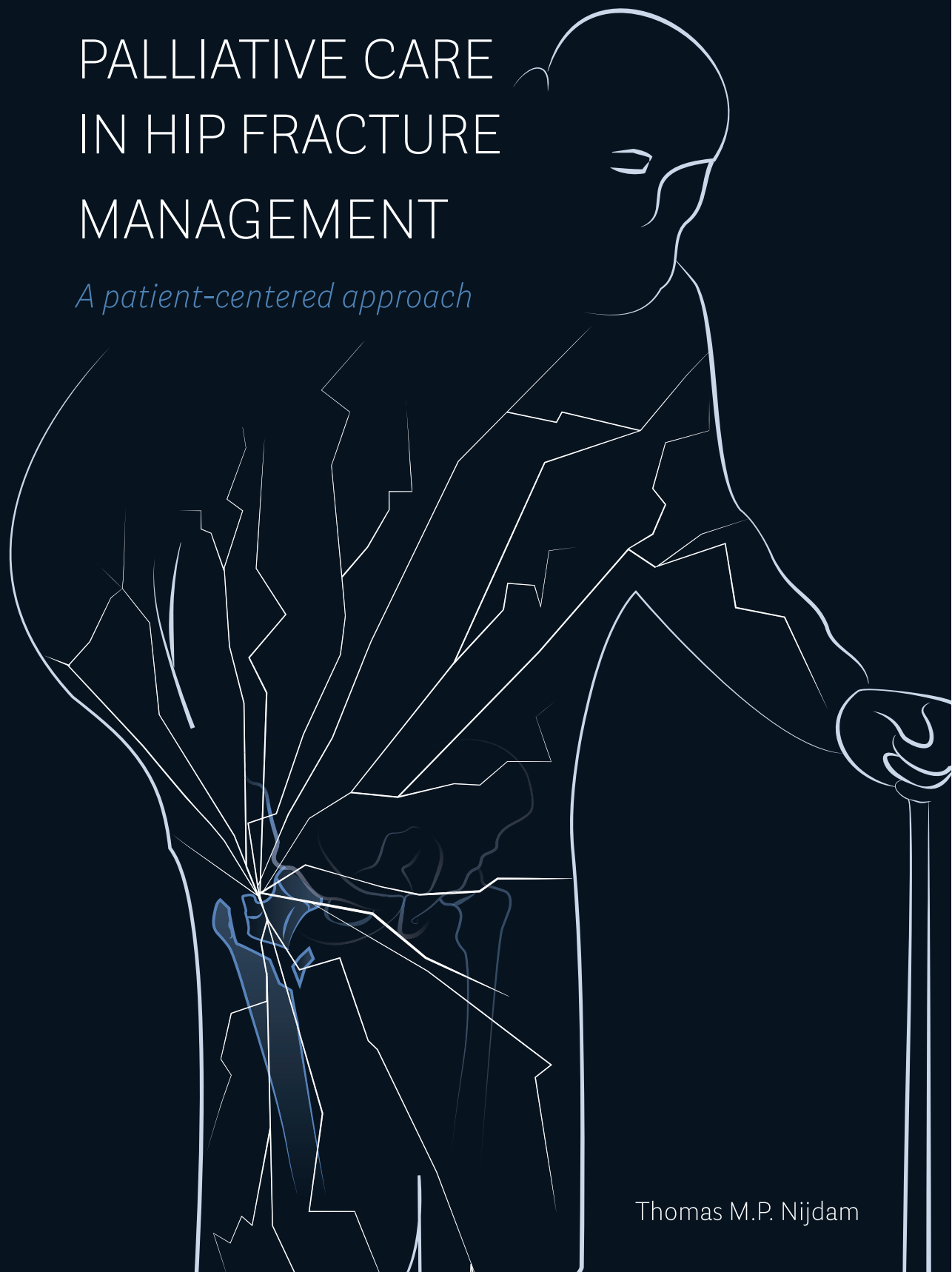
PALLIATIVE CARE IN HIP FRACTURE MANAGEMENT

A patient-centered approach



Thomas M.P. Nijdam

Palliative care in hip fracture management

A patient-centered approach

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PhD Thesis, Utrecht University, The Netherlands
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Palliative care in hip fracture management

A patient-centered approach

Palliatieve zorg voor patiënten met een gebroken heup

Een handelswijze waarbij de patiënt centraal staat

(met een samenvatting in het Nederlands)

Proefschrift

ter verkrijging van de graad van doctor aan de
Universiteit Utrecht
op gezag van de
rector magnificus, prof. dr. H.R.B.M. Kummeling,
ingevolge het besluit van het college voor promoties
in het openbaar te verdedigen

dinsdag 28 november 2023 des middags te **4:15** uur

door

Thomas Marcus Paulus Nijdam

geboren op 13 januari 1993
te Son en Breugel

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	Prof. dr. J.H. Hegeman
	Prof. dr. F.C. Öner
	Prof. dr. J.M.A. Visser-Meilij (voorzitter)

Voor pap en mam,
Die kosten noch moeite gespaard hebben om het mooiste in ons naar boven te halen,

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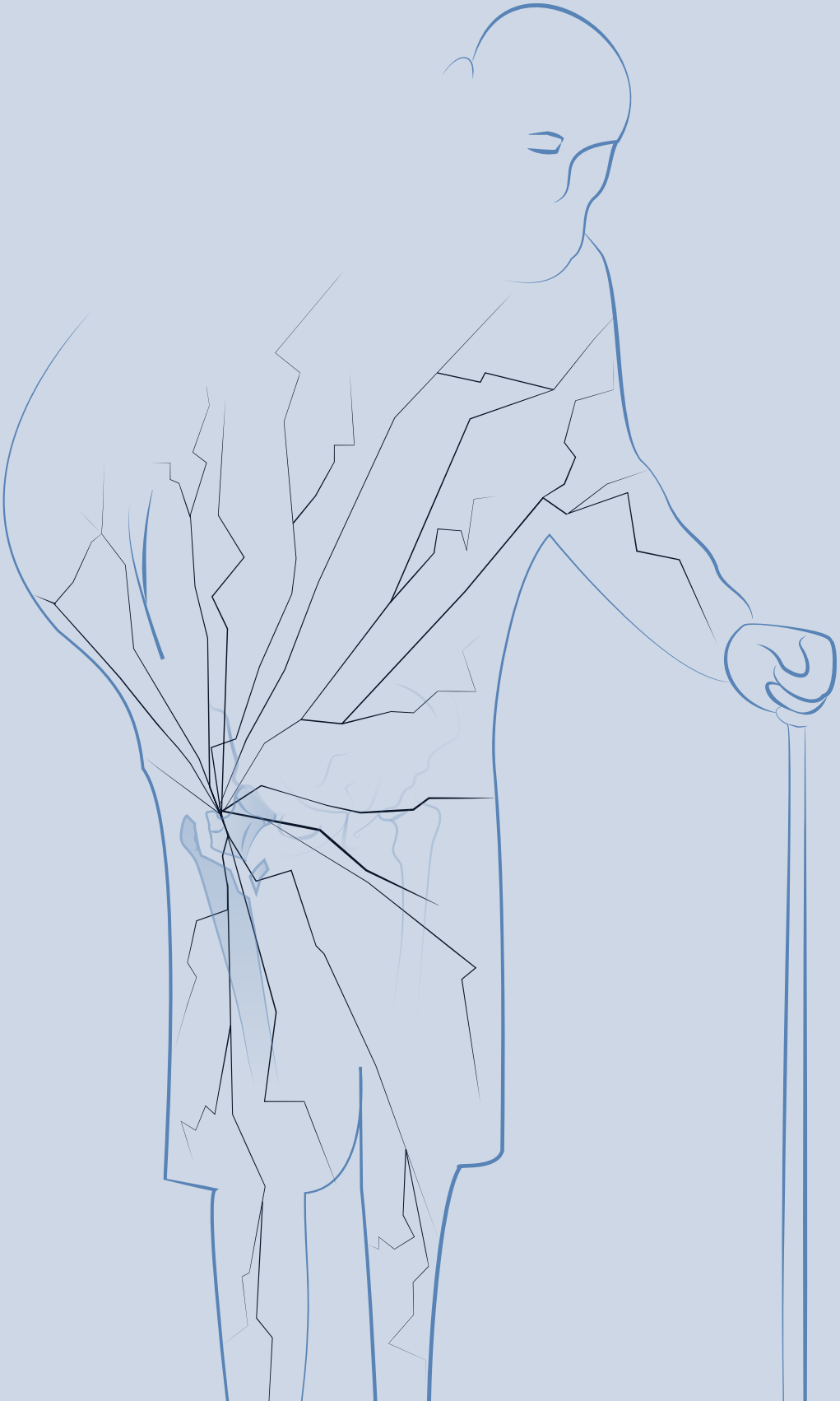

CHAPTER 1

General introduction and thesis outline

THE GERIATRIC HIP FRACTURE PATIENT

Hip fractures are a major concern for healthcare systems globally due to their increasing prevalence among the elderly.[1–3] These fractures can be especially serious for frail patients who may also have other health issues. Even for these vulnerable patients, surgery is required to alleviate pain and regain mobility following a hip fracture. However, complications after surgery, such as delirium, pneumonia, wound infections, are common in this population.[4–8] Falls, which are the leading cause of hip fractures, are prevalent among older adults and can result in injury, hospitalization, or even death. These falls can be caused by muscle weakness, unsteady gait, confusion, and certain medications. The falls, followed by a hip fractures in older adults can occur due to frailty and also may indicate approaching end-of-life.[9,10] Consequently, when patients are admitted to the hospital due to a hip fracture, the associated mortality rates are remarkably high, reaching up to 22-30% within one year after the surgery.[11,12] Furthermore, the 30-day mortality rate following a hip fracture is also substantial, ranging from 7% to 14%.[13,14]

Problems may arise when healthcare providers focus on managing diseases rather than the patients as a whole and their underlying health problems.[15] Over the years, orthogeriatric care models have increased the trend to patient oriented care where the multidisciplinary approach matches the needs of the geriatric hip fracture patient.[16,17] Both short- and long-term outcomes seems to benefit for the postoperative path.[18,19] However, the patient-centered approach lacks in the pre-operative process were solely focus is set on the hip fracture rather than the holistic view on the geriatric patient.[20]

What are the goals of care of this hip fracture patient?
What would be favorable for this geriatric patient?
Will surgery match the patients' preferences?

Recent evidence demonstrates that non-operative management is equally effective as operative management in terms of sustaining satisfactory quality of life for geriatric patients with limited life expectancy.[21] For frail geriatric patients who have a notably limited life expectancy, the consideration of palliative, non-operative management (P-NOM) has gained prominence as an alternative to traditional operative management (OM).[9,21,22] Through the path of shared decision-making, patients have the opportunity to choose for a more peaceful final phase of life with P-NOM, as opposed to an uncertain period of intensive recovery following surgical intervention for hip fractures.[23] Given the viability of P-NOM, it is crucial for physicians to engage in Shared Decision Making (SDM) discussions regarding this option in acute care settings.[24] SDM after all, plays a critical role in delivering high-quality care as a physician.[25] It empowers patients by providing them with comprehensive

information and a deeper understanding of potential risks associated with their treatment options, resulting in improved patient satisfaction and informed decision-making.[26] Not every patient will have the same desire for rehabilitation or life-prolonging interventions. Therefore exploring the patient's Goals of Care (GOC) in acute setting is crucial, especially in hip fracture management.[10,27]

Unlike patients with oncological or chronic conditions, geriatric trauma patients and their family members often have not contemplated their palliative needs until faced with life changing events such as a the diagnosis of a hip fracture at the emergency department. Exploring the general GOCs of hip fracture patients can assist physicians in discussing and evaluating individual preferences for future patients in the Emergency Department (ED).[27]

Since the introduction of palliative care in hip fracture management, there has been a significant increase in the utilization of SDM. This shift is particularly pronounced due to its applicability to a significant and progressively growing cohort of frail geriatric patients. This message not only regarding patients who already fractured the hip but also geriatric patients susceptible to sustain a hip fracture in the near future. Evaluation, improvement, and ensuring the general availability of this management appear to be crucial for the future of hip fracture management. Patient and proxy reported opinions and experiences are the cornerstones of these improvements. Therefore, the studies presented in this thesis aim to contribute to some particular ambitions:

1. **Explore the patients' side of clinical hip fracture management**

2. **Address the value of shared decision-making in hip fracture management**

3. **Assess possible improvements of the newly introduced palliative non-operative management**

4. **Underline the need for a major transition in 'Advance Care Planning' in the near future**

THESIS OUTLINE

Chapter 2 of the thesis explores the impact of comprehensive geriatric pathways on orthogeriatric care for hip fracture patients, with a focus on improving their quality of life. A systematic review was conducted to gather empirical evidence on in-hospital orthogeriatric care enhancements.

In **Part 2**, a detailed analysis of frail geriatric hip fracture patients and their characteristics is presented. **Chapter 3** identifies short- and long-term predictors of mortality in hip fracture patients to offer transparency in the postoperative process after hip surgery. **Chapter 4** describes frail hip fracture patients living at home. The goal is to understand complex prognostic factors, focusing on geriatric patients initially not institutionalized.

Part 3 evaluates newly introduced palliative care methods for hip fracture management. **Chapter 5** presents the first evaluation of Palliative Non-Operative Management (P-NOM) reported by proxies of P-NOM patients. **Chapter 6** monitors and outlines the impact of P-NOM on surgically treated hip fracture patients, comparing pre- and post-implementation cohorts.

