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*Antti Lahtinen*

# REHABILITATION AFTER HIP FRACTURE

## *COMPARISON OF PHYSICAL, GERIATRIC AND CONVENTIONAL TREATMENT*

*UNIVERSITY OF OULU GRADUATE SCHOOL;*
*UNIVERSITY OF OULU,*
*FACULTY OF MEDICINE;*
*MEDICAL RESEARCH CENTER OULU*

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# REHABILITATION AFTER HIP FRACTURE

Comparison of physical, geriatric and conventional treatment

Academic Dissertation to be presented with the assent of the Doctoral Training Committee of Health and Biosciences of the University of Oulu for public defence in Auditorium 1 of Oulu University Hospital (Kajaanintie 50), on 10 May 2019, at 12 noon

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***Abstract***

Hip fracture causes substantial burden for individual and society, with increased mortality and loss of function. The purpose of this study was to (1) examine the effects of specialized (physical and geriatric) rehabilitation on home-dwelling hip fracture patients 50 years or older on recovery one year after the fracture, (2) to evaluate the costs and cost-effectiveness of specialized rehabilitation modalities, (3) to study the recovery after hip fracture between home-dwelling male and female patients and (4) to determine recommendations for hip fracture rehabilitation concerning the general rehabilitation practices in Finland.

A total of 538 consecutively, independently living patients with non-pathological hip fracture treated in Oulu University hospital, were randomized to one of the three rehabilitation modalities: privately-based rehabilitation unit (physical rehabilitation), geriatric department (geriatric rehabilitation) and healthcare centre hospital (control group). Patients were evaluated on admission, at 4 and 12 months for social status, residential status, walking ability, use of walking aids, pain in the hip, activities of daily living and mortality. Costs were evaluated by recording the use of healthcare service and the prices were obtained from Diagnosis Related Group (DRG) price list for the hospital and from a publication of the National Research and Development Centre for Welfare and Health.

Mortality was lower in the physical rehabilitation group 4 and 12 months after the fracture compared to geriatric and the control rehabilitation group. Physical and geriatric rehabilitation improved the ability of independent living after 4 months, but this effect could not be seen after 12 months. The rehabilitation costs were higher in the physical rehabilitation than in the control group, but the total healthcare-related costs one year after the fracture were lower in the physical rehabilitation group than in the control. Male and female patients recovered similarly after hip fracture. Age, poor functional status before the fracture and high ASA-score increased the mortality risk.

This thesis suggests that intensive mobilization and rehabilitation is a recommended practice after the hip fracture, resulting in better functional recovery, survival and lower economic costs compared to routine treatment. Poor recovery was predicted not by sex, but by prefracture function and morbidity.

*Keywords:* cost of rehabilitation, cost-effectiveness, functional outcome, hip fracture, hospital costs, rehabilitation

**Lahtinen, Antti, Kuntoutus lonkkamurtuman jälkeen. Satunnaistettu kontrolloitu vertailutkimus kolmen kuntoutusyksikön välillä**

Oulun yliopiston tutkijakoulu; Oulun yliopisto, Lääketieteellinen tiedekunta; Medical Research Center Oulu

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## *Tiivistelmä*

Lonkkamurtuma on yksi merkittävimmistä toimintakyvyn laskua ja kuolleisuutta aiheuttavista vammoista. Tämän väitöskirjatutkimuksen tarkoituksena oli (1) tutkia tehostetun (fysikaalisen ja geriatrisen) kuntoutuksen vaikutusta itsenäisesti asuvien, vähintään 50-vuotiaiden lonkkamurtumapotilaiden kuntoutumiseen murtumaa seuraavan vuoden aikana, (2) arvioida lonkkamurtuman hoidon kustannuksia ja kustannusvaikuttavuutta tehostetussa kuntoutusyksikössä, (3) tutkia lonkkamurtuman kuntoutumisen eroja mies- ja naispotilaiden välillä sekä (4) tarkentaa lonkkamurtuman hoitoketjun yleisiä suosituksia Suomessa.

Tutkimuksessa seurattiin 538 lonkkamurtumapotilasta, jotka hoidettiin kirurgisesti Oulun yliopistollisessa sairaalassa. Valintakriteereihin kuului vähintään 50 vuoden ikä sekä kyky itsenäiseen asumiseen joko omassa kodissa tai kodinomaisessa ympäristössä ennen murtumaa. Lonkkaleikkauksen jälkeen potilaat satunnaistettiin yhteen kolmesta kuntoutusryhmästä: fysikaaliseen kuntoutusryhmään (Oulun Diakonissalaitos), geriatriseen kuntoutusryhmään (Oulun kaupunginsairaalan kuntoutusosasto) sekä kontrolliryhmään (terveyskeskussairaalassa tapahtuva kuntoutus). Seuranta-aika oli yksi vuosi. Potilaat haastateltiin ennen kuntoutusta, sekä neljän ja 12 kuukauden kuluttua murtumasta, joiden yhteydessä aineisto kerättiin koskien yleistä terveydentilaa, toiminta- ja kävelykykyä, asumismuotoa ja kuolleisuutta. Kustannukset arvioitiin terveyspalveluiden käytöstä ja näiden hintoina käytettiin sairaalan yksikköhintoja (DRG) ja sosiaali- ja terveysalan tutkimus- ja kehittämiskeskuksen (STAKES) yksikköhintoja.

Fysikaalinen kuntoutus vähensi merkittävästi potilaiden kuolleisuutta neljän ja 12 kuukauden seurannoissa verrattuna geriatriseen kuntoutukseen sekä kontrolliryhmään. Lisäksi fysikaalinen ja geriatrinen kuntoutus lisäsivät lyhytaikaisesti potilaiden kykyä itsenäiseen asumiseen verrattuna kontrolliryhmään. Taloudellisten vaikutusten osalta fysikaalinen kuntoutusjakso oli huomattavasti tavanomaista kuntoutusta kalliimpi, mutta fysikaalisen kuntoutusryhmän kokonaiskustannukset vuoden aikana olivat pienemmät kuin kontrolliryhmän potilailla. Sukupuolella ei ollut vaikutusta potilaiden toimintakykyyn, laitostumiseen tai kuolleisuusriskiin murtuman jälkeen. Merkittäviksi kuolleisuutta ennustaviksi tekijöiksi osoittautuivat ikä, toimintakyky ennen murtumaa sekä leikkauskelpoisuusluokitus.

Tulokset puoltavat tehostetun, erikoistuneessa kuntoutusyksikössä suoritetun hoidon käyttöä lonkkamurtumapotilailla sekä terveydellisten että taloudellisten syiden osalta.

*Asiasanat:* kuntoutuksen kustannukset, kuntoutus, kustannus-hyötyanalyysi, kustannustehokkuus, lonkkamurtuma, sairaalakustannukset, toimintakyky

*To my family*

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Oulu, January 2019 Antti Lahtinen

# Abbreviations

| | |
|---|---|
| 15D | 15D health-related quality of life instrument |
| ADL | Activities of daily living |
| AO/ASIF | Association for Osteosynthesis/Association for the Study of Internal Fixation |
| ASA | American Society of Anesthesiologists |
| BADL | Basic activities of daily living |
| CI | Confidence interval |
| CT | Computed tomography |
| DRG | Diagnosis related group |
| HR | Hazard ratio |
| IADL | Instrumental activities of daily living |
| i.e. | id est |
| LOS | Length of stay |
| MMSE | Mini-Mental State Examination |
| MRI | Magnetic resonance imaging |
| QOL | Quality of life |
| RCT | Randomized controlled trial |
| SAHFE | Standardised Audit of Hip Fractures in Europe |
| SD | Standard deviation |
| SEM | Standard error of mean |
| SPMSQ | Short Portable Mental Status Questionnaire |

# List of original publications

This thesis is based on the following publications, which are referred throughout the text by their Roman numerals:

I Lahtinen, A., Leppilahti, J., Harmainen, S., Sipilä, J., Antikainen, R., Seppänen, M. L., Willig, R., Vähänikkilä, H., Ristiniemi, J., Rissanen, P., & Jalovaara, P. (2015). Geriatric and physically oriented rehabilitation improves the ability of independent living and physical rehabilitation reduces mortality: a randomised comparison of 538 patients. *Clinical Rehabilitation*, 29(9), 892–906.

II Lahtinen, A., Leppilahti, J., Vähänikkilä, H., Harmainen, S., Koistinen, P., Rissanen, P., & Jalovaara, P. (2017). Costs after hip fracture in independently living patients: A randomised comparison of three rehabilitation modalities. *Clinical Rehabilitation*, 31(5), 672–685.

III Lahtinen, A., Leppilahti, J., Vähänikkilä, H., Kujala, S., Ristiniemi, J., & Jalovaara, P. (2019). No major differences in recovery after hip fracture between home-dwelling female and male patients. *Scandinavian Journal of Surgery* (In press)

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# 1 Introduction

Hip fracture is the most common injury requiring hospitalization in elderly persons, with incidence rates that are expected to increase exponentially, up to 6.3 million in 2050 (Cooper, Campion & Melton, 1992). The greatest incidence rates concentrate in Nordic countries and North America (Johnell, Gullberg, Allander & Kanis, 1992; Kanis et al., 2002). In Finland, the number of hip fractures among people aged 50 or more rose sharply between 1970 and 1997 (to 7122 fractures) (Korhonen et al., 2013). The increase has since levelled off, however, and with 4370 surgically treated hip fractures in 2015 (PERFECT, 2015). In the Finnish population, the lifetime risk of sustaining a hip fracture among people aged 50 is 5.5% in men and 12.7% in women (Kanis et al., 2002).

Hip fracture causes substantial burden for individual and society. Most patients do not gain their prefracture level of mobility and function (Penrod et al., 2008; Tang et al., 2017), and up to 20%–30% of them face potential institutionalization (Huusko, Karppi, Avikainen, Kautiainen & Sulkava, 2002; Koval, Aharonoff, Su & Zuckerman, 1998). In addition, excess mortality has been reported among hip fracture patients (Gregersen, Mørch, Hougaard & Damsgaard, 2012; Koval et al., 1998; Naglie et al., 2002), and the risk of death following a hip fracture remains high up to 10–20 years compared to rest of the population (von Friesendorff et al., 2016).

Hip fractures are generally treated surgically, followed by rehabilitation to recover prefracture mobility. Countries vary considerably in the provision of rehabilitation, applying many different methods. Some studies have shown that a high frequency of mobilization exercises during rehabilitation improves post-fracture function (Hagsten, Svensson & Gardulf, 2004) and that rehabilitation in a specialized, geriatric unit may improve the likelihood of independent living (Huusko et al., 2002). However, other studies have found no additional improvement with specialized rehabilitation settings (Naglie et al., 2002; Ponten et al., 2015; Röder et al., 2003). Comparison of results among studies is limited because of a lack of standardization of study design, follow-up, and recorded variables.

In addition to major impacts on individual health, hip fracture also leads to excessive healthcare costs. An estimated one third of hip fracture costs accumulates during the first 6 months after the fracture is sustained (Braithwaite, Col & Wong, 2003). One of the main causes for increased costs after the fracture is admission to a long-term care facility (Wiktorowicz, Goeree, Papaioannou, Adachi &

Papadimitropoulos, 2001). Few studies have compared the expenditures between different rehabilitation settings, and cost-reducing strategies often have focused on shortening the initial hospital stay (Farnworth, Kenny & Shiell, 1994; Polder, van Balen, Steyerberg, Cools & Habbema, 2003). However, this tactic may only shift the costs elsewhere, generating no additional savings (Polder et al., 2003).

This thesis focuses on the impact of specialized rehabilitation on functional outcome, capacity for independent living, and mortality as well as economic costs and cost-effectiveness in home-dwelling hip fracture patients, using routine rehabilitation as a control. We also studied recovery in male compared to female patients after the fracture.

# 2 Review of literature

This thesis focuses on hip fracture patients age 50 years or older. Hip fractures in this age group are often caused by low-energy trauma, usually by falling. In younger patients, hip fracture is associated with high-energy trauma, and these fracture types should be treated as separate entities (Damany, Parker & Chojnowski, 2005).

## 2.1 Anatomy and classification of hip fractures

A hip fracture is a break in the upper quarter of the femur (thigh) bone. The diagnosis and classification of hip fracture are generally confirmed radiographically, by an X-ray (Zuckerman, 1996). In some cases the fracture may not be visible in radiographs, and the diagnosis is confirmed by computed tomography (CT) or magnetic resonance imaging (MRI) (Rizzo et al., 1993).

Hip fractures are classified into intracapsular and extracapsular fractures based on their location (Zuckerman, 1996; Figure 1). Intracapsular fractures occur at the level of the neck and head of the femur, inside the capsule that surrounds the hip joint itself. Extracapsular fractures occur at a lower level of the femur than intracapsular fractures and outside the actual hip joint. They can be further divided into basicervical, trochanteric, and subtrochanteric fractures. Basicervical is a rare type of fracture occurring at the base of the femoral neck (Saarenpää, Partanen & Jalovaara, 2002). Trochanteric fracture occurs between the neck of the femur and the lesser trochanter. Subtrochanteric fracture occurs in the area below the lesser trochanter, up to 5 cm away.

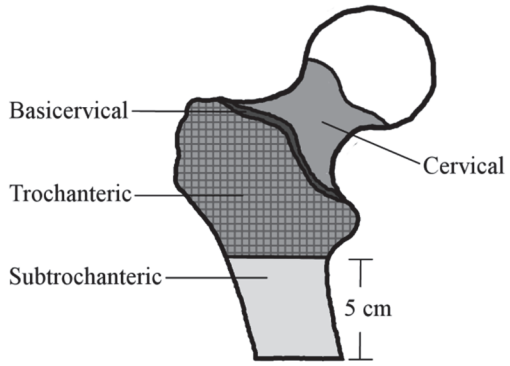


**Fig. 1. Anatomical classification of hip fracture.**

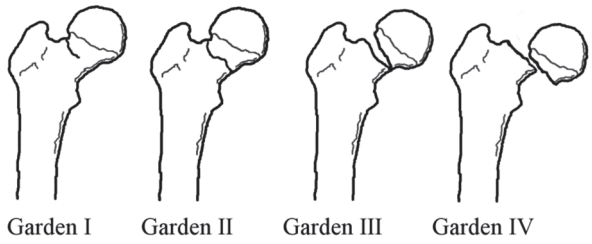


**Fig. 2. Femoral neck fracture classification according to Garden (1961).**

A more detailed classification of hip fractures is used for planning operative treatment. The Garden classification, the most widely used system for categorizing intracapsular fractures (Garden, 1961), is based on displacement of the trabeculae within the femoral head from their normal alignment (Figure 2). The system consists of four grades, subdivided into undisplaced (Garden 1-2) and displaced (Garden 3-4) fractures. This division into undisplaced and displaced fractures has been proved to be clinically relevant (Eliasson, Hansson & Kärrholm, 1988). Other classification systems have also been described, such as the AO/ASIF classification (Müller, Nazarian, Koch & Schatzker, 1990) and the Pauwels (1935) classification based on mechanical stability of the fracture, but these have little clinical relevance (Parker, 1997).

Many classifications exist for trochanteric fractures. The simplest approach is to categorize fractures based on stability, as first described in a system of classification by Evans (1949), later modified by Jensen and Michaelsen (1975). This system divides fractures into five categories, with types 1 and 2 regarded as stable and types 3–5 as multi-part or unstable (Figure 3). The AO/ASIF system uses

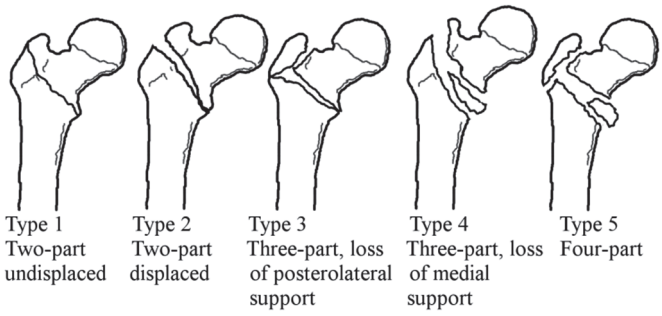


**Fig. 3. Trochanteric fracture classification according to Jensen and Michaelsen (1975).**

nine different subgroups for trochanteric fractures (Müller et al., 1990).

There are also many different classification systems for subtrochanteric fractures, but the categorization is difficult because the borderline between trochanteric and subtrochanteric fracture is controversial (Parker, 1997). The Fielding classification is a three-grade system based on the level of the region through which the fracture extends (Fielding & Magliato, 1966; Figure 4). A later Zickel classification (1976) divided subtrochanteric fractures into six groups. AO/ASIF classification is currently the most subdivided system, with nine different subgroups (Müller et al., 1990). However, it has been recommended that subtrochanteric fractures should be divided into undisplaced, two-part, and comminuted fractures because of their infrequency (Parker, 1997). The relative proportions of different fracture types are presented in Table 1.


**Fig. 4. Fielding classification for subtrochanteric fractures.**

**Table 1. Relative proportion of different hip fracture types (Holt et al., 2008).**

| Fracture type | Male[1] | Female[1] |
|---|---|---|
| Intracapsular | 49 % | 52 % |
| Extracapsular/trochanteric | 42 % | 42 % |
| Subtrochanteric | 5 % | 3 % |
| Pathological | 3 % | 2 % |

[1]Based on hip fracture data in Scotland.

## 2.2 Etiopathology of hip fractures

Most hip fractures occur as a result of stumbling and falling and are multifactorial in nature (Hayes, Myers, Robinovitch & van den Kroonenberg, 1996). In elderly patients, several factors mediate the fall and subsequent hip fracture, such as balance impairment (Kulmala et al., 2007), neuromuscular and musculoskeletal

impairment (Myers et al., 1996), fall type (Greenspan et al., 1998), and fall speed (Hayes et al., 1996). Cummings and Nevitt (1989) described differences in falls: young people tend to fall onto their hands, while the elderly fall laterally onto their hip.

Most hip fractures occur in women (Benetos, Babis, Zoubos, Benetou & Soucacos, 2007), and the risk increases with age (Kannus et al., 1996). Various risk factors associated with hip fracture have been studied. In their meta-analysis, Kanis et al. (2004) reported that genetic factors play a significant role and that having parents who experienced hip fracture increases risk for women. Other known risks range from nutritional factors such as vitamin D deficiency, malnutrition, and low body mass (Kanis et al. 1999) to chronic illnesses such as stroke (Kanis, Oden & Johnell, 2001), Parkinson disease (Marks, 2010), and poor vision (Ivers, Cumming, Mitchell, Simpson & Peduto, 2003). Smoking (Law & Hackshaw, 1997) and alcohol usage also have been reported to increase fracture risk (Kaukonen et al., 2006). Medication such as benzodiazepines (Wang, Bohn, Glynn, Mogun & Avorn, 2001), antidepressants (Liu et al., 1998), and sedatives (Wang et al., 2001) that may impair balance and motor functions are associated with increased risk of hip fracture.

## 2.3 Epidemiology of hip fractures

Hip fracture incidence rates are expected to increase exponentially because of population aging, from 1.6 million in 2000 up to 6.3 million in 2050 (Cooper et al., 1992). Hip fracture incidence shows high geographical variation and is highest in Sweden and North America (Johnell et al., 1992) and lowest in Africa (Zebaze & Seeman, 2003). The incidence increases with poor economic status, reduced winter sunlight, and water fluoridation (Dhanwal, Dennison, Harvey & Cooper, 2011). However, the age-adjusted incidence of new hip fractures is projected to stabilize or decrease in the United States, Canada, Oceania, and some European countries while increasing especially in Asia (Cooper et al., 2011).

According to Kanis et al. (2002), the Finnish population is in the high-risk category for sustaining hip fractures, with men having 5.5% and women 12.7% lifetime risks at the age of 50 years. These rates, however, are the lowest among the Nordic countries (Kanis et al., 2002). The respective lifetime risk rates for men and women are 13.1% and 28.5% in Sweden, 8.7% and 24.5% in Norway, and 5.8% and 16.5% in Denmark (Kanis et al., 2002). The number of hip fractures in Finland among people aged 50 or more rose sharply between 1970 and 1997 (from 1857 to

7122 fractures), but the rise has since levelled off (4370 surgically treated fractures in 2015) (PERFECT, 2015). However, because the size of the population in the 50-year or older range is increasing, it is possible that the number of hip fractures will continue to increase despite decreasing incidence (Korhonen et al., 2013).

## 2.4 Surgical treatment

### *2.4.1 Femoral neck fractures*

Intracapsular fractures (Figure 5) can be treated by fixing the fracture and preserving the femoral head, or in cases of displaced fractures, by hemiarthroplasty or total arthroplasty. The internal fixation allows the patient to retain their own femoral head. Considering arthroplasty, three different types of arthroplasty are available: uni- and bipolar hemiarthroplasty and total arthroplasty.

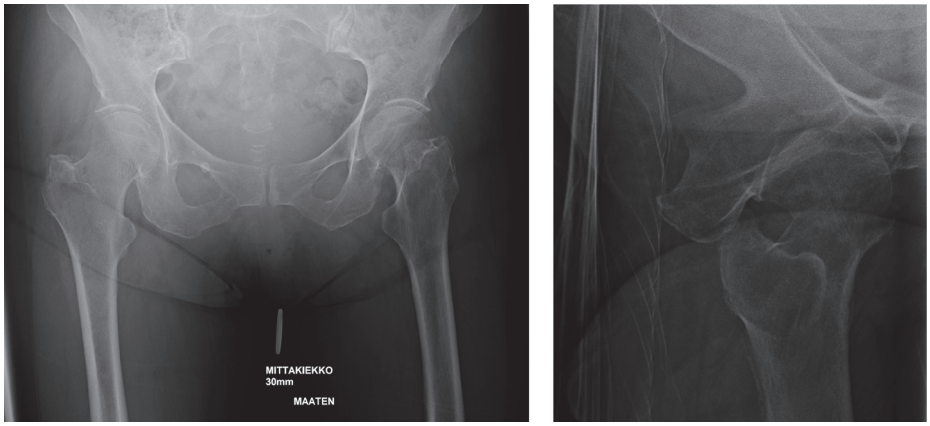


**Fig. 5. X-ray image of femoral neck fracture.**

In undisplaced intracapsular fractures (Garden I and II), internal fixation is usually recommended (Conn & Parker, 2004; Cserhati, Kazar, Manninger, Fekete & Frenyó, 1996). Considering non-union rates, internal fixation with a non-union rate of 5%–10% is superior to conservative treatment with a rate of 15%–60% (Hansen, 1994; Parker & Pryor, 1993; Raaymakers & Marti, 1991). Do, Kruke, Foss & Basso (2016) reported that screw fixation of undisplaced fractures is a relatively safe

procedure, with conversion to arthroplasty occurring in up to 25% in long-term survivors.

In displaced femoral neck fractures (Garden III and IV), arthroplasty is considered the treatment of choice in elderly patients (Frihagen, Nordsletten & Madsen, 2007; Keating, Grant, Masson, Scott & Forbes, 2006; Rogmark & Leonardsson 2016; UK NICE Guidelines, 2017). A meta-analysis by Gao, Liu, Xing & Gong (2012) summarized the results of 20 randomized controlled trials with elderly (at least 60 years old) patients having had dislocated femoral neck fracture. These authors concluded that arthroplasty was associated with a lower risk of major surgical complications, fewer reoperations, and better pain relief compared to internal fixation. Also, function was found to be superior compared to internal fixation, and patients with arthroplasty also reported less pain, but no differences in mortality were observed. Internal fixation may constitute the best treatment option for younger patients (less than 60 years) or those without serious co-morbidities (Shah, Eissler & Radomisli, 2002). However, there are no randomized, controlled studies of internal fixation versus arthroplasty in patients under age 60 years.

Both hemiarthroplasty and total hip arthroplasty are accepted methods for treating dislocated femoral hip fractures, but consensus is lacking regarding the optimal method. UK NICE Guidelines (2017) recommend that total hip arthroplasty should be favoured over hemiarthroplasty in patients who can walk independently outdoors before the fracture, have no cognitive impairments, and are otherwise fit for surgery. In a meta-analysis, Wang, Zhang, Zhang, Ma & Feng (2015) concluded that both reoperation and acetabular erosion rates were higher in bipolar hemiarthroplasty than in total arthroplasty after 4 years, while dislocation rate was higher in total hip arthroplasty. They found no differences in infection rate, general complications, one-year mortality, or functional outcome as measured by the Harris hip score. A meta-analysis by Jia et al. (2015) including 10 randomized controlled trials compared bipolar and unipolar hemiarthroplasty. They concluded that bipolar hemiarthroplasty has similar or slightly better functional outcome with less hip pain and better quality of life, but higher cost compared to unipolar hemiarthroplasty. Bipolar hemiarthroplasty was also associated with a lower incidence of short-term acetabular erosion (in one-year follow-up), while no differences were observed in longer follow-ups.

### 2.4.2 Trochanteric fractures

Trochanteric fractures represent approximately half of all hip fractures caused by a low-energy mechanism (Ahn & Bernstein, 2010; Figure 6). The standard operative methods include the sliding hip screw, intramedullary nail, and fixed angle plate (Ahn & Bernstein, 2010), and proper fracture reduction is paramount. A Cochrane analysis (Parker & Handoll, 2010) concluded that a sliding hip screw was associated with a lower reoperation rate and later fracture of the femur than an intramedullary nail. However, intramedullary nail was associated with fewer fracture fixation complications in unstable fractures compared to fixed nail plates (Parker & Handoll, 2010). Internal fixation also has been reported to have a lower failure rate than sliding hip screws in reverse obliquity fractures (Haidukewych, Israel & Berry, 2001).

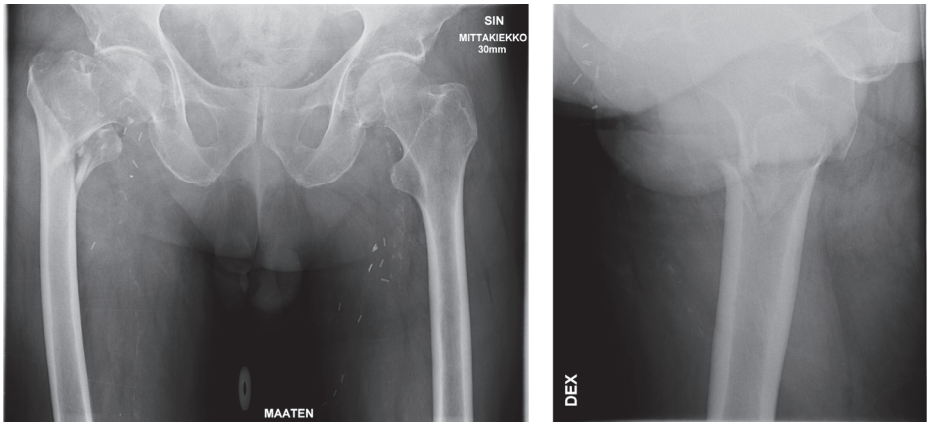


**Fig. 6. X-ray image of trochanteric fracture.**

### 2.4.3 Subtrochanteric fractures

For subtrochanteric fractures, the most common surgical method is fixation with an intramedullary nail (Roberts, Brox, Jevsevar & Sevarino, 2015). Umer, Rashid, Shah and Qadir (2014) reported a healing of rate of 94% within 6 months after using a femoral nail with a spiral blade. Similarly, Borens et al. (2004) reported a success rate of 97% with a primary operation using a proximal femoral intramedullary nail.

### 2.4.4 Timing of surgery

An early fixation performed within 24 hours substantially decreases the risk of non-union (Papakostidis, Panagiotopoulos, Piccioli & Giannoudis, 2015), at least in young patients (Haidukewych, Rothwell, Jacofsky, Torchia & Berry, 2004). Manninger et al. (1989) suggested that an even earlier fixation performed within 6 hours lowers the non-union rate while other studies found no differences in patients treated either within or after 12 hours from the time of the fracture (Jain et al., 2002; Karaeminogullari et al., 2004; Papakostidis et al., 2015). The timing of the surgical treatment does not seem to affect the avascular necrosis rate (Haidukewych et al., 2004; Jain et al., 2002; Karaeminogullari et al., 2004; Loizou & Parker, 2009; Manninger et al., 1989). UK NICE Guidelines summarized the evidence for complications and mortality from delayed surgery, finding lower post-operative mortality among patients treated within 24 hours (vs patients treated after 24 hours) or 48 hours (vs patients treated after 48 hours) after the fracture. No definitive cut-off point was found, however, for where possible benefits ceased to exist. Early surgery also decreased the risk for pressure ulcers, prolongation of pain, and complications (UK NICE Guidelines, 2017).

### 2.4.5 Anaesthesia

A cohort study by Neuman, Rosenbaum, Ludwig, Zubizarreta and Silber (2014) found no differences in mortality between patients with general or regional anaesthesia, but the regional anaesthesia was associated with a slightly (0.6 days) shorter hospital stay. A Cochrane database review (Parker, Handoll & Griffths, 2004) showed borderline statistical significance in mortality, with regional anaesthesia tied to a slightly better survival rate than general anaesthesia.

## 2.5 Rehabilitation

The purpose of hip fracture rehabilitation is to restore prefracture mobility and functional status and enable independent living and function. Countries vary considerably regarding the choice of rehabilitation protocol for hip fracture. In some countries, inpatient rehabilitation is conducted in the primary hospital, while in others. the conventional treatment is done in rehabilitation centres or nursing homes (Adunsky et al., 2010; Ponten et al., 2015; Röder et al., 2003). Direct

discharge to home is rare and depends on the patient's general health, functional status, and living conditions (Handoll, Cameron, Mak & Finnegan, 2009).

