Falling in the Netherlands: prevention, care, and follow-up of fall-related injury
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Summary

This thesis describes free falls, staircase falls, falls in older people, fall related injury and its complications. The nine chapters are divided in three parts.

Part I. On Fall-related Skeletal injury and Thrombo-embolic Complications

Chapter 1 describes a study of 464 patients who sustained a staircase fall. Injury characteristics and high risk groups are described. The majority of patients was female and the mean age of the population was 35 years. The incidence of head injury was significantly higher in children under five years. Thoracic injuries were significantly more common in men than in women. Spinal injuries were seen exclusively in patients under 25 years. Older patients sustained more rib fractures and were significantly more often admitted than younger patients. The characteristics of this cohort were comparable with the national population data on staircase falls. However, in comparison to the national population data, older patients in this study had an incidence that was markedly higher than in younger patients. Fall prevention programs should aim at the children under five years and people over 65 years of age.

Chapter 2 concerns patients with a extremely rare, unstable fracture of the pelvic ring: the U-shaped sacrum fracture. The injury characteristics, treatment, and follow-up are described in detail. In a six year period, eight patients with a U-shaped sacrum fracture were admitted in our hospital, five females and three men with a median age of 29 years. All patients had severe associated injuries and their Injury Severity Score varied between 17 and 45 (median, 23). Definitive operative fixation was achieved using percutaneous iliosacral screws, transsacral plate osteosynthesis, or triangular osteosynthesis with or without transsacral plate. The choice of fixation depended on the type of fracture, the associated spinal fractures, and the preference of the operating surgeon. Pain, mood disorders, and mobility problems dominated their health related quality of life. The low incidence of this injury and the severe associated injuries make individual injuries difficult to analyze.

Chapter 3 describes a study of the health related quality of life and functional outcome of patients who received operative treatment for their dislocated calcaneal fracture. One hundred and ten patients (66 % men) with a dislocated fracture of the calcaneus were included between 1999 and 2007. The median age was 41 years and 42% was multitrauma patient. Fractures were classified according to the Essex-Lopresti and Sanders classification. The number of Essex-Lopresti Joint Depression fractures and Essex-Lopresti Tongue Type
fractures were equal. Sanders type II fracture was the most common (46%). In total 65% of the patients was available for follow-up. At follow up the median EuroQol-5D score (health related quality of life) was 0.69 for the entire cohort and 0.71 for patients with an isolated calcaneal fracture. The median Foot an Ankle Outcome Survey (functional outcome) (100=highest score) were: pain (78), symptoms (57), daily activities (85), sports (55), and quality of life (63). The EuroQol-5D and Foot and Ankle Outcome Survey score were significantly worse in the patients with multitrauma and patients with an arthrodesis. There was no relationship between the type of fracture (according to Essex-Lopresti of Sanders) and the EuroQol-5D and Foot and Ankle Outcome Survey score.

Venous thrombo-embolisms (VTE) are frequently found in trauma patients but are often asymptomatic. Prophylaxis in these patients, who often have an increased risk of bleeding, deserves extra attention. Chapter 4 describes an overview article and an ‘Evidence based’ tool for VTE prophylaxis for the individual trauma patient. After an injury to the lower extremity, low molecular weight heparin prophylaxis is advised during the period of immobilization. After operative treatment of hip fractures, Fondaparinux is advised during the first four weeks. In poly- and neurotrauma patients, low molecular weight heparin has shown the best results. It is found that VTE prophylaxis is also indicated in burn patients. Based on these results we concluded that VTE prophylaxis is indicated in most trauma patients. There is a trend towards a broader use in polytraumatized and neurotrauma patients.

Part II. On Fall-related Abdominal Injury and Abdominal Complications

Chapter 5 concerns abdominal injuries following free falls from height. One hundred and thirty-nine patients (76% man and a median age of 31 years) met the main inclusion criterion of this study, namely a fall from five meters or more. Forty-one patients (29%) sustained abdominal injury following the fall. In total 9% sustained a retroperitoneal bleeding, 5% a liver laceration, 6% a kidney laceration, and 6% a laceration of the spleen. Eleven patients (8%) underwent emergency laparotomy and/or endovascular stenting to stop the bleeding. Abdominal injury was associated with a tenfold increase in mortality (20% versus 2%). In surviving patients abdominal injuries were not associated with a worse long-term outcome. Based on these results we conclude that abdominal injuries occur frequently after a fall from height and that they are associated with a tenfold increase in mortality. Chapter 6 describes a systematic review to assess which temporary abdominal closure technique is associated with the highest delayed primary
fascial closure rate. In a search of the literature search, we identified 154 abstracts of which 96 were considered relevant. After reading them, 51 articles were included, describing 57 case series. The temporary closure techniques described were VAC, Vacuum pack, Artificial burr, Mesh/sheet, Zipper, Silo, Skin closure, Dynamic Retention Sutures and Loose packing. The highest delayed fascial closure rates were seen in the Artificial burr (90%), DRS (85%), and VAC (60%). The lowest mortality rates were seen in the Artificial burr (17%), VAC (18%), and DRS (23%). The results of this review may suggest that the Artificial burr and the Vacuum Assisted Closure are associated with the highest delayed primary fascial closure rates as well as the lowest mortality rates.