In **Part 4**, the evaluation of P-NOM leads to the identification of novel themes to refine the method, aligned with patient preferences. **Chapter 7** aims to enhance shared decision-making by identifying goals of care for geriatric patients with hip fractures in the acute setting**. Chapter 8** examines patient preferences in decision-making dialogues, specifically focusing on the choice between hip fracture surgery and (palliative) non-operative management.

Lastly, **Chapter 9** introduces a pilot study integrating a immunologic clinical test involving the evaluation of geriatric immune response in the Emergency Department through the assessment of neutrophil activation subsequent to a hip fracture.

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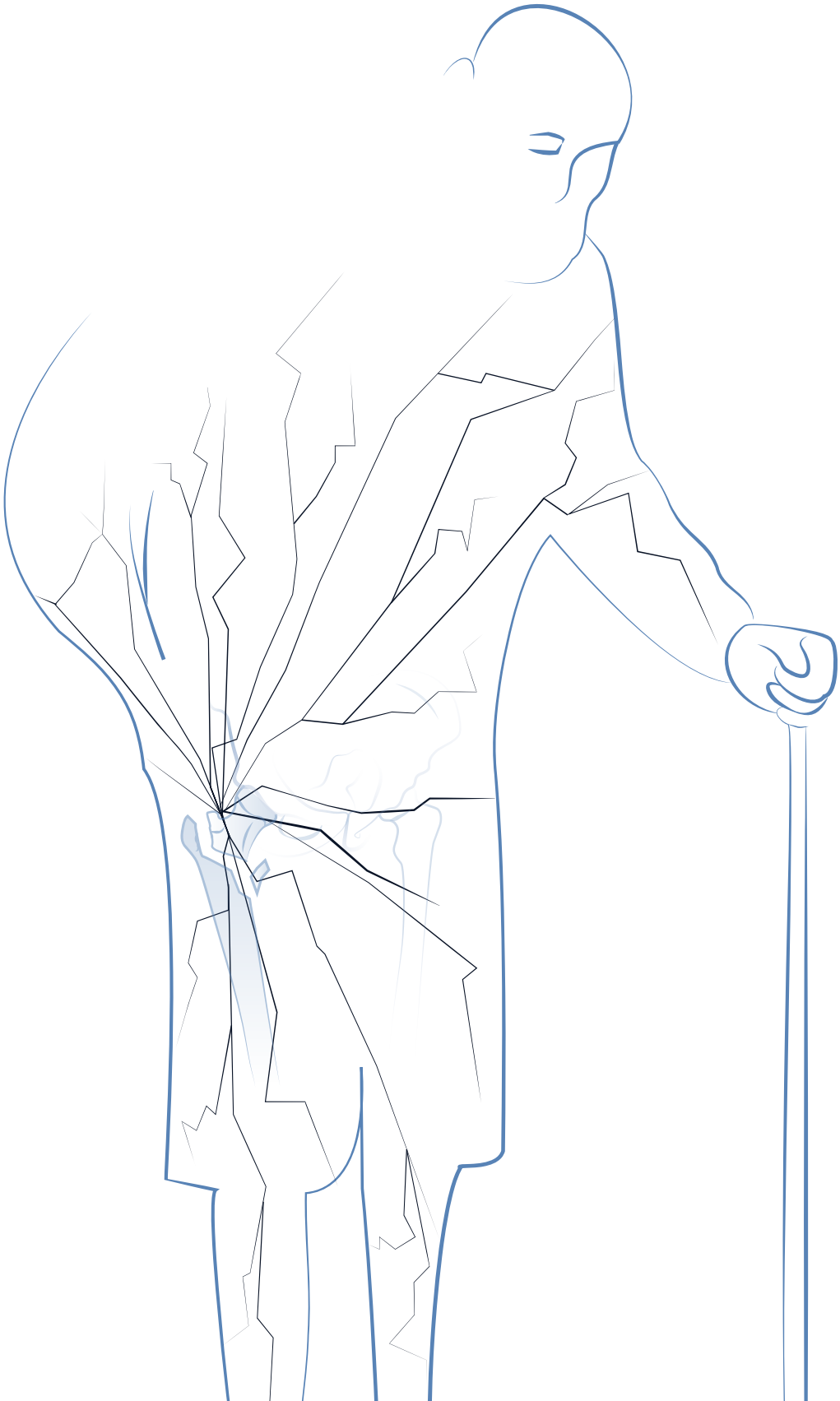
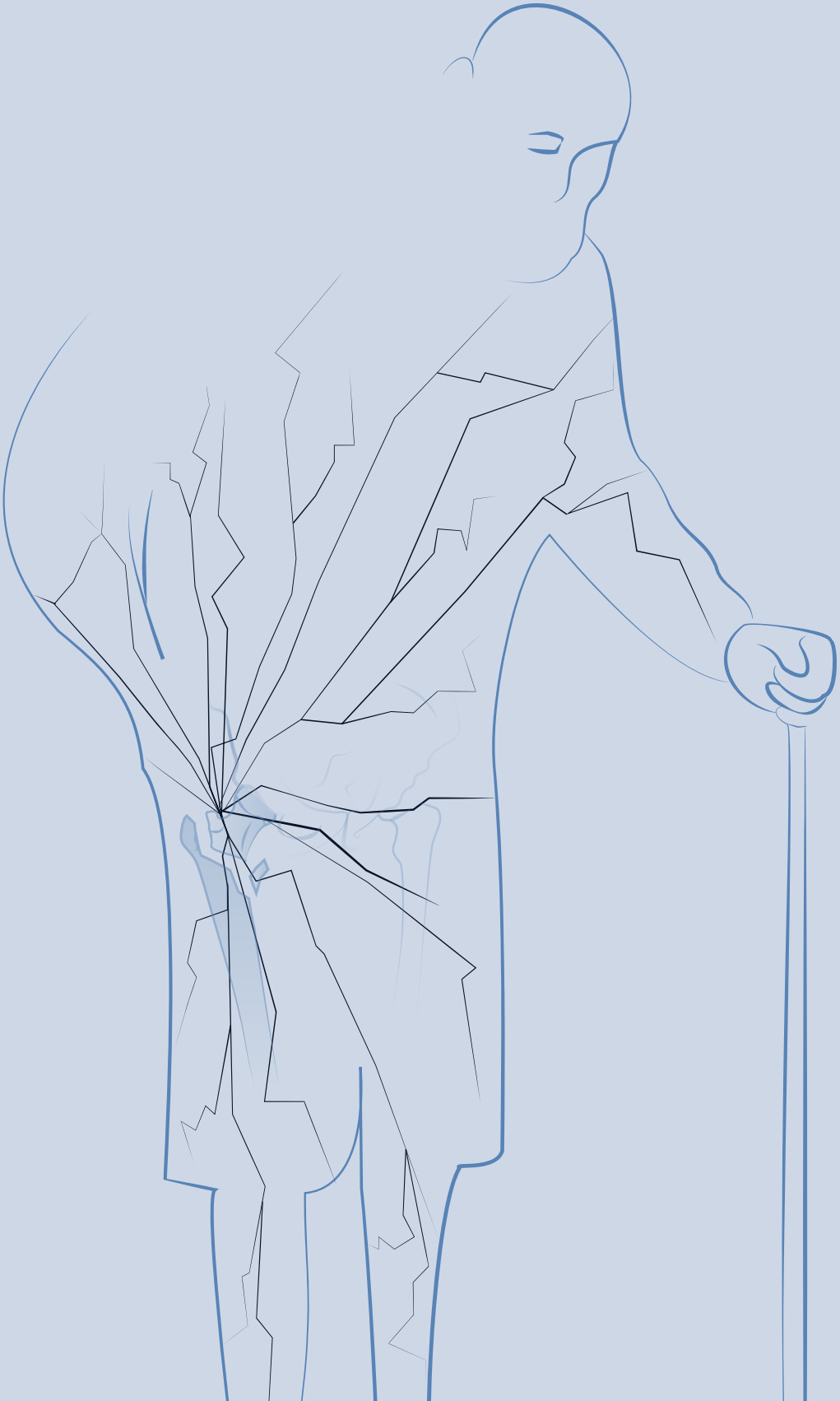


PART I

Geriatric Care in Hip Fracture Management



CHAPTER 2

Impact of geriatric care interventions on Quality of Life for geriatric hip fracture patients; a systematic review

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T. Kobes
M.C.P.M. van Baal
D.P.J. Smeeing
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Submitted

ABSTRACT

Objective

Orthogeriatric care models focus not only on fracture care but offer a more holistic approach to regular fracture care. The orthogeriatric care models have been introduced in recent years to improve outcomes in hip fracture patients. However, the effect of in-hospital geriatric care interventions on the quality of life of hip fracture patients is not well understood and was the focus of this systematic literature review.

Methods

A literature search was conducted on PubMed/MEDLINE, Embase, and Cochrane. Studies published in the past 15 years involving in-hospital geriatric care interventions for patients aged 65 years or older, measuring the quality of life, and with a follow-up of at least 12 weeks were included. The methodological quality of included studies was assessed using the MINORS criteria.

Results

Out of 1,604 non-duplicate studies, six articles were included. Interventions ranged from early mobilization to a complete comprehensive care pathway. Three of the six included studies found a significant improvement in the quality of life after implementing the in-hospital geriatric intervention for the hip fracture patient. The instituted care interventions differed from early mobilization or rehabilitation to multidisciplinary pathways.

Conclusions

In conclusion, orthogeriatric interventions have been increasingly introduced in orthopedic wards in recent years. Multiple studies observed significant higher quality of life scores in patients treated with in-hospital geriatric care postoperatively. These interventions are broadly implemented in fracture care and aim to improve experienced outcomes in (frail) hip fracture patients.

INTRODUCTION

Due to an aging population, the absolute number of hip fractures is expected to rise globally to 4,5 million by 2050.[1,2] Most of these patients will undergo surgery for early mobilization to gain the possibility to rehabilitate.[3] Despite several improvements in the surgical field, about one-third of patients lose the ability to walk independently, and 22 to 33% are deceased one year after trauma, reflecting the frail population sustaining a hip fracture.[4]

For elderly individuals, preserving mobility is crucial to maintaining their quality of life and independence.[4] However, the concept of quality of life in the elderly is multidimensional and not limited to mobility.[11] Physical health, mental health, independence, and social factors all play a role and are interdependent. Even in the absence of any injury, elderly individuals are more likely to experience physical disabilities and social isolation. In addition to the physical challenges posed by a hip fracture, such as pain and disability, individuals experience emotional and social consequences such as depression, fear of falling, disability, institutionalization, and (increased) social isolation.[5] Hence, the quality of life in hip fracture patients can be affected in multiple domains, which all require attention. A more holistic approach could improve outcomes in elderly hip fracture patients.

In the last decades, orthogeriatric care models were introduced, focusing not solely on fracture care. With a multidisciplinary perspective, physicians aimed to improve outcomes in older hip fracture patients.[6,7] This more holistic approach should enable physicians to manage the patients' multimorbidity and consequent frailty. Multiple studies showed promising results on clinical outcomes of the hip fracture patient in favor of comprehensive geriatric pathways and interventions.[8,9] Compared to traditional orthopedic care, hip fracture patients aged 70 years or older benefit from perioperative geriatric care on short- and long-term outcomes, including mobility and activities of daily living. [10] The most recent systematic review on quality of life in hip fracture patients was published in 2016.[12] Since that review, the shift toward orthogeriatric and multidisciplinary care has increased.[13] In addition, the impact of (specific) orthogeriatric care interventions on separate dimensions of the quality of life has, to our knowledge, not been reviewed. Therefore, this systematic literature review aimed to assess the effect of in-hospital geriatric interventions on the quality of life of elderly hip fracture patients.

MATERIAL & METHODS

Study design

No ethical committee approval was necessary for this study. This systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis Statement (PRISMA).[14] The review protocol was registered in PROSPERO (CRD42022350122).

Search Strategy and Selection of studies

A systematic literature search was conducted in PubMed/MEDLINE, Embase, and Cochrane on July 22nd, 2022. All relevant synonyms for two search terms – 'hip fracture' and 'quality of life' – were included in the search syntax (**Appendix 1**). Studies issued after 2007 (last 15 years) were included as the focus on orthogeriatric care increased during these years and it created an arbitrary overlap in the inclusion periods of Peeters et al. and ours.[12] The other inclusion criteria were 1) hip fracture patients aged 65 years or older, 2) treated with an active in-hospital geriatric care intervention, 3) quality of life as a study outcome, 4) the minimal follow-up was 12 weeks, 5) the paper was available in Dutch, English, or German language, 6) original data was reported (no reviews, editorial letters, or expert opinions, et cetera). Also, studies on outpatient interventions or studies that described a relevant intervention without a comparison group were excluded. Rayyan was used for data management and selection of the studies.[15] After removing duplicates, titles and abstracts were screened for relevance. Two independent researchers (TN and TK) performed the screening, blinded to the other's verdict. After separately screening all titles and abstracts, a consensus was reached by discussion when necessary; a third reviewer (DS) was available for an additional verdict in case no consensus could be reached. Full texts of eligible studies were read before final inclusion. Reference checking of included studies was performed to search for additional relevant studies.

Data Extraction

The following data were extracted: first author, year of publication, the country in which the study was conducted, study design (e.g., cohort study, randomized clinical trial (RCT)), study period, number of patients, mean age, the sex distribution, the applied intervention, the quality of life measure, follow-up moment(s), and the effect of the intervention on the quality of life.