**Fig. 7. Mobilization and strength exercises typically include treadmill gait, quadriceps training, and femoral abductor training.**

Mobilization is a major component of post-operative rehabilitation and aims to re-establish ambulatory capacity with increasing levels of complexity, maintaining upright posture and speed (UK NICE Guidelines 2017). It is recommended that the mobilization should start early after the surgical treatment, usually the following day (Halbert et al., 2007). Proper pain treatment is paramount to support ambulatory functions (Hip fracture: Current Care Guidelines, 2011). The rehabilitation ward typically encourages mobility with the support of staff, which includes physicians, physiotherapists, occupational therapists, and nurses. Specific strategies include muscle strength training, weight-bearing exercises, bed exercises, and use of walking aids (UK NICE Guidelines, 2017; Handoll & Sherrington, 2007;

Figure 7). Occupational therapists assist in recovery of skills and functions required in daily living. Although a large number of interventions have been studied, they are difficult to compare because of lack of standardization of terms for naming and describing differences in rehabilitation types and for differences in control groups and heterogeneity in study populations (Table 2, Table 3).

**Table 2. Summary of studies with rehabilitation interventions.**

| Study name | Study type | N | Follow-up time (months) | Main outcome measurements |
|---|---|---|---|---|
| Shyu et al. (2005) | RCT | 137 | 3 | Ambulation, mortality, ADL, pain, falls |
| Naglie et al. (2002) | RCT | 279 | 6 | Mortality, ambulation, residence |
| Tseng et al. (2012) | RCT | 162 | 24 | Function |
| Vidan et al. (2005) | RCT | 319 | 12 | Mortality, hospital stay |
| Khasraghi et al. (2005) | Nonrandomized | 510 | - | LOS, time to surgery, complications |
| Gregersen et al. (2012) | Nonrandomized | 495 | Varied[1] | LOS |
| Huusko et al. (2002) | RCT | 243 | 12 | LOS, mortality, residence |
| Adunsky et al. (2010) | Nonrandomized | 3114 | 12 | Mortality |
| Röder et al. (2003) | Nonrandomized | 283 | 12 | ADL |
| Ponten et al. (2015) | Nonrandomized | 173 | 12 | LOS, length of rehabilitation |
| Koval et al. (1998) | Nonrandomized | 609 | 12 | Ambulation, ADL, residence |
| Kramer et al. (1997) | Nonrandomized | | 6 | Function, discharge location |
| Hoenig et al. (1997) | Nonrandomized | 1880 | 6 | LOS, ambulation |
| Mitchell et al. (2001) | RCT | 80 | 4 | Function, muscle strength, QOL |
| Hagsten et al. (2004) | RCT | 100 | 2 | Functional recovery |
| Sylliaas et al. (2011) | RCT | 150 | 3 | Balance, ADL, ambulation |
| Sylliaas et al. (2012) | RCT | 95 | 9 | Balance, ADL, ambulation |
| Tsauo et al. (2005) | RCT | 25 | 6 | Ambulation, strength, QOL |
| Binder et al., (2004) | RCT | 90 | 6 | Functional recovery |
| Bischoff-Ferrari et al. (2010) | RCT | 173 | 12 | Falls rate |
| Zidén et al. (2008) | RCT | 102 | 1 | ADL, ambulation |
| Latham et al. (2014) | RCT | 232 | 6 | Function, mobility |
| Kuisma (2002) | RCT | 81 | 12 | Ambulation |
| Crotty et al. (2002) | RCT | 66 | 12 | Function, ambulation, balance |
| van Balen et al. (2002) | RCT | 208 | 4 | Mortality, ADL, complications, QOL, residence |

[1]Depended on variable: 3 months (haemoglobin, readmission rate, mortality), 6 months (haemoglobin, readmission rate), 2 years (new fractures)

**Table 3. Rehabilitation interventions and key results.**

| Study | Intervention | Control group | Key results in intervention group |
|---|---|---|---|
| Multidisciplinary rehabilitation | | | |
| Shyu et al. (2005) | Interdisciplinary rehabilitation team with geriatric consultations | Standard care (short rehabilitation period in orthopaedic ward) | Improved walking ability, ADL functions, muscle strength, mental health, and less pain |
| Naglie et al. (2002) | Interdisciplinary care by specialized rehabilitation team | Standard care, possibility for geriatrician consultations | 6 months postoperatively: no differences in mortality, place of residence, or ambulation |
| Tseng et al. (2012) | Interdisciplinary program | Routine care in ward | Intervention decreased the likelihood of poor recovery |
| Vidan et al. (2005) | Multidisciplinary rehabilitation (orthopaedic team and geriatric team) | Standard care (orthopaedic team) | Shorter hospital stay, lower in-hospital mortality, lower complication rate<br>Better partial recovery at 3 months, but no differences at 6 and 12 months |
| Khasraghi et al. (2005) | Multidisciplinary hip fracture service | Usual care | Shorter hospital stay, fewer complications, less delay to surgery |
| Gregersen et al. (2012) | Geriatric multidisciplinary team | Standard care in orthopaedic ward | Shorter hospital-stay, no differences in in-hospital mortality and readmissions to the hospital |
| Huusko et al. (2002) | Rehabilitation in geriatric ward | Rehabilitation in healthcare centre hospital | 3 months postoperatively, more patients with mild or moderate dementia were able to live independently |
| Adunsky et al. (2010) | Rehabilitation in geriatric unit | Rehabilitation in orthopaedic ward | Lower mortality at 1 and 3 months of follow-up |
| Röder et al. (2003) | Rehabilitation in geriatric unit | Rehabilitation in orthopaedic ward | No differences in functional recovery |
| Intensive rehabilitation | | | |
| Ponten et al. (2015) | Specialized rehabilitation unit, PT 2 times/day | Rehabilitation in nursing home | Shorter hospital stay, no difference in survival |
| Koval et al. (1998) | Intensive inpatient rehabilitation, PT 2 h/day, OT 1h/d | Inpatient rehabilitation in separate unit | No effect on walking ability, place of residence, need for home assistance or ADL functions |
| Kramer et al. (1997) | Rehabilitation in specialized hospital rehabilitation unit | Nursing home | No differences in ADL functions or return to community rates 6 months postoperatively |

| Study | Intervention | Control group | Key results in intervention group |
|---|---|---|---|
| Hoenig et al. (1997) | Physiotherapy more than 5 times/week | Physiotherapy less than 5 times/week | Increased the possibility for early ambulation |
| Mitchell et al. (2001) | Inpatient rehabilitation, additional quadriceps training 5 times/week | Same rehabilitation but without quadriceps training | Better functional reach, leg extensor power and mobility |
| Hagsten et al. (2004) | Inpatient rehabilitation, additional occupational therapy sessions/day | Same rehabilitation, but without additional therapy session | Improved ADL functions at discharge |
| Extended home-based rehabilitation | | | |
| Sylliaas et al. (2011) | Inpatient rehabilitation followed by 3 months outpatient physiotherapy | Inpatient rehabilitation only | Better functional balance, mobility, and IADL functions |
| Sylliaas et al. (2012) | Inpatient rehabilitation followed by 6–9 months outpatient physiotherapy | Intervention group in Sylliaas et al (2011)[1] | No differences in Berg Balance Scale (primary outcome); improved strength, gait speed, gait distance, self-rated health, and IADL |
| Tsauo et al. (2005) | | | |
| Binder et al. (2004) | Supervised outpatient exercise training for 6 months | Standard care with self-exercising and monthly 1-hour group exercise | Improvement in Physical Performance Test (PPT) and Functional Status Questionnaire physical function subscale (FSQ) and ADL |
| Bischoff-Ferrari et al. (2010) | 60 min/day physiotherapy during acute care + unsupervised home program | 30 min/day physiotherapy during acute care | Reduced rate of falls and hospital readmissions |
| Zidén et al. (2008) | Geriatric ward rehabilitation followed with home-based rehabilitation up to 3 weeks | Rehabilitation in ward only | One month after discharge, better self-care, mobility, domestic and instrumental activities, and confidence in balance |
| Latham et al. (2014) | Self-exercises taught by a therapist | Cardiovascular nutrition education | Slight improvement in physical function |
| Home-based rehabilitation | | | |
| Kuisma (2002) | Discharged home, physiotherapist visits | Rehabilitation centre | Higher ambulation one year postoperatively |

| Study | Intervention | Control group | Key results in intervention group |
|---|---|---|---|
| Crotty et al. (2002) | Discharged home | Rehabilitation in hospital | At 4 months, better modified Barthel Index Score (independence), longer rehabilitation period; no differences in QOL or falls rate |
| van Balen et al. (2002) | Early discharge (median stay at hospital 11 days) | Usual stay in hospital (18 days) | At 4 months, no differences in disabilities, quality of life, and cognition |

### *2.5.1 Multidisciplinary care*

Multidisciplinary rehabilitation emphasizes collaboration and cooperation of all participants in the rehabilitation process, with regular communication among the team members. Different levels of a multidisciplinary approach have been described: interdisciplinary (highest level of cooperation), multidisciplinary (professionals work with the same person, but within their own professional field), and transdisciplinary, where professionals cross borders into another team's professionalism (Momsen, Rasmussen, Nielsen, Iversen & Lund, 2012). However, most of the published studies tend to use the term "multidisciplinary team" interchangeably (Neumann et al., 2010). A multidisciplinary approach in rehabilitation has been proved to result in superior outcomes in multiple studies (Cameron, 2005; Handoll et al., 2009; Momsen et al., 2012). Shyu et al. (2005) reported improved walking ability and ADL functions among patients treated in an interdisciplinary rehabilitation team. On the other hand, Naglie et al. (2002) compared the outcomes of elderly people with hip fracture in interdisciplinary care (with individual discharge planning, specialized education for nursing staff, multidisciplinary team led by internist-geriatrician) and conventional care. The 3 and 6 months follow-ups showed no significant differences regarding mortality, place of residence, or ambulation. Tseng, Shyu and Liang (2012) found that hip fracture patients usually followed three distinctive trajectories concerning functional recovery: excellent (45% of the patients), moderate (47%), and poor recovery (7%). High age, low prefracture functional status, depression, and low cognitive functions were risk factors for poor and moderate recovery. Moreover, interdisciplinary care intervention significantly reduced the likelihood of poor recovery.

### *Ortho-geriatric model*

The ortho-geriatric care model emphasizes collaboration between orthopaedic surgeons and geriatricians, with interventions ranging from routine consultation to integrated rehabilitation teams (Grigoryan, Javedan & Rudolph, 2014). A randomized controlled trial by Vidán, Serra, Moreno, Riquelme and Ortiz (2005) randomized 319 hip fracture patients to either conventional care (orthopaedic team) or multidisciplinary rehabilitation (consisting of orthopaedic team and geriatric team). Patients in the intervention group were reported to have a shorter hospital stay, lower in-hospital mortality rate, and lower major complication rate. Patients in the intervention group were also more likely to achieve partial recovery at 3 months (57% vs 44%) but the differences had disappeared at 6 and 12 months of follow-up. A shorter hospital stay in these models has also been suggested in other studies (Gregersen et al., 2012; Khasraghi, Christmas, Lee, Mears & Wenz, 2005).

### *Geriatric rehabilitation*

Hip fracture rehabilitation conducted in specialized unit, run by a geriatrician and where staff are specialized in treating geriatric patients, has been reported to somewhat improve recovery in elderly patients. Huusko et al. (2002) evaluated the effect of intensive geriatric rehabilitation (in geriatric ward) on patients with dementia and hip fracture, with control patients receiving conventional care in healthcare centre hospital. Three months postoperatively, more patients with mild or moderate dementia treated in geriatric rehabilitation could live independently, compared to those in the control group. An Israeli study by Adunsky et al. (2010) reported a slightly lower mortality rate among patients in a geriatric unit compared to those in orthopaedic ward at short-term (1 and 3 months) follow-up. However, Röder et al. (2003) found no differences in functional recovery between those treated in geriatric ward and those in the control group (orthopaedic ward).

## *2.5.2 Intensive rehabilitation*

Some studies have evaluated whether more intensive rehabilitation in a specialized rehabilitation unit with a higher frequency of physical and occupational therapy improves outcomes (Table 4). Ponten et al. (2015) found no differences in survival between intensive rehabilitation (specialized unit providing physiotherapy sessions two times a day) and regular rehabilitation in nursing home, although intensive

rehabilitation resulted in a significantly shorter hospital stay. Koval et al. (1998) compared two groups of patients in different rehabilitation units. The intervention group received intensive physical therapy 2 hours/day and occupational therapy 1 hour/day, but no effect on intensive rehabilitation was seen regarding walking ability, place of residence, need for home assistance, or ADL functions up to 12 months follow-up. However, the authors noted that the prefracture characteristics were not identical between the two groups. Kramer et al. (1997) studied the return-to-home rates in hip fracture patients whose rehabilitation was based in either a specialized rehabilitation hospital unit or a nursing home. Six months postoperatively, no differences were observed in the ability to return to community or in ADL functions, but there were no specific details regarding the contents of these rehabilitations.

A high frequency of occupational and physical therapy improves earlier ambulation (more than five sessions a week; Hoenig, Rubenstein, Sloane, Horner & Kahn, 1997), and additional quadriceps strength training may improve walking ability (Mitchell, Stott, Martin & Grant, 2001). Hagsten et al. (2004) reported better ADL function at discharge to home among patients who received additional daily occupational therapy during the rehabilitation, but these differences disappeared during the follow-up.

### *2.5.3 Extended outpatient/home-based rehabilitation*

Prolonging rehabilitation and physical therapy at home after conventional rehabilitation in an institution may improve functional outcome (Table 4). Sylliaas, Brovold, Wyller and Bergland (2011) studied the effect of prolonged post-hip fracture rehabilitation, where home-dwelling patients received additional outpatient physiotherapy up to 3 months. This additional therapy resulted in better functional balance, mobility, and IADL functions. However, prolonging this rehabilitation even further (Sylliaas, Brovold, Wyller & Bergland, 2012) did not yield additional improvements in balance, although improvements in strength, walking, and instrumental activities were observed. Extended outpatient rehabilitation has resulted in similar improvements regarding physical function at 3 (Tsauo, Leu, Chen & Yang, 2005) and 6 months of follow-up (Binder et al., 2004; Latham et al., 2014). One randomized controlled trial (Bischoff-Ferrari et al., 2010) found that extended physiotherapy significantly reduced the rate of falls. Zidén, Frändin and Kreuter (2008) reported that geriatric ward rehabilitation followed by home-based rehabilitation up to 3 weeks improved patient self-care, mobility,

domestic and instrumental activities, and confidence in balance when compared to care in a ward only.

### 2.5.4 Early discharge and home-based rehabilitation

In recent years, home-based rehabilitation has been presented as a viable option compared to institutional rehabilitation, emphasizing early discharge from the hospital and thus potentially reducing the financial burden (Table 4). A randomized controlled trial by Kuisma (2002) compared hip fracture patients discharged to home and those discharged to a rehabilitation centre (control). The results indicated that five physiotherapist visits per month at home resulted in better ambulation ability than one month in institution-based rehabilitation. Crotty, Whitehead, Gray and Finucane (2002) concluded that home-based rehabilitation with early discharge improved short-term independence compared with conventional care in a hospital unit. On the other hand, van Balen et al. (2002) found no differences in disabilities, quality of life, and cognition up to 4 months postoperatively between early-discharge patients (11 hospital days) and control (18 days).

**Table 4. Summary of different rehabilitation settings and interventions.**

| Intervention | Description | Potential benefits | Potential drawbacks |
|---|---|---|---|
| Multidisciplinary rehabilitation | Collaboration of all participants and professionals in rehabilitation team | May improve functional recovery | Time intensive, requires resources |
| *Ortho-geriatric model*[a] | Multidisciplinary team including orthopaedics and geriatricians | Shorter LOS, less complications, lower mortality | " |
| *Geriatric rehabilitation*[a] | Multidisciplinary team led by geriatrician, staff specialized in treating geriatric patients | May improve ability to live independently and lower mortality | " |
| Intensive rehabilitation | High frequency of physical and/or occupational therapy during rehabilitation period | Shorter time in hospital, improvement in ADL and ambulation | Requires resources, early mobilization may not be suitable for frail patients |
| Extended rehabilitation | Additional home-based rehabilitation following routine inpatient rehabilitation | May improve physical performance and balance | Requires more resources |
| Home-based rehabilitation | Early discharge, home-based rehabilitation | Cost reduction | May not be suitable for all patients |

[a]Subsection of multidisciplinary rehabilitation.

### 2.5.5 Rehabilitation after hip fracture in Finland

In Finland, conventional rehabilitation following surgical treatment is started in the orthopaedic ward and continued in the healthcare centre hospital ward (Figure 8). The treatment period in the orthopaedic ward is usually short (Huusko et al., 2002). Elderly patients with poor physical function are preferably treated in specialized geriatric units, which may improve function especially among patients with dementia (Hip fracture: Current Care Guidelines, 2011). A small number of patients may be discharged straight to the prefracture place of residence with outpatient rehabilitation program, but no Finnish studies have addressed the possible benefits in this kind of treatment (Hip fracture: Current Care Guidelines, 2011). In 2015, the mean length of rehabilitation period after hip fracture was 40.7 days (PERFECT, 2015).

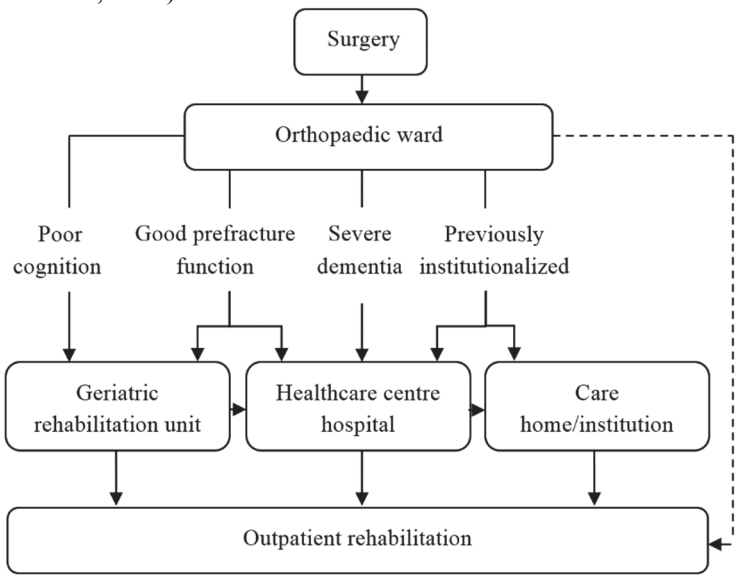


**Fig. 8. Finnish national recommendations for care pathway (Hip fracture: Current Care Guidelines, 2011).**

Finnish national recommendations emphasize a multidisciplinary approach, with a rehabilitation team that includes a physician, registered and practical nurses, physical therapist, occupational therapist, and social worker. The rehabilitation period includes mobilization and occupational therapy, aiming for a return to prefracture functional status and independent living. Various aids are in use to

support maintaining balance and posture during ambulatory exercises (Figure 9). The prevention of new falls and secondary fractures is also emphasized, and individual risk of falling is evaluated in accordance with general health status and medication (Hip fracture: Current Care Guidelines, 2011). The patient and the patient's family are actively encouraged to participate in the decisions and rehabilitation.

**Fig. 9. Various aids used in walking exercises.**

Although Finnish hip fracture rehabilitation practises are based on national recommendations (Current Care Guidelines), the rehabilitation periods tend to be long, and the therapy received in post-fracture rehabilitation may not be intensive enough (Panula et al., 2011). Some local or sub-national projects have been undertaken that have successfully implemented the national recommendations for practical care. One of the recent innovations is the Lonkkaliukumäki-project (lit. hip slide project) conducted in Jorvi hospital in Southern Finland (Hagfors & Korhola, 2012). The project aimed to improve the outcomes for hip fracture treatment by emphasizing the collaboration between different organizations, and by providing clear aims and standardization for the total hip fracture care pathway (Hagfors & Korhola, 2012; Komulainen et al., 2014). This approach resulted in a shorter overall hospital stay and shortened the overall rehabilitation period.

## 2.6 Outcomes

### *2.6.1 Mortality*

Hip fracture causes excess mortality and is one of the most frequently studied outcomes. In earlier studies, the mortality rate range was 7%–16% at 3 months of follow-up (Gregersen et al., 2012; Naglie et al., 2002), 5%–15% at 6 months (Koval et al., 1998; Naglie et al., 2002), and 3%–21% at one year after the fracture (Gjertsen, Fevang, Matre, Vinje & Engesæter, 2011; Koval et al., 1998). The most common cause of death in elderly patients (over 65 years old) postoperatively is circulatory system disease (Panula et al., 2011). In a long-term follow-up (22 years), excess mortality remained high for women up to 10 years and for men up to 20 years, with cardiovascular disease and pneumonia being the leading causes of death (von Friesendorff et al., 2016). Risk factors for post-fracture mortality include older age (Endo, Aharonoff, Zuckerman, Egol & Koval, 2005), ASA score (Endo et al., 2005; Swanson et al., 1998) and comorbidities (Endo et al., 2005).

Survival between men and women differs among studies. Male sex has often been associated with poor survival (Endo et al., 2005; Fransen et al., 2002; Hawkes, Wehren, Orwig, Hebel & Magaziner, 2006), while others have reported higher mortality among women (Nurmi-Lüthje, Lüthje, Kaukonen & Kataja, 2015) or no differences at all between men and women (Lieberman & Lieverman, 2004). However, it also has been reported that men often have more chronic illnesses at the time of the fracture and been suggested that other factors explain the differences in mortality between male and female patients (Aharonoff, Koval, Skovron & Zuckerman, 1997; Jensen, 1984).

### *2.6.2 Activities of daily living*

Function is usually evaluated by specific ADL functions, divided into two subcategories: basic activities of daily living (feeding, bathing, dressing, using a toilet) and instrumental activities of daily living (shopping, preparing meals, managing finances, laundry and housework, using public transportation) (Zuckerman, 1996). Zuckerman, Koval, Aharonoff, Hiebert & Skovron (2000) later developed and validated a Functional Recovery Score based on these ADL functions and walking ability. Another widely used method of measurement is the Barthel Index, a 10-item scale examining ADL functions (Hutchings, Fox & Chesser, 2011; Mahoney & Barthel, 1965). Other evaluation methods are the Katz

Index of Independence in Activities of Daily living, a dichotomous scoring for various functional (Katz, Ford, Moskowitz, Jackson & Jaffe, 1963) and Functional Independence Measure (Linacre, Heinemann, Wright, Granger & Hamilton, 1994).

Most of the patients do not regain their prefracture functional status. High age, dementia, and stroke have been associated with poor ADL function recovery (Penrod et al., 2008). Heikkinen and Jalovaara (2005a) summarized in their study that recovery in ADL functions concentrates in the first 6 months post-fracture, with no major gain observed afterwards. Tang et al. (2017) reported that among elderly patients, only 31% regained their prefracture ADL functional ability. Rosell and Parker (2003) found that among hip fracture patients over age 50 years, the mean loss of function was 21% one year after the fracture.

### *2.6.3 Mobility*

Most patients recover their walking ability during the first 4 to 6 months, with minor improvements accruing afterwards (Borgquist, Ceder & Thorngren, 1990; Heikkinen & Jalovaara 2005a; Magaziner et al., 2000). Tang et al. (2017) found that prefracture walking ability was achieved in only 34% of patients. Reported predictive variables for poor post-fracture walking ability are high age, dementia, and arrhythmia (Penrod et al., 2008). The use of walking aids is seldom reported. Magaziner et al. (2000) found that 26% of patients could walk unaided at 2 months and 54% at 12 months. Heikkinen and Jalovaara (2005a) found these respective numbers to be 21% at 4 months and 27% at 12 months.

### *2.6.4 Residential status*

While residential status is not clearly a functional variable, it reflects the patient's functional capabilities. The change in independent living among previously home-dwelling patients 50 years or older has been reported to decrease to 68.7% after one year post-fracture (Rosell & Parker, 2003). Ariza-Vega, Jiménez-Moleón & Kristensen (2014) reported that among patients 65 years or older, 73% of patients were living independently before the fracture and 58% at one year after the fracture. Other studies have reported community-dwelling rates of 67%–96% at 3 months (Huusko et al., 2002; Koval et al., 1998) and 17%–90% at 12 months (Huusko et al., 2002; Koval et al., 1998), but there is great heterogeneity among the study populations.

## 2.7 Costs

The analyses of the economic impact of hip fractures carry numerous challenges, mainly because of the wide range of long-lasting consequences of this type of fracture (Haentjens, Lamraski & Boonen, 2005). Methods and measurements also vary greatly (Haentjens & Annemans, 2003). The conventional methods of treatment and rehabilitation differ among countries, and comparison of study results is limited because of different follow-up times, general cost levels, exchange rates, and inflation rates.

### *2.7.1 Initial costs*

Most studies have focused on the short-term costs of the hip fracture (Haentjens et al., 2005). The costs usually include expenditures from initial hospitalization, such as operational costs, hospital ward costs, and the costs related to healthcare personnel, usually derived from hospital invoices (Finnern & Sykes, 2003; Haentjens et al., 2005). Finnern and Sykes (2003) reported primary hip fracture treatment expenses within the EU countries using European Commission cost data. The costs were lowest in Ireland (3714€) and highest in Germany (13,776€). The average cost per patient in the EU was 8125€, while the treatment cost in Finland was 4086€. The most important factor for the primary hospital costs is the length of stay, while the operational costs are relatively low (Hollingworth, Todd, Parker, Roberts & Williams, 1993; Beck, Brinker & Daum, 1996). Ioro et al. (2001) reported that operating room supplies and implants totalled 6%–17% of the total hospital cost, depending on the used materials.

The reported costs of rehabilitation vary greatly, depending on whether post-fracture rehabilitation is conducted in a primary hospital, other institution, or at home. A French study by Duclos et al. (2010) reported costs in the rehabilitation ward to be 5673€. Haentjens, Autier, Barette & Boonen (2001) reported the rehabilitation centre admission costs in female hip fracture patients to be 2735$. In a Norwegian study (Prestmo et al., 2015), rehabilitation stay costs were 8105€ in comprehensive geriatric care and 9633€ in orthopaedic care. Few studies have compared costs among different rehabilitation settings. Kramer et al. (1997) compared the costs between rehabilitation hospital, a subacute nursing home, and a traditional nursing home. As expected, the costs were higher in the hospital setting with more physical, recreational, and occupational therapy.

### 2.7.2 Long-term costs

Reported long-term costs of hip fracture again vary widely, depending on the follow-up time and the recorded expenses (Haentjens et al., 2005; Nurmi, Narinen, Lüthje & Tanninen, 2003; Wiktorowicz et al., 2001). Usually these costs include all healthcare expenditures required post-fracture. Braithwaite et al. (2003) estimated that of the total hip fracture costs, 33% occurred in the first 6 months, 11% in the second 6 months, and 56% after the first year. Admittance to a long-term care facility (in previously community-dwelling patients) after the fracture has been reported to double the costs during the year following the hip fracture (Wiktorowicz et al., 2001). A Finnish study by Nurmi et al. (2003) reported total hip fracture costs (including the use of healthcare services) during the first post-operative year to be 14410€ per patient. Similarly, Borgström et al. (2006) reported one-year cost to be 14221€ in Sweden and Autier et al. (2000) reported costs of 15151€ for each patient in Belgium. At least two studies, by Brainsky et al. (1997) and Zethraeus, Strömberg, Jönsson, Svensson & Öhlén (1997), compared the one-year healthcare costs after hip fracture to healthcare usage in the year before the fracture, reporting excess costs to be 18727$ and 17704$, respectively.

### 2.7.3 Cost-reduction strategies

Various cost-reducing strategies have been studied, usually focussing on shortening the initial hospital-stay. Polder et al. (2003) compared costs between patients with early hospital discharge to a nursing home (including rehabilitation facilities) and patients in conventional treatment. They reported that early discharge results in lower initial hospital costs but a higher rate of later institutionalization, resulting in no overall benefit with regard to total treatment costs. On the other hand, Cameron, Lyle and Quine (1994) reported that accelerated rehabilitation and early discharge decreased costs by 17% compared to conventional treatment in short-term (4 months) follow-up. Farnworth et al. (1994) reported similar cost-savings in multidisciplinary care and earlier discharge, but the authors noted that the expenditures were calculated from the point of view of the freed resources in the hospital and that the discharge may shift costs to patients' families. Hollingworth et al. (1993) found a smaller total cost with a "hospital at home" program in the UK (providing nursing care, social services, and rehabilitation at patients' home), but only about 40% of the patients were eligible for this program.

### 2.7.4 Organization of healthcare services in Finland

The Finnish healthcare system strongly resembles healthcare organizations in other Nordic countries but is more decentralized (Teperi, Porter, Vuorenkoski & Baron, 2009). Primary healthcare services are provided in municipal healthcare centre hospitals, which are legally obligated to provide adequate healthcare services (including rehabilitation) for residents (Teperi et al., 2009). Specialized healthcare services are provided in district, central, and university hospitals. Most of the Finnish healthcare costs are covered by the Finnish Social Insurance Institution funded by taxation, with patients paying only a minority of costs. Patients themselves pay a fee, which depends on quantity of uses of healthcare services (i.e., number of visits to a doctor and number of days in hospital). From an economic perspective, healthcare-related costs are usually calculated using DRG (diagnosis-related group) price lists, where patients are grouped by diagnosis, comorbidities, and treatments (Mikkola, Keskimäki & Häkkinen, 2002). Resource consumption is calculated for each DRG group, based on average treatment costs in that group, as the cases are expected to undergo similar evolution (Mikkola et al., 2002; Mihailovic, Kocic & Jakovljevic, 2016). Nationwide one-year costs after hip fracture were 30,258 € for each patient in 2011–2013 (PERFECT, 2015).

# 3 Aims

1. To examine the effects of physical and geriatric rehabilitation on home-dwelling hip fracture patients age 50 years or older in terms of mortality, residential status, and function following the year after the fracture
2. To evaluate the costs and cost-effectiveness of physical and geriatric rehabilitation during one year following hip fracture.
3. To study the recovery after hip fracture between home-dwelling female and male patients in terms of functional status, residential status, and mortality.
4. To determine recommendations for hip fracture rehabilitation concerning the general rehabilitation practices in Finland.

# 4 Patients and methods

## 4.1 Patients

The patients included in this study were 538 consecutively admitted non-pathological hip fracture patients treated in Oulu University hospital between 1997 and 2000. The patients were aged 50 years or older and were living in their own home or in sheltered housing (comparable to own home but some assistance available) at the time of sustaining fracture.

