11. Kenzora JE, McCarthy RE, Lowell JD, Sledge CB. Hip fracture mortality. *Clin Orthop Rel Res*. 1984;186:45-56.
12. Hudson JL, Kenzora JE, Hebel JR, et al. Eight-year outcome associated with clinical options in the management of femoral neck fractures. *Clin Orthop Rel Res*. 1998;348:59-66.
13. Karumo I. Recovery and rehabilitation of elderly subjects with femoral neck fractures. *Ann Chir Gynaecol*. 1977;66:170-176.
14. Lulu DJ. Femoral head prosthesis. *Am Surg*. 1969;35:418-421.
15. Davis TR, Sher JL, Porter BB, Checketts RG. The timing of surgery for intertrochanteric femoral fractures. *Injury*. 1988;19:244-246.
16. Clayer M, Bruckner J. Occult hypoxia after femoral neck fracture and elective hip surgery. *Clin Orthop Rel Res*. 2000;370:265-271.
17. Milisen K, Abraham IL, Broos PL. Postoperative variation in neurocognitive and functional status in elderly hip fracture patients. *J Adv Nurs*. 1998;27:59-67.
18. Krasheninnikoff M, Ellitsgaard N, Rude C, Moller JT. Hypoxaemia after osteosynthesis of hip fractures. *Int Orthop*. 1993;17:27-29.
19. Niemann KM, Mankin HJ. Fractures about the hip in an institutionalized patient population, II: survival and ability to walk again. *J Bone Joint Surg Am*. 1968;50:1327-1340.
20. Smith DM, Oliver CH, Ryder CT, Stinchfield FE. Complications of Austin Moore arthroplasty. *J Bone Joint Surg Am*. 1975;57:31-33.
21. Gerber C, Strehle J, Ganz R. The treatment of fractures of the femoral neck. *Clin Orthop Rel Res*. 1993;292:77-86.
22. Turner P, Cocks J, Cade R, Ewing H, Collopy B, Thompson G. Fractured neck of the femur (DRG 210/211). *Aust N Z J Surg*. 1997;67:126-130.
23. Pospisil M, Franz J, Loutocky A. Complications and mortality during treatment of fractures of the upper end of the femur in patients including diabetics: analysis of 597 cases treated in 1968-1979. *Acta Univ Carol [Med] (Praha)*. 1985;31:127-152.
24. Juelsgaard P, Sand NPR, Felsby S, et al. Perioperative myocardial ischaemia in patients undergoing surgery for fractured hip randomized to incremental spinal, single-dose spinal or general anaesthesia. *Eur J Anaesthesiol*. 1998;15:656-663.
25. Chen HT. Prosthetic arthroplasty of the hip. *J Int Coll Surg*. 1965;44:432-440.
26. Russin LA, Sonni A. Treatment of intertrochanteric and subtrochanteric fractures with Ender's intramedullary rods. *Clin Orthop Rel Res*. 1980;148:203-212.
27. Warwick D, Hubble M, Sarris I, Strange J. Revision of failed hemiarthroplasty for fractures at the hip. *Int Orthop*. 1998;22:165-168.
28. Hornby R, Evans JG, Vardon V. Operative or conservative treatment for trochanteric fractures of the femur. *J Bone Joint Surg Br*. 1989;71:619-623.
29. Miller K, Arzenhofer K, Gerber G, Reichel M. Risk prediction in operatively treated fractures of the hip. *Clin Orthop Rel Res*. 1993;293:148-152.
30. Ohman U, Bjorkegren NA, Fahlstrom G. Fracture of the femoral neck: a five-year follow up. *Acta Chir Scand*. 1969;135:27-42.
31. Jensen TT, Juncker Y. Pressure sores common after hip operations. *Acta Orthop Scand*. 1987;58:209-211.
32. Hogh J, Lund B, Lucht U. Trochanteric and subtrochanteric fractures: the operative results in a prospective and comparative study of Ender nailing and McLaughlin osteosynthesis. *Acta Orthop Scand*. 1981;52:639-643.
33. Lindholm RV, Puranen J, Kinnunen P. The Moore vitallium femoral-head prosthesis in fractures of the femoral neck. *Acta Orthop Scand*. 1976;47:70-78.
34. Tillberg B. Treatment of fractures of the femoral neck by primary arthroplasty. *Acta Orthop Scand*. 1976;47:209-213.
35. Kolind-Sorensen V. Mortality in intertrochanteric fracture of the femoral neck. *Acta Orthop Scand*. 1975;46:654-656.
36. Brostrom LA, Barrios C, Kronberg M, Stark A, Walheim G. Clinical features and walking ability in the early postoperative period after treatment of trochanteric hip fractures: results with special reference to fracture type and surgical treatment. *Ann Chir Gynaecol*. 1992;81:66-71.
37. Jensen JS, Holstein P. A long term follow-up of Moore arthroplasty in femoral neck fractures. *Acta Orthop Scand*. 1975;46:764-774.