Assessment of methodological quality

Two independent researchers (TK and TN) assessed the methodological quality according to the Methodological Index for Non-Randomized Studies (MINORS) for all full texts of included studies.[16] The MINORS score for comparative studies ranges from 0 to 24, with a higher score representing a better methodologic quality. For this review, a score of less than 14 was considered poor quality, 15-19 moderate quality, and 20-24 for good quality for comparative studies.[17] This index is validated to assess the quality of non-randomized and randomized studies. Disagreements were resolved by discussion with a third reviewer (DS) until a consensus was reached.

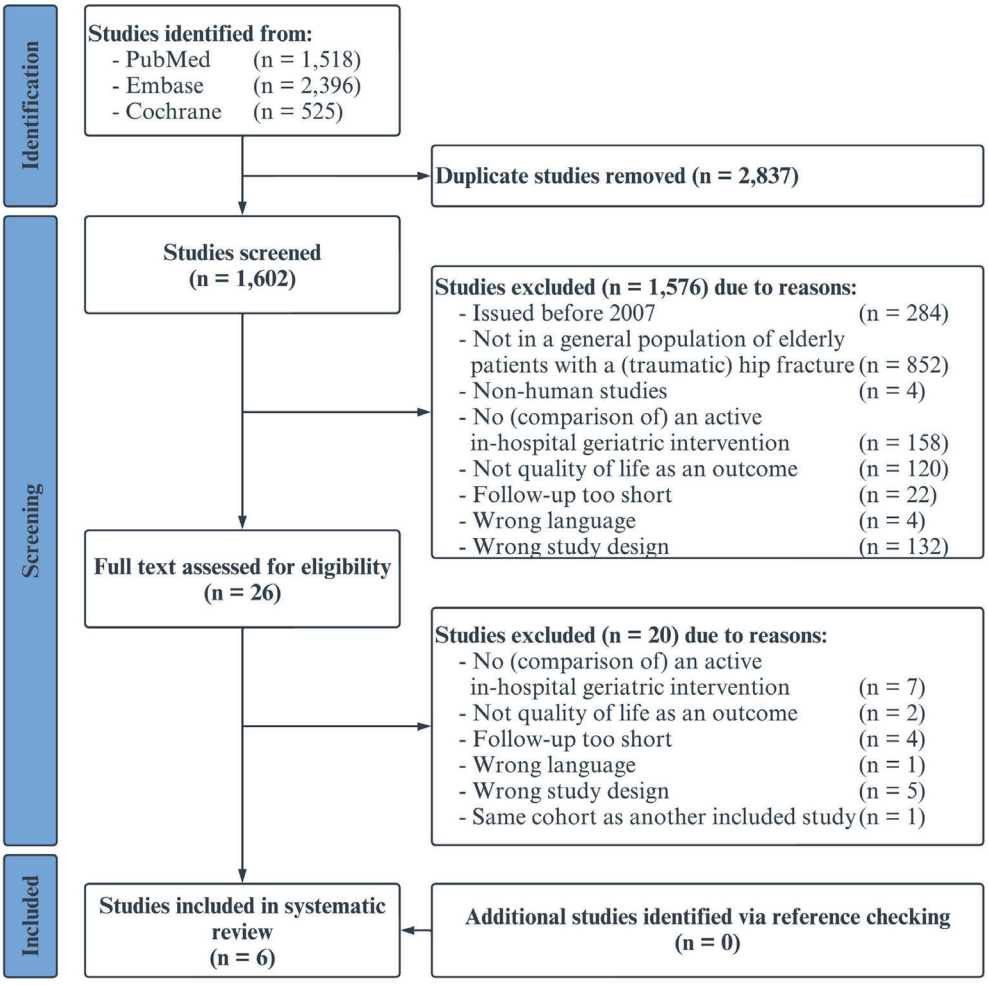

Figure 1. PRISMA flow diagram for in- and exclusion of studies that assess quality of life in elderly hip fracture patients.

RESULTS

Search

In total, 1,518 (PubMed/MEDLINE), 2,396 (Embase), and 525 (Cochrane) articles were identified. After removing duplicates, 1,602 articles were screened for title and abstract. A total of 27 full text of studies were screened for eligibility, of which six were included. No additional studies were identified through reference checking. The study selection is illustrated in **Figure 1** using the PRISMA flow diagram.

Table 1. Study characteristics of the included studies.

First author	Year	Country	Study design	Study period(s)	Number of patients	Mean age in years (SD)	% of patients female (n)
Flikweert	2021	The Netherlands	Prospective controlled trial	2012 – 2013	357	79 (9)	65 232)
Xiang	2021	China	Prospective cohort study	2015 – 2017	284	80.7 (7.6)	69.7 (198)
Schoeneberg	2021	Germany	Retrospective cohort study	2016 – 2019	21,734	84.4 (6.5)	72 (15,648)
Griffin	2021	United Kingdom	Observational cohort study	2014 – 2017	8,673	83 (8.5)	73 (6,331)
Kalmet	2019	The Netherlands	Retrospective cohort study	2012 and 2015	398	82.7 (7.5)	70.9 (282)
Prestmo	2015	Norway	Randomized controlled trial	2008 – 2010	397	83.3 (5.9)	74 (294)

Abbreviations: SD, standard deviation.

Table 2. Description of geriatric care intervention for patients with a hip fracture.

Study	Intervention	Description of intervention
Flikweert (2021)	Comprehensive care pathway	Trauma geriatric ward and dedicated operating room time slot on the morning after admission.
Xiang (2021)	Early mobilization	Immediate in-bed mobilization after surgery and followed a standardized daily exercise program during 12 weeks.
Schoeneberg (2021)	Early geriatric rehabilitation	Orthogeriatric co-management two patient visits from the interdisciplinary team including geriatrics and surgeons, weekly. Treatment of delirium, diagnostic and treatment of osteoporosis and malnutrition, and structured identification of patients with the need for geriatric assessment preoperative.
Griffin (2021)	Best Practice Tariff criterion	Surgery <36h, Geriatrician < 72h, Joint care, Multidisciplinary team, Fall risk assessment, Delirium assessment, and Geriatrician-directed rehabilitation.
Kalmet (2019)	Multidisciplinary clinical pathways	Actively involvement of orthopedic trauma surgeon, a geriatrician, an anesthesiologist, and a physiotherapist start from presentation .
Prestmo (2015)	Comprehensive geriatric care	Structured, systematic interdisciplinary comprehensive geriatric assessment and care focusing on: somatic health (comorbidity management, review of drug regimens, pain, nutrition, elimination, hydration, osteoporosis, and prevention of falls); mental health (depression, delirium); function (mobility, p-ADL and i-ADL) and social situation - Early discharge planning - Early mobilization and initiation of rehabilitation

Abbreviations: ADL, activities of daily living.

Of the included studies, one was a randomized controlled trial [18], two were prospective – a controlled trial and cohort study [19,20], two were retrospective [21,22], and one had an observational design.[23] Five of the six included studies were conducted in Europe [18,19,21–23] and the other in China.[20] The study by Prestmo et al. [18] was published in 2015, whereas the remaining studies were published in 2019 [22] or 2021.[19–21,23]

Baseline Characteristics

The number of included patients ranged widely: four studies had a cohort of 284 to 398 patients, one study included 8,673 patients [23], and one had 21,734 patients.[21] All studies had an elderly population (mean age 68 – 84) and a predominantly female cohort (range 65 – 74%).

Study characteristics are described in **Table 1**. The study periods ranged from one to four years, and all were conducted between 2008 and 2019. Studies did not apply different inclusion or exclusion criteria in terms of age, trauma mechanism or fracture treatment.

Interventions

The type of in-hospital geriatric intervention varied from early mobilization after hip fracture surgery to a comprehensive care pathway with a multidimensional dedicated approach. Five studies introduced multidisciplinary interventions. These interventions contained:

- Dedicated geriatric operating time slots [19];
- Any geriatric assessment and/or involvement [18,21 –23];
- Delirium assessment and/or treatment [18,21,23];
- Osteoporosis and malnutrition evaluation [18,21];
- Fall risk appraisal. [18,23]

In addition, Griffin et al. pursued surgery within 36 hours of presentation [23], and Prestmo et al. initiated early discharge planning.[18]

One study provided patients with early mobilization, starting immediately post-surgery and continuing during the weeks after surgery.[20] Also, early mobilization was part of the comprehensive geriatric care of Prestmo et al..[18] Kalmet et al. involved a physiotherapist directly from admission.[22] An overview of geriatric care interventions is stated in **Table 2**.

Quality of Life

Five studies used the EQ-5D form to assess the quality of life; three used the EQ-5D-3L version [18,19,21], one study used the EQ-5D-5L [23], and one did not state the particular EQ-5D used.[20] Kalmet et al. used the Short Form (SF)-12 for the quality of life assessment.[22]

Follow-up moments to assess the quality of life ranged from 7 days to 2 years, with 1 to 3 times per study. Three studies described a statistically significant higher quality of life during follow-up for patients in the intervention group compared to the control cohort respectively (0.91 (0.88 – 0.93) vs. 0.87 (0.85 – 0.89); p = 0.033, 0.54 (0.26) vs. 0.46 (0.26);

Table 3. Quality of life assessment of geriatric patients with a hip fracture.

Study	Quality of life assessment tool	Follow-up moment(s) for quality of life	Quality of life in the intervention group vs. control group	*p*-value
Flikweert (2021)	EQ-5D-3L	6 months post fracture	0.69 (-0.13 – 1.00) vs. 0.61 (0.17 – 1.00)	0.70
Xiang (2021)	EQ-5D	12 weeks	0.91 (0.88 – 0.93) vs. 0.87 (0.85 – 0.89)	0.033
Schoeneberg (2021)	EQ-5D-3L	7 and 120 days	0.70 (0.29 – 0.70) & 0.79 (0.40 – 0.90)	NA
Griffin (2021)	EQ-5D-5L	4 months	0.438 vs 0.419*	0.026
Kalmet (2019)	SF-12	2 years	47.9 (24.4) vs. 45.4 (27.6)	0.65
Prestmo (2015)	EQ-5D-3L	1, 4, and 12 months	0.54 (0.26) vs. 0.46 (0.26)	0.033

*Only presented in mean without 95% CI.
Abbreviations: CI, confidence interval; NA = not applicable.

Table 4. Risk of bias appraisal following MINORS criteria of studies included in this systematic review.

Study	A stated aim of the study	Inclusion of consecutive patients	Prospective collection of data	Endpoint appropriate to the study aim	Unbiased evaluation of endpoint	Follow-up period appropriate to the major endpoint	Loss to follow-up <5%	Prospective sample size calculation	Gold standard for control group	Contemporary groups	Baseline equivalence	Statistical analysis for study design	Total score
Flikweert (2021)	2	1	2	1	1	1	1	2	1	2	1	1	**16**
Xiang (2021)	2	1	2	2	1	1	1	2	2	2	2	2	**20**
Schoeneberg (2021)	2	1	0	2	1	1	1	0	1	1	2	1	**13**
Griffin (2021)	1	1	0	1	0	1	1	0	0	1	1	1	**8**
Kalmet (2019)	2	1	0	2	0	1	1	2	2	1	1	1	**14**
Prestmo (2015)	2	1	2	2	1	1	1	2	2	2	1	2	**19**

0 indicating that it was not reported in the article evaluated, 1 indicating that it was reported but inadequately, and 2 indicating that it was reported adequately.

$p = 0.033$, and 0.438 vs 0.419;$p = 0.026$) [18,20,23], whereas two studies did not respectively (0.69 (-0.13 – 1.00) vs. 0.61 (0.17 – 1.00); $p = 0.70$, 47.9 [24.4] vs. 45.4 (27.6); $p = 0.65$).[19,22] One study did not conduct statistical testing on the quality of life between groups (**Table 3**).[21]

Assessment of methodological quality

Table 4 shows the distribution of the study quality across the studies. The mean MINORS score for included studies was 15 (ranging from 8 to 20). Three studies were of poor methodological quality, two retrospective studies [21,22] and one observational cohort study.[23] A prospective controlled trial and randomized controlled trial were rated moderate.[18,19] The methodologic quality prospective cohort study by Xiang et al. was considered good.[20]

DISCUSSION

This systematic review aimed to assess the effect of in-hospital geriatric care interventions on the quality of life in elderly hip fracture patients. Six studies with a variation of geriatric interventions were included in this review. The utilized care interventions differed from early mobilization or rehabilitation to multidisciplinary pathways. Except for one study, the EQ-5D questionnaire was used to measure the quality of life of study subjects. From the included studies, 3 out of 6 studies observed significant improvement for hip fracture patients in terms of quality of life in the geriatric intervention group.

Discussion of key findings

We observed a wide spectrum of geriatric interventions in the included studies. This diversity complicated the comparison but gave insight into the broad interest and applicability of in-hospital geriatric care interventions. Several studies introduced geriatric or comprehensive care pathways in their hospitals. In summary, these interventions consisted of multidisciplinary care with a holistic approach – introducing co-treatment of a geriatrician – combined with dedicated surgery time. The latter included specialized nursing staff, nutritional advice, fall risk assessment, and increased attention to delirium. Two studies provided early geriatric rehabilitation or early mobilization to their patients. All these concepts – a multidisciplinary collaboration with early rehabilitation implemented in dedicated pathways – have been described previously by Devas [24] and, more recently, Mangram et al. [25], Friedman et al. [26], and Vidan et al. [27], among others. With the aim to improve care for geriatric trauma patients, the geriatric orthopedic unit started with Devas's introduction of the geriatrician as the treating physician of elderly orthopedic trauma patients [24], which is still one of the main characteristics of orthogeriatric care, though to a varying extent.[28] Also, the cluster of accompanying interventions – involvement of physiotherapists and rehabilitation specialists, pain control, delirium prevention, early discharge planning, and many more – became more extensive; our results also highlight this.[13,25,27,29] These (different bundles of) interventions reduced mortality, complications, and hospital length of stay. Previous studies focused on the efficacy, usefulness, and benefits during hospital stay; however, the patient-reported and long-term effects remained underexposed. Furthermore, the wide range of

implemented interventions inhibits proper identification of the most influential aspects of orthogeriatric care, though it emphasizes the importance of this holistic and specialist perspective on managing geriatric hip fracture patients.