The hip fracture patients were transferred to orthopaedic ward following the surgery and randomized to one of the three rehabilitation modalities, based on the following conditions. About half of the patients treated were admitted from city of Oulu while the other half of the patients came from the surrounding towns and municipalities. There were two randomization lines based on the patients' place of residence: two thirds of the Oulu residents were randomized to geriatric department (geriatric rehabilitation group) and one third to the privately-based rehabilitation unit (physical rehabilitation group). Considering the patients coming from surrounding municipalities, two thirds were randomized to rehabilitation in healthcare center hospital (control group, a standard procedure in Finland) and one third to the physical rehabilitation group (Figure 10).

Physically oriented rehabilitation occured in the rehabilitation unit (36 beds) of a private hospital, Oulu Deaconess Institute. It was chaired and run by a neurologist with a special qualification in rehabilitation of disabilities in locomotor function. There was also a general practitioner and part-time (50%) physiatrist. Consultations with a psychiatrist were available daily and with other specialists as required. There were five physiotherapists on the ward, three occupational therapists, one hospital attendant, 18 registered and practical nurses and three rehabilitation attendants. The patients were given assistance in activities of daily living (ADL), mobilization therapy, occupational therapy and rehabilitation physiotherapy including physical, balance and gym exercises. The patients were evaluated by a physician, physiotherapist and rehabilitation attendant on admission. The duration of the rehabilitation was restricted to about a maximum of three weeks by the payers for the services, the City of Oulu and the counties and towns of the surroundings. In some cases, the rehabilitation could not be continued until the patient was able to return to the original place of living, and therefore such patients

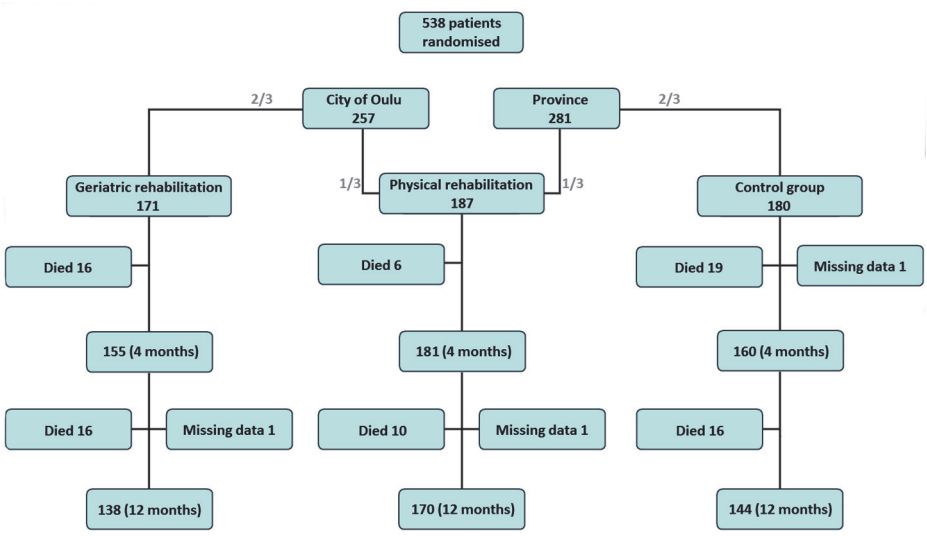


**Fig. 10. Flow chart and follow-up protocol.**

had to be discharged to their respective healthcare centre hospitals.

The geriatric rehabilitation took place at the geriatric department of Oulu city hospital containing 28 beds. The unit was chaired by a geriatrician and was focused on both the physical training as well as the associated geriatric problems. There was also a general practitioner. The remaining staff consisted of one physiotherapist, one hospital attendant, 17 registered and practical nurses and one rehabilitation attendant. Consultations with a psychiatrist were available daily and with other specialists as required. A physiotherapist provided physiotherapy and group therapy, and with assistance of the nurses, ADL training and mobilisation. In some cases, the rehabilitation could not be continued until the patient was able to return to their original place of living, and such patients were discharged to healthcare centre ward.

The control group received routine basic level of rehabilitation which took place in the local health centre hospitals, considered the standard rehabilitation method for the majority of hip fracture patients in Finland. In this group there were 33 health centre hospitals, which are similar in regard to administrative structure, resources, and treatment protocols. The mean number of beds per ward was 32 (Standard Deviation = SD 12). The wards were run by general practitioners and mostly attended by registered and practical nurses. The availability of physiotherapists and consultations with other specialists was minimal and variable.

The average staff of a ward consisted of one physiotherapist (SD 1), four hospital attendants (SD 2), 17 registered and practical nurses (SD 4) and one part-time (60%) rehabilitation attendant. The patients were given mobilization therapy and assistance in ADL. The active rehabilitation continued until the patient could be discharged to the prefracture place of living or when the responsible general practitioner considered that the rehabilitation did not have any response in the patient after which the patient received only basic care in the same hospital.

## 4.2 Methods

### *4.2.1 Function, residential status and mortality*

On admission, the data were collected using Standardized Audit of Hip Fractures in Europe (SAHFE) forms (Heikkinen, Partanen, Ristiniemi & Jalovaara, 2005b; Appendix I), providing data concerning the patients' age, sex, place of residence, locomotor ability, use of walking aids, use of home help services, type of fracture, any pathological fractures, primary operation, ADL functions, social status, psychological status, cognition (Mini-Mental State Examination, Short Portable Mental Status Questionnaire), associated diseases (cardiovascular diseases, paralysis, respiratory diseases, urological diseases, diabetes, rheumatism, Parkinson´s disease, malignomas, Paget´s disease, dizziness, use of corticosteroids), alcohol abuse, smoking and ASA (American Society of Anesthesiologists, 1963) grade (Table 5).

Data concerning rehabilitation was recorded using a special form. It included the number events and time used in ADL-exercises as well as number and time used in walking and mobility exercises (Appendix I).

The four-month follow-up was performed using an inquiry form (Heikkinen et al., 2005b) to be filled in by the patient and completed by the nurse by means of a telephone interview in the event of missing data. Data concerning the place of residence four months postoperatively, locomotor ability, use of walking aids, the patients' own evaluation of his/her walking ability and pain in the hip, use of home help services and ADL functions were recorded. At 12 months postoperatively, the patients were examined by an orthopaedic surgeon and interviewed by a study nurse and the same data were recorded as above for four months. ADL functions (dressing, bathing or showering, eating, toileting, shopping, household chores, laundry, preparation of meals, banking/finances, use of transportation) were

recorded and analysed using a five-step classification according to Zuckerman et al. (2000). Mortality and re-operations (type and reason) up to 12 months postoperatively were recorded on a special form.

**Table 5. Prefracture characteristics.**

| Parameter | Physical rehabilitation | % | Geriatric rehabilitation | % | Control group | % | p-value |
|---|---|---|---|---|---|---|---|
| Age | | | | | | | p=0.226 |
| Mean (SD) | 77,5 (9,4) | | 79,1 (9,4) | | 77.7(9,1) | | |
| Range | 53,1–94,5 | | 50,0–99,6 | | 53.7–98,2 | | |
| Sex | | | | | | | p=0.560 |
| Males | 41 | 21,9 | 30 | 17,5 | 34 | 18,9 | |
| Females | 146 | 78,1 | 141 | 82,5 | 146 | 81,1 | |
| Side of fracture | | | | | | | p=0.454 |
| Right | 86 | 46,0 | 90 | 52,6 | 88 | 48,9 | |
| Left | 101 | 54,0 | 81 | 47,4 | 92 | 51,1 | |
| Type of fracture | | | | | | | p=0.733 |
| Undisplaced intracapsular | 25 | 13,4 | 25 | 14,6 | 23 | 12,8 | |
| Displaced intracapsular | 99 | 52,9 | 75 | 43,9 | 99 | 55,0 | |
| Basocervical | 3 | 1,6 | 2 | 1,2 | 2 | 1,1 | |
| Trochanteric two-fragment | 26 | 13,9 | 30 | 17,5 | 22 | 12,2 | |
| Trochanteric multi-fragment | 27 | 14,4 | 34 | 19,9 | 30 | 16,7 | |
| Subtrochanteric | 7 | 3,7 | 5 | 2,9 | 4 | 2,2 | |
| Primary operation | | | | | | | p=0.358 |
| Three screws | 42 | 22,5 | 38 | 22,3 | 39 | 21,6 | |
| Single screw with slide plate | 25 | 13,3 | 24 | 14,0 | 21 | 11,7 | |
| Intramedullary nail | 41 | 21,9 | 50 | 29,2 | 42 | 23,4 | |
| Hemiarthroplasty | 70 | 37,4 | 56 | 32,7 | 65 | 36,1 | |
| Total hip arthroplasty | 9 | 4,8 | 3 | 1,8 | 13 | 7,2 | |
| ASA grade | | | | | | | p=0.825 |
| I | 3 | 1,6 | 5 | 2,9 | 5 | 2,8 | |
| II | 39 | 21,1 | 32 | 18,7 | 29 | 16,3 | |
| III | 117 | 63,2 | 113 | 66,1 | 113 | 63,5 | |
| IV | 25 | 13,5 | 21 | 12,3 | 30 | 16,9 | |
| V | 1 | 0,5 | 0 | 0 | 1 | 0,6 | |
| Associated diseases | | | | | | | |
| Cardiovascular diseases | 136 | 72,7 | 125 | 73,1 | 144 | 80,0 | p=0.197 |
| Paralysis | 27 | 14,4 | 30 | 17,5 | 23 | 12,8 | p=0.446 |
| Respiratory organ diseases | 31 | 16,6 | 37 | 21,6 | 29 | 16,1 | p=0.329 |
| Urinary organ diseases | 45 | 24,1 | 41 | 24,0 | 40 | 22,2 | p=0.897 |
| Diabetes mellitus | 36 | 19,3 | 37 | 21,6 | 34 | 18,9 | p=0.783 |

| Parameter | Physical rehabilitation | % | Geriatric rehabilitation | % | Control group | % | p-value |
|---|---|---|---|---|---|---|---|
| Rheumatism | 23 | 12,3 | 24 | 14,0 | 22 | 12,2 | p=0.848 |
| Parkinson's disease | 9 | 4,8 | 4 | 2,3 | 9 | 5,0 | p=0.374 |
| Malignant tumour or haemopathy | 25 | 13,4 | 22 | 12,9 | 20 | 11,1 | p=0.791 |

### *4.2.2 The costs and cost-effectiveness*

Baseline equality of different rehabilitation groups and cost-effectiveness was evaluated by recording the numbers of visits to a healthcare centre, visits to a private doctor, days in a hospital (healthcare centre, district hospital, private hospital, or central hospital), drugs used in the six months prior to fracture and 15D-instrument of health-related quality of life (Sintonen, 2001). 15D score was calculated based on questionnaire on 15 different areas of life (mobility, vision, hearing, breathing, sleeping, eating, speech, excretion, usual activities, mental function, discomfort and symptoms, depression, distress, vitality and sexual activity), with five ordinal levels on each dimension, and the total score scaled between 0 (being dead) to 1 (no problems in any dimension). To assess the costs of institutional treatment, special forms were used to collect the following data during the hospital stay and rehabilitation: inpatient stay at primary hospital, days in rehabilitation, and days of hospital treatment after rehabilitation. At 12 months, a study nurse collected the following data from the patients: visits to an outpatient clinic, visits to the hospital or a doctor's office, number of re-operations, home medical treatment, number of physiotherapy visits, taxi usage by patient, taxi usage by relatives, hours of home help services, help provided by a relative and 15D score (Appendix II).

For the basic cost calculations, we used prices from 2001, which were adjusted to prices of 2012 by multiplying all values by a factor of 1.466, obtained from the Finnish Hospital Cost Index (2009).The cost of the primary hospital treatment—including both the costs of the operation and of treatment in the surgical ward (emergency room, operating theatre, intensive care unit, nursing care, and medication)—was obtained from the Diagnosis Related Group (DRG) price list for the hospital. To provide a fiscal estimation of the usually unreimbursed cost to society, the help provided by a relative was calculated as a different proportions of a home aid's salary (30%, 50% or 100%). The information for these calculations

was obtained from a publication of the National Research and Development Centre for Welfare and Health (STAKES; Hujanen, 2003).

### 4.2.3 Comparison of recovery between male and female patients

The patients were assessed on admission by a surgeon and by a study nurse who were involved in the research. A standardized form (SAHFE) was completed for each patient on admission (Appendix I). The forms recorded the following information: patient age, sex, place of residence, locomotor ability, use of walking aids, use of home help services, type of fracture, any pathological fractures, primary operation, ADL functioning, social status, associated diseases (cardiovascular diseases, paralysis, respiratory diseases, urological diseases, diabetes, rheumatism, Parkinson's disease, malignancies, Paget's disease, dizziness, use of corticosteroids), alcohol abuse, smoking and ASA grade.

The 4- and 12-month follow-ups were performed using an inquiry form that was completed by the patient and, if there were missing data, by the nurse via a telephone interview. The following information was recorded at 4 and 12 months postoperatively: the place of residence, locomotor ability, the use of walking aids, the patient's own evaluation of his or her walking ability and hip pain, the use of home help services and ADL functions. ADL functions (dressing, bathing or showering, eating, using the toilet, shopping, household chores, laundry, preparation of meals, banking/finances, use of transportation) were recorded and analysed using a five-point scale classification according to Zuckerman et al (Heikkinen et al., 2005b). The ADL score was calculated based on this classification so that each separate function was scored from 1 (best function) to 5 (worst function) and the total score was calculated by summing the scores for all ten ADL functions. The maximum score was 50 points. Mortality and re-operations (type and reason) up to 12 months postoperatively were recorded on a special form.

A separate matched-pair analysis was conducted to eliminate the possible effect of age differences on recovery. Pairs were formed manually by pairing all male patients with a female patient having the smallest age difference.

### 4.2.4 Statistics

The statistical analysis was performed using SPSS for Windows version 20 (SPSS Inc., Chicago, IL, USA). The chi-square ($\chi^2$) test was used to analyse the categorical variables, and Kruskal-Wallis and Mann-Whitney U-test for continuous variables.

Cox Regression analysis was used for the evaluation of an estimate of the treatment effect on survival after adjustment for explanatory variables. In matched-pair analysis, McNemar test was used for dichotomic and Wilcoxon test for categorical or continuous variables. P-value $< 0.05$ was considered statistically significant. The evaluation of the sample size was based on an estimate that 20% of the patients are in danger of being institutionalized. We postulated that a reduction in the institutionalization rate to 10% would be clinically important. A reduction of this size with a two tailed P-value of 0.01 and a power of 0.80 required a minimum sample size of 160 for each group. Due to possible loss of cases, the sample size was increased to 180.

# 5 Results

## 5.1 The effect of specialised rehabilitation on recovery after hip fracture

No significant differences were observed between the groups in the demographic data, 15D (Health-Related Quality of Life), social status, psychological status, cognition (MMSE, SPMSQ), associated diseases or other background data except for one ADL function – the use of toilet ($P<0.003$, Kruskal-Wallis test) in favour of the physical rehabilitation group (Table 5, Appendix III).

Patients in physical rehabilitation had more exercises per day (both ADL-exercises and mobilisation exercises) and used more time in these exercises than geriatric rehabilitation and control group patients ($p<0.001$, Table 6). Geriatric rehabilitation patients received more mobilisation exercises per day ($p=0.001$) and used more time in these exercises ($p=0.015$) than control group (Table 6). Control group patients used more time in ADL-exercises than the geriatric rehabilitation patients ($p=0.005$, Table 6). Mortality was lower in the physical rehabilitation group at four months compared to geriatric rehabilitation group at ($p=0.026$) or control group ($p=0.006$) and at 12 months ($p=0.005$ and $p=0.004$, respectively, Table 7). Significant differences remained the same when only patients older than 64 years were analysed.

Significantly more patients in the physical rehabilitation group ($p=0.012$) and geriatric rehabilitation group ($p<0.001$) were able to live in their own homes or sheltered housing (independent living) at four months than in the control group (Table 7). Subgroup analysis of femoral neck and trochanteric fractures between different rehabilitation modalities showed that the significant difference was true only for femoral neck fractures (physical rehabilitation group vs geriatric rehabilitation group $p=0.308$, physical rehabilitation group versus control group $p<0.001$ and geriatric rehabilitation group versus control group $p<0.001$) but not for trochanteric fractures ($p=0.299$). The differences in residential status considering the whole groups or femoral neck fracture were, however, no longer visible at 12 months. We also analysed the results excluding the patients under 65 years of age but this did not change the result. There were no significant differences between the groups in any ADL function at 4 or 12 months of follow-up. (Appendix III). There were no statistically significant differences between the groups

regarding walking ability, walking aids, pain in the injured hip or re-operation rate at four or 12 months of follow-up (Table 7).

**Table 6. Hospital days, number of exercise events and time used in exercises.**

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | Mean (SEM) | n | Mean (SEM) | n | Mean (SEM) | |
| Primary hospital | 187 | 7.4 (0.3) | 171 | 8.9 (0.4) | 180 | 6.3 (0.2) | |
| Rehabilitation clinic | 176 | 20.8 (1.3) | 145 | 31.4 (1.7) | | | |
| Healthcare centre hospital | | | | | 157 | 31.0 (1.9) | |
| Healthcare centre hospital after rehabilitation | 98 | 37.4 (3.6) | 61 | 57.8 (5.8) | 66 | 58.1 (5.3) | |
| Total | 187 | 46.5 (2.7) | 171 | 56.1 (3.6) | 180 | 56.7 (3.5) | |
| Total number of exercises per day | | 5,46 (0,231) | | 3,00 (0,185) | | 3,25 (0,283) | p<0.001[1] |
| ADL-exercises | | | | | | | |
| Number per day | | 4,69 (0,236) | | 2,42 (0,169) | | 2,85 (0,282) | p<0.001[2] |
| Time used (min) per day | | 50,21 (2,976) | | 12,99 (1,134) | | 24,96 (2,055) | p<0.001[3] |
| Mobilization and walking exercises | | | | | | | |
| Number per day | | 0,72 (0,035) | | 0,61 (0,045) | | 0,41 (0,038) | p<0.001[4] |
| Time used (min) per day | | 20,06 (0,925) | | 12,06 (0,864) | | 8,95 (0,957) | p<0.001[5] |

[1]Physical vs geriatric p<0.001; physical vs control p<0.001; geriatric vs control p=0.952

[2]Physical vs geriatric p<0.001; physical vs control p<0.001; geriatric vs control p=0.568

[3]Physical vs geriatric p<0.001; physical vs control p<0.001; geriatric vs control p=0.005

[4]Physical vs geriatric p=0.005; physical vs control p<0.001; geriatric vs control p=0.001

[5]Physical vs geriatric p=0.005; physical vs control p<0.001; geriatric vs control p=0.015

**Table 7. Comparison of functional status and mortality between rehabilitation groups.**

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Place of residence prefracture | | | | | | | p=0.897 |
| Own home | 163 | 87,2 | 147 | 86 | 154 | 85,6 | |
| Sheltered housing | 24 | 12,8 | 24 | 14 | 26 | 14,4 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| Residential status 4 months | | | | | | | p<0.001 |
| Own home | 131 | 72.8 | 100 | 64,5 | 100 | 62,5 | |
| Sheltered housing | 19 | 11,6 | 21 | 13,5 | 15 | 9,4 | |
| Health centre hospital | 9 | 5,0 | 5 | 3,2 | 11 | 6,9 | |
| Permanent institutional inpatient | 10 | 5,6 | 16 | 10,3 | 8 | 5,0 | |
| Rehabilitation unit | 2 | 1,1 | 5 | 3,2 | 0 | 0 | |
| Temporary stay in acute hospital | 9 | 5,0 | 8 | 5,2 | 26 | 16,3 | |
| Total | 180 | 100 | 155 | 100 | 160 | 100 | |
| Residential status 12 months | | | | | | | p=0.673 |
| Own home | 118 | 69,4 | 90 | 65,2 | 97 | 66,9 | |
| Sheltered housing | 20 | 11,8 | 15 | 10,9 | 20 | 13,8 | |
| Health centre hospital | 15 | 8,8 | 16 | 11,6 | 18 | 12,4 | |
| Permanent institutional inpatient | 10 | 5,9 | 9 | 6,5 | 7 | 4,8 | |
| Rehabilitation unit | 3 | 1,8 | 2 | 1,4 | 0 | 0 | |
| Temporary stay in acute hospital | 4 | 2,4 | 6 | 4,3 | 3 | 2,1 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| Walking ability prefracture | | | | | | | p=0.124 |
| Alone outdoors | 156 | 83,4 | 121 | 70,8 | 133 | 73,9 | |
| Outdoors only if accompanied | 5 | 2,7 | 9 | 5,3 | 10 | 5,6 | |
| Alone indoors but not outdoors | 26 | 13,9 | 40 | 23,4 | 36 | 20,0 | |
| Indoors only if accompanied | 0 | 0 | 0 | 0 | 1 | 0,6 | |
| Unable to walk | 0 | 0 | 1 | 0,6 | 0 | 0 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| Walking ability 4 months | | | | | | | p=0.169 |
| Alone outdoors | 87 | 48,3 | 57 | 36,8 | 69 | 43,1 | |
| Outdoors only if accompanied | 20 | 11,1 | 17 | 11,0 | 10 | 6,3 | |
| Alone indoors but not outdoors | 49 | 27,2 | 50 | 32,3 | 50 | 31,3 | |
| Indoors only if accompanied | 16 | 8,9 | 17 | 11,0 | 23 | 14,4 | |
| Unable to walk | 8 | 4,4 | 14 | 9,0 | 8 | 5,0 | |
| Total | 180 | 100 | 155 | 100 | 160 | 100 | |
| Walking ability 12 months | | | | | | | p=0.775 |
| Alone outdoors | 94 | 55,3 | 80 | 58,0 | 78 | 54,2 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Outdoors only if accompanied | 16 | 9,4 | 14 | 10,1 | 15 | 10,4 | |
| Alone indoors but not outdoors | 40 | 23,5 | 28 | 20,3 | 34 | 23,6 | |
| Indoors only if accompanied | 14 | 8,2 | 6 | 4,3 | 8 | 5,6 | |
| Unable to walk | 6 | 3,5 | 10 | 7,2 | 9 | 6,3 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| Walking aids prefracture | | | | | | | p=0.496 |
| Can walk without aids | 104 | 55,6 | 97 | 56,7 | 97 | 53,9 | |
| One aid | 39 | 20,9 | 23 | 13,5 | 30 | 16,7 | |
| Two aids | 3 | 1,6 | 1 | 0,6 | 4 | 2,2 | |
| Frame | 41 | 21,9 | 49 | 28,7 | 48 | 26,7 | |
| Wheelchair/Bedbound | 0 | 0 | 1 | 0,6 | 1 | 0,6 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| Walking aids 4 months | | | | | | | p=0.323 |
| No aids | 27 | 15,0 | 22 | 14,2 | 23 | 14,4 | |
| One aid | 36 | 20,0 | 18 | 11,6 | 23 | 14,4 | |
| Two aids | 7 | 3,9 | 5 | 3,2 | 12 | 7,5 | |
| Frame | 100 | 55,6 | 98 | 63,2 | 90 | 56,3 | |
| Wheelchair/bedbound | 10 | 5,6 | 12 | 7,7 | 12 | 7,5 | |
| Total | 180 | 100 | 155 | 100 | 160 | 100 | |
| Walking aids 12 months | | | | | | | p=0.657 |
| No aids | 42 | 24,7 | 28 | 20,3 | 30 | 20,8 | |
| One aid | 31 | 18,2 | 23 | 16,7 | 26 | 18,1 | |
| Two aids | 2 | 1,2 | 3 | 2,2 | 7 | 4,9 | |
| Frame | 83 | 48,8 | 72 | 52,2 | 68 | 47,2 | |
| Wheelchair/bedbound | 12 | 7,1 | 12 | 8,7 | 13 | 9,0 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| Pain in the injured hip 4 months | | | | | | | p=0.966 |
| Severe and spontaneous, even at rest | 5 | 2,8 | 2 | 1,3 | 3 | 1,9 | |
| Severe when walking and prevents all activity | 10 | 5,6 | 7 | 4,5 | 13 | 8,1 | |
| Tolerable, permitting limited activity | 28 | 15,6 | 25 | 16,1 | 29 | 18,1 | |
| Occurs only after some activity, disappears quickly at rest | 28 | 15,6 | 26 | 16,8 | 23 | 14,4 | |
| Slight or intermittent, alleviated in normal activity | 48 | 26,7 | 37 | 23,9 | 42 | 26,3 | |
| No hip pain | 56 | 31,1 | 52 | 33,5 | 45 | 28,1 | |
| Unable to answer | 5 | 2,8 | 6 | 3,9 | 5 | 3,1 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Total | 180 | 100 | 155 | 100 | 160 | 100 | |
| Pain in the injured hip 12 months | | | | | | | p=0.116 |
| Severe and spontaneous, even at rest | 0 | 0 | 0 | 0 | 2 | 1,4 | |
| Severe when walking and prevents all activity | 5 | 2,9 | 1 | 0,7 | 6 | 4,2 | |
| Tolerable, permitting limited activity | 17 | 10,0 | 11 | 8,0 | 18 | 12,5 | |
| Occurs only after some activity, disappears quickly at rest | 18 | 10,6 | 6 | 4,3 | 13 | 9,0 | |
| Slight or intermittent, alleviated in normal activity | 37 | 21,8 | 42 | 30,4 | 29 | 20,1 | |
| No hip pain | 92 | 54,1 | 75 | 54,3 | 74 | 51,4 | |
| Unable to answer | 1 | 0,6 | 3 | 2,2 | 2 | 1,4 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| Mortality | | | | | | | |
| Mortality at 4 months | 6 | 3,2 | 16 | 9,6 | 19 | 10,6 | p=0.017 |
| Mortality at 12 months | 16 | 8.6 | 32 | 18,7 | 35 | 19,4 | p=0.005 |

## 5.2 The costs and cost-effectiveness in different rehabilitation settings

No significant differences were seen between the groups with regards to use of healthcare services six months prior to fracture (Table 8). The cost of primary treatment was significantly higher in the physical and geriatric rehabilitation groups, than in the control group (Table 9). This cost was also significantly higher in the geriatric than in the physical rehabilitation group. Similarly, the expenditures of rehabilitation were significantly higher in the physical rehabilitation and geriatric rehabilitation compared to control group. Costs of institutional care after rehabilitation were significantly higher in the physical rehabilitation group than the control group, but no other differences were observed. Total expenditures for institutional treatment (including primary treatment, rehabilitation, and post-rehabilitation treatment in the healthcare center hospital) were higher in the geriatric rehabilitation than in the control group, but no significant differences were seen between physical rehabilitation group and other groups.

**Table 8. Use of healthcare and related costs 6 months prior the fracture.**

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | |
|---|---|---|---|---|---|---|
| | Mean times (SEM) | Euros | Mean times (SEM) | Euros | Mean times (SEM) | Euros |
| Visits to healthcare centre | 0.99 (0.19) | 110.4 | 0.62 (0.10) | 68.8 | 0.93 (0.15) | 103.4 |
| Visits to private doctor | 0.08 (0.03) | 6.1 | 0.10 (0.03) | 7.6 | 0.01 (0.01) | 1.0 |
| Hospital treatment | | | | | | |
| Healthcare centre hospital | 1.44 (0.33)[1] | 286.6 | 1.44 (0.60)[1] | 286.6 | 2.39 (0.51)[1] | 476.3 |
| District hospital | 0.44 (0.28)[1] | 87.4 | 0.94 (0.47)[1] | 187.6 | 0.36 (0.21)[1] | 72.5 |
| Private hospital | 0.01 (0.00)[1] | 1.1 | 0.04 (0.03)[1] | 7.0 | - | - |
| Central hospital | 1.84 (0.41)[1] | 367.6 | 3.64 (0.69)[1] | 724.7 | 1.44 (0.38)[1] | 287.1 |
| Number of drugs | 5.25 (0.24) | | 5.73 (0.30) | | 5.49 (0.24)[1] | |
| Total | | 859.1[2] (122.0) | | 1282.3[2] (214.8) | | 940.3[2] (149.7) |

[1]Mean hospital days

[2]Physical vs geriatric p=0.424; physical vs control p=0.638; geriatric vs control p=0.197.

**Table 9. Costs of primary treatment, rehabilitation and post-rehabilitation treatment at the healthcare centre hospital.**

| Parameter | Physical rehabilitation | Geriatric rehabilitation | Control group | p-value |
|---|---|---|---|---|
| | Mean euros (SEM) | Mean euros (SEM) | Mean euros (SEM) | |
| Primary hospital | 5105.1 (94.4) | 5597.9 (129.1) | 4779.3 (54.2) | $p < 0.001$[1] |
| Rehabilitation | 6609.0 (272.1) | 7034.7 (439.1) | 4945.2 (331.2) | $p = 0.006$[2] |
| Post-rehabilitation treatment at healthcare centre hospital | 3944.9 (486.4) | 4569.1 (655.7) | 3713.8 (489.7) | $p = 0.068$[3] |
| Total | 15,659.1 (561.2) | 17,201.7 (826.2) | 13,438.4 (667.8) | $p < 0.001$[4] |

[1]Physical vs geriatric p=0.047; physical vs control p=0.001; geriatric vs control p<0.001

[2]Physical vs geriatric p=0.666; physical vs control p=0.002; geriatric vs control p<0.001

[3]Physical vs geriatric p=0.058; physical vs control p=0.043; geriatric vs control p=0.900

[4]Physical vs geriatric p<0.001; physical vs control p=0.252; geriatric vs control p=0.055

The non-institutional costs are presented in Table 10. Patients in control group had more doctor visits compared to geriatric rehabilitation group, while the physical rehabilitation group had significantly lower costs compared to geriatric rehabilitation. Outpatient hospital visits cost significantly less in the control group compared to physical and geriatric rehabilitation groups. The physical rehabilitation group used significantly more physiotherapy than the geriatric rehabilitation group. Taxi usage costs were lowest in the geriatric rehabilitation group compared to physical rehabilitation and the control group. No other significant differences were observed. There were no significant between-group differences regarding the costs of reoperation, home medical treatment, home help services, or travel expenses for a patient's relative. Total costs did not significantly differ between any of the groups.

