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

This thesis describes free falls, staircase falls, fall in older people, fall related injury and its complications. The nine chapters are classified in three parts. In part one, three studies on fall related skeletal injuries are grouped with the thrombo-embolic complications because the type and duration of thrombosis prophylaxis strongly depends on the location of the skeletal injury. In part two, fall related abdominal injuries are described, together with a systematic review on the open abdomen in patients with abdominal trauma. Part three includes three studies that describe the use of the CAREFALL Triage instrument.

On Fall-related Skeletal Injury and Thrombo-embolic Complications

Falls are the most common cause of injury in western countries. Yet little has been described about the epidemiology, patterns, and severity of fall-related injury. One of the reasons for this lack of data may be that falls are heterogeneous. Examples are slips and trips, staircase falls, or free falls (intentional or unintentional). Another reason may be that falls are very difficult to study prospectively. Therefore, unless the trauma mechanisms are structurally assessed at the Emergency Department, a study on falls relies heavily on retrospective recordings (ED charts) of the falls. In addition, when the trauma mechanism is assessed in a structured way, these data are not always linked to the data on hospital stay and treatment. The result is that the circumstances surrounding the fall are largely unknown or not linked to additional patient data. Therefore, it is unknown what people are particularly at risk and which injuries they sustain. In Chapter 1 we describe high risk groups and injury characteristics in staircase falls.

U-shaped sacral fractures are rare injuries that result from high energy axial loading (most commonly a fall from height). Not only do they have a low prevalence, their nature and associated injuries are heterogeneous. The combination of rarity and heterogeneity makes these injuries, their treatment, and the follow-up potentially difficult to assess. However, the severity and heterogeneity oblige us to further assess these injuries. The injury characteristics, treatment, and follow-up of patients with a U-shaped sacral fracture is described in Chapter 2.

Calcaneal fractures are more prevalent than U-shaped sacral fractures. Despite this, there is no evidence for the optimal treatment. There is a trend towards operative treatment, primarily in dislocated fractures. We believe that operative treatment is preferred for dislocated fractures of the calcaneus. Over the years, our hospital, the Academic Medical Center (Amsterdam), has gained a wide experience in the Open Reduction and Internal Fixation (ORIF)
of dislocated calcaneal fractures. It has become a referral center for the region. Despite the seemingly satisfying results, there are no detailed data of how patients live and function after ORIF of the calcaneus. Assessing the quality of life and functional outcome improves the understanding and care for these patients. In Chapter 3 we evaluate the quality of life and functional outcome of patients who have received operative treatment for a dislocated calcaneal fracture.

Fall related injury may give rise to a number of complications. One of the most important complications following skeletal injury is a Venous Thromboembolism (VTE). These VTE can be divided into Deep Venous Thrombosis (DVT) and Pulmonary Embolism (PE). VTE may occur in a patient after injury with or without subsequent immobilization. The prevalence of VTE in trauma patients is high. However, the prevention of VTE in trauma patients presents a dilemma. Trauma patients are at risk of VTE without prophylaxis and at risk of bleeding when given anticoagulants. The prophylaxis of VTE in many ambulant patients is subject to debate because thrombosis is frequently asymptomatic. Because the clinical diagnosis of DVT is unreliable, the clinical significance of VTE prophylaxis is sometimes questioned. For all clinicians who treat trauma patients it is important to be fully informed about the benefits and harms of thrombosis prophylaxis. Chapter 4 is an evidence based tool for the prophylaxis of VTE in each type of trauma patient.

On Fall-related Abdominal Injury and Abdominal Complications.
The pattern of fall related injury differs from other causes of blunt trauma. Severe injuries commonly happen to the head, followed by the chest and abdomen. However, most reports are about skeletal injuries, and not about the abdomen. This is surprising because the prevalence of abdominal injuries after fall from height may be up to 20%. The prevalence of abdominal injuries in the patients that are treated at our hospital is unknown. Knowing the prevalence and nature of the most common abdominal injuries may aid early diagnosis and treatment in patients after a fall from height. In Chapter 5 we describe abdominal injuries following free falls from height.

Any abdominal trauma, including fall related injury, may be complicated by other conditions. One of the most severe complications following surgical treatment of abdominal trauma is the ‘open abdomen’. The open abdomen is a feared complication in any patient with abdominal trauma or infection. It is defined as ‘the inability to primarily close the abdominal fascia after laparotomy’. When the fascia cannot be closed primarily it can be closed temporarily. Temporary abdominal closure is meant to cover and protect the bowel. It should allow the swelling to decrease before the fascia is to be closed.
Several techniques are available for temporary closure of the abdomen. At the end of the temporary abdominal closure period, preferably the abdomen must be closed primarily. The rate of successful primary fascial closure after temporary closure varies between different techniques. However, it is unknown which technique has the highest rate of fascial closure. In Chapter 6 we describe the search for the optimal treatment in patients with an open abdomen by means of a systematic review of the literature.

**The CAREFALL Triage Instrument**

Falls cause injury in many thousands of older people annually in the Netherlands. In addition, one in four fall related Emergency Department (ED) visits results in hospital admission. Over the years there have been many studies on fall-prevention. These studies have lead to multiple different guidelines. These guidelines focus on multifactorial assessment and intervention to reduce the risk of falling. Despite these great efforts, however, the guidelines tend to be paper tigers. They have not been transformed into questionnaires that can be used to actually practice fall-prevention. There is no valid instrument for screening older patients and assess the risk of recurrent falls. The CAREFALL Triage Instrument (CTI) was developed to bring the evidence into daily practice: as a questionnaire for the older people who visit the Emergency Department (ED) after a fall. However, before the CTI could be used, the authors had to make sure that it measures what it should measure. In other words, the CTI had to be validated. The construction and validation of the CAREFALL Triage Instrument is described in Chapter 7.

Despite the fact that many people visit the ED, there may be many more people who do not visit the ED after a fall. This may be either because they sustain little or no injury, or because the injury they sustained happened to be lethal. It is unknown how many people suffer from recurrent falls and if0 they have the same risk factors for recurrent falling as the ED patients. Furthermore, it is unknown if the CTI is also a valuable tool for secondary fall-prevention in this population. In Chapter 8 we describe how we used the CTI as an instrument for secondary fall-prevention in community-dwelling older people.

In all older people, but specifically in women, the incidence of osteoporosis increases dramatically after the menopause. Therefore, the risk of sustaining a fracture increases. The risk of osteoporosis of a fracture can be estimated using several algorithms. Osteoporosis can also be measured with devises such as the ‘Dual-energy X-ray and Laser Absorptiometry (DXL)’ calcaneus scan. However, it is unknown if these two methods correlate with each other. The correlation of the estimated fracture risk of the CTI and Osteoporosis guideline with the measured of the DXL calcaneus scan is described in Chapter 9.