Five included studies measured the quality of life using the EQ-5D score, and one used the SF-12. In line with the study by Peeters et al., these were the most common quality of life measures.[12] Parsons et al. studied the EQ-5D questionnaire specifically in hip fracture patients and reported that using the EQ-5D in hip fracture patients, even proxy-reported (for cognitively impaired patients), is an adequate tool to measure HRQoL in the hip fracture population.[30] Most included studies measured quality of life at different time points. Only two studies measured the quality of life at more than one time point after injury: one study had two follow-up time points [21], and the other had three.[18] In their systematic review, Peeters and colleagues observed the overall impact of a hip fracture on quality of life.[12] They concluded that the first two to six months were the most essential for the recovery of the quality of life in elderly hip fracture patients. Now, the wide range and inconsistency of follow-up moments make it impossible to compare outcomes.

Pre-fracture quality of life or functioning were missing in all studies as a variable. Though difficult in trauma research – as recollection can introduce bias – it could provide valuable information on patient opportunities, self-efficacy, and reminiscence. The WHiTE study group published on the wide variety and multifactorial origin of the preinjury quality of life in hip fracture patients.[31] For instance, cognitive impairment, comorbidities, and preinjury mobility status were important. If we pursue a more holistic approach to our geriatric hip fracture patient, we should acknowledge there is a patient that needs specialized management besides having a hip fracture requiring (surgical) treatment. The quality of life in the elderly is a broad concept and subject to mental health, physical health, and self-efficacy.[11,32,33] Furthermore, for hip fracture patients with limited life expectancy, quality of life is the most important quality benchmark and patient-outcome measure.[31] Therefore, we deemed it the primary outcome of interest in this study. We advise that future studies measure the quality of life on the EQ-5D scale, to enhance comparability, at several follow-up moments for at least six months after injury. Ideally, this feature could be included in the nationwide hip fracture registration as a quality indicator (in the Netherlands; Dutch Hip Fracture Audit). The differences in EQ-5D scores varied between 0.02 and 0.09 when comparing the intervention and control groups of all included studies. Even though the difference between groups was statistically significant in some studies, the low differences raise questions about the clinical implications. However, no study provided information on the within-group improvement. Therefore, a potentially relevant difference for patients within an intervention group, with additional improvement due to an interdisciplinary approach, could not be evaluated. Future research should report on the in-group changes and the inter-group differences to properly assess the clinical effect or benefit of geriatric interventions.

Limitations

Our systematic review has several limitations to consider. Firstly, we did not use a predefined definition of orthogeriatric care to include studies, which highlighted the diverse range of interventions being studied but also made it difficult to determine exactly what part of the geriatric care interventions impacted the quality of life scores most. Secondly, we did not discuss nor consider other short- or long-term outcome measures in our conclusions since this was beyond the scope of this review, however, it is important to note that quality of life can change over time and is a multifaceted outcome that may require a multifactorial approach in hip fracture patients. Lastly, a meta-analysis of the included studies could have strengthened our conclusions, but the wide range of interventions and different follow-up moments made this impossible to accomplish.

Clinical and future implications

Future studies should focus on multiple aspects to improve comparability and, consequently, the care for the elderly. Firstly, for assessment of the quality of life, the advice is to assess multiple time points in the first six months after injury, as the recovery process is volatile. A patient trend illustrates recovery better than only a comparison between treatment groups; the pre-fracture quality of life as an addition would increase the insight into the recovery process. Secondly, it might be interesting to analyze the quality of life domains separately. Tseng et al. showed that the SF-36 physical component is more prone to improve than the mental health component, physical recovery is dividable into three groups, and more intensive interventions were more profitable for the quality of life in geriatric hip fracture patients.[34] One could hypothesize that several interdisciplinary interventions apply more in specific subgroups. For instance, fall risk assessment could have more effect on the visually impaired, whereas a physically frail patient requires increased physiotherapy. Ultimately, future studies should use the EQ-5D questionnaire to evaluate the quality of life, obtain multiple follow-up moments, evaluate in-group change in addition to between-group differences, and collect patient-specific vulnerabilities to improve patient-tailored treatment.

Conclusion

Orthogeriatric interventions have been increasingly introduced in orthopedic wards in recent years. Multiple studies observed significant higher quality of life scores in patients treated with in-hospital geriatric care postoperatively. These interventions are broadly implemented and consist of a wide range of holistic alterations in specialized care aimed to aid the shortcomings of the frail geriatric hip fracture patient.

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APPENDIX 1 – SEARCH SYNTAX:

PubMed/MEDLINE

("Hip Fractures"[MeSH Terms] OR "hip fracture*"[Title/Abstract] OR "trochanteric fracture*"[Title/Abstract] OR "intertrochanteric fracture*"[Title/Abstract] OR "subtrochanteric fracture*"[Title/Abstract] OR "proximal femur fracture*"[Title/Abstract] OR "proximal femoral fracture*"[Title/Abstract] OR "femur neck fracture*"[Title/Abstract] OR "femoral neck fracture*"[Title/Abstract] OR "femur head fracture*"[Title/Abstract] OR "femoral head fracture*"[Title/Abstract])

AND

("Quality of Life"[MeSH Terms] OR "Quality of Life"[Title/Abstract] OR "QoL"[Title/Abstract] OR "HRQoL"[Title/Abstract] OR "eq 5d*"[Title/Abstract] OR "eq-5d*"[Title/Abstract] OR "TOPICS-SF*"[Title/Abstract] OR "euroqol*"[Title/Abstract] OR "Short Form Health Survey"[Title/Abstract] OR "SF-12"[Title/Abstract] OR "SF-36"[Title/Abstract] OR "Quality-Adjusted Life Years"[MeSH Terms] OR "quality adjusted life year*"[Title/Abstract] OR "quality adjusted life year*"[Title/Abstract] OR "qaly*"[Title/Abstract] OR (("patient reported outcomes measurement information system"[Title/Abstract] OR "patient reported outcomes measurement information system"[Title/Abstract] OR "PROMIS"[Title/Abstract]) AND ("Global Health"[Title/Abstract] OR "GH"[Title/Abstract])))

Embase

('hip fracture'/exp OR 'hip fracture*':ti,ab OR 'trochanteric fracture*':ti,ab OR 'intertrochanteric fracture*':ti,ab OR 'subtrochanteric fracture*':ti,ab OR 'proximal femur fracture*':ti,ab OR 'proximal femoral fracture*':ti,ab OR 'femur neck fracture*':ti,ab OR 'femoral neck fracture*':ti,ab OR 'femur head fracture*':ti,ab OR 'femoral head fracture*':ti,ab)

AND

('quality of life'/exp OR 'Quality of Life':ti,ab OR 'QoL':ti,ab OR 'HRQoL':ti,ab OR 'eq 5d*':ti,ab OR 'eq-5d*':ti,ab OR 'TOPICS-SF*':ti,ab OR 'euroqol*':ti,ab OR 'Short Form Health Survey':ti,ab OR 'SF-12':ti,ab OR 'SF-36':ti,ab OR 'quality adjusted life year'/de OR 'quality adjusted life year*':ti,ab OR 'quality adjusted life year*':ti,ab OR 'qaly*':ti,ab OR (('patient reported outcomes measurement information system':ti,ab OR 'patient reported outcomes measurement information system':ti,ab OR 'PROMIS':ti,ab) AND ('Global Health':ti,ab OR 'GH':ti,ab)))

NOT

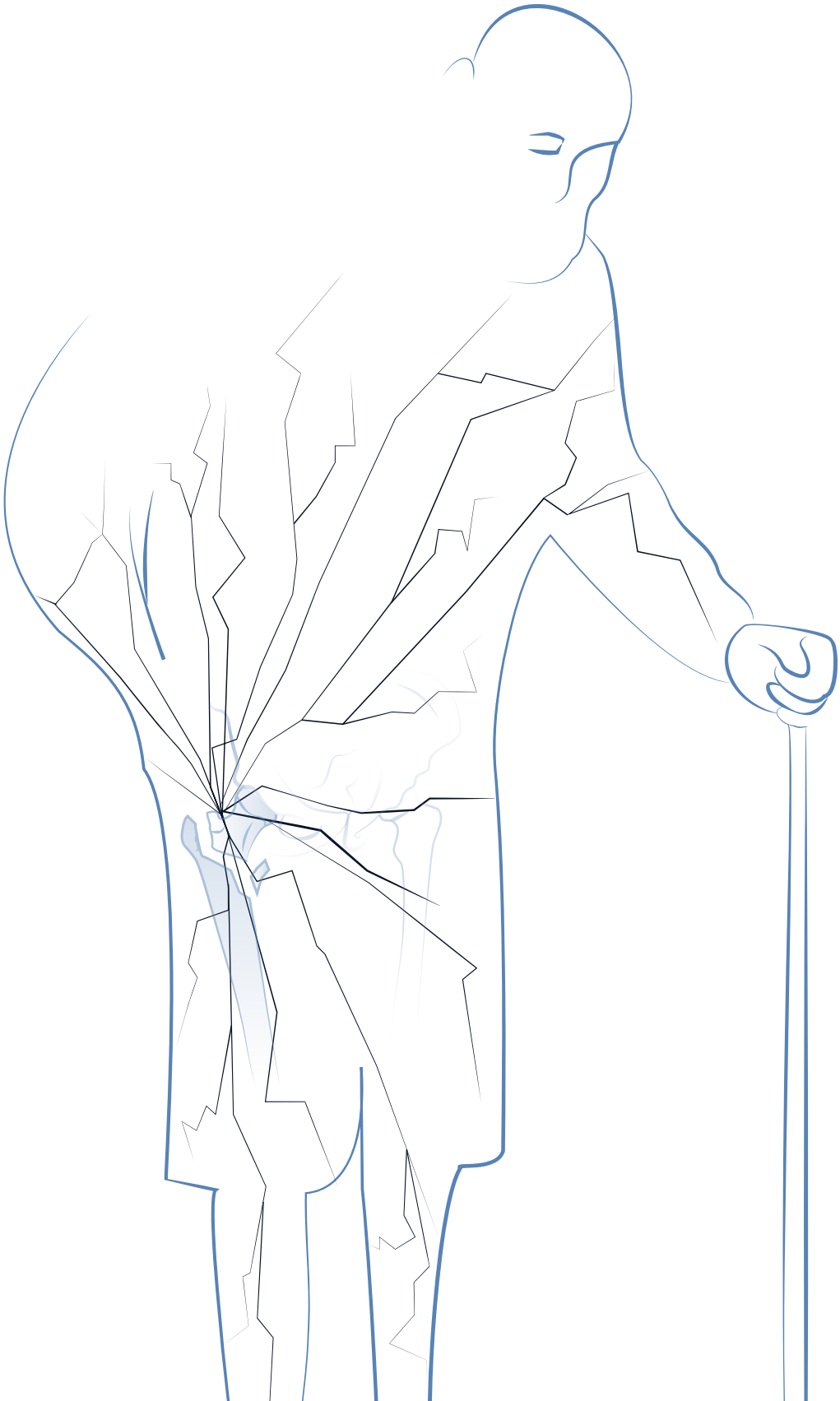
('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it)

Cochrane Library

(('hip' NEXT 'fracture*'):ti,ab OR ('trochanteric' NEXT 'fracture*'):ti,ab OR ('intertrochanteric' NEXT 'fracture*'):ti,ab OR ('subtrochanteric' NEXT 'fracture*'):ti,ab OR ('proximal femur' NEXT 'fracture*'):ti,ab OR ('proximal femoral' NEXT 'fracture*'):ti,ab OR ('femur neck' NEXT 'fracture*'):ti,ab OR ('femoral neck' NEXT 'fracture*'):ti,ab OR ('femur head' NEXT 'fracture*'):ti,ab OR ('femoral head' NEXT 'fracture*'):ti,ab)