The cost of help provided by a relative was estimated as a proportion of a home aid's salary (30%, 50%, or 100%, Table 10). Physical rehabilitation was less expensive than control rehabilitation but more costly than geriatric rehabilitation in all proportions of the salary. We found no difference between geriatric rehabilitation and the control group. Total costs of post-rehabilitation healthcare services, including help from a relative, were significantly higher in the physical rehabilitation group than in the geriatric rehabilitation group when using the 30%, 50% and 100% proportions of a home aid's salary. When using the 100% proportion, the total cost for the physical rehabilitation group was significantly lower than that of the control group. No differences were found between the geriatric rehabilitation group and the control group at any salary percentage.

Total treatment costs, when excluding help by a relative, were significantly smaller in the control group than in the physical rehabilitation and geriatric rehabilitation groups (Table 11). When considering the costs of home help from a relative estimated as 30% of a home aid's salary, the significances of these differences disappeared (Table 11). When the costs of home help from a relative were estimated as 50% and 100% of a home aid's salary, the total costs of hip fracture treatment with physical rehabilitation were significantly lower than in the control group, but no significant difference was observed between the geriatric rehabilitation (the distribution was very skewed in this group) and physical rehabilitation groups or the geriatric rehabilitation and control groups (Table 11).

The total treatment costs with the cost of home help from a relative estimated as 100% of a home aid's salary minus costs before the fracture significantly differed between the physical rehabilitation group and the control group, but not between the physical and geriatric rehabilitation groups or the geriatric

rehabilitation and control groups (Table 11). Pre-fracture 15D scores did not differ between groups. At one year post-fracture, the 15D score was significantly higher in the physical rehabilitation group than the geriatric rehabilitation group and the control group (Table 11). Post-fracture 15D score did not significantly differ between the geriatric rehabilitation and the control group. We observed a similar pattern in differences between pre-fracture and one-year follow-up scores, with the physical rehabilitation group showing a smaller change in score than geriatric rehabilitation group and the control group.

**Table 10. Use of healthcare services.**

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | Mean times (SD) | Mean euros (SD) | Mean times (SD) | Mean euros (SD) | Mean times (SD) | Mean euros (SD) | |
| Visits to a doctor | 1.1 (0.2) | 116.7 (17.3) | 1.3 (0.4) | 122.9 (39.9) | 1.7 (0.6) | 194.8 (73.8) | p=0.001[3] |
| Outpatient visits to the hospital | 1.2 (0.1) | 128.4 (14.2) | 1.6 (0.2) | 156.3 (23.8) | 0.9 (0.1) | 87.9 (16.2) | p=0.016[4] |
| Physiotherapy | 5.8 (1.1) | 467.8 (89.1) | 3.3 (0.8) | 263.5 (62.6) | 4.1 (1.0) | 366.9 (95.8) | p=0.028[5] |
| Home help services | 92.1 (16.3)[1] | 4522.1 (789.3) | 86.9 (16.8)[1] | 4219.0 (816.0) | 90.8 (14.5)[1] | 3821.0 (726.7) | p=0.522 |
| Taxi usage | | 51.6 (10.2) | | 17.9 (5.6) | | 50.7 (13.1) | p=0.023[6] |
| Home medical treatment | 0.14 (0.03)[2] | 437.6 (82.6) | 0.14 (0.04)[2] | 417.4 (111.2) | 0.26 (0.06)[2] | 971.8 (216.4) | p=0.077 |
| Travel expenses of patient's relatives | | 132.2 (46.7) | | 104.1 (39.1) | | 59.4 (16.7) | p=0.257 |
| Re-operations | | 642.1 (155.5) | | 1082.7 (235.5) | | 1000.9 (215.9) | p=0.458 |
| Home help provided by relatives (30% of the salary) | 10.0 (2.0)[2] | 8785.2 | 8.4 (2.0)[2] | 6238.0 | 13.0 (2.5)[2] | 11,392.0 | p=0.028[7] |
| Home help provided by relatives (50% of the salary) | | 14,662.5 | | 10411.2 | | 19,013.2 | p=0.028[7] |
| Home help provided by relatives (100% of the salary) | | 29,325.1 | | 20822.3 | | 38,026.4 | p=0.028[7] |
| Total (0% of the salary) | | 6034.1 (776.7) | | 5393.2 (756.7) | | 5566.5 (724.9) | p=0.150[8] |
| Total (30% of the salary) | | 14,819.3 (1884.8) | | 11,631.2 (1628.9) | | 16,958.5 (2401.5) | p=0.102[9] |
| Total (50% of the salary) | | 20,696.6 (2934.2) | | 15,804.4 (2546.3) | | 24,579.7 (3895.3) | p=0.068[10] |
| Total (100% of the salary) | | 35,359.1 (5657.0) | | 26,215.5 (4955.8) | | 43,592.9 (7698.0) | p=0.036[11] |

[1]Hours

[2]Hours / week

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | Mean times (SD) | Mean euros (SD) | Mean times (SD) | Mean euros (SD) | Mean times (SD) | Mean euros (SD) | |

[3]Visits to a doctor: physical vs geriatric p=0.010; physical vs control p=0.288; geriatric vs control p=0.001

[4]Outpatient visits to the hospital: physical vs geriatric p=0.591; physical vs control p=0.021; geriatric vs control p=0.007

[5]Physiotherapy: physical vs geriatric p=0.017; physical vs control p=0.087; geriatric vs control p=0.458

[6]Taxi usage: physical vs geriatric p=0.002; physical vs control p=0.428; geriatric vs control p=0.029

[7]Home help provided by relatives: physical vs geriatric p=0.041; physical vs control p=0.016; geriatric vs control p=0.520

[8]Total (0%): physical vs geriatric p=0.098; physical vs control p=0.090; geriatric vs control p=0.990

[9]Total (30%): physical vs geriatric p=0.042; physical vs control p=0.120; geriatric vs control p=0.612

[10]Total (50%): physical vs geriatric p=0.030; physical vs control p=0.078; geriatric vs control p=0.708

[11]Total (100%): physical vs geriatric p=0.018; physical vs control p=0.041; geriatric vs control p=0.839

**Table 11. Total costs and incremental cost-effectiveness analysis.**

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | |
| Total costs excluding home help from relatives | 21,693 | 1028.2 | 22,595 | 1162.0 | 19,005 | 984.0 | $p = 0.012$[1] |
| Total costs including home help from relatives (30% of the salary) | 30,478 | 1994.7 | 28,833 | 1813.6 | 30,397 | 2494.9 | $p = 0.137$ |
| Total costs including home help from relatives (50% of the salary) | 36,356 | 3002.8 | 33,006 | 2650.3 | 38,018 | 3954.8 | $p = 0.088$[2] |
| Total costs including home help from relatives (100% of the salary) | 51,018 | 5688.8 | 43,417 | 4986.4 | 57,031 | 7729.9 | $p = 0.041$[3] |
| Costs before the fracture | 859 | 122.0 | 1282 | 214.8 | 940 | 149.7 | |
| Difference in cost | 50,159 | 5691.4 | 42,135 | 4916.2 | 55,965 | 7725.4 | p=0.055[4] |
| 15D score before the fracture | 0.780 | 0.010 | 0.790 | 0.032 | 0.755 | 0.010 | p=0.296 |
| 15D score at one year follow-up | 0.697 | 0.018 | 0.586 | 0.025 | 0.594 | 0.025 | p=0.009[5] |
| Difference in 15D score | 0.083 | 0.015 | 0.205 | 0.037 | 0.161 | 0.021 | p=0.018[6] |

[1]Physical vs geriatric p=0.971; physical vs control p=0.009; geriatric vs control p=0.011
[2]Physical vs geriatric p=0.476; physical vs control p=0.032; geriatric vs control p=0.144
[3]Physical vs geriatric p=0.324; physical vs control p=0.014; geriatric vs control p=0.115
[4]Physical vs geriatric p=0.305; physical vs control p=0.018; geriatric vs control p=0.161
[5]Physical vs geriatric p=0.008; physical vs control p=0.009; geriatric vs control p=0.938
[6]Physical vs geriatric p=0.009; physical vs control p=0.028; geriatric vs control p=0.667

## 5.3 Recovery after hip fracture in male and female patients

Table 12 summarizes the prefracture characteristics. Male patients (mean 73.3 years) were significantly younger than female patients (mean 79.2 years, p<0.001) at the time of the fracture. Men were more often treated with three screws or a single screw with a slide plate while female patients had more operations with intramedullary nail and hemiarthroplasty (p<0.001). ADL functions are described in detail in Appendix IV. Male patients were more likely to have better prefracture walking ability than female patients (p<0.001) and were more able to shop independently (p=0.001), manage finances (p<0.001) and travel independently before the fracture (p<0.001). Female patients had better prefracture ADL-functions in housework chores (p<0.001) and preparing meals (p=0.035) than male patients. No differences were observed regarding other ADL functions. There were

no differences between genders regarding distribution to different rehabilitation modalities (p=0.563), side of fracture (p=0.277), type of fracture (p=0.656) or associated diseases. In matched-pair analysis, there were no significant differences in any prefracture parameters (Table 13).

**Table 12. Prefracture characteristics between male and female patients.**

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Age | | | |
| Mean (SD) | 73.3 (10.1) | 79.2 (8.7) | p<0.001 |
| Range | 52.9-91.2 | 50.0-99.6 | |
| | | | |
| Rehabilitation modality | | | p=0.563 |
| Physical rehabilitation | 41 (39.0%) | 146 (33.7%) | |
| Geriatric rehabilitation | 30 (28.6%) | 141 (32.6%) | |
| Healthcare centre hospital | 34 (32.4%) | 146 (33.7%) | |
| Side of fracture | | | p=0.277 |
| Right | 48 (45.7%) | 226 (52.2%) | |
| Left | 57 (54.3%) | 207 (47.8%) | |
| Type of fracture | | | p=0.656 |
| Undisplaced intracapsular | 17 (16.2%) | 56 (12.9%) | |
| Displaced intracapsular | 51 (48.6%) | 222 (51.3%) | |
| Basocervical | 2 (1.9%) | 5 (1.2%) | |
| Trochanteric two-fragment | 11 (10.5%) | 67 (15.5%) | |
| Trochanteric multi-fragment | 21 (20.0%) | 70 (16.2%) | |
| Subtrochanteric | 3 (2.9%) | 13 (3.0%) | |
| Primary operation | | | p<0.001 |
| Three screws | 38 (36.2%) | 81 (18.7%) | |
| Single screw with slide plate | 19 (18.1%) | 51 (11.8%) | |
| Intramedullary nial | 17 (16.2%) | 116 (26.8%) | |
| Hemiarthroplasty | 27 (25.7%) | 164 (37.9%) | |
| Total hip arthroplasty | 4 (3.8%) | 21 (4.8%) | |
| Associated diseases | | | |
| Cardiovascular diseases | 72 (68.6%) | 333 (76.9%) | p=0.079 |
| Paralysis | 16 (15.2%) | 64 (14.8%) | p=1.000 |
| Respiratory organ diseases | 19 (18.1%) | 78 (18.0%) | p=1.000 |
| Urinary organ diseases | 23 (21.9%) | 103 (23.8%) | p=0.703 |
| Diabetes mellitus | 17 (16.2%) | 90 (20.8%) | p=0.341 |
| Rheumatism | 10 (9.5%) | 59 (13.6%) | p=0.329 |
| Parkinson's disease | 5 (4.8%) | 17 (3.9%) | p=0.783 |
| Malignant tumour or haemopathy | 15 (14.3%) | 52 (12.0%) | p=0.621 |

**Table 13. Matched-pair analysis.**

| Parameter | Male (n=105[1]) | Female (n=105[1]) | p-value |
|---|---|---|---|
| Mortality | | | |
| 4 months | 5 | 6 | p=0.763 |
| 12 months | 17 | 13 | p=0.433 |
| Rehabilitation modality | | | P=0.658[2] |
| Physically oriented rehabilitation | 41 | 30 | |
| Geriatrically oriented rehabilitation | 30 | 37 | |
| Control group | 34 | 38 | |
| Side of fracture | | | P=0.199 |
| Left | 48 | 57 | |
| Right | 57 | 48 | |
| Associated diseases | | | |
| Cardiovascular diseases | 72 | 76 | P=0.516 |
| Paralysis | 16 | 16 | P=1.000 |
| Respiratory organ diseases | 19 | 15 | P=0.450 |
| Urinary organ diseases | 23 | 20 | P=0.564 |
| Diabetes mellitus | 17 | 17 | P=1.000 |
| Rheumatism | 10 | 12 | P=0.670 |
| Parkinson's disease | 5 | 4 | P=0.705 |
| Malignant tumor or haemopathy | 15 | 13 | P=0.695 |
| Residential status prefracture | | | P=0.250[3] |
| Own house | 90 | 94 | |
| Sheltered housing | 15 | 11 | |
| Total | 105 | 105 | |
| Residential status 4 months | | | P=1.000[3] |
| Own house | 74 | 71 | |
| Sheltered housing | 9 | 9 | |
| Permanent institutional patient | 2 | 6 | |
| Hospital | 5 | 8 | |
| Rehabilitation unit | 2 | 0 | |
| Temporary stay in acute hospital | 8 | 5 | |
| Total | 100 | 99 | |
| Residential status 12 months | | | P=1.000[3] |
| Own house | 60 | 63 | |
| Sheltered housing | 10 | 12 | |
| Permanent institutional patient | 8 | 9 | |
| Hospital | 5 | 3 | |
| Rehabilitation unit | 1 | 1 | |
| Temporary stay in acute hospital | 3 | 3 | |
| Total | 87 | 91 | |

| Parameter | Male (n=105[1]) | Female (n=105[1]) | p-value |
|---|---|---|---|
| Walking ability prefracture | | | P=0.077 |
| Alone outdoors | 92 | 81 | |
| Outdoors only if accompanied | 2 | 6 | |
| Alone indoors but not outdoors | 10 | 17 | |
| Indoors only if accompanied | 0 | 1 | |
| Unable to walk | 1 | 0 | |
| Total | 105 | 105 | |
| Walking ability 4 months | | | P=0.550 |
| Alone outdoors | 59 | 50 | |
| Outdoors only if accompanied | 4 | 9 | |
| Alone indoors but not outdoors | 21 | 24 | |
| Indoors only if accompanied | 10 | 10 | |
| Unable to walk | 6 | 6 | |
| Total | 100 | 99 | |
| Walking ability 12 months | | | P=0.622 |
| Alone outdoors | 59 | 54 | |
| Outdoors only if accompanied | 8 | 11 | |
| Alone indoors but not outdoors | 12 | 17 | |
| Indoors only if accompanied | 3 | 5 | |
| Unable to walk | 5 | 4 | |
| Total | 87 | 91 | |
| Walking aids prefracture | | | P=0.485 |
| No aids | 65 | 70 | |
| One aid | 17 | 14 | |
| Two aids | 1 | 2 | |
| Frame | 21 | 18 | |
| Wheelchair/bedbound | 1 | 1 | |
| Total | 105 | 105 | |
| Walking aids 4 months | | | P=0.354 |
| No aids | 21 | 22 | |
| One aid | 20 | 19 | |
| Two aids | 6 | 8 | |
| Frame | 44 | 43 | |
| Wheelchair/bedbound | 9 | 7 | |
| Total | 100 | 99 | |
| Walking aids 12 months | | | P=0.419 |
| No aids | 30 | 28 | |
| One aid | 22 | 19 | |
| Two aids | 2 | 6 | |
| Frame | 28 | 31 | |
| Wheelchair/bedbound | 5 | 7 | |

| Parameter | Male (n=105[1]) | Female (n=105[1]) | p-value |
|---|---|---|---|
| Total | 87 | 91 | |
| Pain 4 months | | | P=0.004 |
| Severe and spontaneous, even at rest | 2 | 4 | |
| Severe when walking and prevents all activity | 14 | 2 | |
| Tolerable, permitting limited activity | 29 | 10 | |
| Occurs only after some activity, diseappears quickly at rest | 14 | 17 | |
| Slight or intermittent, alleviated in normal activity | 19 | 27 | |
| No hip pain | 21 | 34 | |
| Unable to answer | 1 | 5 | |
| Total | 100 | 99 | |
| Pain 12 months | | | P=0.018 |
| Severe and spontaneous, even at rest | 1 | 2 | |
| Severe when walking and prevents all activity | 4 | 9 | |
| Tolerable, permitting limited activity | 8 | 6 | |
| Occurs only after some activity, diseappears quickly at rest | 6 | 21 | |
| Slight or intermittent, alleviated in normal activity | 34 | 52 | |
| No hip pain | 0 | 1 | |
| Total | 87 | 91 | |
| ADL-score | | | |
| Mean score prefracture (SD) | 20.13 (11.020) | 18.16 (9.413) | P=0.145 |
| Mean score at 4 months (SD) | 26.87 (12.305) | 24.69 (12.108) | P=0.132 |
| Mean score at 12 months (SD) | 25.16 (12.172) | 23.29 (12.697) | P=0.389 |

[1]One male and one female patient were lost during the follow-up

[2]McNemar test, specialized rehabilitation (physical or geriatric) vs standard rehabilitation (control)

[3]McNemar test, independent living (own house or sheltered housing) vs institutionalized

Pain in the injured hip was less common among female than male patients at 4 and at 12 months follow-up (p=0.001, p=0.005, respectively, Table 14). No differences were found between the groups in residential status (p=0.181, p=0.883 at 4 and 12 months, respectively) or mortality (p=0.232, p=0.880, Table 14). An analysis of matched pairs showed significant differences in postoperative pain at 4 and at 12 months in favor of female patients (p=0.004 vs. p=0.018), but no gender differences were found regarding mortality (p=0.763 vs. p=0.433) or residential status (p=1.000 vs. p=1.000, Table 13).

Male patients had better walking ability at 4 ($p<0.001$) and at 12 months ($p=0.031$) after the fracture and needed less walking aids at 12 months ($p=0.008$) than their female counterparts (Table 14). The walking ability was decreased more among women at 4 months compared to prefracture walking ($p=0.046$, Table 14), but no differences were observed at 12 months ($p=0.052$, Table 14). In an analysis of matched-pairs, no differences in walking ability were observed prefracture ($p=0.077$) or at 4 ($p=0.550$) and 12 ($p=0.622$) months after the fracture. Similarly, no differences regarding the use of walking aids were observed (Table 13).

**Table 14. Mortality, residential status, functional capacity and complication rate.**

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Mortality | | | |
| 4 months | 5 (4.8%) | 36 (8.3%) | p=0.232 |
| 12 months | 17 (16.2%) | 66 (15.2%) | p=0.880 |
| Residential status prefracture | | | p=0.529 |
| Own house | 93 (88.6%) | 371 (85.7%) | |
| Sheltered housing | 12 (11.4%) | 62 (14.3%) | |
| Total | 105 | 433 | |
| Residential status 4 months | | | p=0.181 |
| Own house | 74 (74.0%) | 257 (65.1%) | |
| Sheltered housing | 9 (9.0%) | 46 (11.6%) | |
| Permanent institutional patient | 2 (2.0%) | 23 (5.8%) | |
| Hospital | 5 (5.0%) | 29 (7.3%) | |
| Rehabilitation unit | 2 (2.0%) | 5 (1.3%) | |
| Temporary stay in acute hospital | 8 (8.0%) | 35 (8.9%) | |
| Total | 100 | 395 | |
| Residential status 12 months | | | p=0.883 |
| Own house | 60 (69.0%) | 245 (66.9%) | |
| Sheltered housing | 10 (11.5%) | 45 (12.3%) | |
| Permanent institutional patient | 8 (9.2%) | 41 (11.2%) | |
| Hospital | 5 (5.7%) | 21 (5.7%) | |
| Rehabilitation unit | 1 (1.1%) | 4 (1.1%) | |
| Temporary stay in acute hospital | 3 (3.4%) | 10 (2.7%) | |
| Total | 87 | 366 | |
| Walking ability prefracture | | | p<0.001 |
| Alone outdoors | 92 (87.6%) | 318 (73.4%) | |
| Outdoors only if accompanied | 2 (1.9%) | 22 (5.1%) | |
| Alone indoors but not outdoors | 10 (9.5%) | 92 (21.2%) | |
| Indoors only if accompanied | 0 | 1 (0.2%) | |
| Unable to walk | 1 (1.0%) | 0 | |
| Total | 105 | 433 | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Walking ability 4 months | | | p<0.001 |
| Alone outdoors | 59 (59.0%) | 154 (38.9%) | |
| Outdoors only if accompanied | 4 (4.0%) | 43 (10.9%) | |
| Alone indoors but not outdoors | 21 (21.0%) | 128 (32.3%) | |
| Indoors only if accompanied | 10 (10.0%) | 47 (11.9%) | |
| Unable to walk | 6 (6.0%) | 24 (6.1%) | |
| Total | 100 | 396 | |
| Walking ability 12 months | | | |
| Alone outdoors | 59 (67.8%) | 193 (52.9%) | p=0.031 |
| Outdoors only if accompanied | 8 (9.2%) | 37 (10.1%) | |
| Alone indoors but not outdoors | 12 (13.8%) | 90 (24.7%) | |
| Indoors only if accompanied | 3 (3.4%) | 25 (6.8%) | |
| Unable to walk | 5 (5.7%) | 20 (5.5%) | |
| Total | 87 | 365 | |
| Walking aids prefracture | | | p=0.108 |
| No aids | 65 (61.9%) | 233 (53.8%) | |
| One aid | 17 (16.2%) | 75 (17.3%) | |
| Two aids | 1 (1.0%) | 7 (1.6%) | |
| Frame | 21 (20.0%) | 117 (27.0%) | |
| Wheelchair/bedbound | 1 (1.0%) | 1 (0.2%) | |
| Total | 105 | 433 | |
| Walking aids 4 months | | | p=0.059 |
| No aids | 21 (21.0%) | 51 (12.9%) | |
| One aid | 20 (20.0%) | 57 (14.4%) | |
| Two aids | 6 (6.0%) | 18 (4.5%) | |
| Frame | 44 (44.0%) | 245 (61.9%) | |
| Wheelchair/bedbound | 9 (9.0%) | 25 (6.3%) | |
| Total | 100 | 396 | |
| Walking aids 12 months | | | p=0.008 |
| No aids | 30 (34.5%) | 70 (19.2%) | |
| One aid | 22 (25.3%) | 58 (15.9%) | |
| Two aids | 2 (2.3%) | 10 (2.7%) | |
| Frame | 28 (32.2%) | 195 (53.4%) | |
| Wheelchair/bedbound | 5 (5.7%) | 32 (8.8%) | |
| Total | 87 | 365 | |
| Pain in the injured hip 4 months | | | p=0.001 |
| Severe and spontaneous, even at rest | 2 (2.0%) | 8 (2.0%) | |
| Severe when walking and prevents all activity | 14 (14.0%) | 16 (4.0%) | |
| Tolerable, permitting limited activity | 29 (29.0%) | 53 (13.4%) | |
| Occurs only after some activity, diseappears quickly at rest | 14 (14.0%) | 63 (15.9%) | |
| Slight or intermittent, alleviated in normal activity | 19 (19.0%) | 108 (27.3%) | |
| No hip pain | 21 (21.0%) | 133 (33.6%) | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Unable to answer | 1 (1.0%) | 15 (3.8%) | |
| Total | 100 | 396 | |
| Pain in the injured hip 12 months | | | p=0.005 |
| Severe and spontaneous, even at rest | 1 (1.1%) | 1 (0.3%) | |
| Severe when walking and prevents all activity | 4 (4.6%) | 8 (2.2%) | |
| Tolerable, permitting limited activity | 8 (9.2%) | 38 (10.4%) | |
| Occurs only after some activity, diseappears quickly at rest | 6 (6.9%) | 31 (8.5%) | |
| Slight or intermittent, alleviated in normal activity | 34 (39.1%) | 74 (20.3%) | |
| No hip pain | 34 (39.1%) | 207 (56.7%) | |
| Unable to answer | 0 | 6 (1.6%) | |
| Total | 87 | 365 | |
| Change in walking ability at 4 months | | | p=0.046 |
| Walking ability increased | 2 (2.0%) | 11 (2.8%) | |
| Stayed same | 61 (61.0%) | 187 (47.2%) | |
| Walking ability decreased | 37 (37.0%) | 198 (50.0%) | |
| Total | 100 | 396 | |
| Change in walking ability at 12 months | | | p=0.052 |
| Walking ability increased | 2 (2.3%) | 17 (4.7%) | |
| Stayed same | 63 (72.4%) | 214 (58.6%) | |
| Walking ability decreased | 22 (25.3%) | 134 (36.7%) | |
| Total | 87 | 365 | |
| Reoperations | | | |
| No of patients | 19 (18.1%) | 65 (15.0%) | |
| No of reoperations | 26 | 112 | |
| Post-operative complications | | | |
| Pneumonia | 9 (8.6%) | 33 (7.6%) | p=0.839 |
| Cardiac failure | 3 (2.9%) | 2 (0.5%) | p=0.054 |
| Deep vein thrombosis | 1 (1.0%) | 2 (0.5%) | p=0.480 |
| Pulmonary embolism | 1 (1.0%) | 2 (0.5%) | p=0.480 |
| Superficial infection | 3 (2.9%) | 8 (1.9%) | p=0.457 |
| Deep infection | 0 | 3 (0.7%) | p=1.000 |
| Haematoma | 1 (1.0%) | 14 (3.2%) | p=0.324 |
| Urinary retention | 11 (10.5%) | 23 (5.3%) | p=0.071 |
| Urinary tract infection | 10 (9.5%) | 98 (22.7%) | p=0.003 |
| Renal insufficiency | 0 | 3 (0.7%) | p=1.000 |
| Gastrointestinal bleeding | 1 (1.0%) | 6 (1.4%) | p=1.000 |
| Myocardial infarction | 1 (1.0%) | 11 (2.5%) | p=0.476 |
| Stroke | 1 (1.0%) | 2 (0.5%) | p=0.480 |
| Other | 24 (22.9%) | 92 (21.3%) | p=0.791 |

Male patients were more able to shop independently at 4 ($p<0.001$) and 12 months ($p=0.013$), use transportation ($p<0.001$, $p=0.038$, respectively) and manage banking/finances 4 months ($p=0.010$) after the fracture (Appendix IV). Female patients were more able to prepare meals independently at 4 ($p=0.021$) and 12 months ($p=0.002$), do household chores ($p=0.030$, $p=0.016$, respectively) and do laundry at 12 months ($p=0.029$). No other significant differences were observed in ADL functions. There were no significant differences in total ADL-scores between genders at 4 ($p=0.546$) and 12 months ($p=0.435$). More detailed outcomes can be seen in Appendix IV. The matched-pair analysis did not show significant differences in total ADL-scores (Table 13).

A Cox regression analysis (Table 15) of survival 12 months after the fracture showed that the following significantly increased the risk of death: age (hazard ratio [HR] 1.028, 95% confidence interval [CI] 1.001–1.059), prefracture ADL score (HR 1.047, 95% CI 1.020–1.074), ASA score 4–5 compared to ASA score 1–3 (HR 1.880, 95% CI 1.135–3.113), and physical rehabilitation compared to geriatric (HR 2.019, 95% CI 1.092-3.733) and standard rehabilitation (HR 2.151, 95% CI 1.167-3.965). Sex ($p=0.236$), type of fracture ($p=0.559$), prefracture walking ability ($p=0.068$), living alone ($p=0.321$), and cardiovascular disease ($p=0.629$) were factors that did not affect the mortality rate.

We also compared male and female patients separately in each different rehabilitation settings (Appendix V). At 4 and 12 months, no differences in mortality between genders was observed in physical ($p=0.342$, $p=0.755$ respectively), geriatric ($p=0.741$, $p=0.456$) or control rehabilitation ($p=1.000$, $p=0.355$). Similarly, we found no differences regarding ADL-score at 4 and 12 months follow-up in physical ($p=0.757$, $p=0.639$, respectively), geriatric ($p=0.436$, $p=0.920$) and control group ($p=0.213$, $p=0.523$).

**Table 15. Cox regression analysis on mortality.**

| Variable | Hazard ratio | Confidence interval | | p-value |
|---|---|---|---|---|
| | | Lower | Upper | |
| Age | 1.028 | 1.001 | 1.059 | p=0.050 |
| Prefracture ADL-score | 1.047 | 1.020 | 1.074 | p=0.001 |
| Rehabilitation | | | | p=0.034 |
| Physical rehabilitation | 1.0 | | | |
| Geriatric rehabilitation | 2.019 | 1.092 | 3.733 | |
| Control/standard rehabilitation | 2.151 | 1.167 | 3.965 | |
| ASA-score | | | | p=0.014 |
| 1-3 | 1.0 | | | |
| 4-5 | 1.880 | 1.135 | 3.113 | |
| Sex[1] | n/a | n/a | n/a | p=0.236 |
| Type of fracture[1] | n/a | n/a | n/a | p=0.559 |
| Prefracture walking ability[1] | n/a | n/a | n/a | p=0.068 |
| Living alone[1] | n/a | n/a | n/a | p=0.321 |
| Cardiovascular disease[1] | n/a | n/a | n/a | p=0.629 |

[1]HR and CI not calculated.