**Part III. The CAREFALL Triage Instrument**

The validation of the CAREFALL Triage Instrument (CTI) is described in chapter 7. The CTI was developed as a self-administered questionnaire for assessing modifiable risk factors for recurrent falls in older patients (65 years or older). The risk factors were ‘medication’, ‘balance and mobility’, ‘fear of falling’, ‘orthostatic hypotension’, ‘mood disorders’, ‘high risk of osteoporosis’, ‘impaired vision’, and ‘urinary incontinence’. The construct validity, clinical validity, and test-retest reliability were tested. Construct validity: Recurrent falls correlated with more risk factors. Age, female gender, and six risk factors correlated with recurrent falls. Clinical validity: the agreement between the CTI and FPC (classified as almost perfect, substantial, moderate, fair and slight) was fair for ‘balance and mobility’, ‘orthostatic hypotension’, and ‘urinary incontinence’, moderate for ‘mood’, ‘fear of falling’, and ‘high risk of osteoporosis’, and substantial for ‘medication’, and ‘impaired vision’. Test-retest reliability: the agreement between the two CTI’s was substantial for ‘medication’, ‘high risk of osteoporosis’, moderate for ‘balance and mobility’, ‘mood’, fair for ‘orthostatic hypotension’, ‘impaired vision’ and ‘urinary incontinence’, and poor for ‘fear of falling’. Based on these results we conclude that the CTI is a reliable and valid instrument for the assessment of modifiable risk factors for recurrent falls in older patients.

The use of the CTI for secondary fall prevention in older patients outside the hospital is assessed in chapter 8. In order to compare the older patients outside the hospital to the older patients at the Emergency Department (ED), two cohorts were included. The Two hundred and forty-five older patients who visited the ED were matched by age and gender to 245 older patients who attended a fall prevention and intervention program. The two cohorts contained 490 individuals (77% female and the median age was 77 years). The
number of individuals with recurrent falls was greater in the ED cohort (61%; p=0.008). The median number of risk factors was higher in the ED cohort (4; Inter Quartile Range (IQR) 3-5) compared with the fall prevention cohort (3; IQR 3-4). In both cohorts a significant association between the number of risk factors per individual and the risk of recurrent falls was found. In the fall prevention cohort, each added risk factor per individual increased the risk of recurrent falls by 37% for that individual. This increased risk per added risk factor was slightly higher in the ED cohort (38%). Based on these results we concluded that the CTI is also a useful instrument for the assessment of modifiable risk factors in older patients who stayed outside the ED.

**Chapter 9** describes a study of the correlation between the estimated fracture risk and the measured bone mineral density (osteoporosis). The fracture risk is estimated using the information from the CTI and calculations from the Dutch Institute for Healthcare Improvement (Dutch: CBO) national guideline ‘Osteoporosis’. The level of osteoporosis is measured with the Dual-energy X-Ray and Laser Absorptiometry (DXL) calcaneus scan. The 10-year risk of sustaining a wrist fracture, vertebral fracture, or hip fracture was estimated for all individuals. They also underwent a DXL calcaneus bone mineral density scan. A total of 177 individuals were included. Their median age was 78 years and 54% was female. Over 70% of the individuals had a recent history of recurrent falls. Approximately half of the individuals had one or more factors that contributed to an increased fracture risk. The median 10-year risk of this community dwelling population sustaining a wrist fracture was 2%. The median risk of sustaining a vertebral fracture was 5%. The median risk of sustaining a hip fracture was also 5%. Women had a higher 10-year fracture risk than men. According to the DXL calcaneus scan, 43% individuals suffered from (severe) osteoporosis. There was a significant correlation between the estimated 10-year fracture risk and the diagnosis osteoporosis according to the DXL calcaneus scan. Based on these results we conclude that the estimated fracture risk and the measured osteoporosis correspond. However, in daily practice the CTI and DXL calcaneus scan complement each other. Therefore, they are best applied as a combined assessment for the (secondary) prevention of falls and associated fractures in older patients.