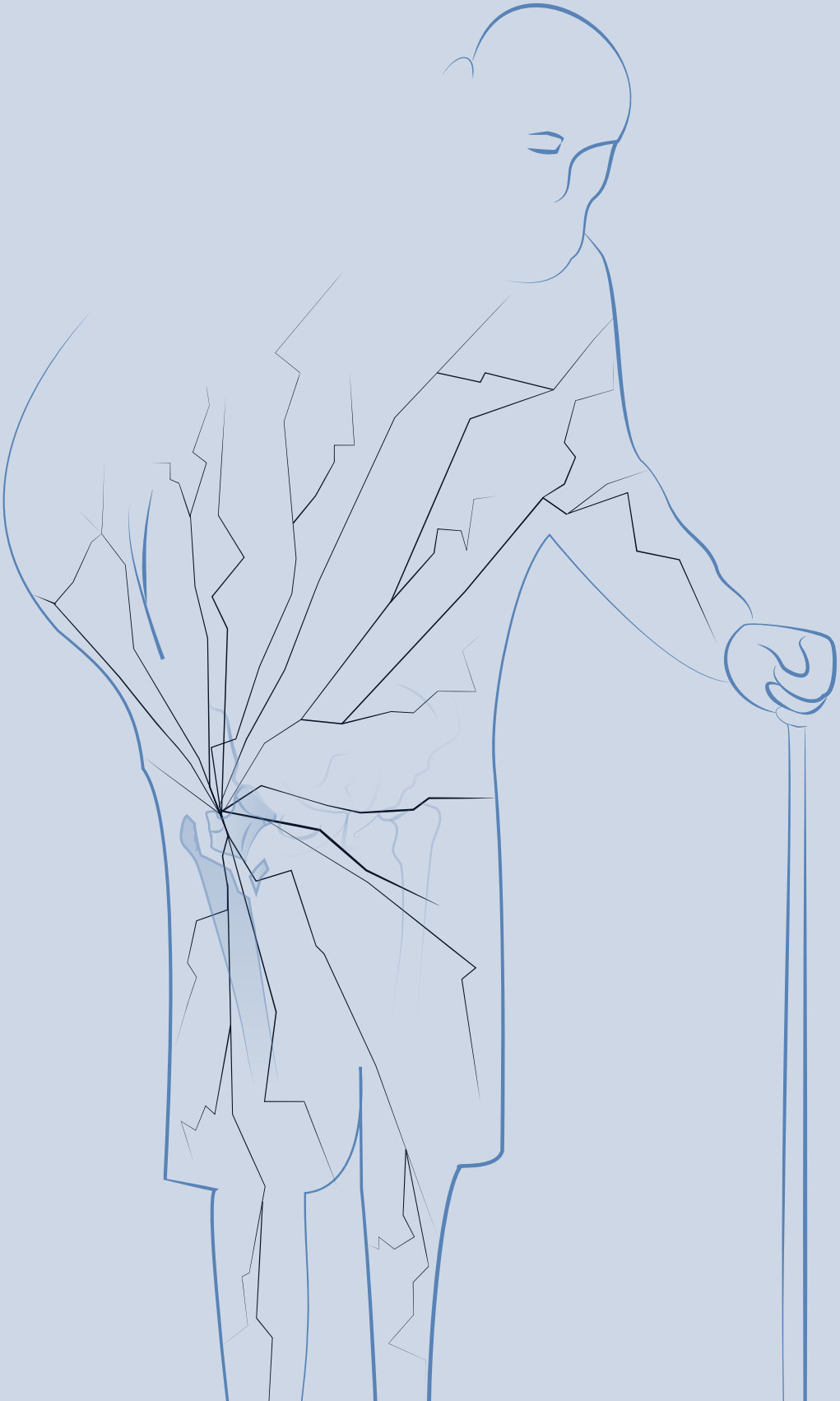
AND

('Quality of Life':ti,ab OR 'QoL':ti,ab OR 'HRQoL':ti,ab OR ('eq' NEXT '5d*'):ti,ab OR 'eq-5d*':ti,ab OR 'TOPICS-SF*':ti,ab OR 'euroqol*':ti,ab OR 'Short Form Health Survey':ti,ab OR 'SF-12':ti,ab OR 'SF-36':ti,ab OR ('quality adjusted life' NEXT 'year*'):ti,ab OR ('quality adjusted life' NEXT 'year*'):ti,ab OR 'qaly*':ti,ab OR (('patient reported outcomes measurement information system':ti,ab OR 'patient reported outcomes measurement information system':ti,ab OR 'PROMIS':ti,ab) AND ('Global Health':ti,ab OR 'GH':ti,ab)))



PART II

Identification of the Frail Patient



CHAPTER 3

Predictors of Mortality Over Time in Geriatric Hip Fracture Patients

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Submitted

ABSTRACT

Introduction

The aim of this study is to determine the variations in effect for predictors of mortality over time and risk of in-hospital complications in geriatric patients with a hip fracture. Many studies have investigated risk factors of short- and long-term mortality separately. However, in current literature, little is known about the variations in effect of risk factors over time, within the same study population.

Materials and methods

All patients with a hip fracture aged 70 years or above admitted to our hospital between the 1st of January 2016 and the 1st of May 2018 were included in this retrospective study. The primary outcome was mortality after 1 year. Secondary outcomes were mortality after 30 days, 90 days, 2 years and in-hospital complications. Kaplan Meier curves for risk factors were generated to measure and visualize the probability of survival over time.

Results

A total of 685 geriatric patients with hip fractures were included with a 1-year mortality of 27%. The adjusted odds ratios (AOR) found differed over time, age (per year above 70: AOR 1.07), living in an institutional care facility (AOR 1.69), diagnosis of dementia (AOR 1.64), male sex (AOR 1.88) and ASA classification per class increase (AOR 2.14). Five risk factors for mortality that were investigated in this study using Kaplan Meier curves differed over time: age, pre-fracture living situation, dementia, sex and ASA classification.

Conclusions

Over time the variation of five risk factors for mortality were visualized in geriatric patients with a hip fracture: age, pre-fracture living situation, dementia, sex and ASA classification. The variation in effect observed in these risk factors plays a vital role in prognosis. This insight will help guide accurate medical decision making for a more tailored treatment plan for geriatric patients with a hip fracture.

INTRODUCTION

Due to an aging population, the incidence of geriatric hip fractures in older patients has increased in developed countries over the past decades and will continue to increase in the future[1–3]. In addition, the risk of mortality in older adults with osteoporotic hip fractures is higher[4–7]. Risk factors associated with mortality after a hip fracture include: older age, living in an institutional care facility, cognitive impairment including dementia, male sex, comorbidities and a higher American Society of Anesthesiologists physical status classification (ASA)[8–11]. Several systematic reviews have investigated risk factors of short- and long-term mortality separately[12–15]. However, in current literature, little is known about the variations in effect of risk factors over time, within the same study population [16,17]. These risk factors for mortality after a hip fracture play a crucial role in determining prognosis and are likely to vary during follow-up. Identification of the associated effect of time on risk factors for mortality and in-hospital complications could help guide medical decision making. Also, it could enhance patient-tailored treatment in terms of choice for implant type, and rehabilitation plans for patients undergoing hip fracture surgery[18]. The aim of this study is to determine the variations in effect for predictors of mortality over time and risk of in-hospital complications in geriatric patients with a hip fracture.

MATERIALS AND METHODS

This retrospective cohort study was conducted at a level 2 trauma center, the St. Antonius hospital, Utrecht, The Netherlands. All patients with a hip fracture admitted between 1st January 2016 and 1st June 2018 were screened by an independent author (HS). Patients aged 70 years or above with an isolated unilateral non-pathological hip fracture (OTA classification 31-A or 31-B) who were admitted to the emergency department were included in this study[19]. Exclusion criteria for were 1; patients undergoing total hip replacement surgery, 2; periprosthetic hip fractures, and 3; patients who were lost to follow-up.

In this study, the period of follow-up was 2 years. The primary outcome of this study was mortality after 1 year. For the baseline table, patients were classified into two groups: a group that survived at least 1 year after sustaining a hip fracture and the other group consisted of hip fracture patients who deceased after or during hospital admission.

Secondary outcomes were: mortality after 30 days, 90 days, 2 years, and in-hospital complications. Mortality data was collected by consulting the municipal personal records database. A complicated course during admission was defined as one or more of the following complications according to the National Hip Fracture Audit guidelines: anemia (considered present when a patient received red blood cell transfusion), congestive heart failure (confirmed by chest radiograph), pressure ulcer (diagnosed by an attending

physician), delirium (diagnosed by a geriatrician), pulmonary embolism (Computed Tomography Angiography (CTA) confirmed), deep venous thrombosis (duplex ultrasound confirmed), renal insufficiency (a >24ml/min decrease in glomerular filtration rate compared to glomerular filtration rate at admission), pneumonia (confirmed by chest radiograph or positive sputum culture), urinary tract infections (positive urine culture), in-hospital falls and surgical wound infection (diagnosed by a ward physician)[20]. These data were obtained from electronic health records.
The following patient characteristics were collected at baseline: age, patient living situation (at home, at home with ADL assistance and institutional care facility), pre-existent diagnosis of dementia (from medical records or diagnosed by primary care physician or geriatrician), sex, ASA classification (I to IV) and type of fracture (femoral neck, intertrochanteric and subtrochanteric).[8]

Statistical methods

Statistical analysis was performed using SPSS statistical software (SPSS version 25.0, IBM Inc. Armonk, New York, USA). Normally distributed continuous data were presented as mean with standard deviation (SD) and tested with an unpaired t-test. Not normally distributed continuous data were presented as median with interquartile range (IQR) and tested with a Mann–Whitney U test. Distribution was determined with the Shapiro–Wilk test for normality. All categorical and dichotomous data were tested with a chi-square test. Kaplan Meier curves were generated to gain insight in survival trends. A Log Rank test was used to test for similarity between groups for the Kaplan Meier curves.

A multivariable binary logistic regression analysis was performed for binary patient outcomes (i.e. mortality and complications) using adjusted odds ratio's (AOR). Missing data were imputed 100 times. The authors chose to include, age, pre-fracture living situation, diagnosis of dementia, sex, ASA classification and type of anesthesia in the model. Independent variables in a model should not correlate because the results are less reliable than statistical inferences. It is better to use independent variables that are not correlated or repetitive when building multiple regression models that use two or more variables [21]. Pre-fracture mobility, KATZ-ADL, and living situation likely reflect a degree of dependency. Therefore, the fracture mobility score (used to assess pre-fracture mobility) and KATZ index of independence in Activities of Daily Living (KATZ-ADL, score 0-6) were not included in the model[20,22]. Statistical significance was defined as a p-value < 0.05.

Missing data were analyzed for patterns and considered missing at random. The number of events per variable was ten or more for all multivariable analyses. Models had no lack of fit (Hosmer-Lemeshow >0.05).

The study was approved by the local institutional review board and medical ethical committee. This article is written in accordance with the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines[23].

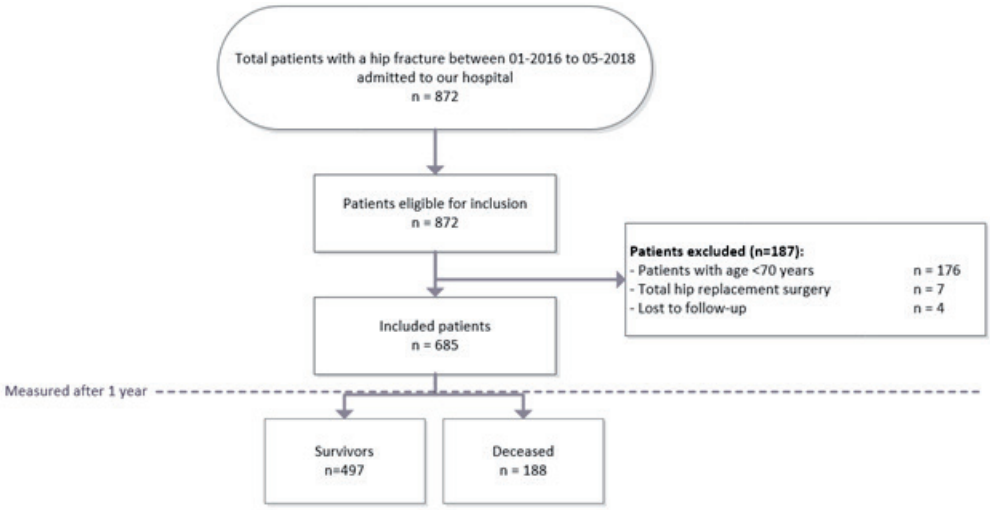


Figure 1. Patient flowchart for inclusion of patients aged 70 years or above with a hip fracture.

RESULTS

A total of 872 patients with a hip fracture presented to the emergency department of our institution. For this study 685 patients were included, the main reason for exclusion was age below 70 (n=176) (Figure 1). Of these 685 patients, 369 patients were admitted with a femoral neck fracture, 291 patients with an intertrochanteric fracture, and 4 patients with a subtrochanteric fracture. The study population consisted of 190 (28%) males and 495 females with a median age of 85 (80-90). In total 27% of the patients were diagnosed with dementia. One year after surgery significant differences in five baseline characteristics between survivors and deceased patients were observed ($p<0.01$) (Table 1).

Survivors one year after surgery had a median age of 84 (79-88), whereas deceased patients had a median age of 87 (83-92) ($p<0.01$). In survivors, 25% (n=124) were male patients compared to 35% (n=66) of the deceased patients. Dementia was diagnosed in 107 (22%) survivors and in 78 (42%) of the deceased patients, 1 year after surgery ($p<0.01$). The median ASA classification of survivors and deceased patients was 2 (2-3) and 3 (2-3) ($p<0.01$) respectively. Of the 196 patients living in an institutional care facility prior to the fracture, 112 patients were still alive and 84 patients deceased within one year after surgery ($p<0.01$). There were no significant differences in terms of fracture type ($p=0.36$) and type of anesthesia ($p=0.49$).