# 6 Discussion

## 6.1 The effect of specialised rehabilitation to recovery after hip fracture

Both specialized rehabilitation modalities significantly increased the number of patients able to live independently (at 4 months follow-up), reducing the need for institutional care relative to routine after-treatment. This phenomenon might be explained by the effective physical therapy provided at these two specialised rehabilitation settings, as seen in the both quantities of exercise events and the used time. This also realizes the generally known concern (regarding the control group patients) that the patients with minimal remaining walking ability are in danger of losing their mobility, personal independence, social connectedness and physical and mental health when treated in a hospital setting where maintaining basic functional mobility is overlooked (Bertheussen et al., 2011; Boltz, Resnick, Capezuti, Shuluk & Secic, 2012; Brown, Friedkin & Inouye, 2004; Salguero, Martínez-García, Molinero & Márquez, 2011). This effect was transient, however, and had disappeared by 12 months. Earlier, similar effect has been seen in patients with mild or moderate dementia treated in geriatric ward (Huusko et al., 2010), while no such effect has been reported in some other studies that have considered location of residence after 3 and 6 months of follow-up (Kramer et al., 1997; Naglie et al., 2002). One explanation to this discrepancy might be the fact that the scale of places of independent living used here was quite extensive allowing to record even small effects in the ability to live independently. It should be noted that patients with femoral neck fracture benefitted more of the rehabilitation than those with trochanteric fracture, probably due the fact that the hemiarthroplasty used in most cases with femoral neck fracture allows more efficient rehabilitation than the internal fixation of trochanteric fractures because of earlier full-weight bearing.

Physically oriented rehabilitation reduced mortality, an effect that has not been seen in other studies at three (Naglie et al., 2002), four (Cameron et al., 1994), six (Koval et al., 1998; Naglie et al., 2002) or 12 months (Huusko et al., 2010; Koval et al., 1998) after the fracture, although the Cochrane meta-analysis performed in 2004 showed a tendency for a decrease in mortality in rehabilitation groups. A single study found lower mortality on patients treated in geriatric ward (compared to orthopaedic ward) at 1 and 3 months follow-up (Adunsky et al., 2010). It is unlikely that the background factors influenced these results as the factors recorded

here were very similar between groups. It is probable that the emphasized role of mobilisation observed in the physically weighed rehabilitation group explains the impact on the mortality. Similar decrease in mortality by even minimal physical exercise has been observed in some earlier studies (Franco et al., 2005; Sabia et al., 2012; Wen et al., 2011).

The treatment period at the primary hospital was shorter in the control group than in the intervention groups, as was also the case in the study by Naglie et al. (2002), but in some other reports (Cameron et al., 1994; Huusko et al., 2002) the stay in the primay hospital was shorter in the intervention groups, due the reason that rehabilitation took place in the primary hospital. Our finding is explained by differences in the capacities of the rehabilitation centers and healthcare centre hospitals to admit patients from the primary hospital. The health care centre hospitals are sufficiently well equipped and the network sufficiently dense so that they were able to admit patients at a very early postoperative phase without queuing, whereas 1–2 days of waiting of admission to the rehabilitation was a problem that affected the geriatric rehabilitation in particular.

On the other hand, the mean stays in the different rehabilitations varied, with the physical rehabilitation group showing the shortest. This can be explained by the high cost of privately arranged physical rehabilitation. The local authorities paid an individual fee that covered a limited period of time, usually 2–3 weeks, although this could be extended on request when needed. Such limitations did not apply to the geriatric and standard rehabilitation, which was paid for out of public funds. The long periods of the stays in the institutional care (hospitals and rehabilitation units) in all groups is explained by the fact that the home rehabilitation system was not used and developed at the time of this study but the rehabilitation of hip fractures as well as rehabilitation in general was based on institutional rehabilitation.

We did not find any significant differences in ADL functions or walking ability at either 4 months or 12 months postoperatively. The results as well as settings considering hip fracture rehabilitation vary considerably in literature. While it has been generally suggested that outcomes are improved with rehabilitation, the best approach is not clear (Sherrington et al., 2011; Stott et al., 2011). Hagsten et al. (2004) observed that early postoperative occupational training improved ADL functions, but these differences disappeared during the follow-up. Similar transitional effect in intensive rehabilitation program was reported by Koval et al. (1998), while Kramer et al. (1997) found no effect regarding functional status. Some studies have found that rehabilitation in geriatric ward improves short-term ADL functions (Huusko et al., 2002; Adunsky et al., 2010), while other studies

have reported no differences (Röder et al., 2003). Extended rehabilitation after inpatient period has been proved to improve ADL-functions (Sylliaas et al., 2011; Binder et al., 2004). In recent years, home-based rehabilitation has been presented as a viable option compared to institutional rehabilitation, but there is a great variation in reported results. Some have reported similar results to outpatient exercise training (Binder et al. 2004) while at least one study found that home-based rehabilitation with early discharge from hospital improved patients' functional status compared to care in ward only (Zidén et al., 2008).

All the patients came from a geographically limited, and relatively small area, ensuring that the total study population was homogenous. However, due administrative reasons, all the patients of the geriatric rehabilitation were residents of the City of Oulu whereas the control group patients consisted of people from the surrounding 33 towns and counties. Physical rehabilitation group admitted patients regardless of the place of residence. More than 75% of the city residents live in suburban area, comparable to central areas of towns and counties. This is supported also by the fact that there are no significant differences in the life expectancy between people living in rural like or urban like conditions in Finland (81,01years for females, 74,50 years for males and 77,76 years for all in rural like, and 81,08 years, 74,20 years and 77,85 years in urban like living, respectively) (Population statistics of the year 2000). Despite these considerations, our data showed that physical and geriatric rehabilitation modalities increased the number of patients able to live independently at short follow-up. Physical rehabilitation also decreased mortality.

## 6.2 The costs and cost-effectiveness in different rehabilitation settings

Our results showed that specialised rehabilitations (physical rehabilitation and geriatric rehabilitation) were significantly more expensive than standard rehabilitation following hip fracture. The high costs were expected due the high resource demand in both physical and geriatric rehabilitation, reflected in high day prices and the total cost of rehabilitation. It must be considered that the local authorities paid an individual fee that covered a limited period of physical rehabilitation—usually two to three weeks—which influenced the rehabilitation duration in this patient group. Such limitations did not apply to geriatric and standard rehabilitation, which were paid for by public funds. Our present study enabled the separate evaluation of rehabilitation costs, in contrast to many earlier

papers in which rehabilitation costs were combined with other hospital costs. While a wide range of rehabilitation strategies have been investigated (Cameron, 2005), few studies have compared the costs between different rehabilitation settings. To our knowledge, no previously published study has used a design similar to our present investigation. In a group of hip fracture and stroke patients, Kramer et al. (1997) compared the effectiveness and costs of rehabilitation in three different settings: rehabilitation hospital, subacute nursing home, and a traditional nursing home. As expected, the medicare costs were greater in the rehabilitation hospital setting, which involved more physical, occupational and recreational therapy, compared to the subacute nursing home setting. Moreover, and the costs for subacute nursing home patients were greater than for traditional nursing home patients at the 6-month follow-up. However, it is difficult to compare their results to our present findings due to inflation, exchange rates, and differences in rehabilitation practices and healthcare. In fact, we identified no clear comparisons for our presently examined specialised rehabilitation settings.

We also found that specialised rehabilitation settings were associated with a longer stay in the primary hospital, thus increasing the primary treatment costs. This was because the rehabilitation centres and healthcare centre hospitals have different capacities to admit patients from the primary hospital, which directly affected the initial hospitalization cost. The healthcare centre hospitals are sufficiently well equipped and have a dense enough network to allow patient admission at a very early postoperative phase and without queuing, which was a problem that particularly affected the geriatric rehabilitation centre. Initial hip fracture treatment costs vary substantially between different countries. Finnern and Sykes (2003) reported primary hip fracture treatment expenses within the EU countries using European Commission cost data. The costs were lowest in Ireland (3714€) and highest in Germany (13,776€). The average cost per patient in the EU was 8125€, while the treatment cost in Finland was 4086€. This great variance in primary hospital costs related to healthcare system differences among different countries. In some countries, rehabilitation occurs in the primary hospitals, whereas early discharge and rehabilitation in other institutions is the routine practice in other countries. Our estimates of the initial hospitalization costs are well within the previously reported range of values when costs are adjusted for present day prices.

The total costs of institutional hip fracture treatment (primary hospital, rehabilitation, and post-rehabilitation healthcare centre hospital costs) were 17% higher in the physically oriented rehabilitation and 28% higher in the geriatrically oriented rehabilitation groups compared to in the control group. In all groups,

rehabilitation constituted a major share of the total costs, while post-rehabilitation hospital care was the smallest component of the expenditures. Studies comparing total hip fracture costs between different rehabilitation methods have mainly focused on the effects of early discharge and the costs of the intensified rehabilitation period (Cameron et al., 1994; Hollingworth et al., 1993; Polder et al., 2003). Polder et al. (2003) compared costs between patients with early hospital discharge to a nursing home (including rehabilitation facilities) and patients in conventional treatment. They reported that early discharge results in lower initial hospital costs, but a higher rate of later institutionalization, resulting in no overall benefit with regards to total treatment costs. On the other hand, Hollingworth et al. (1993) found smaller total costs with the "hospital at home" program in UK, which provided nursing care, social services, and rehabilitation in the patient's home. However, only 40% of patients benefitted from the "hospital at home" program, and these patients were more mobile and younger prior to hip fracture. Similarly, an Australian study concluded that accelerated rehabilitation reduced costs by 17% compared to conventional care, but these savings were relatively modest (Cameron et al., 1994). Again, these results are not fully comparable to our present findings, as the reported rehabilitation methods and study designs were somewhat different from our specialised rehabilitation settings.

Use of other healthcare services—including visits to a doctor or outpatient hospital, physiotherapy, home help services, taxi usage, home medical treatment, travel expenses for patients' relatives, reoperations, and help from a relative—and the costs generated following hip fracture were lower in the geriatric rehabilitation group than in the physical rehabilitation group. This was mainly attributed to the costs estimated for home help provided by relatives, as other expenditures had relatively small impacts on the costs. The costs of home help from relatives were estimated as different percentages of a home aid's salary. Even at the lowest proportion (30% of the salary), these costs constituted over half of the total costs during the year after the fracture. The methods for calculating post-rehabilitation costs of hip fracture vary considerably in the literature (Cameron et al., 1994; Haentjens et al., 2001; Nurmi et al., 2003). Kondo, Zierler, Isokawa, Hagino & Ito (2009) estimated the loss of salary in cases where a patient's relatives took a leave of absence from work; however, these costs were very low (150 dollars on average) and the use of an elderly care services was the routine practice. A Finnish study by Nurmi et al. (2003) reported non-institutional costs of 3013€ during the one-year follow-up after hip fracture. This was significantly lower than in our present results; however, their study didn't account for some of the expenditures we included in

our study, such as help from a relative, reoperations, relatives' travel expenses, and physiotherapy. Again, the great variance in methods for cost calculations made it difficult to clearly compare our results to previous findings, with the main difference being the costs of help from a relative.

Intensive physical and geriatric rehabilitation are usually considered to be costly to society. However, our present results showed that the total hip fracture treatment costs over one year following fracture were similar between rehabilitation groups when accounting for the estimated cost of help given by relatives as 30% of a home aid's salary. When this cost estimate was made using 50% and 100% of the home aid's salary, the mean cost of routine treatment exceeded that of the physical rehabilitation modality. These results suggest that, although routine treatment is viewed as the least costly method, it may actually only serve to shift the costs, such that the expenditures of the hospital are carried by the patients' relatives. This possibility has also been suggested in other studies (van Balen et al., 2002; Polder et al., 2003; Haentjens et al., 2005).

## 6.3 Recovery after hip fracture in male and female patients

We found no difference in mortality between home-dwelling male and female hip fracture patients during the 12-month post-fracture follow-up period. This finding differs from many earlier studies that found that male patients have a higher mortality risk after hip fracture than female patients (Endo et al., 2005; Fransen et al., 2002; Hawkes et al., 2006; Schroder & Erlandsen, 1993). However, one previous study (Lieberman & Lieverman, 2004) found no difference in mortality and an earlier Finnish study reported higher mortality among female patients (Nurmi-Lüthje et al., 2015). Notably, only a few of these studies focused on home-dwelling patients (Endo et al., 2005; Fransen et al., 2002; Hawkes et al., 2006) as in our study. In these three studies, the statistical methods differed from our direct comparison between male and female sex as they did not take into account other factors that affect mortality using either regression analysis or generalized estimating equations. This makes it difficult to compare them to our study. The patients were also generally older in these earlier studies, i.e. 60 years old (Fransen et al., 2002) or 65 years old (Endo et al., 2005; Hawkes et al., 2006) or older.

Because of the difference in age between the men and women in this study, we also conducted a Cox regression analysis on survival and found that age, ASA score and prefracture ADL score were independent risk factors for mortality. Sex alone did not predict mortality. Previous studies reported that the prefracture risk factors

for post-fracture mortality include comorbidities (Endo et al., 2005), ASA score (Endo et al., 2005; Swanson et al., 1998) and age (Endo et al., 2005); our findings are consistent with most of these studies. Men have often been reported to have a higher ASA rating or preoperative risk, suggesting that they have more severe medical comorbidities at the time of surgery than women (Diamond, Thornley, Sekel & Smerdely, 1997; Fisher et al., 1991). Men have also been reported to have a higher risk of postoperative complications (Endo et al., 2005). Myers et al. (1991) found that men were 10 times more likely to develop pneumonia than women. Some studies have reported that male sex is an independent factor for mortality after surgery for hip fracture in home-dwelling patients. Endo et al. (2005) conducted a study of 983 independently-living hip fracture patients with one year of follow-up and reported an increased risk of death among men after considering age, ASA rating, comorbidities and postoperative complications. Similarly, Fransen et al. (2002) studied patients age 65 years or older and concluded that male sex was a risk factor for mortality after taking into account baseline characteristics; these authors noted that the mostly two-level measurement (diseases and function often reported as yes-no answers instead of larger rating scale) of prefracture health status may have overestimated the effect of male gender on mortality. Hawkes et al. (2006) also found higher mortality in previously community-dwelling male patients one year post-fracture. Our Cox regression analysis results suggested the opposite, indicating that other pre-existing factors explain the gender differences rather than gender itself, a view that has been proposed by some earlier studies (Aharonoff et al., 1997; Jensen, 1984). The reasons underlying the conflicting results remain unclear, but they may be related to the use of different covariates in the analyses as well as differences in inclusion criteria or differences in postoperative rehabilitation that were not controlled for in the analysis.

There were no major differences in functional recovery between men and women. Male patients had better outcomes for mobility-requiring tasks and for walking, while female patients had better results for housework-related tasks. Quite often the differences were present before the fracture. It seems likely that these differences in specific ADL functions may be due to conformity to traditional gender roles that are imposed by society rather than to better physical function per se. Men seemed to have significantly better walking ability than women even before the fracture. We found no differences between men and women in terms of the change in walking ability from before fracture versus one year after. Our findings are in line with numerous earlier studies that found no significant differences in functional recovery between men and women (Beaupre, Carson,

Noveck & Magaziner, 2015; Endo et al., 2005; Hawkes et al., 2006; Lieberman & Lieverman, 2004; Penrod et al., 2008). At least one study found that female gender was a risk factor for lower functional recovery after hip fracture (Alegre-López, Cordero-Guevara, Alonso-Valdivielso & Fernández-Melón, 2005). It has been suggested that patients who survive the initial post-fracture period are similar in terms of the factors that influence functional status in the later post-fracture period (Penrod et al., 2008).

We observed no differences in residential status between men and women after the fracture. After 12 months, approximately 80% of both male and female patients were able to live independently or in sheltered housing that was comparable to living at home. The ability to live independently requires a certain level of mobility and function, which explains the similar results in both residential status as well as mobility and ADL function. It was reported previously that hip fracture significantly increases the risk of being institutionalized regardless of gender (Fransen et al., 2002), with age, low level of mobility and dementia identified as known risk factors for institutionalization (Vochteloo et al., 2012). While some studies have reported a higher risk of institutionalization in men (Fransen et al., 2002; Holt et al., 2008), others found no difference between men and women (Beaupre et al., 2015; Alegre-López et al., 2005; Vochteloo et al., 2012). A study by Holt et al. (2008) conducted in Scotland found that men and women were similar in their ability to return home at a 120-day follow-up, but they also found that men had a greater risk of institutionalization when the prefracture characteristics were considered. We did not consider prefracture characteristics in our direct chi-square tests, making it hard to compare their study with ours; in addition, in the Scottish study, only two-thirds of the patients were living at home prior to hip fracture. Vochteloo et al. (2012) studied the risk factors for failure to return to the prefracture place of residence and found that female sex was associated with higher risk at discharge but that there were no differences between men and women 3 and 12 months later. However, the authors noted that the data involving residential status was greatly limited (66 patients at the 12-month follow-up). Fransen et al. (2002) compared previously community-dwelling hip fracture patients to randomly selected controls and found that hip fracture increased the risk of institutionalization and mortality in both men and women, but the effect was markedly greater in men. However, the study used institutionalization and mortality rate as a single variable, so it may not be comparable to other studies. In general, it is difficult to compare studies in this field in terms of determining the risk of

institutionalization because there is great variation regarding the methods that are used and in the study populations.

These results show that home-dwelling men and women have similar risk of mortality, institutionalization and functional decline after hip fracture. High ASA score, age and low prefracture functional status predict mortality. More attention should be directed towards patients with these attributes in order to minimize poor treatment outcomes.

## 6.4 Strengths and limitations of the study

There are several strengths in this study. The major strength was a clear, randomized, controlled trial design with conventional hip fracture treatment in Finland as a control. The outcome factors were recorded in detail, especially ADL functions and place of residence, allowing us to observe even small changes in functional recovery. Although we did not validate the tests used in our study, they have been widely applied as outcome factors in many earlier trials. We also recorded a wide range of data during admission regarding patient prefracture health, functional abilities, and living status. The rehabilitation settings were also well-defined. We collected data concerning mobilization and training exercises during the rehabilitation periods, which allowed us to reflect the underlying causes of different outcomes between patient groups after post-fracture rehabilitation. Our study population was also sufficiently large, with more than 500 patients, and only three patients were lost during the follow-up.

One weakness of our study was that the patients' residences influenced their randomization to rehabilitation groups, potentially affecting the results. This effect was the result of administrative factors because the geriatric rehabilitation group in the city of Oulu accepted only residents of the city, while healthcare centre hospitals could take only patients in their respective municipalities. However, we found no significant differences regarding health and function in the prefracture status of the patients between different rehabilitation groups. We also compared patients separately based on the place of residence and found on effect on the results. It should also be noted that the place of residence affected economic costs. Some healthcare services had higher prices in the city than in the surrounding areas (included the healthcare centre hospital prices), resulting in higher costs in the specialized rehabilitation groups. However, this distinction actually highlights rather than diminishes our results because specialized rehabilitation settings were still less costly than conventional treatment.

There was sometimes a great difference in the rehabilitation unit capacities, particularly among patients undergoing geriatric rehabilitation. These patients often had to wait in the primary hospital before being admitted to the rehabilitation centre, which increased costs in this group. However, although these factors influenced the results by increasing the costs of specialized rehabilitation modalities, they again highlight our findings because conventional treatment was more expensive than physical rehabilitation treatment.

The method we used to evaluate hip fracture treatment costs (by using DRG prices) should also be considered. In general, the treatment costs can be calculated from many different viewpoints, namely the patient, the hospital, or the third-party payer (such as health maintenance organization). Usually however, the expenditures are calculated from a societal perspective (Haentjens et al., 2005), and the use of national DRG prices is a common approach for determining the approximate costs in the use of healthcare services. Therefore, our study methods are line with earlier studies. Few of these earlier studies have calculated the treatment costs more accurately by recording the amount and type of specific procedures, such as time used in operation room, need for healthcare personnel, and the use of medicine in the hospital, but these studies focus on the allocation of resources from the point of view of the hospital instead of general costs of treatment.

Another limitation of our study is that there were more women than men, with a 4 to 1 ratio. This skew is common in hip fracture studies because most hip fractures occur in women. Although not a particular weakness, our results for these home-dwelling patients may not be generalizable to patients in institutions.

It should also be noted that the present study material is quite old, which raises the question how these findings reflect current practice. Over the years, hip fracture rehabilitation practices in Finland have changed very little. The greatest change has been that the stay in the primary/orthopaedic ward has shortened. Although some recent interventions (such as Lonkkaliukumäki-project) regarding overall hip fracture treatment pathway have shown promising outcomes, most rehabilitation is still conducted in healthcare centre hospital wards, with planned and supported discharge later to home where outpatient rehabilitation can be continued.

## 6.5 Summary and future aspects for studies in rehabilitation after hip fracture

This study found superior clinical outcomes in specialized, physically oriented rehabilitation (focused especially on mobilization therapy) by reducing mortality

and increasing the capacity for independent living, in contrast to conventional rehabilitation. Rehabilitation conducted in a geriatrically oriented unit also resulted in improvements regarding short-term ability to live in the patient's own home after the fracture. Although some earlier studies showed that more intensive mobilization, physiotherapy, and occupational therapy may improve short-term functional independence and earlier ambulation, our study is the first to report a significant improved survival among patients. Thus, we can conclude that an intensive rehabilitation and mobilization strategy is recommended after hip fracture.

We also found that although rehabilitation was more costly in specialized rehabilitation units, the total costs at one year after the fracture were smaller in patient groups treated in a physically oriented rehabilitation unit compared to conventional treatment in Finland. This cost was mostly attributed to the fact that patients who received conventional rehabilitation needed more help from their relatives after discharge. This factor, when proportioned to a regular home aide's salary, significantly increased the total expenditures. Similarly, earlier studies have suggested that cost-reduction strategies including early discharge from the hospital may save costs only for the hospital and shift these costs elsewhere, generating no additional benefits.

The results of this study also suggest that men and women recover similarly after hip fracture. Poor prefracture functional status, high age, and poor fitness to surgery (ASA grade) were risk factors for mortality during the year after the fracture. Earlier studies have reported that men have a higher risk of mortality and functional decline than women after sustaining a fracture, while other studies have suggested that the sex differences are explained by differences in prefracture health. Our findings suggest the latter, as we found no major differences in outcome between male and female patients, not even when taking into account other risk factors for poor recovery.

As the population ages and elderly hip fractures become more frequent, various rehabilitation practices have been studied in the search for an optimal treatment and rehabilitation method. In recent years, home-based hip fracture rehabilitation has gained more attention, but knowledge of this area is quite limited, with few randomized controlled trials evaluating it. Early supported discharge and subsequent rehabilitation at home could potentially reduce overall healthcare costs and possibly result in similar outcomes compared to institutional rehabilitation. Thus, one future research recommendation is to evaluate the role and outcomes of hip fracture rehabilitation involving early discharge and home-based rehabilitation compared to usual care in institution.

Another potential aspect for future research would be the identification and proper individualized rehabilitation of high-risk patients in danger of losing remaining mobility and facing permanent institutionalization, in order to minimize these worst outcomes. Most studies of hip fracture rehabilitation interventions tend to centre on relatively healthy, independently living, elderly patients (usually over age 50 or 65 years), while high-risk patients living in nursing homes have attracted less attention. Functional recovery after hip fracture tends to follow three distinctive paths, with a minority of patients having poor outcomes. These patients could potentially benefit most from multidisciplinary, intensive rehabilitation.

# 7 Conclusions

1. Physical rehabilitation reduced mortality. Physical and geriatric rehabilitation significantly improved the capacity for independent living (at short term) after 4 months, especially among patients with femoral neck fracture, but this effect could not be seen after 12 months.
2. Physical rehabilitation was significantly more cost-effective than routine treatment when considering total costs during the year after the hip fracture. This finding was mainly attributed to less need for help at home after a rehabilitation period in physical rehabilitation group. The quality of life at one year after the fracture was considered to be better among patients in the physical rehabilitation group compared to the geriatric rehabilitation group and the control group patients.
3. Home-dwelling male and female patients recover similarly from hip fracture regarding functional status, residential status, and mortality. High age, ASA score, and poor prefracture function predict mortality after hip fracture.
4. Treatment after hip fracture surgery should include a sufficient amount of mobilization to be effective. Hospital-based hip fracture rehabilitation in Finland may not include enough mobilization, although there are recent local interventions aiming to improve the hip fracture care pathway. This finding should be considered in general rehabilitation practices and national guidelines.

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# Appendices

# Appendix I. Following are the SAHFE patient registration forms and the form for recording quantity and type of rehabilitation exercises

**S**tandardised
**A**udit of
**H**ip
**F**ractures in
**E**urope

**Primary questions – form 1**

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1. |__|__|__|-|__|__|__|__|__|__|__| **Country and hospital code**
   First 3 numbers are the countries international dialing code, then 6 numbers for the hospital code.

2. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **Patient ID number**
   Each hospital may choose their own ID number, e.g. social security number, hospital record number.
   Even if the patient is admitted later for a second fracture the same number is used.

3. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **SAHFE number** (Computer generated when form 1 is registered).

4. |__| **Side of fracture** 1=Left 2=Right (If simultaneous bilateral fracture, use 2 forms)

5. |__|__| / |__|__| / |__|__|__|__| **Date of fracture** (If not known, use "date of admission", form 1)

6. |__|__| / |__|__| / |__|__|__|__| **Date of birth** (eg. 25/06/1945)

7. |__| **Sex** 1=Male 2=Female

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8. |__|__| / |__|__| / |__|__|__|__| **Date of admission**

9. |__| **Admitted from** Choose the one option that best applies. For full explanation see on the back of this form.
   1=Own home 2=Sheltered housing 3=Institutional care 4=Nursing home
   5=Permanent hospital inpatient 6=Rehabilitation unit 7=Acute hospital 8=Other 9=Died

10. |__| |__| **Living alone** (A modification to this is available in the optional section)
    1.0=Yes 2.0=No 3.0=Institutional care (categories 3-7 above)

11. |__| **Walking** Refers to the patient's normal walking ability immediatly before the fracture occured
    1=Walked alone outdoors 2=Walked alone outdoors only if accompanied
    3=Walked alone indoors but not outdoors 4= Walked indoors only if accompanied 5=Unable to walk

12. |__| **Walking aids** Refers to the walking aids normally used before the fracture occured
    1=Can walk without aids 2=One aid (stick, crutch, tripod or hemiwalker)
    3= Two aids (stick, crutch, tripod or hemiwalker) 4= Frame (walking frame or rollator) 5=Wheelchair/bedbound

13. |__| **ASA grade**
    1=Completely fit and healthy, 2=Some illness but this has no effect on normal daily activity, that is an asymptomatic condition such as hypertension, 3=Symptomatic illness present, but minimal restriction on life, e.g. mild diabetes mellitus, 4=Symptomatic illness causing secere restriction, 5=Moribund

14. |__| **Type of fracture** (See figure on the back of this form)
    Choose the area of bone in which the main fracture line crossing femur is predominately found.
    1=Undisplaced intracapsular 2=Displaced intracapsular 3=Basocervical
    4=Trochanteric two fragments 5=Trochanteric multi-fragments 6=Subtrochanteric (any number of fragments)

15. |__| **Pathological fracture**
    1=No 2=Malignant secondary bone tumor 3=Malignant primary tumor
    4=Bone cyst 5=Paget's disease 6=Other (specify)

16. |__|__| / |__|__| / |__|__|__|__| **Date of operation** Leave blank only if not operated on

17. |__|. |__|__| **Primary operation** (A modification to this is available in the optional section)
    1=Single screw, pin or nail 2=Two screws, pins or nails 3=Three or more screws, pins or nails
    4= Single screw, pin or nail with side plate 5=Intramedullary nail 6=Hemiarthroplasty
    7=Total hip arthroplasty 8=Conservative 9=Other (specify)

18. |__|__| / |__|__| / |__|__|__|__| **Date of discharge or death from primary admission ward**
    Has any operation been performed? If yes, complete form 3 (questions 28-34) for each re-operation

19. |__| **Discharged to** (Code as question 9)

## Codes for ”Admitted from”

1=Own home. Independent living accomodation although the person may receive assistance from relatives and outside agencies at home. Own, rented house, family member’s home

2=Sheltered housing, warden-controlled accomodation, special flat. Partly independent living accomodation where major assistance is given.

3=Institutional care. Long term/permanent placement in a full service residential home, home for the elderly or infirm where meals are provided but the patient is mobile and generally able to carry out basic activities of daily living (dressing, washing, fedding, toileting). A social provision with minimum nursing output.

4=Nursing home. Long term/permanent placement in an institutional home which has provision of nursing facilities to provide assistance in the basic activities od daily living of dressing, washing and toileting.

5=Permanent hospital inpatient. Long term/permanent placement of a patient in hospital which has nursing and medical support and for which there are no plans for discharge

6=Rehabilitation unit. Short term/temporary placement in either a community rehabilitation unit, temporary nursing care, geriatric assessment unit, respite care, convalescent home.

7=Acute hospital. Short term/temporary placement.

8=Other (specify)

9=Died (only applies when answering questions 19, 34)

## Codes for ”Type of fracture”

1=Undisplaced intracapsular (subcapital or cervical). Garden grade 1 or 2

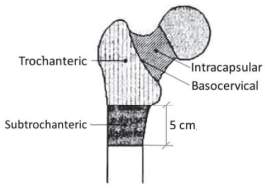
2=Displaces intracapsular (subcapital or cervical). Garden grade 3 or 4

3=Basocervical (basal)

4=Trochanteric two fragments (a two part fracture, stable fracture). Trochanteric fractures are also termed intertrochanteric or pertrochanteric fractures.

5=Trochanteric multi-fragments (the extra fragments are generally the greater or lesser trochanter or both)

6=Subtrochanteric (any number of fragments).



**S**tandardised
**A**udit of
**H**ip
**F**ractures in
**E**urope

**4 month assessment – form 2**

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1. |__|__|__|-|__|__|__|__|__|__|__| **Country and hospital code**
   First 3 numbers are the countries international dialing code, then 6 numbers for the hospital code.

2. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **Patient ID number**
   Each hospital may choose their own ID number, e.g. social security number, hospital record number.
   Even if the patient is admitted later for a second fracture the same number is used.

3. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **SAHFE number** (Computer generated when form 1 is registered).