38. Kenzora JE, Magaziner J, Hudson J, et al. Outcome after hemiarthroplasty for femoral neck fractures in the elderly. *Clin Orthop Rel Res*. 1998;348:51-58.
39. Miller K, Atzenhofer K, Gerber G, Reichel M. Risk prediction in operatively treated fractures of the hip. *Clin Orthop Rel Res*. 1993;293:148-152.
40. Laskin RS, Gruber MA, Zimmerman AJ. Intertrochanteric fractures of the hip in the elderly: a retrospective analysis of 236 cases. *Clin Orthop Rel Res*. 1979;141:188-195.
41. Levi N. Early mortality after cervical hip fractures. *Injury*. 1996;27:565-567.
42. Parker MJ. Internal fixation or arthroplasty for displaced subcapital fractures in the elderly? *Injury*. 1992;23:521-524.
43. Bryan AS. Pugh nail system as a form of treatment for fractures of the proximal femur. *Injury*. 1990;21:213-216.
44. Skinner P, Riley D, Ellery J, Beaumont A, Coumine R, Shafighian B. Displaced subcapital fractures of the femur: a prospective randomized comparison of internal fixation, hemiarthroplasty and total hip replacement. *Injury*. 1989;20:291-293.
45. Albareda J, Laderiga A, Palanca D, Paniagua L, Seral F. Complications and technical problems with the gamma nail. *Int Orthop*. 1996;20:47-50.
46. Lu-Yao GL, Keller RB, Littenberg B, Wennberg JE. Outcomes after displaced fractures of the femoral neck. *J Bone Joint Surg Am*. 1994;76:15-25.
47. Sikorski JM, Barrington R. Internal fixation versus hemiarthroplasty for the displaced subcapital fracture of the femur: a prospective randomised study. *J Bone Joint Surg Br*. 1981;63:357-361.
48. Hardy DC, Descamps PY, Krallis P, et al. Use of an intramedullary hip-screw compared with a compression hip-screw with a plate for intertrochanteric femoral fractures: a prospective, randomized study of one hundred patients. *J Bone Joint Surg Am*. 1998;80:618-630.
49. Kyle RF, Gustilo RB, Premer RF. Analysis of six hundred and twenty-two intertrochanteric hip fractures. *J Bone Joint Surg Am*. 1979;61:216-221.
50. D'Arcy J, Devas M. Treatment of fractures of the femoral neck by replacement with the Thompson prosthesis. *J Bone Joint Surg Br*. 1976;58:279-286.
51. Chan RN, Hoskinson J. Thompson prosthesis for fractured neck of femur: a comparison of surgical approaches. *J Bone Joint Surg Br*. 1975;57:437-443.
52. Waddell JP, Czitrom A, Simmons EH. Ender nailing in fractures of the proximal femur. *J Trauma Injury Infect Crit Care*. 1987;27:911-916.
53. Gossling HR, Hardy JH. Fracture of the femoral neck: a comparative study of methods of treatment in 400 consecutive cases. *J Trauma Injury Infect Crit Care*. 1969;9:423-429.
54. Carson JL, Duff A, Berlin JA, et al. Perioperative blood transfusion and postoperative mortality. *JAMA*. 1998;279:199-205.
55. Crow RS, Prineas R, Jacobs DR, Blackburn H. A new epidemiologic classification system for interim myocardial infarction from serial electrocardiographic changes. *Am J Cardiol*. 1989;64:454-461.
56. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987; 40:373-383.
57. Auerbach AD. Beta-blockers and reduction of perioperative cardiac events. In: Shojania KG, Duncan BW, McDonald KM, et al, eds. *Making Health Care Safer: A Critical Analysis of Patient Safety Practices*. Rockville, Md: Agency for Healthcare Research and Quality; July 2001. Evidence Report/Technology Assessment No. 43. Prepared by the University of California at San Francisco–Stanford University Evidence-based Practice Center under contract 290-97-0013. AHRQ publication 01-E058.
58. Geerts WH, Heit JA, Clagett CP, et al. Prevention of venous thromboembolism: Sixth ACCP Consensus Conference on Antithrombotic Therapy. *Chest*. 2001;119 (suppl):132S-174S.
59. Polanczyk CA, Marcantonio E, Goldman L, et al. Impact of age on perioperative complications and length of stay in patients undergoing noncardiac surgery. *Ann Intern Med*. 2001;134:637-643.
60. Polanczyk CA, Rohde LE, Goldman L, et al. Right heart catheterization and cardiac complications in patients undergoing noncardiac surgery. *JAMA*. 2001;286:309-314.
61. Paciaroni M, Eliasziw M, Kappelle LJ, Finan JW, Ferguson GG, Barnett HJM. Medical complications associated with carotid endarterectomy. *Stroke*. 1999;30:1759-1763.
62. Arozullah AM, Khuri SF, Henderson WG, Daley J. Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. *Ann Intern Med*. 2001;135:847-857.
63. Lawrence VA. Predicting postoperative pulmonary complications: the sleeping giant stirs. *Ann Intern Med*. 2001;135:919-921.