The multivariable logistic regression analysis revealed five predictors for mortality at 30 days, 90 days, 1 year, and 2 years after surgery (Table 2). The predictors for mortality

Table 1. Baseline characteristics for one-year mortality vs. survivors

Variable	Missing n (%)	Total	Survivors	Deceased	*p*-value
Total number of patients, n (%)	-	685	497 (73)	188 (27)	n/a
Age in years, median (IQR)	0 (0)	85 (80-90)	84 (79-88)	87 (83-92)	**<0.01**
Male sex, n (%)	0 (0)	190 (28)	124 (25)	66 (35)	**0.01**
Dementia, n (%)	17 (3)	185 (28)	107 (22)	78 (42)	**<0.01**
ASA classification, median (IQR)	50 (7)	635 (93)	2 (2-3)	3 (2-3)	**<0.01**
ASA classification	50 (7)				
ASA classification 1		21 (3)	17 (3)	4 (2)	
ASA classification 2		305 (45)	251 (51)	54 (29)	
ASA classification 3		296 (43)	184 (37)	112 (60)	
ASA classification 4		13 (2)	3 (1)	10 (5)	
Living in an institutional care facility, n (%)	16 (2)	196 (29)	112 (23)	84 (46)	**<0.01**
Regional anesthesia, n (%)	20 (3)	63 (9)	48 (10)	15 (8)	0.49
Type of fracture, n (%)	21 (3)				0.36
Femoral neck		369 (54)	271 (57)	98 (53)	
Intertrochanteric femur		291 (42)	207 (43)	84 (46)	
Subtrochanteric femur		4 (1)	2 (0)	2 (1)	

All variables are in total amount (percentage) or median (IQR). Abbreviations: ASA= American society of Anesthesiologists.

within the first year after surgery were age (per year above 70: AOR 1.07), living in an institutional care facility (AOR 1.69), diagnosis of dementia (AOR 1.64), male sex (AOR 1.88) and ASA classification (per class increase: AOR 2.14). There were no significant differences in terms of the type of anesthesia used. The AOR for mortality per year above 70 years of age varied little over time. AOR for type of sex, diagnosis of dementia, living in an institutional care facility, ASA classification per class increase and type of anesthesia differed over time post operatively (Table 2). Patients living in an institutional care facility had a lower AOR for complications and for delirium during admission.

The effect of the predictors' age, pre-fracture living situation, dementia, sex, and ASA classification for mortality differed over time as shown in the Kaplan Meier curves (Figure 2-6). vSurvival between age groups during the first 90 days showed a difference at the expense of the older population, after 90 days mortality was observed higher in the older two groups (80-89 & 90+ years) with a similar decline of survival over time (Figure 2). Male patients' survival rates were lower during the first 90 days compared to female patients, after 90 days the Kaplan Meier curve showed less decline in terms of survival, and followed a similar trajectory as seen in female patients (Figure 3). The Kaplan Meier curve among patients living in an institutional care facility during the first 90 days showed higher mortality rates compared to patients living at home (28% vs. 12%). The mortality over time was higher among patients living in an institutional care facility in comparison with patients

Table 2. Adjusted OR for mortality after 1 year, 30 days, 90 days and 2 years

	Adjusted OR	95% confidence interval	p-value
1-year mortality (n=188)			
Age (per year above 70)	1.07	1.04-1.11	**<0.01**
Male sex	1.88	1.26-2.80	**<0.01**
Diagnosis of dementia	1.64	1.03-2.60	**0.04**
Living in an institutional care facility	1.69	1.07-2.69	**0.03**
ASA classification per class increase	2.14	1.54-2.99	**<0.01**
Regional anesthesia	0.80	0.41-1.55	0.51
30-day mortality (n=60)			
Age (per year above 70)	1.05	1.01-1.10	**0.02**
Male sex	1.83	1.02-3.28	**0.04**
Diagnosis of dementia	1.47	0.75-2.91	0.26
Living in an institutional care facility	1.67	0.84-3.33	0.15
ASA classification per class increase	2.50	1.49-4.20	**<0.01**
Regional anesthesia	0.36	0.08-1.53	0.17
90-day mortality (n=110)			
Age (per year above 70)	1.07	1.04-1.11	**<0.01**
Male sex	2.25	1.41-3.59	**<0.01**
Diagnosis of dementia	1.40	0.81-2.42	0.23
Living in an institutional care facility	1.86	1.08-3.22	**0.03**
ASA classification per class increase	2.60	1.71-3.94	**<0.01**
Regional anesthesia	0.72	0.31-1.65	0.43
2-year mortality (n=262)			
Age (per year above 70)	1.10	1.07-1.13	**<0.01**
Male sex	2.11	1.42-3.13	**<0.01**
Diagnosis of dementia	1.92	1.22-3.01	**<0.01**
Living in an institutional care facility	2.48	1.58-3.89	**<0.01**
ASA classification per class increase	2.12	1.54-2.92	**<0.01**
Regional anesthesia	0.78	0.42-1.47	0.45

All variables are in total amount (percentage) or median (IQR). Abbreviations: ASA= American society of Anesthesiologists.

living at home (Figure 4). Patients diagnosed with dementia had a notably lower survival compared to patients without dementia in terms of short and long term survival of time (Figure 5). ASA classification involved mainly classifications 2 and 3, the difference in survival over time between these classifications after the first 30 days was 20% for the entire period of follow-up (Figure 6).

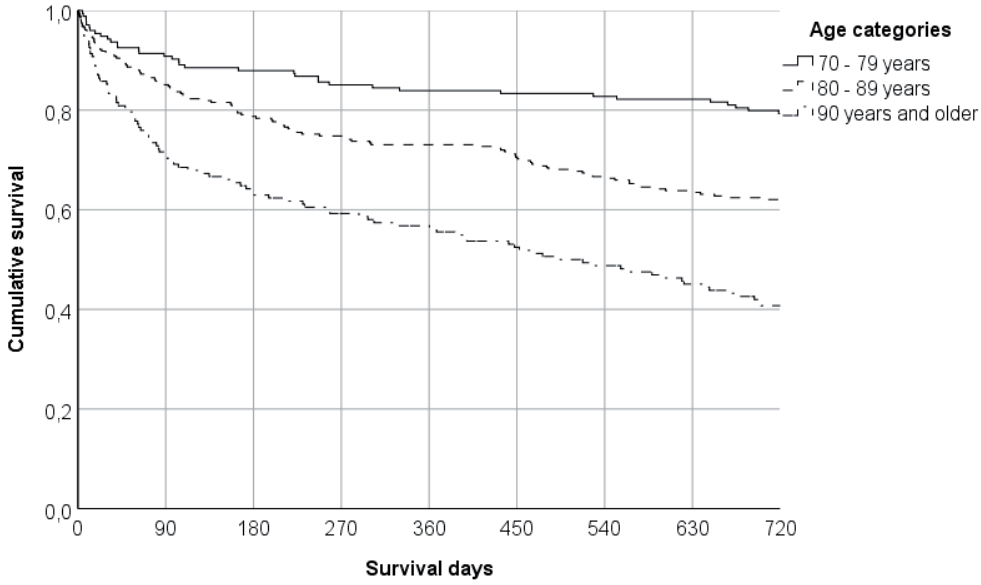


Figure 2. Kaplan Meier curve for age.

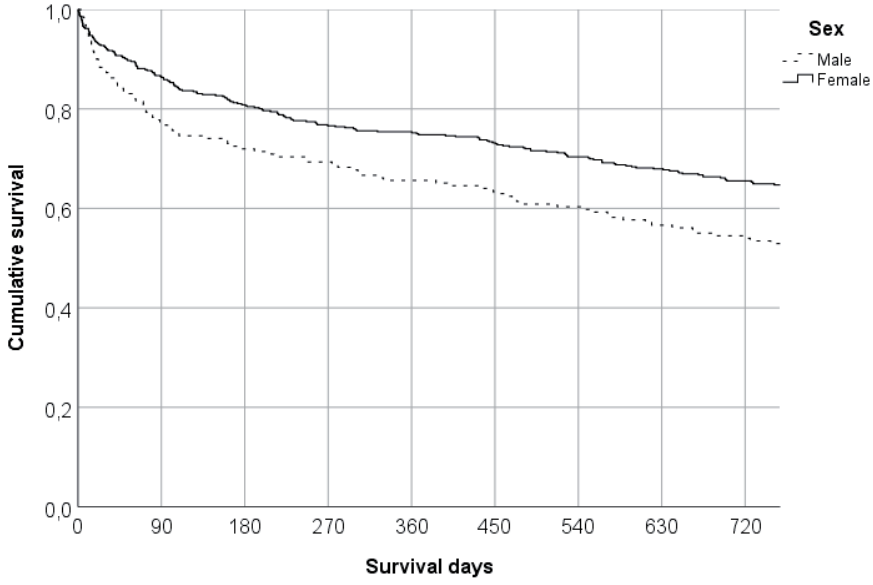
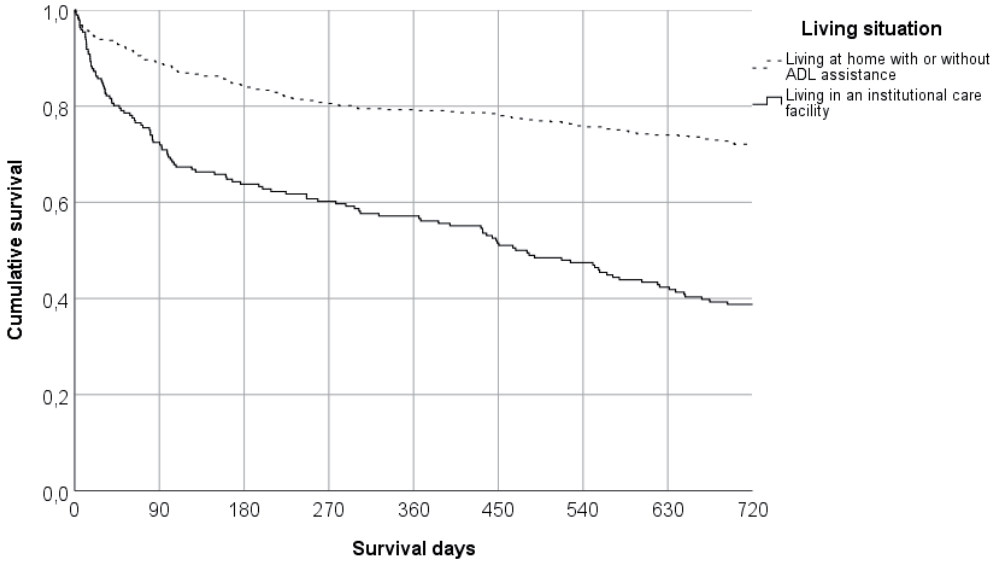


Figure 3. Kaplan Meier curve for sex.



Abbreviations: ADL= Activities of daily living

Figure 4. Kaplan Meier curve for living situation pre-fracture.

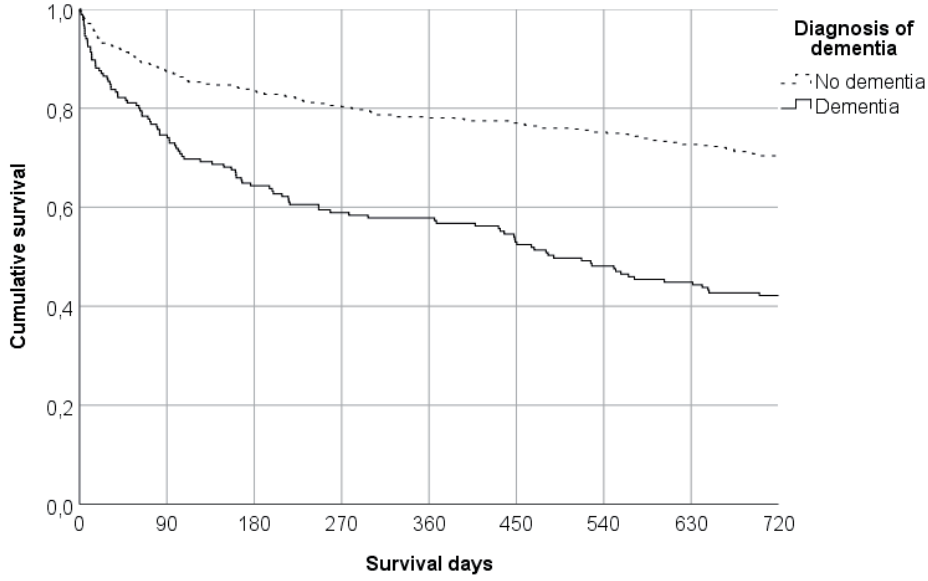
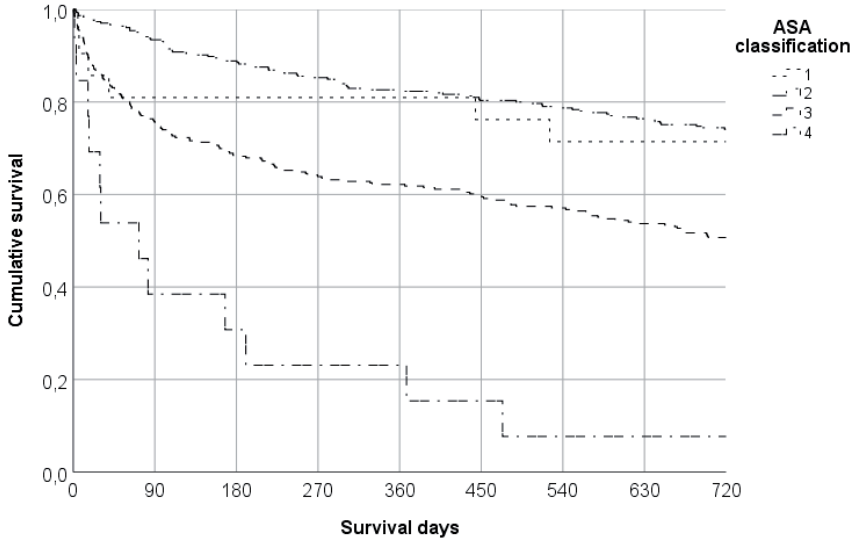


Figure 5. Kaplan Meier curve for diagnosis of dementia.