4. |__| **Side of fracture** 1=Left 2=Right (If simultaneous bilateral fracture, use 2 forms)

5. |__|__| / |__|__| / |__|__|__|__| **Date of fracture** (If not known, use "date of admission", form 1)

6. |__|__| / |__|__| / |__|__|__|__| **Date of birth** (eg. 25/06/1945)

7. |__| **Sex** 1=Male 2=Female

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20. |__|__| / |__|__| / |__|__|__|__| **Date of assessment**

21. |__| **Assessment done by**
    1=Face to face interview by patient
    2=Face to face interview with care/relatie friend
    3=Phone to patient
    4=Phone to carer/relative/friend
    5=Postal questionnaire completed by patient
    6=Postal questionnaire completed by carer/relative/friend
    7=Other (specify)

22. |__| **Residential status** Choose the one option that best applies. For full explanation see on the back of this form
    1=Own home
    2=Sheltered housing
    3=Institutional care
    4=Nursing home
    5=Permanent hospital inpatient
    6=Rehabilitation unit
    7=Acute hospital
    8=Other
    9=Died

23. |__| **Locomotor ability** Refers to the patient's normal walking ability at 4 months after the fracture occured
    1=Walked alone outdoors
    2=Walked alone outdoors only if accompanied
    3=Walked alone indoors but not outdoors
    4= Walked indoors only if accompanied
    5=Unable to walk

24. |__| **Walking aids** Refers to the walking aids normally used at 4 months after the fracture occured.
    1=Can walk without aids
    2=One aid (stick, crutch, tripod or hemiwalker)
    3= Two aids (stick, crutch, tripod or hemiwalker)
    4= Frame (walking frame or rollator)
    5=Wheelchair/bedbound

25. |__| **Pain at the hip** (Choose the one most relevant option)
    1=The pain in my hip is severe and spontaneous. I experience it even when I am not moving.
    2= The pain in my hip is severe when I attempt to walk and prevents all activity.
    3=The pain in my hip is tolerable, permitting limited activity.
    4=The pain in my hip occurs only after some activity and diseappears quickly with rest.
    5=The pain in my hip is slight and intermittent. I experience pain when starting to walk but the pain gets less with normal activity
    6=I experience no pain in my hip.
    7=Unable to answer.

26. **Type of stay /re-admissions**
    For the type of stay, use options in questions 9 (see the back of this form). For days, give number of days stay at each residential category from the time of discharge from primary admission up to 120 from fracture. For reason, use the following codes.
    1=Surgical complications requiring re-operation (ensure questions 28-34 have been completed for each re-operation).
    2=Surgical complications not requiring re-operation.
    3=Medical complications related to hip fracture.
    4=Failure to manage at the place of origin due to hip fracture
    5=Admitted for reasons not related to hip fracture.
    6=Return to place of origin
    7=Unknown/not stated.

    1: type |__|, days |__|__|__| and reason |__|
    5: type |__|, days |__|__|__| and reason |__|
    2: type |__|, days |__|__|__| and reason |__|
    6: type |__|, days |__|__|__| and reason |__|
    3: type |__|, days |__|__|__| and reason |__|
    7: type |__|, days |__|__|__| and reason |__|
    4: type |__|, days |__|__|__| and reason |__|
    8: type |__|, days |__|__|__| and reason |__|

27. |__|__| / |__|__| / |__|__|__|__| **Death** (If death within 4 months of fracture give date of death.)

## Codes for ”Admitted from”

1=Own home. Independent living accomodation although the person may receive assistance from relatives and outside agencies at home. Own, rented house, family member’s home

2=Sheltered housing, warden-controlled accomodation, special flat. Partly independent living accomodation where major assistance is given.

3=Institutional care. Long term/permanent placement in a full service residential home, home for the elderly or infirm where meals are provided but the patient is mobile and generally able to carry out basic activities of daily living (dressing, washing, fedding, toileting). A social provision with minimum nursing output.

4=Nursing home. Long term/permanent placement in an institutional home which has provision of nursing facilities to provide assistance in the basic activities od daily living of dressing, washing and toileting.

5=Permanent hospital inpatient. Long term/permanent placement of a patient in hospital which has nursing and medical support and for which there are no plans for discharge

6=Rehabilitation unit. Short term/temporary placement in either a community rehabilitation unit, temporary nursing care, geriatric assessment unit, respite care, convalescent home.

7=Acute hospital. Short term/temporary placement.

8=Other (specify)

9=Died (only applies when answering questions 19, 34)

**S**tandardised
**A**udit of
**H**ip
**F**ractures in
**E**urope

**Re-operation – form 3**

---

1. |__|__|__|-|__|__|__|__|__|__|__| **Country and hospital code**
   First 3 numbers are the countries international dialing code, then 6 numbers for the hospital code.

2. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **Patient ID number**
   Each hospital may choose their own ID number, e.g. social security number, hospital record number.
   Even if the patient is admitted later for a second fracture the same number is used.

3. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **SAHFE number** (Computer generated when form 1 is registered).

4. |__| **Side of fracture** 1=Left 2=Right (If simultaneous bilateral fracture, use 2 forms)

5. |__|__| / |__|__| / |__|__|__|__| **Date of fracture** (If not known, use "date of admission", form 1)

6. |__|__| / |__|__| / |__|__|__|__| **Date of birth** (eg. 25/06/1945)

7. |__| **Sex** 1=Male 2=Female

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28. |__|__| / |__|__| / |__|__|__|__| **Date of admission**
    IF already in hospital and not discharged since primary admission use same date as question 8

29. |__| **Admitted from** Choose the one option that best applies. For full explanation see on the back of this form.
    1=Own home 2=Sheltered housing 3=Institutional care 4=Nursing home
    5=Permanent hospital inpatient 6=Rehabilitation unit 7=Acute hospital 8=Other 9=Died

30. |__|__| / |__|__| / |__|__|__|__| **Date of re-operation**

31. |__| **Type of re-operation**
    1=Removal implant 2=Hemiarthroplasty 3=Total hip arthroplasty
    4=Re-osteosynthesis (revision with internal fixation) 5=Girdlestone/excision arthroplasty
    6=Drainage haematoma or infection 7=Reduction dislocation 8=Other (specify)

32. |__|__| **Reason for re-operation**
    1=Fracture displacement
    2=Loss of position of osteosynthesis material without fracture displacement
    3=Additional fracture around the implant
    4=Non-union (pseudoarthrosis). Non-union normally takes 3-6 months to occur so fracture displacement or loss of position of implant before this time should normally be coded as 1 or 2
    5=Femoral head necrosis (segmental collapse, avascular necrosis in a fracture that has healed)
    6=Local pain or tenderness at operation site or prominent implant causing discomfort with healed fracture
    7=Wound infection
    8=Wound haematoma
    9=Dislocation of athroplasty
    10=Breakage of the implant
    11=Dissembling of the implant
    12='Elective' removal of the implant. Fracture healed and no significant symptoms
    99=Other (specify)

33. |__|__| / |__|__| / |__|__|__|__| **Date of discharge or death in hospital**

34. |__| **Discharged to** (code as question 29)

## Codes for ”Admitted from”

1=Own home. Independent living accomodation although the person may receive assistance from relatives and outside agencies at home. Own, rented house, family member’s home

2=Sheltered housing, warden-controlled accomodation, special flat. Partly independent living accomodation where major assistance is given.

3=Institutional care. Long term/permanent placement in a full service residential home, home for the elderly or infirm where meals are provided but the patient is mobile and generally able to carry out basic activities of daily living (dressing, washing, fedding, toileting). A social provision with minimum nursing output.

4=Nursing home. Long term/permanent placement in an institutional home which has provision of nursing facilities to provide assistance in the basic activities od daily living of dressing, washing and toileting.

5=Permanent hospital inpatient. Long term/permanent placement of a patient in hospital which has nursing and medical support and for which there are no plans for discharge

6=Rehabilitation unit. Short term/temporary placement in either a community rehabilitation unit, temporary nursing care, geriatric assessment unit, respite care, convalescent home.

7=Acute hospital. Short term/temporary placement.

8=Other (specify)

9=Died (only applies when answering questions 19, 34)

**S**tandardised **A**udit of **H**ip **F**ractures in **E**urope FORM 4

ABILITIES OF PATIENT IMMEDIATLY PRIOR TO THE FALL
FILLED IN |__|__| / |__|__| / |__|__|__|__|

2. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **Patient ID number**

4. |__| **Side of fracture** 1=Left 2=Right (If simultaneous bilateral fracture, use 2 forms)

5. |__|__| / |__|__| / |__|__|__|__| **Date of fracture** (If not known, use "date of admission")

7. |__| **Sex** 1=Male 2=Female

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41. |__| **Occurence for registration** 1=Prior 2=4 months follow-up 3=12 months follow-up

40. |__| **SPMSQ-test** (score 0-10)

1. State age (1 point for exact age only)

2. Give current time (1 point only if correct to nearest hour)

3. Address to remember then repeat at the end of the test (Use a three point address e.g. 42 Alexandria Road, Birmingham to recall. Score 1 if recalls correctly near beginning of test and at end of test)

4. State present year (1 point for current year only)

5. Name of institution to which the patient has been admitted. (Score 1 only if exact hospital name, 'in hospital' is insufficient)

6. Recognition of two people (score 1 if roles of two people are correctly recognized e.g. nurse, doctor)

7. State date of birth (score 1 for correct date and month, year not required)

8. Year of the start of the first or Second World War. (Score 1 for correct year of start or finish of either war i.e. 1914, 1918, 1939, 1945. Only one year required).

9. Name of present monarch or head of state. (Score 1 for current monarch/head of state only)

10. Count backwards 20-1. (Score 1 if no mistakes or subject corrects themselves spontaneously)

41. |__| **Dressing**

1. Able to dress completely without help

2. Needs some help with buttons or zippers

3. Needs assistance with shoes and stockings

4. Needs assistance with up to 3 items

5. Needs to be dressed by others

42. |__| **Bathing or taking a shower**

1. Able to bath or shower

2. Needs some help in washing a single part of the body, such as back or feet, or needs a bystander

3. Needs assistance in getting in and out of the bathtub

4. Needs assistance in washing one or several parts of the body

5. Always needs to be bathed by others

43. |__| **Feeding** (not cooking or preparing meals)

1. Able to cut food and eat without help

2. Needs help from others to cut hard food

3. Needs assistance in handling food, e.g. buttering bread

4. Needs a lot of help to eat

5. Has to be completely fed by others

44. |__| **Toileting**

1. Able to get to the toilet, get on and off, manage clothing, etc.

2. Needs assistance in getting to and from toilet

3. Needs assistance in getting on and off the toilet and adjusting clothing

4. Needs assistance in cleaning organs of excretion

5. Wears pads or uses a catheter or bedpan at all times

45. |__| **Shopping**

1. Able to do all shopping without assistance

2. Needs assistance in getting to or returning from shops, can only shop independently for small purchases or is able to shop but gets someone else to do it

3. Needs assistance with selecting shopping, is unsure what he/she needs to buy or must always be accompanied due to physical, psychological or visual impairment

4. Needs help with two or more tasks associated with grocery shopping

5. Completely unable to shop

46. |__| **Housework**

1. Able to manage housekeeping alone or with only occasional assistance

2. Able to perform all home maintenance tasks but needs some assistance with, e.g., lifting or is able to do housework but has someone else do it

3. Able to perform only light daily tasks

4. Needs assistance with light household duties

5. Unable to do housework

47. |__| **Laundry**

1. Able to do laundry

2. Needs assistance in doing or hanging up laundry or is able to do it but somebody else does it or would be able to do laundry if there were a machine at home

3. Able to wash delicates and personals by hand or needs some assistance in loading or unloading the machine

4. Needs a lot of help to do laundry

5. Unable to do laundry

48. |__| **Food preparation**

1. Able to prepare meals

2. Able to prepare meals but someone else does it

3. Able to prepare a small meal or sandwich if supplied with ingredients

4. Able only to reheat meals

5. Must have all meals prepared

49. |__| **Banking and finances**

1. Able to manage all financial matters

2. Needs assistance in going to bank or does billing and banking by mail or cannot go to bank but is able to perform all other financial tasks or is able to do it but someone else does it

3. Able to manage day-to-day purchases, but needs assistance with banking and major purchases

4. Needs to be taken to the bank and requires someone to handle the transactions and all other financial needs

5. Unable to handle financial matters

50. |__| **Use of transportation**

1. Able to travel independently on public transportation or drive a car.

2. Arranges his/her own travel by taxi but does not use bus or train

3. Must always be accompanied due to physical, psychological or visual impairment

4. Travels in taxi or car only with assistance

5. Unable to travel

51. |__|__| **ADL-score** (Calculate the sum of questions 41.-50. if all questions are answered)

52. |__| **Social support and assistance**

1=Needs no assistance in normal activities od daily living (shopping, coorking, dressing, housework)

2=Needs some assistance in a few aspects of the more strenuous activities of daily living (eg. heavy shopping, demanding housework)

2=Needs lots of assistance in a few aspects of the more strenuous activities of daily living (eg. heavy shopping, demanding housework)

4=Needs assistance in washing and dressing, but can get to toilet independently

5=Needs assistance in toileting and feeding.

53. |__| **Social support and assistance provided by**

1=No assistance necessary.

2=Spouse.

3=Other relatives.

4=Spouse and other relatives.

5=Paid help either private provided or from the state.

6=Spouse and paid help.

7=Paid help and relatives.

8=Spouse, relatives and paid help.

54. |__| **Social support is economically provided by**
1=Privately paid for (informal care)
2=Provided by the state (formal care)
3=None received

55. |__| **Hours of social support received** (Average hours per wrrk of social services/home help received.)

56. **Psychological state**

Listed below are some statements about how people feel in their daily life. Please fill in the box under whichever answer (1=yes or 2=no) was most true for the patient before they broke their hip.

|__| 1. Do you enjoy the things you have used to? 1=yes 2=no

⌊__⌋ 2. Do you feel yourself lonely? 1=yes 2=no

⌊__⌋ 3. Do you find hard to make contact to people? 1=yes 2=no

⌊__⌋ 4. Do you feel that there is nobody to be close to? 1=yes 2=no

⌊__⌋ 5. Do you feel that you are burden to people? 1=yes 2=no

⌊__⌋ 6. Do you enjoy a good book, radio or TV program? 1=yes 2=no

57. ⌊__|__|__⌋ **Blood haemoglobin** (Hb) (g/l)
58. ⌊__|__|__⌋ **Serum creatinine** (μmol/l)
59. ⌊__|__⌋ **Serum albumen** (g/l)
60. ⌊__.__⌋ **Height** (m)
61. ⌊__|__|__⌋ **Weight** (kg)
62. ⌊__|__.__⌋ **Body mass index, BMI**
63. ⌊__|__⌋ **Age of menarche**
64. ⌊__|__⌋ **Age of menopause**

**Concomitant diseases** (In following questions fill in **1=yes, 2=no**)

65. ⌊__⌋ **Cardiovascular disease**
66. ⌊__⌋ **Previous stroke**
67. ⌊__⌋ **Respiratory disease**
68. ⌊__⌋ **Renal disease**
69. ⌊__⌋ **Diabetes mellitus**
70. ⌊__⌋ **Rheumatoid disease**
71. ⌊__⌋ **Parkinson's disease**
72. ⌊__⌋ **Malignant disease**
73. ⌊__⌋ **Paget's disease**
74. ⌊__⌋ **Smoking**
75. ⌊__⌋ **On oral steroids**
76. ⌊__⌋ **Falls during last year before hip fracture / during 4 months / one year follow-up**

    1=No

    2=Up to three falls

    3=More than three falls

78. ⌊__⌋ **Fear of fall**

    1=No

    2=Yes

**S**tandardised **A**udit of **H**ip **F**ractures in **E**urope FORM 5

ADDITIONAL DETAILS OF THE INJURY AND TREATMENT

FILLED IN |__|__| / |__|__| / |__|__|__|__|

2. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **Patient ID number**

4. |__| **Side of fracture** 1=Left 2=Right (If simultaneous bilateral fracture, use 2 forms)

5. |__|__| / |__|__| / |__|__|__|__| **Date of fracture** (If not known, use "date of admission")

7. |__| **Sex** 1=Male 2=Female

---

80. |__| **Place of fall**

1=At own home.

2=Indoors but not at own home or hospital.

3=Outdoors.

4=Hospital, institution, sheltered housing.

5=No fall (a spontaneous fracture, which occured without injury).

81. |__| **Other coexistent fracture(s)**

1=Upper limb fracture

2=Additional lower limb fracture.

3=Other upper and lower limb fractures.

4=Other fracture not of limbs.

5=Fracture of limb(s) and other areas of body.

82. |__|__| **Time of admission** (to the nearest hour, 24-hour clock)

84. |__|__| **Time of occurence of hip fracture** (to the nearest hour, 24-hour clock)

85. |__|__| **Time of start of operation** (to the nearest hour, 24-hour clock)

86. |__.__| , |__.__| , |__.__| **Delay to operation** (If the patient waited more than 24 hours from the time the fracture was diagnosed to having their operation, indicate the cause of the delay. If more than 1 reason for the delay, you can fill up to 3 reasons.)

1.0=No delay (i.e. operation within 24 hours after the fracture).
2.0=Prior to admission to orthopaedic ward.
3.0=To establish/confirm the diagnosis (specify or classify as below 3.1-3.4).
3.1=Diagnosis confirmed by later review.
3.2=Diagnosis confirmed by repeat x-rays.
3.3=Diagnosis confirmed by bone scan.
3.4=Diagnosis confirmed by CT scan.
3.9 Other method of confirming diagnosis, specify: _____
4.0=Administrative delay, specify: _____
4.1=Lack of hospital bed on orthopaedic ward.
4.2=Lack of available theatre space.

4.3=No surgeon available.
4.4=No anaesthetist available.
4.9=Other cause delay, specify: _____
5.0=The fracture was initially treated conservatively.
6.0=Operation delayed as patient was medically unfit.
6.1=Electrolyte imbalance.
6.2=Diabetes mellitus to stabilise.
6.3=Chest condition (treatment of).
6.7=Cardiac arrhytmia (treatment of).
6.8=Gastrointestinal bleed.
6.9=Other, specify:_____
7.0=To assess medical state (get results of investigations etc.)
8.0=No reason apparent.

87. |__| **Grade of surgeon** (Indicate the grade of surgeon who performed the operation. A 'fully qualified' surgeon refers to one who has completed their orthopaedic training. IF trainee surgeon was assisting a fully qualified surgeon when it is classified as 1).

1=Qualified/specialist

2=Staff grade surgeon/associate specialist (permanent member of the hospital staff but below level of category 1)

3=A trainee surgeon on a training scheme.

4=Other trainee surgeon but on on a trainee scheme.

5=Locum or temporary surgeon.

6=Other, specify: _____

88. |__| **Type of surgeon** (Specialty of operating surgeon. Choose the most appropriate category for the surgeon mentioned in question 87. An orthopaedic surgeon refers to one who does elective orthopaedic and emergency orthopaedic surgery, whilst a general surgeon is the one who specialises in another branch apart from orthopaedics. A traumatologist only does emergency accident/trauma surgery.)

1=Orthopaedist/orthopaedic.

2=Traumatologist.

3=General surgeon.

4=Other, specify: _____

89. |__| **Grade of anaesthetist** (Indicate the grade of anaesthetist who performed or who directly supervised the anaesthetic.)

1=Qualified/specialist

2=Staff grade surgeon/associate specialist (permanent member of the hospital staff but below level of category 1)

3=A trainee anaesthetist

4=An anaesthetic technician.

5=Locum or temporary anaesthetist.

6=Other, specify: _____

90. |__|__|__| **Length of surgery** (From the start to finish of the operative procedure (knife to skin time to closure of the wound) in minutes.)

91. |__|__|__| **Length of surgery and anaesthetic time** (This should include the time from the start to finish of the anaesthetic. IT can be estimate from the anaesthetic record or theatre records. Record in minutes.)

92. |__| **Type of anaesthetic**

1=General

2=Spinal or epidural

3=Local blocks and infiltration

4=Other, specify:_____

93. |__|__|__|__|__| **Operative blood loss** (ml)

94. |__|__|__|__|__| **Volume of packed blood transfused prior to surgery** (ml)

95. |__|__|__|__|__| **Volume of packed blood transfused in the 5 days from surgery** (ml)

96. |__|__|__| **Haemoglobin, Hb, immediatly after surgery** (g/l)

97. |__|__|__| **Haemoglobin, Hb, day one after surgery** (g/l)

98. |__| **Cement used to fix fracture of prosthesis** 1=yes 2=no

99. |__| **Surgical approach for arthroplasty**

1=Anterior

2=Anterolateral

3=Lateral with osteotomy

4=Posterior

100. |__| **Use of growth factor** 1=yes 2=no

101. |__.__| , |__.__| , |__.__| **Thromboembolic prophylaxis used** (Detail which if any forms of thromboembolic prophylaxis were used.)

1.0=Mechanical, specify if not 1.1-1.3: _____

1.1=Graduated stockings below knee.

1.2=Graduated stockings above knee.

1.3=Foot pump

1.4=Pneumatic calf compression.

2.0=Heparin (other or unknown type).

2.1=Conventional heparin

2.2=Low-molecular weight heparin.

3.0=Warfarin

4.0=Dextran.

5.0=Aspirin.

6.0=No prophylaxis used.

7.0=Other, specify: _____

102. ⌊__⌋ **Commencement of thromboembolic prophylaxis.**

1.0=Before surgery.

1.1=Within 6 hours of admission but before surgery.

1.2=Within 12 hours of admission but before surgery.

1.3=Within 24 hours of admission but before surgery.

1.4=More than 24 hours of admission but before surgery.

2.0=After surgery.

2.1=Within 6 hours of after surgery.

2.2=Within 12 hours of after surgery.

2.3=Within 24 hours of after surgery.

2.4=More than 24 hours of after surgery.

103. ⌊__|__⌋ **Duration of thromboembolic prophylaxis in days**

104. ⌊__⌋ **Antibiotic prophylaxis** 1=yes 2=no

105. ⌊__|__⌋ **Time in days from surgery to mobilisation**

106. ⌊__|__⌋ **Time in days to be allowed to fully weight bear**

**S**tandardised **A**udit of **H**ip **F**ractures in **E**urope

FORM 6

ADDITIONAL DETAILS OF THE TYPE OF FRACTURE AND REDUCTION

FILLED IN |__|__| / |__|__| / |__|__|__|__|

2. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **Patient ID number**

4. |__| **Side of fracture** 1=Left 2=Right (If simultaneous bilateral fracture, use 2 forms)

5. |__|__| / |__|__| / |__|__|__|__| **Date of fracture** (If not known, use "date of admission")

7. |__| **Sex** 1=Male 2=Female

---

107. |__|__|__|__|__| **AO classification of all fractures**

108. |__| **Garden grade of intracapsular fracture**

109. |__| **Pauwels grade of intracapsular fracture**

110. |__| **Jensen & Michaelsen classification of trochanteric fracture**

111. |__|__|__| **Preoperative Garden alignment index on anterior-posterior radiograph** (degrees)

112. |__|__|__| **Preoperative Garden alignment index on lateral radiograph** (degrees)

113. |__| **Additional classification of intracapsular fractures**

1=Even fracture surfaces.

2=Rostiform, intended fracture surfaces.

3=One extra fragment

4=Several extra fragments.

5=Comminuted zone.

114. |__| **Singh grade of osteoporosis**

115. |__| **Osteoporosis as measued by dexa**

1=None.

2= < 1 standard deviation

3= < 2 standard deviation

4= < 3 standard deviation

116. |__|__|__| **Postoperative Garden alignment index on anterior-posterior radiograph** (degrees)

117. |__|__|__| **Postoperative Garden alignment index on lateral radiograph** (degrees)

ADDITIONAL DETAILS OF THE TYPE OF FRACTURE AND REDUCTION

FILLED IN |__|__| / |__|__| / |__|__|__|__|

2. |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__| **Patient ID number**

4. |__| **Side of fracture** 1=Left 2=Right (If simultaneous bilateral fracture, use 2 forms)

5. |__|__| / |__|__| / |__|__|__|__| **Date of fracture** (If not known, use "date of admission")

7. |__| **Sex** 1=Male 2=Female

---

119. |__| **Occurence for registration**

1=At discharge.

2=At 4 months follow-up.

3=At 12 months follow-up

120. |__| **Occurence of pressure sores on buttock or sacrum.**

1=None.

2=Non blanching erythema of intact skin. That is a red, violet area of skin that does not blanch when pressed, indicating that blood has escaped from capillaries into the institital tissues.

3=Partial thickness skin loss. The skin surface is broken resulting in an abrasion or crater.

4=Full thickness skin loss and extension into subcutaneous fat but not through underlying facia.

5=Extensive destruction involving damage to muscle, bone or tendon.

121. |__| **Occurence of pressure sores on heel**

1=None.

2=Non blanching erythema of intact skin. That is a red, violet area of skin that does not blanch when pressed, indicating that blood has escaped from capillaries into the institital tissues.

3=Partial thickness skin loss. The skin surface is broken resulting in an abrasion or crater.

4=Full thickness skin loss and extension into subcutaneous fat but not through underlying facia.

5=Extensive destruction involving damage to muscle, bone or tendon.

122. |__| **Occurence of pressure sores on any other area**

1=None.

2=Non blanching erythema of intact skin. That is a red, violet area of skin that does not blanch when pressed, indicating that blood has escaped from capillaries into the institital tissues.

3=Partial thickness skin loss. The skin surface is broken resulting in an abrasion or crater.

4=Full thickness skin loss and extension into subcutaneous fat but not through underlying facia.

5=Extensive destruction involving damage to muscle, bone or tendon.

**Occurence of complications** (In following questions use 1=yes, 2=no)

123. |___| **Chest infection** (Signs in chest and antibiotic treatment)
124. |___| **Cardian failure** (Necessitating treatment)
125. |___| **Deep vein thrombosis** (Confirmed by ultrasound of venography)
126. |___| **Pulmonary embolism** (Confirmed by lung scan or angiography)
127. |___| **Superficial wound infection** (Redness of the wound requiring antibiotics)
128. |___| **Deep wound infection** (Infection around the implant)
129. |___| **Wound haematoma** (Necessitating drainage)
130. |___| **Urine retention** (Necessitatin catheterisation)
131. |___| **Urine infection** (Confirmed by culture)
132. |___| **Acute renal failure** (Doubling of serum urea or creatininine)
133. |___| **Gastrointestinal haemorrhage** (Haematemesis or maelena)
134. |___| **Myocardial infarctation** (Changes in ECG and clinical features)
135. |___| **Cerebrovascular accident**
136. |___| **Other, specify:**_____

## KUNTOUTTAVAN HOITOTYÖN SEURANTALOMAKE

**POTILASTARRA** **(LONKKAMURTUMAPOTILAASTA)** **HOITOPAIKKA**_____

| PVM | APUVÄLINE | KUNTOUTTAVA HOITOTYÖ | AIKA/MIN | AMMATTI-NIMIKE | LÄÄKÄRIN KÄYNT POTILAAN LUONA MINUUTTEJA | LABORATTUTKM NIMI/KPL | RTGTUTKM NIMI/KPL | HUOMIOI-TAVAA |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

# Appendix II. Following are the forms used in cost-benefit analysis (in Finnish)

COST BENEFIT ANALYYSI

Lomake 8

Potilas tarra

1. |__|__|__|__|__|__|--|__|__|__|__| Henkilötunnus

A. Base line

137. |__|__|__| Montako terveyskeskuskäyntiä viimeisen 6 kuukauden aikana

138. |__|__|__| Montako käyntiä yksityislääkärillä viimeisen 6 kuukauden aikana

Seuraavaan merkitään kaikki sairaalahoidot viimeisen 6 kuukauden aikana

1. Terveyskeskussairaala
2. Aluesairaala
3. Yksityissairaala
4. Keskussairaala

| | Sairaalan nimi | | Päivien lukumäärä |
|---|---|---|---|
| 139. |__| _____ | 145. |__|__| |
| 140. |__| _____ | 146. |__|__| |
| 141. |__| _____ | 147. |__|__| |
| 142. |__| _____ | 148. |__|__| |
| 143. |__| _____ | 149. |__|__| |
| 144. |__| _____ | 150. |__|__| |

151. Kotilääkitys _____
_____
_____
_____
_____
_____

B. Kustannukset OYS:ssa

152. |__|__|__| Leikkaussaliaika minuuteissa

153. |__|__|__| Implantti _____(kirjoitetaan nimi)

154. |__|__|__| Leikkaussalihoitaja (aika minuuteissa)

155. |__|__|__| Leikkaussalihoitaja (aika minuuteissa)

156. |__|__|__| Leikkaussalihoitaja (aika minuuteissa)

157. |__|__|__| Anestesiahoitaja (aika minuuteissa)

158. |__|__|__| Anestesiahoitaja (aika minuuteissa)

159. |__|__|__| Lääkintävahtimestari (aika minuuteissa)

160. |__|__|__| Anestesialääkäri (aika minuuteissa)

161. |__|__|__| Kirurgien lukumäärä

162. |__|__|__| Heräämöaika (minuuteissa)

163. |__|__|__| Tehohoito (tunteina)

C. Osastohoidon kustannukset

164. |__|__|__| Tromboosiprofylaksia_____
_____(lääkkeiden nimet, annokset ja hoidon kesto)

165. |__|__|__| Antibioottiprofylaksia_____

166. |__|__|__| Muu antibioottihoito_____

167. |__|__|__| Muut lääkkeet (nimet ja annokset)
_____
_____
_____

168. |__|__|__| RTG-tutkimukset
_____

169. |__|__|__| Laboratoriotutkimukset_____
_____

170. |__|__|__| Hoitajien suorittama mobilisaatio (minuutteina)

171. |__|__|__| Lääkintävoimistelijoiden suorittama kuntoutus (minuutteina)

172. |__|__|__| Perushoitajan suorittama kuntoutus (minuutteina)

173. |__|__|__| Sairaala-apulaisen suorittama kuntoutus (minuutteina)

_____

174. |__|__|__| Hotellikustannus (päivien lukumäärä)

D. Kuntoutusjakson kustannukset

175. |__|__| Lääkärikontaktit (kertoja viikossa)

176. |__|__| Kuntoutukseen käytetty aika (tunteja vikossa)

178. |__|__|__| RTG-tutkimukset_____

176. |__|__|__| Laboratoriotutkimukset_____

177. |__|__|__| Hotellikustannus (päivinä)

E. Terveyspalvelujen käyttö kuntoutuksen jälkeen

178. |__|__|__| Käynnit terveyskeskuksessa (yhteensä kertoja)

179. |__|__|__| Käynnit yksityislääkärillä (yhteensä kertoja)

180. |__|__|__| Lääkärin kotikäynnit (kertoja yhteensä)

181. |__|__|__| PKL-käynnit (kertoja yhteensä)

182.-193. Sairaalajaksot päivinä (lomakkeesta 2)

194.-202. Toimenpiteet (lomakkeista 3)

203. |__|__|__| Kotisairaanhoito (tuntia viikossa)

204. |__|__|__| Fysioterapia (tuntia viikossa)

F. SOSIAALIPALVELUJEN KÄYTTÖ

205. |__|__|__| Kuljetuspalvelut (taksit) (kertoja yhteensä)

206. |__|__|__| Ambulanssipalvelut (kertoja yhteensä)

207. |__|__|__| Kodinhoitopalvelut (tuntia viikossa)

G. Potilaan omaisten kustannukset

208. Matkakustannukset

209. Omaisten antama apu (tuntia viikossa)

---

Kuntoutukseen käytetty kokonaisaika / tunti

| | | |
|---|---|---|
| Kuntoutuksen suorittaja: | Fysioterapeutti | /min |
| | Kuntohoitaja | /min |
| | Sairaanhoitaja | /min |
| | Perushoitaja | /min |
| | Opiskelijat | /min |
| | Sairaala-apulainen | /min |

# Appendix III. ADL functions in different rehabilitation groups.

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Dressing | | | | | | | p=0.447 |
| *Able to dress completely without help* | 168 | 89,8 | 149 | 87,1 | 149 | 82,8 | |
| *Needs some help with buttons or zippers* | 4 | 2,1 | 5 | 2,9 | 10 | 5,6 | |
| *Needs assistance with shoes and stockings* | 7 | 3,7 | 4 | 2,3 | 5 | 2,8 | |
| *Needs assistance with up to 3 items* | 6 | 3,2 | 8 | 4,7 | 11 | 6,1 | |
| *Needs to be dressed by others* | 2 | 1,1 | 5 | 2,9 | 5 | 2,8 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| Dressing 4 months | | | | | | | p=0.708 |
| *Able to dress completely without help* | 107 | 59,8 | 91 | 59,5 | 81 | 50,9 | |
| *Needs some help with buttons or zippers* | 6 | 3,4 | 5 | 3,3 | 6 | 3,8 | |
| *Needs assistance with shoes and stockings* | 32 | 17,9 | 22 | 14,4 | 32 | 20,1 | |
| *Needs assistance with up to 3 items* | 19 | 10,6 | 16 | 10,5 | 18 | 11,3 | |
| *Needs to be dressed by others* | 15 | 8,4 | 19 | 12,4 | 22 | 13,8 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |
| Dressing 12 months | | | | | | | p=0,519 |
| *Able to dress completely without help* | 113 | 66,5 | 95 | 68,8 | 93 | 64,6 | |
| *Needs some help with buttons or zippers* | 9 | 5,3 | 2 | 1,4 | 3 | 2,1 | |
| *Needs assistance with shoes and stockings* | 17 | 10,0 | 15 | 10,9 | 22 | 15,3 | |
| *Needs assistance with up to 3 items* | 10 | 5,9 | 7 | 5,1 | 6 | 4,2 | |
| *Needs to be dressed by others* | 21 | 12,4 | 19 | 13,8 | 20 | 13,9 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| Bathing or showering | | | | | | | p=0.076 |
| *Able to bath or shower* | 129 | 69,0 | 110 | 64,3 | 111 | 61,7 | |
| *Needs some help in washing a single part of the body, such as back or feet, or needs a bystander* | 20 | 10,7 | 22 | 12,9 | 14 | 7,8 | |
| *Needs assistance in getting in and out of the bathtub* | 10 | 5,3 | 4 | 2,3 | 4 | 2,2 | |
| *Needs assistance in washing one or several parts of the body* | 17 | 9,1 | 21 | 12,3 | 31 | 17,2 | |
| *Always needs to be bathed by others* | 11 | 5,9 | 14 | 8,2 | 20 | 11,1 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Bathing or showering 4 months | | | | | | | p=0.653 |
| *Able to bath or shower* | 73 | 40,8 | 59 | 38,6 | 50 | 31,4 | |
| *Needs some help in washing a single part of the body, such as back or feet, or needs a bystander* | 39 | 21,8 | 30 | 19,6 | 34 | 21,4 | |
| *Needs assistance in getting in and out of the bathtub* | 10 | 5,6 | 5 | 3,3 | 9 | 5,7 | |
| *Needs assistance in washing one or several parts of the body* | 24 | 13,4 | 27 | 17,6 | 30 | 18,9 | |
| *Always needs to be bathed by others* | 33 | 18,4 | 32 | 20,9 | 36 | 22,6 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |
| Bathing or showering 12 months | | | | | | | p=0,343 |
| *Able to bath or shower* | 76 | 44,7 | 67 | 64,3 | 55 | 38,7 | |
| *Needs some help in washing a single part of the body, such as back or feet, or needs a bystander* | 25 | 14,7 | 11 | 12,9 | 17 | 12,0 | |
| *Needs assistance in getting in and out of the bathtub* | 10 | 5,9 | 4 | 2,3 | 10 | 7,0 | |
| *Needs assistance in washing one or several parts of the body* | 21 | 12,4 | 19 | 12,3 | 17 | 12,0 | |
| *Always needs to be bathed by others* | 38 | 22,4 | 37 | 8,2 | 43 | 30,3 | |
| Total | 170 | 100 | 138 | 100 | 142 | 100 | |
| Eating | | | | | | | p=0.684 |
| *Able to cut food and eat without help* | 184 | 98,4 | 169 | 98,8 | 174 | 96,7 | |
| *Needs help from others to cut hard food* | 1 | 0,5 | 1 | 0,6 | 3 | 1,7 | |
| *Needs assistance in handling food, e.g. buttering bread* | 2 | 1,1 | 1 | 0,6 | 2 | 1,1 | |
| *Needs a lot of help to eat* | 0 | 0 | 0 | 0 | 1 | 0,6 | |
| *Has to be completely fed by others* | | | | | | | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| Eating 4 months | | | | | | | p=0.565 |
| *Able to cut food and eat without help* | 156 | 87,2 | 131 | 85,6 | 134 | 84,3 | |
| *Needs help from others to cut hard food* | 10 | 5,6 | 8 | 5,2 | 5 | 3,1 | |
| *Needs assistance in handling food, e.g. buttering bread* | 8 | 4,5 | 4 | 2,6 | 8 | 5,0 | |
| *Needs a lot of help to eat* | 3 | 1,7 | 6 | 3,9 | 6 | 3,8 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| *Has to be completely fed by others* | 2 | 1,1 | 4 | 2,6 | 6 | 3,8 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |
| | | | | | | | |
| Eating 12 months | | | | | | | p=0.545 |
| *Able to cut food and eat without help* | 157 | 92,4 | 122 | 88,4 | 131 | 91,0 | |
| *Needs help from others to cut hard food* | 3 | 1,8 | 2 | 1,4 | 2 | 1,4 | |
| *Needs assistance in handling food, e.g. buttering bread* | 7 | 4,1 | 6 | 4,3 | 6 | 4,2 | |
| *Needs a lot of help to eat* | 1 | 0,6 | 7 | 5,1 | 3 | 2,1 | |
| *Has to be completely fed by others* | 2 | 1,2 | 1 | 0,7 | 2 | 1,4 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| | | | | | | | |
| Toileting | | | | | | | p=0.011 |
| *Able to get to the toilet, get on and off, manage clothing, etc.* | 185 | 98,9 | 164 | 95,9 | 165 | 91,7 | |
| *Needs assistance in getting to and from toilet* | 0 | 0 | 2 | 1,2 | 4 | 2,2 | |
| *Needs assistance in getting on and off the toilet and adjusting clothing* | 2 | 1,1 | 0 | 0 | 2 | 1,1 | |
| *Needs assistance in cleaning organs of excretion* | 0 | 0 | 0 | 0 | 4 | 2,2 | |
| *Wears pads or uses a catheter or bedpan at all times* | 0 | 0 | 5 | 2,9 | 5 | 2,8 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| | | | | | | | |
| Toileting 4 months | | | | | | | p=0.055 |
| *Able to get to the toilet, get on and off, manage clothing, etc.* | 148 | 82,7 | 118 | 77,1 | 115 | 72,3 | |
| *Needs assistance in getting to and from toilet* | 4 | 2,2 | 3 | 2,0 | 5 | 3,1 | |
| *Needs assistance in getting on and off the toilet and adjusting clothing* | 5 | 2,8 | 10 | 6,5 | 11 | 6,9 | |
| *Needs assistance in cleaning organs of excretion* | 15 | 8,4 | 5 | 3,3 | 14 | 8,8 | |
| *Wears pads or uses a catheter or bedpan at all times* | 7 | 3,9 | 17 | 11,1 | 14 | 8,8 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Toileting 12 months | | | | | | | p=0,288 |
| *Able to get to the toilet, get on and off, manage clothing, etc.* | 141 | 82,9 | 113 | 81,9 | 111 | 77,1 | |
| *Needs assistance in getting to and from toilet* | 1 | 0,6 | 2 | 1,4 | 3 | 2,1 | |
| *Needs assistance in getting on and off the toilet and adjusting clothing* | 5 | 2,9 | 2 | 1,4 | 4 | 2,8 | |
| *Needs assistance in cleaning organs of excretion* | 3 | 1,8 | 3 | 2,2 | 10 | 6,9 | |
| *Wears pads or uses a catheter or bedpan at all times* | 20 | 11,8 | 18 | 13,0 | 16 | 11,1 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| Shopping | | | | | | | p=0.188 |
| *Able to do all shopping without assistance* | 84 | 44,9 | 67 | 39,2 | 62 | 34,4 | |
| *Needs assistance in getting to or returning from shops, can only shop independently for small purchases or is able to shop but gets someone else to do it* | 41 | 21,9 | 39 | 22,8 | 56 | 31,1 | |
| *Needs assistance with selecting shopping, is unsure what he/she needs to buy or must always be accompanied due to physical, psychological or visual impairment* | 11 | 5,9 | 6 | 3,5 | 9 | 5,0 | |
| *Needs help with two or more tasks associated with grocery shopping* | 8 | 4,3 | 4 | 2,3 | 5 | 2,8 | |
| *Completely unable to shop* | 43 | 23,0 | 55 | 32,2 | 48 | 26,7 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| Shopping 4 months | | | | | | | p=0.616 |
| *Able to do all shopping without assistance* | 24 | 13,4 | 19 | 12,4 | 24 | 15,1 | |
| *Needs assistance in getting to or returning from shops, can only shop independently for small purchases or is able to shop but gets someone else to do it* | 67 | 37,4 | 53 | 34,6 | 51 | 32,1 | |
| *Needs assistance with selecting shopping, is unsure what he/she needs to buy or must always be accompanied due to physical, psychological or visual impairment* | 4 | 2,2 | 2 | 1,3 | 5 | 3,1 | |
| *Needs help with two or more tasks associated with grocery shopping* | 10 | 5,6 | 3 | 2,0 | 7 | 4,4 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| *Completely unable to shop* | 74 | 41,3 | 76 | 49,7 | 72 | 45,3 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |
| | | | | | | | |
| Shopping 12 months | | | | | | | p=0.470 |
| *Able to do all shopping without assistance* | 39 | 22,9 | 36 | 26,1 | 32 | 22,2 | |
| *Needs assistance in getting to or returning from shops, can only shop independently for small purchases or is able to shop but gets someone else to do it* | 49 | 28,8 | 41 | 29,7 | 32 | 22,2 | |
| *Needs assistance with selecting shopping, is unsure what he/she needs to buy or must always be accompanied due to physical, psychological or visual impairment* | 4 | 2,4 | 7 | 5,1 | 6 | 4,2 | |
| *Needs help with two or more tasks associated with grocery shopping* | 9 | 5,3 | 3 | 2,2 | 6 | 4,2 | |
| *Completely unable to shop* | 69 | 40,6 | 51 | 37,0 | 68 | 47,2 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| | | | | | | | |
| Household chores | | | | | | | p=0.188 |
| *Able to manage housekeeping alone or with only occasional assistance* | 68 | 36,4 | 55 | 32,2 | 51 | 28,3 | |
| *Able to perform all home maintenance tasks but needs some assistance with, e.g., lifting or is able to do housework but has someone else do it* | 23 | 12,3 | 17 | 9,9 | 23 | 12,8 | |
| *Able to perform only light daily tasks* | 49 | 26,2 | 33 | 19,3 | 45 | 25,0 | |
| *Needs assistance with light household duties* | 12 | 6,4 | 21 | 12,3 | 14 | 7,8 | |
| *Unable to do housework* | 35 | 18,7 | 45 | 26,3 | 47 | 26,1 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| | | | | | | | |
| Household chores 4 months | | | | | | | p=0.579 |
| *Able to manage housekeeping alone or with only occasional assistance* | 26 | 14,5 | 25 | 16,3 | 26 | 16,4 | |
| *Able to perform all home maintenance tasks but needs some assistance with, e.g., lifting or is able to do housework but has someone else do it* | 24 | 13,4 | 17 | 11,1 | 13 | 8,2 | |
| *Able to perform only light daily tasks* | 47 | 26,3 | 35 | 22,9 | 34 | 21,4 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| *Needs assistance with light household duties* | 12 | 6,7 | 11 | 7,2 | 7 | 4,4 | |
| *Unable to do housework* | 70 | 39,1 | 65 | 42,5 | 79 | 49,7 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |
| | | | | | | | |
| Household chores 12 months | | | | | | | p=0.527 |
| *Able to manage housekeeping alone or with only occasional assistance* | 31 | 18,2 | 20 | 14,5 | 26 | 18,1 | |
| *Able to perform all home maintenance tasks but needs some assistance with, e.g., lifting or is able to do housework but has someone else do it* | 18 | 10,6 | 17 | 12,3 | 8 | 5,6 | |
| *Able to perform only light daily tasks* | 37 | 21,8 | 34 | 24,6 | 29 | 20,1 | |
| *Needs assistance with light household duties* | 13 | 7,6 | 13 | 9,4 | 11 | 7,6 | |
| *Unable to do housework* | 71 | 41,8 | 54 | 39,1 | 70 | 48,6 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| | | | | | | | |
| Laundry | | | | | | | p=0.058 |
| *Able to do laundry* | 95 | 50,8 | 66 | 38,6 | 73 | 40,6 | |
| *Needs assistance in doing or hanging up laundry or is able to do it but somebody else does it or would be able to do laundry if there were a machine at home* | 25 | 13,4 | 19 | 11,1 | 23 | 12,8 | |
| *Able to wash delicates and personals by hand or needs some assistance in loading or unloading the machine* | 7 | 3,7 | 14 | 8,2 | 6 | 3,3 | |
| *Needs a lot of help to do laundry* | 15 | 8,0 | 10 | 5,8 | 15 | 8,3 | |
| *Unable to do laundry* | 45 | 24,1 | 62 | 36,3 | 63 | 35,0 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| | | | | | | | |
| Laundry 4 months | | | | | | | p=0.412 |
| *Able to do laundry* | 46 | 25,7 | 41 | 26,8 | 38 | 23,9 | |
| *Needs assistance in doing or hanging up laundry or is able to do it but somebody else does it or would be able to do laundry if there were a machine at home* | 32 | 17,9 | 13 | 8,5 | 21 | 13,2 | |
| *Able to wash delicates and personals by hand or needs some assistance in loading or unloading the machine* | 8 | 4,5 | 8 | 5,2 | 7 | 4,4 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| *Needs a lot of help to do laundry* | 13 | 7,3 | 17 | 11,1 | 12 | 7,5 | |
| *Unable to do laundry* | 80 | 44,7 | 74 | 48,4 | 81 | 50,9 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |
| | | | | | | | |
| Laundry 12 months | | | | | | | p=0.752 |
| *Able to do laundry* | 47 | 27,6 | 37 | 26,8 | 41 | 28,5 | |
| *Needs assistance in doing or hanging up laundry or is able to do it but somebody else does it or would be able to do laundry if there were a machine at home* | 25 | 14,7 | 16 | 11,6 | 19 | 13,2 | |
| *Able to wash delicates and personals by hand or needs some assistance in loading or unloading the machine* | 6 | 3,5 | 12 | 8,7 | 6 | 4,2 | |
| *Needs a lot of help to do laundry* | 7 | 4,1 | 5 | 3,6 | 6 | 4,2 | |
| *Unable to do laundry* | 85 | 50,0 | 68 | 49,3 | 72 | 50,0 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| | | | | | | | |
| Preparation of meals | | | | | | | p=0.324 |
| *Able to prepare meals* | 108 | 57,8 | 87 | 50,9 | 86 | 47,8 | |
| *Able to prepare meals but someone else does it* | 15 | 8,0 | 13 | 7,6 | 11 | 6,1 | |
| *Able to prepare a small meal or sandwich if supplied with ingredients* | 21 | 11,2 | 16 | 9,4 | 21 | 11,7 | |
| *Able only to reheat meals* | 16 | 8,6 | 22 | 12,9 | 18 | 10,0 | |
| *Must have all meals prepared* | 27 | 14,4 | 33 | 19,3 | 44 | 24,4 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| | | | | | | | |
| Preparation of meals 4 months | | | | | | | p=0.219 |
| *Able to prepare meals* | 57 | 31,8 | 53 | 34,6 | 46 | 28,9 | |
| *Able to prepare meals but someone else does it* | 22 | 12,3 | 9 | 5,9 | 13 | 8,2 | |
| *Able to prepare a small meal or sandwich if supplied with ingredients* | 23 | 12,8 | 14 | 9,2 | 25 | 15,7 | |
| *Able only to reheat meals* | 19 | 10,6 | 21 | 13,7 | 13 | 8,2 | |
| *Must have all meals prepared* | 58 | 32,4 | 56 | 36,6 | 62 | 39,0 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |
| | | | | | | | |
| Preparation of meals 12 months | | | | | | | p=0.870 |
| *Able to prepare meals* | 71 | 42,0 | 56 | 40,6 | 55 | 38,2 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| *Able to prepare meals but someone else does it* | 11 | 6,5 | 10 | 7,2 | 11 | 7,6 | |
| *Able to prepare a small meal or sandwich if supplied with ingredients* | 17 | 10,1 | 19 | 13,8 | 14 | 9,7 | |
| *Able only to reheat meals* | 15 | 8,9 | 8 | 5,8 | 9 | 6,3 | |
| *Must have all meals prepared* | 55 | 32,5 | 45 | 32,6 | 55 | 38,2 | |
| Total | 169 | 100 | 138 | 100 | 144 | 100 | |
| | | | | | | | |
| Banking/finances | | | | | | | p=0.120 |
| *Able to manage all financial matters* | 84 | 44,9 | 78 | 45,6 | 67 | 37,2 | |
| *Needs assistance in going to bank or does billing and banking by mail or cannot go to bank but is able to perform all other financial tasks or is able to do it but someone else does it* | 46 | 24,6 | 27 | 15,8 | 50 | 27,8 | |
| *Able to manage day-to-day purchases, but needs assistance with banking and major purchases* | 1 | 0,5 | 4 | 2,3 | 1 | 0,6 | |
| *Needs to be taken to the bank and requires someone to handle the transactions and all other financial needs* | 15 | 8,0 | 13 | 7,6 | 15 | 8,3 | |
| *Unable to handle financial matters* | 41 | 21,9 | 49 | 28,7 | 47 | 26,1 | |
| Total | 187 | 100 | 171 | 100 | 180 | 100 | |
| | | | | | | | |
| Banking/finances 4 months | | | | | | | p=0.905 |
| *Able to manage all financial matters* | 34 | 19,0 | 23 | 15,0 | 31 | 19,5 | |
| *Needs assistance in going to bank or does billing and banking by mail or cannot go to bank but is able to perform all other financial tasks or is able to do it but someone else does it* | 54 | 30,2 | 44 | 28,8 | 39 | 24,5 | |
| *Able to manage day-to-day purchases, but needs assistance with banking and major purchases* | 4 | 2,2 | 3 | 2,0 | 4 | 2,5 | |
| *Needs to be taken to the bank and requires someone to handle the transactions and all other financial needs* | 24 | 13,4 | 25 | 16,3 | 21 | 13,2 | |
| *Unable to handle financial matters* | 63 | 35,2 | 58 | 37,9 | 64 | 40,3 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Banking/finances 12 months | | | | | | | p=0.355 |
| *Able to manage all financial matters* | 46 | 27,1 | 41 | 29,7 | 34 | 23,6 | |
| *Needs assistance in going to bank or does billing and banking by mail or cannot go to bank but is able to perform all other financial tasks or is able to do it but someone else does it* | 44 | 25,9 | 40 | 29,0 | 32 | 22,2 | |
| *Able to manage day-to-day purchases, but needs assistance with banking and major purchases* | 0 | 0 | 1 | 0,7 | 3 | 2,1 | |
| *Needs to be taken to the bank and requires someone to handle the transactions and all other financial needs* | 11 | 6,5 | 7 | 5,1 | 13 | 9,0 | |
| *Unable to handle financial matters* | 69 | 40,6 | 49 | 35,5 | 62 | 43,1 | |
| Total | 170 | 100 | 138 | 100 | 144 | 100 | |
| Use of transportation | | | | | | | p=0.561 |
| *Able to travel independently on public transportation or drive a car.* | 73 | 39,0 | 61 | 35,7 | 62 | 34,4 | |
| *Arranges his/her own travel by taxi but does not use bus or train* | 65 | 34,8 | 49 | 28,7 | 62 | 34,4 | |
| *Must always be accompanied due to physical, psychological or visual impairment* | 19 | 10,2 | 20 | 11,7 | 15 | 8,3 | |
| *Travels in taxi or car only with assistance* | 19 | 10,2 | 30 | 17,5 | 28 | 15,6 | |
| *Unable to travel* | 11 | 5,9 | 11 | 6,4 | 13 | 7,2 | |
| Total | 187 | 100 | 171 | 100 | 221 | 100 | |
| Use of transportation 4 months | | | | | | | p=0.359 |
| *Able to travel independently on public transportation or drive a car.* | 24 | 13,4 | 17 | 11,1 | 22 | 13,8 | |
| *Arranges his/her own travel by taxi but does not use bus or train* | 63 | 35,2 | 47 | 30,7 | 44 | 27,7 | |
| *Must always be accompanied due to physical, psychological or visual impairment* | 20 | 11,2 | 15 | 9,8 | 21 | 13,2 | |
| *Travels in taxi or car only with assistance* | 42 | 23,5 | 34 | 22,2 | 45 | 28,3 | |
| *Unable to travel* | 30 | 16,8 | 40 | 26,1 | 27 | 17,0 | |
| Total | 179 | 100 | 153 | 100 | 159 | 100 | |

| Parameter | Physical rehabilitation | | Geriatric rehabilitation | | Control group | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Use of transportation 12 months | | | | | | | p=0.778 |
| *Able to travel independently on public transportation or drive a car.* | 30 | 17,8 | 26 | 18,8 | 30 | 21,0 | |
| *Arranges his/her own travel by taxi but does not use bus or train* | 78 | 46,2 | 62 | 44,9 | 53 | 37,1 | |
| *Must always be accompanied due to physical, psychological or visual impairment* | 12 | 7,1 | 12 | 8,7 | 12 | 8,4 | |
| *Travels in taxi or car only with assistance* | 37 | 21,9 | 27 | 19,6 | 31 | 21,7 | |
| *Unable to travel* | 12 | 7,1 | 11 | 8,0 | 17 | 11,9 | |
| Total | 169 | 100 | 138 | 100 | 143 | 100 | |