Abbreviations: ASA= American society of Anesthesiologists

Figure 6. Kaplan Meier curve for ASA classification.

DISCUSSION

This study has identified several time-related differences in risk factors for mortality, which have previously been identified as risk factors for mortality after a hip fracture in geriatric patients[13–15,24]. The adjusted odds ratios for the risk factors found differed over time. The Kaplan Meier curves depicted that male patients had a higher mortality during the first 90 days compared to female patients. However, after 90 days a similar tendency for survival was observed between sexes.

ASA classification was associated with high mortality during the entire follow-up of the study. Literature shows that a higher ASA classification is associated with an increased risk for mortality[10,25,26].

During the first year after surgery, pre-fracture living situation in an institutional care facility was associated with a considerably higher risk of mortality. After 2 years less than 40% of the patients lived pre-facture in an institutional facility were still alive as shown in the Kaplan Meier curves. This might be the result of the progression of other pathology or comorbidities often found in patients living in an institutional care facility[27,28]. Patients living in an institutional care facility were at minimal risk of developing in-hospital complications, as these patients return to their institutional care facility shortly after surgery for rehabilitation with specialized geriatric care.

Diagnosis of dementia is mostly associated with a higher risk for long-term mortality. Because dementia is a degenerative disease, increased long-term mortality can be attributed to functional decline[29]. In previous literature, it is suggested that rehabilitation resources are not well designed for the capabilities of this subgroup of hip fracture patients [28]. In the Kaplan Meier curves, a rapid decline in survival for patients with dementia is observed compared to patients without dementia. This 20% difference observed after 180 days till the end of follow-up in patients with dementia might be due to comorbidity. The overall survival for patients aged 90 years and older was 10% lower at any given moment during follow-up compared to patients aged 70-79 years. High age is a known predictor of mortality[31,32]. Our study found that higher age is related to higher mortality at any given moment in time.

One of the strengths of this study is the addition of our detailed analysis to current literature. With the Kaplan Meier curves an accurate understanding over time of the predictors of mortality after hip fracture is presented. Also, since the study was performed in a single center we were able to identify a large number of patients and we had unlimited access to all patient charts and laboratory results. Therefore, only 2% of data were missing across 24% of the cases. Lastly, only 4 patients were lost to follow-up.

This study has a few limitations, the retrospective design of this study could potentially cause a selection or information bias. Despite the information regained from death registries, the cause of death remained unknown. Data concerning complications outside of the hospital were not within the scope of our research. This may have led to underestimation of the total amount of complications that occurred. However, in current literature no significant difference was observed in early readmissions between patients discharged home and patients rehabilitating in an institutional care facility [33]. Most of the patients included are classified as ASA 2 or 3 therefore analysis of ASA 1 and 4 must be interpreted with caution.

The Kaplan Meier curves contribute to a more accurate prognosis of mortality over time. This data can be used to visualize chances of survival for patients as well as clinicians and help guide them in the process of medical decision making. It is desirable to generate the Kaplan Meijer curves for hospitals own demographic areas to optimize survival trends for own patient populations. A personalized treatment plan can be developed for patients based on risk factors, in terms conservative versus operative treatment, implant type, and rehabilitation management. Recently published literature by Loggers et al. highlights non-operative treatment as a viable option for frail patients with a limited life expectancy without loss of treatment satisfaction when compared to operative treatment[34]. Our data provides a better understanding of prognosis that can be used by clinicians in the process of shared decision-making. Complications following surgery occur often in geriatric hip fracture patients, it is therefore important to discuss not only survival but also the adverse effects postoperative complications can have on the quality of life. This study provides a more

detailed answer to which patients might be considered at risk of mortality after surgery and offers tools to aid clinicians and patients to determine the optimal treatment strategy. In our hospital, infographics including these Kaplan Meier curves are used by clinicians for shared decision-making with the geriatric hip fracture patient and their relatives. These tools can provide visual insights in prognosis for frail patients with potential limited life expectancy after hip fracture.

In conclusion, over time the variation of five risk factors for mortality were visualized in geriatric patients with a hip fracture: age, pre-fracture living situation, dementia, sex and ASA classification. The variation in effect observed in these risk factors plays a vital role in prognosis. This insight will help guide medical decision making towards a more tailored treatment plan for geriatric patients with a hip fracture. Additionally, geriatric patients in acute setting with a limited life expectancy can be aided in the shared-decision making process with a better understanding of the possible adverse outcomes after hip surgery.

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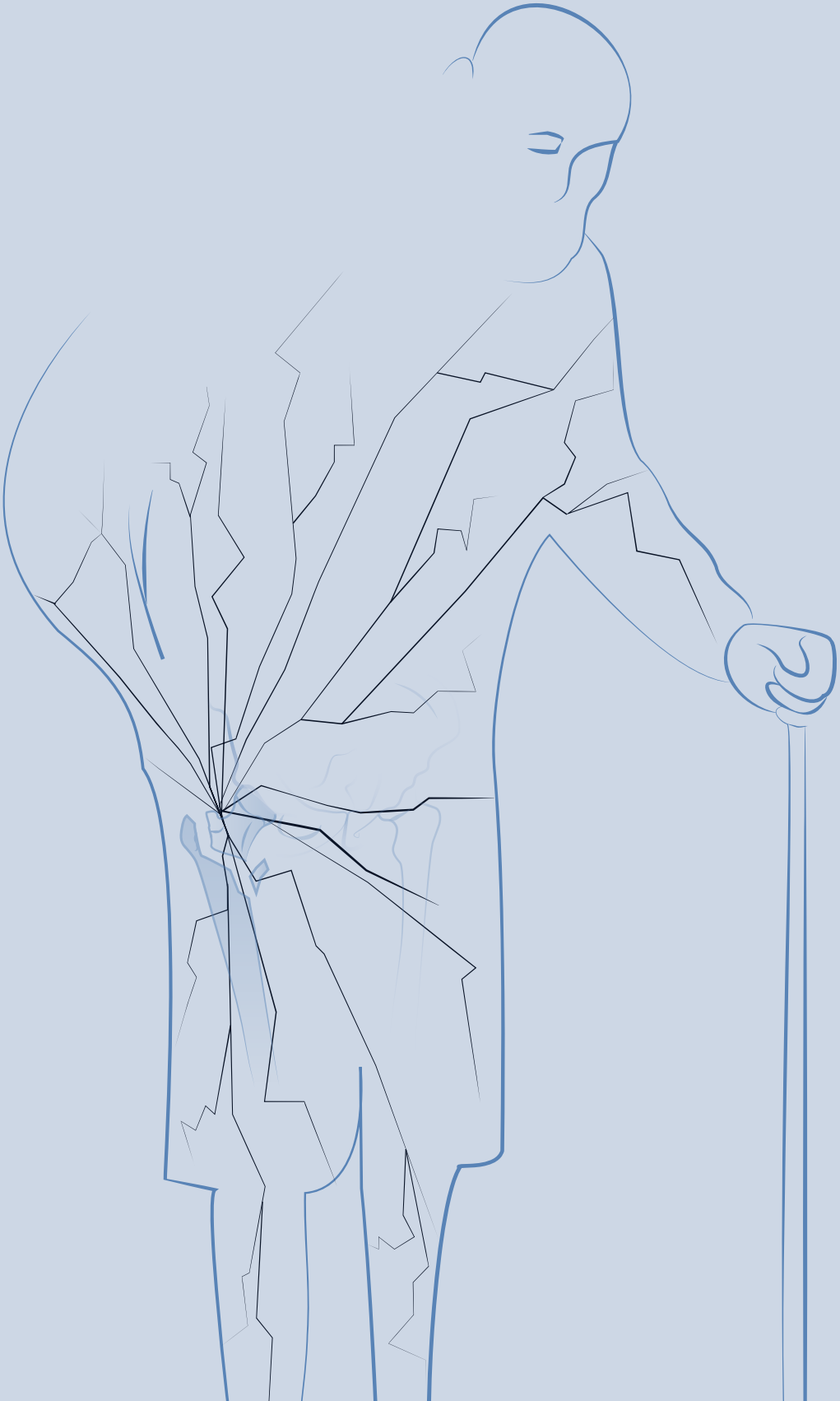

CHAPTER 4

Prognosis and institutionalization of frail community-dwelling older patients following a proximal femoral fracture: a multicenter retrospective cohort study

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ABSTRACT

Purpose: Proximal femoral fractures are a serious public health issue in the older patient. Although a significant rise in frail community-dwelling elderly is expected because of progressive aging, a clear overview of the outcomes in these patients sustaining a proximal femoral fracture is lacking. This study assessed the prognosis of frail community-dwelling patients who sustained a proximal femoral fracture.

Methods: A multicenter retrospective cohort study was performed of frail community-dwelling patients aged over 70 years with a proximal femoral fracture. Patients were considered frail if they were; classified as American Society of Anesthesiologists score ≥4, and/or a BMI <18.5 kg/m^2, and/or Functional Ambulation Category ≤2 pre-trauma. The primary outcome was 6-month mortality. Secondary outcomes were adverse events, health care consumption, rate of institutionalization and functional recovery.

Results: A total of 140 out of 2045 patients matched the inclusion criteria with a median age of 85 (P_{25}-P_{75} 80-89) years. The 6-month mortality was 58 out of 140 patients (41%). A total of 102 (73%) patients experienced adverse events. At 6-months post-trauma, 29 out of 120 (24%) were readmitted to the hospital. Out of the 82 surviving patients after six months, 41 (50%) were unable the return to their home, and only 32 (39%) were able to achieve outdoor ambulation.

Conclusion: Frail community-dwelling older patients with a proximal femoral fracture have high risk of death, adverse events, and institutionalization, and often do not re-obtain their pre-trauma level of independence. Foremost, the results can be used for realistic expectation management.

INTRODUCTION

Proximal femoral fractures are a serious public health issue in the older patient. The injury has major consequences with regards to mortality, morbidity, and (health-related) quality of life (HRQoL).[1-5] Furthermore, recovery to pre-fracture functioning is lengthy and often unsuccessful.[6, 7] Mortality rates for the frailest patients with a proximal femoral fracture are as high as 36-55% after six months, and recovery to pre-trauma mobility is as low as 10-20%.[7-10] The degree of frailty greatly determines the prognosis.[11, 12]

In The Netherlands 92% of the adults aged over 75 years and 65% of adults aged over 90 years are community-dwelling, but while they live independently it is estimated that up to one-third can be considered frail.[13] Due to progressive aging, the number of proximal femoral fractures in patients aged over 65 years is expected to rise with another 69% between 2012 and 2040.[14] With 75% of the patients sustaining a proximal femoral fracture being community-dwelling, a stark rise in frail-community dwelling patients is to be expected.[15]

Remarkably, the prognosis of frail community-dwelling patients is relatively unknown. Current studies addressing the prognosis of patients with a proximal femoral fracture do not separately address community-dwelling frail older patients but focus on institutionalized patients or highly heterogenic study populations which include high proportions of non-frail patients.[16] In addition, these studies mostly focus on patients aged over 65 years old without addressing the effect of frailty and in case they do account for frailty, they do not address the specific prognosis of community-dwelling patients.[12, 17-23] It has been suggested previously, that future studies on older patients with a proximal femoral fracture should focus on certain sub-populations to further elucidate the relation between certain demographic factors and functional- and survival outcomes.[24]

A clear overview of the specific prognosis on frail community-dwelling older patients is needed to properly inform patients and their relatives of the often challenging recovery period ahead. Detailed knowledge on the prognosis will aid in realistic expectation management, better informed decision making, health care planning, advance care planning in the community, and create more awareness about the significant impact of the injury for this patient population.

This multicenter retrospective cohort study assessed the prognosis of a specific group of frail community-dwelling older patients who sustained a proximal femoral fracture with regards to mortality, adverse events, health care consumption, and functional outcome.

METHOD AND MATERIALS

A multicenter retrospective analysis of frail older community-dwelling patients who sustained a proximal femoral fracture that were presented to three large teaching hospitals

(Northwest Clinics, St. Antonius Ziekenhuis, or Ziekenhuisgroep Twente) between January 1, 2018 and September 30, 2019 was performed. Patients were identified based on diagnosis-related group (DRG; in Dutch DBC 218; hip fracture).

Patients were eligible for inclusion if they were: aged ≥ 70 years old, sustained a proximal femur fracture after a low-impact injury, and if they were considered frail. The term frail implied that at least 1 of the following characteristics was present;; classified as American Society of Anesthesiologists (ASA) score ≥4, and/or a BMI <18.5 kg/m^2, and/or Functional Ambulation Category (FAC) of ≤2 pre-trauma (meaning that they require (intermittent) assistance of a person for safe ambulation).[25] We choose to define patients that could be considered frail based on the mentioned criteria because of the retrospective nature of the study and other forms of established frailty assessments could not be performed. Comorbidities[26, 27], decreased BMI[28], and decreased mobility[29] have been described in previous literature as a predictors for adverse outcomes after surgery. Patients with fractures due to metastasis, periprosthetic fractures, concomitant proximal femoral-, pelvic-, or other low extremity fractures in the previous three months prior to the injury, or with a delayed presentation to the ED of ≥7 days post-trauma were excluded.

Outcome measures and data collection

All outcomes were ascertained via retrospective hospital chart reviewing in combination with data from the Dutch Hip Fracture Audit (DHFA) from the participating centers. The DHFA is a nationwide permanent hip fracture registry with a three-month follow-up. Data were collected according to a pre-defined case report form..