# Appendix IV. Comparison of ADL-functions between male and female patients.

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Dressing | | | p=0.788 |
| *Able to dress completely without help* | 89 (84.8%) | 377 (87.1%) | |
| *Needs some help with buttons or zippers* | 4 (3.8%) | 15 (3.5%) | |
| *Needs assistance with shoes and stockings* | 4 (3.8%) | 12 (2.8%) | |
| *Needs assistance with up to 3 items* | 5 (4.8%) | 20 (4.6%) | |
| *Needs to be dressed by others* | 3 (2.9%) | 9 (2.1%) | |
| Total | 105 | 433 | |
| Dressing 4 months | | | p=0.658 |
| *Able to dress completely without help* | 56 (56.6%) | 223 (56.9%) | |
| *Needs some help with buttons or zippers* | 4 (4.0%) | 13 (3.3%) | |
| *Needs assistance with shoes and stockings* | 19 (19.2%) | 67 (17.1%) | |
| *Needs assistance with up to 3 items* | 11 (11.1%) | 42 (10.7%) | |
| *Needs to be dressed by others* | 9 (9.1%) | 47 (12.0%) | |
| Total | 99 | 392 | |
| Dressing 12 months | | | p=0.200 |
| *Able to dress completely without help* | 57 (64.8%) | 244 (66.5%) | |
| *Needs some help with buttons or zippers* | 2 (2.3%) | 12 (3.3%) | |
| *Needs assistance with shoes and stockings* | 16 (18.2%) | 40 (10.9%) | |
| *Needs assistance with up to 3 items* | 5 (5.7%) | 18 (4.9%) | |
| *Needs to be dressed by others* | 8 (9.1%) | 53 (14.4%) | |
| Total | 88 | 367 | |
| Bathing or showering | | | p=0.380 |
| *Able to bath or shower* | 71 (67.6%) | 279 (64.4%) | |
| *Needs some help in washing a single part of the body, such as back or feet, or needs a bystander* | 9 (8.6%) | 47 (10.9%) | |
| *Needs assistance in getting in and out of the bathtub* | 3 (2.9%) | 15 (3.5%) | |
| *Needs assistance in washing one or several parts of the body* | 11 (10.5%) | 58 (13.4%) | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| *Always needs to be bathed by others* | 11 (10.5%) | 34 (7.9%) | |
| Total | 105 | 433 | |
| | | | |
| Bathing or showering 4 months | | | p=0.741 |
| *Able to bath or shower* | 40 (40.4%) | 142 (36.2%) | |
| *Needs some help in washing a single part of the body, such as back or feet, or needs a bystander* | 20 (20.2%) | 83 (21.2%) | |
| *Needs assistance in getting in and out of the bathtub* | 9 (9.1%) | 15 (3.8%) | |
| *Needs assistance in washing one or several parts of the body* | 11 (11.1%) | 70 (17.9%) | |
| *Always needs to be bathed by others* | 19 (19.2%) | 82 (20.9%) | |
| Total | 99 | 392 | |
| | | | |
| Bathing or showering 12 months | | | p=0.286 |
| *Able to bath or shower* | 45 (51.1%) | 153 (41.9%) | |
| *Needs some help in washing a single part of the body, such as back or feet, or needs a bystander* | 7 (8.0%) | 46 (12.6%) | |
| *Needs assistance in getting in and out of the bathtub* | 5 (5.7%) | 19 (5.2%) | |
| *Needs assistance in washing one or several parts of the body* | 10 (11.4%) | 48 (13.2%) | |
| *Always needs to be bathed by others* | 21 (23.9%) | 99 (27.1%) | |
| Total | 88 | 365 | |
| | | | |
| Eating | | | p=1.000 |
| *Able to cut food and eat without help* | 103 (98.1%) | 424 (97.9%) | |
| *Needs help from others to cut hard food* | 1 (1.0%) | 4 (0.9%) | |
| *Needs assistance in handling food, e.g. buttering bread* | 1 (1.0%) | 4 (0.9%) | |
| *Needs a lot of help to eat* | 0 | 1 (0.2%) | |
| *Has to be completely fed by others* | 0 | 0 | |
| Total | 105 | 433 | |
| | | | |
| Eating 4 months | | | p=0.574 |
| *Able to cut food and eat without help* | 85 (85.9%) | 336 (85.7%) | |
| *Needs help from others to cut hard food* | 4 (4.0%) | 19 (4.8%) | |
| *Needs assistance in handling food, e.g. buttering bread* | 4 (4.0%) | 16 (4.1%) | |
| *Needs a lot of help to eat* | 5 (5.1%) | 10 (2.6%) | |
| *Has to be completely fed by others* | 1 (1.0%) | 11 (2.8%) | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Total | 99 | 392 | |
| | | | |
| Eating 12 months | | | p=0.483 |
| *Able to cut food and eat without help* | 81 (92.0%) | 329 (89.6%) | |
| *Needs help from others to cut hard food* | 0 | 7 (1.9%) | |
| *Needs assistance in handling food, e.g. buttering bread* | 4 (4.5%) | 16 (4.4%) | |
| *Needs a lot of help to eat* | 3 (3.4%) | 8 (2.2%) | |
| *Has to be completely fed by others* | 0 | 7 (1.9%) | |
| Total | 88 | 367 | |
| | | | |
| Toileting | | | p=0.381 |
| *Able to get to the toilet, get on and off, manage clothing, etc.* | 101 (96.2%) | 413 (95.4%) | |
| *Needs assistance in getting to and from toilet* | 0 | 6 (1.4%) | |
| *Needs assistance in getting on and off the toilet and adjusting clothing* | 1 (1.0%) | 3 (0.7%) | |
| *Needs assistance in cleaning organs of excretion* | 0 | 4 (0.9%) | |
| *Wears pads or uses a catheter or bedpan at all times* | 3 (2.9%) | 7 (1.6%) | |
| Total | 105 | 433 | |
| | | | |
| Toileting 4 months | | | p=0.266 |
| *Able to get to the toilet, get on and off, manage clothing, etc.* | 79 (79.8%) | 302 (77.0%) | |
| *Needs assistance in getting to and from toilet* | 0 | 12 (3.1%) | |
| *Needs assistance in getting on and off the toilet and adjusting clothing* | 3 (3.0%) | 23 (5.9%) | |
| *Needs assistance in cleaning organs of excretion* | 7 (7.1%) | 27 (6.9%) | |
| *Wears pads or uses a catheter or bedpan at all times* | 10 (10.1%) | 28 (7.1%) | |
| Total | 99 | 392 | |
| | | | |
| Toileting 12 months | | | p=0.301 |
| *Able to get to the toilet, get on and off, manage clothing, etc.* | 73 (83.0%) | 292 (79.6%) | |
| *Needs assistance in getting to and from toilet* | 0 | 6 (1.6%) | |
| *Needs assistance in getting on and off the toilet and adjusting clothing* | 0 | 11 (3.0%) | |
| *Needs assistance in cleaning organs of excretion* | 3 (3.4%) | 13 (3.5%) | |
| *Wears pads or uses a catheter or bedpan at all times* | 12 (13.6%) | 45 (12.3%) | |
| Total | 88 | 367 | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Shopping | | | p=0.001 |
| *Able to do all shopping without assistance* | 58 (55.2%) | 155 (35.8%) | |
| *Needs assistance in getting to or returning from shops, can only shop independently for small purchases or is able to shop but gets someone else to do it* | 14 (13.3%) | 122 (28.2%) | |
| *Needs assistance with selecting shopping, is unsure what he/she needs to buy or must always be accompanied due to physical, psychological or visual impairment* | 5 (4.8%) | 21 (4.8%) | |
| *Needs help with two or more tasks associated with grocery shopping* | 3 (2.9%) | 14 (3.2%) | |
| *Completely unable to shop* | 25 (23.8%) | 121 (27.9%) | |
| Total | 105 | 433 | |
| Shopping 4 months | | | p<0.001 |
| *Able to do all shopping without assistance* | 27 (27.3%) | 40 (10.2%) | |
| *Needs assistance in getting to or returning from shops, can only shop independently for small purchases or is able to shop but gets someone else to do it* | 28 (28.3%) | 143 (36.5%) | |
| *Needs assistance with selecting shopping, is unsure what he/she needs to buy or must always be accompanied due to physical, psychological or visual impairment* | 0 | 11 (2.8%) | |
| *Needs help with two or more tasks associated with grocery shopping* | 5 (5.1%) | 15 (3.8%) | |
| *Completely unable to shop* | 39 (39.4%) | 183 (46.7%) | |
| Total | 99 | 392 | |
| Shopping 12 months | | | p=0.013 |
| *Able to do all shopping without assistance* | 31 (35.2%) | 76 (20.7%) | |
| *Needs assistance in getting to or returning from shops, can only shop independently for small purchases or is able to shop but gets someone else to do it* | 20 (22.7%) | 102 (27.8%) | |
| *Needs assistance with selecting shopping, is unsure what he/she needs to buy or must always be accompanied due to physical, psychological or visual impairment* | 1 (1.1%) | 16 (4.4%) | |
| *Needs help with two or more tasks associated with grocery shopping* | 3 (3.4%) | 15 (4.1%) | |
| *Completely unable to shop* | 33 (37.5%) | 158 (43.1%) | |
| Total | 88 | 367 | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Household chores | | | p<0.001 |
| *Able to manage housekeeping alone or with only occasional assistance* | 35 (33.3%) | 139 (32.1%) | |
| *Able to perform all home maintenance tasks but needs some assistance with, e.g., lifting or is able to do housework but has someone else do it* | 22 (21.0%) | 41 (9.5%) | |
| *Able to perform only light daily tasks* | 10 (9.5%) | 117 (27.0%) | |
| *Needs assistance with light household duties* | 4 (3.8%) | 43 (9.9%) | |
| *Unable to do housework* | 34 (32.4%) | 93 (21.5%) | |
| Total | 105 | 433 | |
| Household chores 4 months | | | p=0.030 |
| *Able to manage housekeeping alone or with only occasional assistance* | 17 (17.2%) | 60 (15.3%) | |
| *Able to perform all home maintenance tasks but needs some assistance with, e.g., lifting or is able to do housework but has someone else do it* | 15 (15.2%) | 39 (9.9%) | |
| *Able to perform only light daily tasks* | 12 (12.1%) | 104 (26.5%) | |
| *Needs assistance with light household duties* | 5 (5.1%) | 25 (6.4%) | |
| *Unable to do housework* | 50 (50.5%) | 164 (41.8%) | |
| Total | 99 | 392 | |
| Household chores 12 months | | | p=0.016 |
| *Able to manage housekeeping alone or with only occasional assistance* | 20 (22.7%) | 57 (15.5%) | |
| *Able to perform all home maintenance tasks but needs some assistance with, e.g., lifting or is able to do housework but has someone else do it* | 9 (10.2%) | 34 (9.3%) | |
| *Able to perform only light daily tasks* | 8 (9.1%) | 92 (25.1%) | |
| *Needs assistance with light household duties* | 6 (6.8%) | 31 (8.4%) | |
| *Unable to do housework* | 45 (51.1%) | 153 (41.7%) | |
| Total | 88 | 367 | |
| Laundry | | | p=0.082 |
| *Able to do laundry* | 36 (34.3%) | 198 (45.7%) | |
| *Needs assistance in doing or hanging up laundry or is able to do it but somebody else does it or would be able to do laundry if there were a machine at home* | 25 (23.8%) | 42 (9.7%) | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| *Able to wash delicates and personals by hand or needs some assistance in loading or unloading the machine* | 0 | 27 (6.2%) | |
| *Needs a lot of help to do laundry* | 3 (2.9%) | 37 (8.5%) | |
| *Unable to do laundry* | 41 (39.0%) | 129 (29.8%) | |
| Total | 105 | 433 | |
| | | | |
| Laundry 4 months | | | p=0.180 |
| *Able to do laundry* | 18 (18.2%) | 107 (27.3%) | |
| *Needs assistance in doing or hanging up laundry or is able to do it but somebody else does it or would be able to do laundry if there were a machine at home* | 20 (20.2%) | 46 (11.7%) | |
| *Able to wash delicates and personals by hand or needs some assistance in loading or unloading the machine* | 1 (1.0%) | 22 (5.6%) | |
| *Needs a lot of help to do laundry* | 7 (7.1%) | 35 (8.9%) | |
| *Unable to do laundry* | 53 (53.5%) | 182 (46.4%) | |
| Total | 99 | 392 | |
| | | | |
| Laundry 12 months | | | p=0.029 |
| *Able to do laundry* | 15 (17.0%) | 110 (30.0%) | |
| *Needs assistance in doing or hanging up laundry or is able to do it but somebody else does it or would be able to do laundry if there were a machine at home* | 24 (27.3%) | 36 (9.8%) | |
| *Able to wash delicates and personals by hand or needs some assistance in loading or unloading the machine* | 2 (2.3%) | 22 (6.0%) | |
| *Needs a lot of help to do laundry* | 0 | 18 (4.9%) | |
| *Unable to do laundry* | 47 (53.4%) | 181 (49.3%) | |
| Total | 88 | 367 | |
| | | | |
| Preparation of meals | | | p=0.035 |
| *Able to prepare meals* | 44 (41.9%) | 237 (54.7%) | |
| *Able to prepare meals but someone else does it* | 15 (14.3%) | 24 (5.5%) | |
| *Able to prepare a small meal or sandwich if supplied with ingredients* | 6 (5.7%) | 52 (12.0%) | |
| *Able only to reheat meals* | 12 (11.4%) | 44 (10.2%) | |
| *Must have all meals prepared* | 28 (26.7%) | 76 (17.6%) | |
| Total | 105 | 433 | |
| | | | |
| Preparation of meals 4 months | | | p=0.021 |
| *Able to prepare meals* | 20 (20.2%) | 136 (34.7%) | |
| *Able to prepare meals but someone else does it* | 18 (18.2%) | 26 (6.6%) | |
| *Able to prepare a small meal or sandwich if supplied with ingredients* | 11 (11.1%) | 51 (13.0%) | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| *Able only to reheat meals* | 9 (9.1%) | 44 (11.2%) | |
| *Must have all meals prepared* | 41 (41.4%) | 135 (34.4%) | |
| Total | 99 | 392 | |
| | | | |
| Preparation of meals 12 months | | | p=0.002 |
| *Able to prepare meals* | 24 (27.3%) | 158 (43.2%) | |
| *Able to prepare meals but someone else does it* | 17 (19.3%) | 15 (4.1%) | |
| *Able to prepare a small meal or sandwich if supplied with ingredients* | 8 (9.1%) | 42 (11.5%) | |
| *Able only to reheat meals* | 9 (10.2%) | 23 (6.3%) | |
| *Must have all meals prepared* | 30 (34.1%) | 128 (35.0%) | |
| Total | 88 | 366 | |
| | | | |
| Banking/finances | | | p<0.001 |
| *Able to manage all financial matters* | 63 (60.0%) | 166 (38.3%) | |
| *Needs assistance in going to bank or does billing and banking by mail or cannot go to bank but is able to perform all other financial tasks or is able to do it but someone else does it* | 13 (12.4%) | 110 (25.4%) | |
| *Able to manage day-to-day purchases, but needs assistance with banking and major purchases* | 0 | 6 (1.4%) | |
| *Needs to be taken to the bank and requires someone to handle the transactions and all other financial needs* | 4 (3.8%) | 39 (9.0%) | |
| *Unable to handle financial matters* | 25 (23.8%) | 112 (25.9%) | |
| Total | 105 | 433 | |
| | | | |
| Banking/finances 4 months | | | p=0.010 |
| *Able to manage all financial matters* | 28 (28.3%) | 60 (15.3%) | |
| *Needs assistance in going to bank or does billing and banking by mail or cannot go to bank but is able to perform all other financial tasks or is able to do it but someone else does it* | 19 (19.2%) | 118 (30.1%) | |
| *Able to manage day-to-day purchases, but needs assistance with banking and major purchases* | 5 (5.1%) | 6 (1.5%) | |
| *Needs to be taken to the bank and requires someone to handle the transactions and all other financial needs* | 14 (14.1%) | 56 (14.3%) | |
| *Unable to handle financial matters* | 33 (33.3%) | 152 (38.8%) | |
| Total | 99 | 392 | |
| | | | |
| Banking/finances 12 months | | | p=0.088 |
| *Able to manage all financial matters* | 30 (34.1%) | 91 (24.8%) | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| *Needs assistance in going to bank or does billing and banking by mail or cannot go to bank but is able to perform all other financial tasks or is able to do it but someone else does it* | 27 (30.7%) | 89 (24.3%) | |
| *Able to manage day-to-day purchases, but needs assistance with banking and major purchases* | 1 (1.1%) | 3 (0.8%) | |
| *Needs to be taken to the bank and requires someone to handle the transactions and all other financial needs* | 3 (3.4%) | 28 (7.6%) | |
| *Unable to handle financial matters* | 27 (30.7%) | 156 (42.5%) | |
| Total | 88 | 367 | |
| | | | |
| Use of transportation | | | p<0.001 |
| *Able to travel independently on public transportation or drive a car.* | 61 (58.1%) | 135 (31.2%) | |
| *Arranges his/her own travel by taxi but does not use bus or train* | 15 (14.3%) | 161 (37.2%) | |
| *Must always be accompanied due to physical, psychological or visual impairment* | 10 (9.5%) | 44 (10.2%) | |
| *Travels in taxi or car only with assistance* | 16 (15.2%) | 61 (14.1%) | |
| *Unable to travel* | 3 (2.9%) | 32 (7.4%) | |
| Total | 105 | 433 | |
| | | | |
| Use of transportation 4 months | | | p<0.001 |
| *Able to travel independently on public transportation or drive a car.* | 26 (26.3%) | 37 (9.4%) | |
| *Arranges his/her own travel by taxi but does not use bus or train* | 29 (29.3%) | 125 (31.9%) | |
| *Must always be accompanied due to physical, psychological or visual impairment* | 4 (4.0%) | 52 (13.3%) | |
| *Travels in taxi or car only with assistance* | 25 (25.3%) | 96 (24.5%) | |
| *Unable to travel* | 15 (15.2%) | 82 (20.9%) | |
| Total | 99 | 392 | |
| | | | |
| Use of transportation 12 months | | | p=0.038 |
| *Able to travel independently on public transportation or drive a car.* | 25 (28.4%) | 61 (16.7%) | |
| *Arranges his/her own travel by taxi but does not use bus or train* | 34 (38.6%) | 159 (43.6%) | |
| *Must always be accompanied due to physical, psychological or visual impairment* | 7 (8.0%) | 29 (7.9%) | |
| *Travels in taxi or car only with assistance* | 16 (18.2%) | 80 (21.9%) | |
| *Unable to travel* | 6 (6.8%) | 36 (9.9%) | |

| Parameter | Male (%) | Female (%) | p-value |
|---|---|---|---|
| Total | 88 | 365 | |
| | | | |
| ADL-score prefracture | 19.33 (10.90) | 19.30 (9.49) | p=0.451 |
| ADL-score 4 months | 26.57 (12.32) | 26.70 (11.47) | p=0.546 |
| ADL-score 12 months | 25.29 (12.18) | 26.22 (12.52) | p=0.435 |

# Appendix V. Comparison of male and female patients in specific rehabilitation settings.

| Parameter | Physical rehabilitation | | | Geriatric rehabilitation | | | Control group | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | p-value | Male | Female | p-value | Male | Female | p-value |
| Residential status prefracture | | | p=0.185 | | | p=0.356 | | | p=0.032 |
| Own house | 33 (80.5%) | 130 (89.0%) | | 27 (90.0%) | 120 (85.1%) | | 33 (97.1%) | 121 (82.9%) | |
| Sheltered housing | 8 (19.5%) | 16 (11.0%) | | 3 (10.0%) | 21 (14.9%) | | 1 (2.9%) | 25 (17.1%) | |
| Total | 41 | 146 | | 30 | 141 | | 34 | 146 | |
| | | | | | | | | | |
| Residential status 4 months | | | p=0.814 | | | p=1.000 | | | p=0.121 |
| Own house | 29 (70.7%) | 102 (69.9%) | | 20 (66.7%) | 80 (56.7%) | | 25 (73.5%) | 75 (51.4%) | |
| Sheltered housing | 6 (14.7%) | 13 (8.9%) | | 2 (6.7%) | 19 (12.4%) | | 1 (2.9%) | 14 (9.6%) | |
| Permanent institutional patient | 1 (2.4%) | 8 (5.5%) | | 1 (3.3%) | 4 (2.8%) | | 0 | 11 (7.5%) | |
| Hospital | 1 (2.4%) | 9 (6.2%) | | 2 (6.7%) | 14 (9.9%) | | 2 (5.9%) | 6 (4.1%) | |
| Rehabilitation unit | 1 (2.4%) | 1 (0.7%) | | 1 (3.3%) | 4 (2.8%) | | 0 | 0 | |
| Temporary stay in acute hospital | 3 (7.3%) | 6 (4.1%) | | 2 (6.7%) | 6 (4.3%) | | 3 (8.8%) | 23 (15.8%) | |
| Total | 41 | 146 | | 30 | 141 | | 34 | 146 | |
| | | | | | | | | | |
| Residential status 12 months | | | p=0.813 | | | p=0.799 | | | p=1.000 |
| Own house | 25 (61.0%) | 93 (63.7%) | | 16 (53.3%) | 74 (52.9%) | | 19 (57.6%) | 78 (53.4%) | |
| Sheltered housing | 6 (14.7%) | 14 (9.6%) | | 3 (10.0%) | 12 (8.5%) | | 1 (3.0%) | 19 (13.0%) | |
| Permanent institutional patient | 4 (9.8%) | 11 (7.5%) | | 3 (10.0%) | 13 (9.3%) | | 1 (3.0%) | 17 (11.6%) | |
| Hospital | 1 (2.4%) | 9 (6.2%) | | 1 (3.3%) | 8 (5.7%) | | 3 (9.1%) | 4 (2.7%) | |
| Rehabilitation unit | 1 (2.4%) | 2 (1.4%) | | 0 | 2 (1.4%) | | 0 | 0 | |
| Temporary stay in acute hospital | 0 | 4 (2.7%) | | 3 (10.0%) | 3 (2.1%) | | 0 | 3 (2.1%) | |
| Total | 41 | 146 | | 30 | 140 | | 33 | 146 | |

| Parameter | Physical rehabilitation | | | Geriatric rehabilitation | | | Control group | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | p-value | Male | Female | p-value | Male | Female | p-value |
| Walking ability prefracture | | | p=0.095 | | | p=0.018 | | | p=0.128 |
| Alone outdoors | 38 (92.7%) | 118 (80.8%) | | 25 (83.3%) | 96 (68.1%) | | 29 (85.3%) | 104 (71.2%) | |
| Outdoors only if accompanied | 1 (2.4%) | 4 (2.7%) | | 1 (3.3%) | 8 (5.7%) | | 0 | 10 (6.8%) | |
| Alone indoors but not outdoors | 2 (4.9%) | 24 (16.4%) | | 3 (10.0%) | 37 (26.2%) | | 5 (14.7%) | 31 (21.2%) | |
| Indoors only if accompanied | 0 | 0 | | 0 | 0 | | 0 | 1 (0.7%) | |
| Unable to walk | 0 | 0 | | 1 (3.3%) | 0 | | 0 | 0 | |
| Total | 41 | 146 | | 30 | 141 | | 34 | 146 | |
| Walking ability 4 months | | | p=0.004 | | | p=0.401 | | | p=0.111 |
| Alone outdoors | 28 (68.3%) | 59 (42.1%) | | 13 (46.4%) | 44 (34.6%) | | 18 (58.1%) | 51 (39.5%) | |
| Outdoors only if accompanied | 2 (4.9%) | 18 (12.9%) | | 2 (7.1%) | 15 (11.8%) | | 0 | 10 (7.8%) | |
| Alone indoors but not outdoors | 6 (14.6%) | 43 (30.7%) | | 7 (25.0%) | 43 (33.9%) | | 8 (25.8%) | 42 (32.6%) | |
| Indoors only if accompanied | 2 (4.9%) | 15 (10.7%) | | 3 (10.7%) | 14 (11.0%) | | 5 (16.1%) | 18 (14.0%) | |
| Unable to walk | 3 (7.3%) | 5 (3.6%) | | 3 (10.7%) | 11 (8.7%) | | 0 | 8 (6.2%) | |
| Total | 41 | 140 | | 28 | 127 | | 31 | 129 | |
| Walking ability 12 months | | | p=0.012 | | | p=1.000 | | | p=0.299 |
| Alone outdoors | 28 (75.7%) | 66 (49.6%) | | 15 (57.7%) | 65 (58.0%) | | 16 (66.7%) | 62 (51.7%) | |

| Parameter | Physical rehabilitation | | | Geriatric rehabilitation | | | Control group | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | p-value | Male | Female | p-value | Male | Female | p-value |
| Outdoors only if accompanied | 4 (10.8%) | 12 (9.0%) | | 2 (7.7%) | 12 (10.7%) | | 2 (8.3%) | 13 (10.8%) | |
| Alone indoors but not outdoors | 2 (5.4%) | 38 (28.6%) | | 6 (23.1%) | 22 (19.6%) | | 4 (16.7%) | 30 (25.0%) | |
| Indoors only if accompanied | 2 (5.4%) | 12 (9.0%) | | 1 (3.8%) | 5 (4.5%) | | 0 | 8 (6.7%) | |
| Unable to walk | 1 (2.7%) | 5 (3.8%) | | 2 (7.7%) | 8 (7.1) | | 2 (8.3%) | 7 (5.8%) | |
| Total | 37 | 133 | | 26 | 112 | | 24 | 120 | |
| | | | | | | | | | |
| Walking aids prefracture | | | p=0.289 | | | p=0.230 | | p=0.340 | p=0.289 |
| No aids | 26 (63.4%) | 78 (53.4%) | | 17 (56.7%) | 80 (56.7%) | | 22 (64.7%) | 75 (51.4%) | |
| One aid | 6 (14.6%) | 33 (22.6%) | | 6 (20.0%) | 17 (12.1%) | | 5 (14.7%) | 25 (17.1%) | |
| Two aids | 0 | 3 (2.1%) | | 0 | 1 (0.7%) | | 1 (2.9%) | 3 (2.1%) | |
| Frame | 9 (22.0%) | 32 (21.9%) | | 6 (20.0%) | 43 (30.5%) | | 6 (17.6%) | 42 (28.8%) | |
| Wheelchair/bedbound | 0 | 0 | | 1 (3.3%) | 0 | | 0 | 1 (0.7%) | |
| Total | 41 | 146 | | 30 | 141 | | 34 | 146 | |
| | | | | | | | | | |
| Walking aids 4 months | | | p=0.026 | | | p=0.475 | | p=0.583 | p=0.026 |
| No aids | 9 (22.0%) | 18 (12.9%) | | 6 (21.4%) | 16 (12.6%) | | 6 (19.4%) | 17 (13.2%) | |
| One aid | 10 (24.4%) | 26 (18.6%) | | 3 (10.7%) | 15 (11.8%) | | 7 (22.6%) | 16 (12.4%) | |
| Two aids | 2 (4.9%) | 5 (3.6%) | | 2 (7.1%) | 3 (2.4%) | | 2 (6.5%) | 10 (7.8%) | |
| Frame | 15 (36.6%) | 86 (61.4%) | | 15 (53.6%) | 83 (65.4%) | | 14 (45.2%) | 76 (58.9%) | |

| Parameter | Physical rehabilitation | | | Geriatric rehabilitation | | | Control group | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | p-value | Male | Female | p-value | Male | Female | p-value |
| Wheelchair/bedbound | 5 (12.2%) | 5 (3.6%) | | 2 (7.1%) | 10 (7.9%) | | 2 (6.5%) | 10 (7.8%) | |
| Total | 41 | 140 | | 28 | 127 | | 31 | 129 | |
| | | | | | | | | | |
| Walking aids 12 months | | | p=0.268 | | | p=0.343 | | | p=0.097 |
| No aids | 13 (35.1%) | 29 (21.8%) | | 8 (30.8%) | 20 (17.9%) | | 9 (37.5%) | 21 (17.5%) | |
| One aid | 10 (27.0%) | 21 (15.8%) | | 5 (19.2%) | 18 (16.1%) | | 7 (29.2%) | 19 (15.8%) | |
| Two aids | 0 | 2 (1.5%) | | 1 (3.8%) | 2 (1.8%) | | 1 (4.2%) | 6 (5.0%) | |
| Frame | 12 (32.4%) | 71 (53.4%) | | 10 (38.5%) | 62 (55.4%) | | 6 (25.0%) | 62 (51.7%) | |
| Wheelchair/bedbound | 2 (5.4%) | 10 (7.5%) | | 2 (7.7%) | 10 (8.9%) | | 1 (4.2%) | 12 (10.0%) | |
| Total | 37 | 133 | | 26 | 112 | | 24 | 120 | |
| | | | | | | | | | |
| Pain in the injured hip 4 months | | | p=0.355 | | | p=0.030 | | | p=0.008 |
| Severe and spontaneous, even at rest | 1 (2.4%) | 4 (2.9%) | | 0 | 2 (1.6%) | | 1 (3.2%) | 2 (1.6%) | |
| Severe when walking and prevents all activity | 3 (7.3%) | 7 (5.0%) | | 4 (14.3%) | 3 (2.4%) | | 7 (22.6%) | 6 (4.7%) | |
| Tolerable, permitting limited activity | 10 (24.4%) | 18 (12.9%) | | 10 (35.7%) | 15 (11.8%) | | 9 (29.0%) | 20 (15.5%) | |
| Occurs only after some activity, diseappears quickly at rest | 5 (12.2%) | 23 (16.4%) | | 7 (25.0%) | 19 (15.0%) | | 2 (6.5%) | 21 (16.3%) | |
| Slight or intermittent, alleviated in normal activity | 12 (29.3%) | 36 (25.7%) | | 2 (7.1%) | 35 (27.6%) | | 5 (16.1%) | 37 (28.7%) | |

| Parameter | Physical rehabilitation | | | Geriatric rehabilitation | | | Control group | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | p-value | Male | Female | p-value | Male | Female | p-value |
| No hip pain | 9 (22.0%) | 48 (34.3%) | | 5 (17.9%) | 47 (37.0%) | | 7 (22.6%) | 38 (29.5%) | |
| Unable to answer | 1 (2.4%) | 4 (2.9%) | | 0 | 6 (4.7%) | | 0 | 5 (3.9%) | |
| Total | 41 | 140 | | 28 | 127 | | 31 | 129 | |
| | | | | | | | | | |
| Pain in the injured hip 12 months | | | p=0.057 | | | p=0.092 | | | |
| Severe and spontaneous, even at rest | 0 | 0 | | 0 | 0 | | 1 (4.2%) | 1 (0.8%) | |
| Severe when walking and prevents all activity | 3 (8.1%) | 2 (1.5%) | | 0 | 1 | | 1 (4.2%) | 5 (4.2%) | |
| Tolerable, permitting limited activity | 3 (8.1%) | 14 (10.5%) | | 2 (7.7%) | 9 (8.0%) | | 3 (12.5%) | 15 (12.5%) | |
| Occurs only after some activity, diseappears quickly at rest | 4 (10.8%) | 14 (10.5%) | | 1 (3.8%) | 5 (4.5%) | | 1 (4.2%) | 12 (10.0%) | |
| Slight or intermittent, alleviated in normal activity | 11 (29.7%) | 26 (19.5%) | | 13 (50.0%) | 29 (25.9%) | | 10 (41.7%) | 19 (15.8%) | |
| No hip pain | 16 (43.2%) | 76 (57.1%) | | 10 (38.5%) | 65 (58.0%) | | 8 (33.3%) | 66 (55.0%) | |
| Unable to answer | 0 | 1 (0.8%) | | 0 | 3 (2.7%) | | 0 | 2 (1.7%) | |
| Total | 37 | 133 | | 26 | 112 | | 24 | 120 | |
| | | | | | | | | | |
| Mortality | | | | | | | | | |
| 4 months | 0 | 6 (4.1%) | p=0.342 | 2 (6.7%) | 14 (9.9%) | p=0.741 | 3 (8.8%) | 16 (11.0%) | p=1.000 |
| 12 months | 4 (9.8%) | 12 (8.2%) | p=0.755 | 4 (13.3%) | 28 (19.9%) | p=0.456 | 9 (26.5%) | 26 (17.8%) | p=0.355 |

| Parameter | Physical rehabilitation | | | Geriatric rehabilitation | | | Control group | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | p-value | Male | Female | p-value | Male | Female | p-value |
| ADL-score prefracture | 18.62 (10.20) | 18.01 (8.64) | p=0.983 | 19.36 (11.43) | 19.94 (9.67) | p=0.364 | 20.36 (11.72) | 20.13 (10.12) | p=0.768 |
| ADL-score 4 months | 24.95 (11.17) | 25.92 (11.24) | p=0.757 | 30 (13.22) | 26.2 (11.3) | p=0.436 | 25.56 (12.82) | 28.03 (11.85) | p=0.213 |
| ADL-score 12 months | 24.57 (11.66) | 25.83 (12.28) | p=0.639 | 25.8 (11.96) | 25.51 (12.79) | p=0.920 | 25.84 (12.55) | 27.31 (12.55) | p=0.529 |

# Original publications

This thesis is based on the following publications, which are referred throughout the text by their Roman numerals:

I Lahtinen, A., Leppilahti, J., Harmainen, S., Sipilä, J., Antikainen, R., Seppänen, M. L., Willig, R., Vähänikkilä, H., Ristiniemi, J., Rissanen, P., & Jalovaara, P. (2015). Geriatric and physically oriented rehabilitation improves the ability of independent living and physical rehabilitation reduces mortality: a randomised comparison of 538 patients. *Clinical Rehabilitation*, 29(9), 892–906.

II Lahtinen, A., Leppilahti, J., Vähänikkilä, H., Harmainen, S., Koistinen, P., Rissanen, P., & Jalovaara, P. (2017). Costs after hip fracture in independently living patients: A randomised comparison of three rehabilitation modalities. *Clinical Rehabilitation*, 31(5), 672–685.

III Lahtinen, A., Leppilahti, J., Vähänikkilä, H., Kujala, S., Ristiniemi, J., & Jalovaara, P. (2019). No major differences in recovery after hip fracture between home-dwelling female and male patients. *Scandinavian Journal of Surgery* (In press).

1491. Ervasti, Tytti-Maarit (2018) Elämänkulkutietoisen ikäjohtamisen vaikutus terveysalan eri-ikäisen henkilöstön työhyvinvointiin

1492. Karhula, Sakari (2018) Quantification of osteochondral tissue modifications during osteoarthritis using micro-computed tomography

1493. Kylmäoja, Elina (2018) Osteoclastogenesis from bone marrow and peripheral blood monocytes : the role of gap junctional communication and mesenchymal stromal cells in the differentiation

1494. Saukko, Ekaterina (2018) Medical use of radiation in gastroenterology : optimising patient radiation exposure during endoscopic retrograde cholangiopancreatography (ERCP)

1495. Pääkkö, Tero (2018) Predictors of left ventricular hypertrophy, diastolic dysfunction and atrial fibrillation : the roles of adiponectin, ambulatory blood pressure and dietary sodium intake

1496. Lackman, Jarkko (2018) Glycosylation and dimerization of the human δ-opioid receptor polymorphic variants

1497. Hoikka, Marko (2018) Prehospital risk assessment and patient outcome : a population based study in Northern Finland

1498. Wiens, Varpu (2018) Pohjoissuomalaisten nuorten tyttöjen hyvinvointi : hypoteettinen malli

1499. Piispala, Johanna (2019) Atypical electrical brain activity related to attention and inhibitory control in children who stutter

1500. Leppänen, Joni (2019) The role of hypoxia, innate immunity receptors and stromal response in pancreatic cancer

1501. Lahtinen, Sanna (2019) Complications, quality of life and outcome after free flap surgery for cancer of the head and neck

1502. Rajavaara, Päivi (2019) Children's dental general anaesthesia : reasons and associated factors

1503. Varpuluoma, Outi (2019) Drugs, dermatitis herpetiformis and celiac disease as risk factors for bullous pemphigoid in Finland

1504. Mäkelä-Kaikkonen, Johanna (2019) Robotic-assisted and laparoscopic ventral rectopexy in the treatment of posterior pelvic floor procidentia

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