The primary outcome measure was the six-month mortality rate post-trauma. Secondary outcome measures were adverse events, health care, readmission, residency, functional outcome, and activities of daily living (ADL) dependency during the 6-month follow-up period. Health care consumption was measured by length of stay, number of (para)medic consultations, the requirement of intensive care admission, readmissions, and outpatient clinic follow-up. Furthermore, the use of antipsychotic drugs, use of physical restraints to prevent adverse events and the number of blood transfusions were recorded. Functional outcome was measured with the Prefracture Mobility Score (PMS) and was measured at admission, at hospital discharge, and at three and six months post-trauma. ADL dependency was measured via the KATZ Index of Independence Activities of Daily living (KATZ-ADL) score at admission and after three months.

The following patient, fracture, and treatment characteristics were collected; age, sex, Body Mass Index (BMI), ASA grade, Charlson Comorbidity Index (CCI)[30], FAC score pre-trauma, PMS, KATZ-ADL score, pre-trauma level of home care assistance with ADL, nutritional assessment (Short Nutritional Assessment Questionnaire (SNAQ) or Malnutrition Universal Screening Tool (MUST) score), fracture types, additional injuries, time to surgery, type of treatment, and type of anesthesia. These characteristics were also used to identify risk

factors for mortality, inability to return to their own home, and unsuccessful rehabilitation (not regaining pre-fracture PMS) after six months. Death before regaining previous mobility or returning to home was regarded as not regaining pre-trauma PMS or institutionalization at the 6-month follow-up. No data was gathered for excluded patients in this study as no consent or waiver was provided to allow analysis of these patients.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 24.0 (SPSS, Chicago, Ill., USA). The results were reported according to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (STROBE).[31] No data imputation was used to replace missing values. Normality of continuous data was tested with the Shapiro-Wilk test. Continuous data, which were all nonparametric, were shown as median and quartiles. Categorical data were reported as numbers and frequencies. Univariate comparison was done using Mann-Whitney U-test or Chi-squared test or Fisher's Exact test, as applicable. Risk factors for mortality, institutionalization, and unsuccessful rehabilitation after 6 months were performed using logistic regression analysis and reported as OR with 95% corresponding confidence interval. As it is important to predict these factors early in the process, only patient characteristics and fracture type were considered in this analysis. Since the level of home care and the KATZ-ADL score are closely related, as is facture type and surgical treatment, only the level of home care and fracture type were included in the analysis. Parameters that showed a p-value <0.10 in the univariate logistic analysis were included in a multiple logistic regression model with backward selection to identify predictors. The p-value for statistical significance was set at $p<0.05$.

RESULTS

In total, 140 out of 2,045 (7%) patients with a proximal femoral fracture who were admitted within the study period matched the inclusion criteria. The median age at trauma was 85 (P_{25}-P_{75} 80-89) years. Eighty-seven (62%) patients were female. Baseline characteristics are summarized in Table 1. Half of the patients received home care for support for performing activities of daily living (ADL), with a median of daily visits of home care of 2 (P_{25}-P_{75} 2-3). Most falls occurred in the domestic setting (n=125; 89%).

Facture and treatment characteristics

Displaced femoral neck fractures were the most frequent fracture type (Table 2). In 26 (19%) patients there were concomitant traumatic injuries or clinical abnormalities in the preoperative screening (such as urinary tract infections and electrolyte abnormalities). Initially, 132 patients opted for surgical management. Non-operative management (NOM)

Table I. Patient characteristics .

Characteristic		N	Total (N=140)
Age (years)		140	85 (80-89)
Sex (female)		140	87 (62%)
BMI (kg/m^2)		138	21.5 (17.9-25.0)
CCI		140	3 (2-5)
Dementia		140	27 (19%)
Mobility	FAC 2	140	6 (4%)
	FAC 3		6 (4%)
	FAC 4		48 (34%)
	FAC 5		80 (57%)
PMS	Freely mobile without aids	140	39 (28%)
	Mobile outdoors with one aid		5 (4%)
	Mobile outdoors with 2 aids or frame		67 (48%)
	Never outside without help		28 (20%)
	No Functional mobility		1 (1%)
Mobility	Bed-chair transfer	140	1 (1%)
	Few steps (AR<10m)		9 (6%)
	Mobile (AR ≥10m)		130 (93%)
History of falling in last 6 months (yes)		139	89 (64%)
Home care prior to trauma (yes)		140	69 (49%)
KATZ-ADL	0	137	70 (51%)
	1		16 (12%)
	2		25 (18%)
	3		14 (10%)
	4		5 (4%)
	5		5 (4%)
	6		2 (2%)
ASA-score	ASA II	140	12 (9%)
	ASA III		45 (32%)
	ASA IV		83 (59%)
Malnutrition (SNAQ or MUST ≥1)		129	54 (39%)
Hb (mmol/L)		140	7.4 (6.7-8.3)
Creatinine (µmol/L)		140	83 (63-114)

Data are presented as median (P_{25}-P_{75}) or as n (%).
BMI, Body Mass Index; FAC, Functional Ambulatory Category; AR, Action radius; CCI, Charlson Comorbidity Index; PMS, Prefracture Mobility Scale; KATZ-ADL, KATZ Activities of Daily Living; ASA-score, American Society of Anesthesiologists Score; Hb, hemoglobin. SNAQ, Short Nutritional Assessment Questionnaire; MUST, Malnutrition Universal Screening Tool.
Hemoglobin mmol/L to g/dL conversion multiply by factor 1.61; Creatinine µmol/L to mg/DL conversion divide by factor 88.4.

was primarily opted for by eight (6%) patients due to the high perioperative risks of mortality related to cardiac comorbidities or poor health status. Due to clinical deterioration during the preoperative waiting period, 6 additional patients (5%) who primarily opted for surgery (n=132) were no longer considered suitable candidates for operative treatment.

Table 2. Fracture characteristics and management in the non-operative and operative group.

Characteristic		N	Total (N=140)
Fracture type	Femoral neck	140	74 (53%)
	Garden 1-2		19 (26%)
	Garden 3-4		55 (74%)
	Pertrochanteric		61 (44%)
	AO 31-A1		20 (33%)
	AO 31-A2		37 (61%)
	AO 31-A3		4 (7%)
	Subtrochanteric		5 (4%)
Other injuries/clinical abnormalities		140	26 (19%)
Management strategy	Operative	140	126 (92%)
	Non-operative		14 (9%)
Time to surgery (h)	<24	126	74 (59%)
	24-48		40 (32%)
	>48		12 (10%)
Anesthesia type	General	126	72 (57%)
	Spinal		54 (43%)
Implant	Osteosynthesis	126	13 (9%)
	HA		49 (35%)
	THA		1 (1%)
	IMN		54 (39%)
	Extended IMN		8 (6%)
	Girdlestone		1 (1%)
Duration of surgery (min)		126	70 (49-92)
Nerve block		140	14 (10%)
Mobilization policy	Full weight bearing	131	120 (92%)
	Partial weight bearing		4 (3%)
	Non-weightbearing		7 (5%)
HLOS (days)		140	9 (6-14)

Data are presented as median (P_{25}-P_{75}) or as number (% of total).
H, Hours; HA, hemiarthroplasty, THA: Total Hip Arthroplasty; IMN, Intramedullary Nail; Min, minutes; HLOS, Hospital length of stay.

In total 126 (90%) patients were treated surgically and 14 (10%) were managed non-operatively. Seventy-four (59%) patients were operated on within 24 hours after ED admission. The median time to surgery was 21 hours (P_{25}-P_{75} 15-32). Spinal anesthesia was performed in 54 (43%) patients.

Mortality

Within six months post-trauma, 58 (41%) patients died. Twenty (14%) patients died during the index hospital stay. For operatively treated patients (n=126) the 30-day, 3-month and 6-month mortality rates were 15% (n=19), 27% (n=34), and 35% (n=44), respectively, with a

Table 3. Adverse events, severity, readmission and other undesirable events.

Characteristic		Total N=140
Adverse events		
	Total number	216
	Patients with an AE	102 (73%)
	Adverse events per patient	1 (0-2)
	Multiple adverse events (≥2)	65 (46%)
	Time to adverse event (days)	5 (3-15)
General AE		
	Delirium	34 (24%)
	Multiple deliria	2 (1%)
	Pneumonia	34 (24%)
	Pressure ulcer	24 (17%)
	Urine tract infection	24 (17%)
	Retention bladder	13 (9%)
	Gastro-intestinal	7 (5%)
	COPD exacerbation	5 (4%)
	Fracture after recurrent fall	3 (2%)
	Infection of unknown origin	3 (2%)
	CVA	2 (1%)
	Erysipelas/cellulitis	2 (1%)
	Severe dehydration/kidney disfunction	2 (1%)
	Sudden death of unknown origin	2 (1%)
	Morphine intoxication	1 (1%)
	Perioperative n. peroneus paralysis	1 (1%)
	Serotonin syndrome	1 (1%)
	Transfusion reaction	1 (1%)
Cardiovascular AE		
	Heart failure	19 (14%)
	Arrhythmia	8 (6%)
	Multiple arrythmias	1 (1%)
	Myocardial infarction	2 (1%)
Surgery/fracture related AE		
	Deep wound infection	6 (4%)
	Superficial wound infection	5 (4%)
	Perioperative hemodynamic instability	5 (4%)
	Osteosynthesis failure/malposition	4 (3%)
	Hemiarthroplasty dislocation	2 (1%)
	Rebleed	2 (1%)
	Progressive pain*	1 (1%)
	Reoperation	6 (4%)
Clavien-Dindo grade		
	I	33 (15%)
	II	134 (62%)
	IIIa	2 (1%)

Characteristic		**Total N=140**
	IIIb	8 (4%)
	IV	12 (6%)
	IVa	1 (1%)
	IVb	1 (1%)
	V	25 (12%)
Readmission, if survived to discharge	Readmission ED	33 (28%)
	Readmission hospital	29 (24%)
Residence when AE occurred	Hospital	165 (76%)
	Out of hospital	36 (17%)
	During readmission	15 (7%)
Other undesirable events	Antipsychotic drug use	46 (33%)
	Physical fixation	7 (5%)
	Blood transfusion	54 (39%)

Data are presented as number (% of total)
* Initially non-operatively managed patient who were eventually operated on because of progressive pain and fracture dislocation.
AE; adverse events; CVA, cerebrovascular accident; COPD, chronic obstructive pulmonary disease; ED, emergency department.

median time to death of 39 days (P_{25}-P_{75} 15-73). All patients who were eventually managed non-operatively died within 30 days (n=14) with a median time to death of 5 days (P_{25}-P_{75} 3-8). Ten non-operatively treated patients (71%) died during the hospital stay.

Adverse events

A total of 216 adverse events occurred in 102 patients (73% of total) during the study period. Table 3 shows an overview of adverse events. In total 25 surgery-related adverse events occurred in 20 (14%) patients. Nine re-operations were registered in 6 patients (4% of total) within the study period. Delirium (n=34; 24%), pneumonia (n=34; 24%), pressure ulcers (n=23; 17%), and urinary tract infections (n=24; 17%) were the most common adverse events. Three-quarters of the adverse events occurred during the primary hospital stay. In addition, 7 (5%) patients required physical restraints to prevent adverse events and 54 (39%) patients had a blood transfusion. Forty-six (33%) patients were given antipsychotic drugs during admission. Significantly more patients required transfusion in the pertrochanteric/subtrochanteric fracture group than in the femoral neck fracture group (49% vs 30%, p=0.025).

Health care consumption

The median length of stay was 9 days (IQR 6-14). Patients were often managed by multiple disciplines. A total of 578 (para)medic specialisms other than the primary treating (orthopedic) trauma surgeon were consulted during the index admission (median of 4 consultations per

Table 4. Residency, ADL independency, and mobility of patients who survived to point of measurement.

		Admission	Discharge	3 months	6 months
		N=140	N=120	N=89	N=82
Residency	Home, without home care	71 (51%)	1 (1%)	23 (26%)	18 (22%)
	Home, with home care	69 (49%)	13 (11%)	31 (35%)	23 (28%)
	Revalidation center	-	88 (73%)	9 (10%)	1 (1%)
	Retirement home	-	2 (2%)	6 (7%)	3 (4%)
	Nursing home	-	7 (6%)	17 (19%)	15 (18%)
	Hospice/home with palliative care	-	9 (8%)	-	-
	Missing	-	-	3 (3%)	22 (27%)
	Able to return to home	-	15 (13%)	29 (33%)	41 (50%)
		N=140		N=89	
KATZ-ADL	0	70 (50%)	-	26 (30%)	-
	1-2	41 (29%)	-	12 (14%)	-
	3-4	19 (14%)	-	14 (16%)	-
	5-6	7 (5%)	-	19 (21%)	-
	Missing	3 (2%)	-	18 (20%)	
	Retainment of KATZ-ADL		-	32 (36%)	-
		N=140	N=120	N=89	N=82
PMS	Freely mobile without aids	39 (28%)	-	9 (10%)	7 (9%)
	Mobile outdoors with one aid	5 (4%)	-	4 (5%)	3 (4%)
	Mobile outdoors with 2 aids or frame	67 (48%)	26 (22%)	32 (36%)	22 (27%)
	Mobile indoors, but never outside without help	28 (20%)	52 (43%)	22 (25%)	12 (15%)
	No Functional mobility	1 (1%)	42 (35%)	17 (19%)	9 (11%)
	Missing	-	-	5 (6%)	29 (35%)
	Retainment of PMS score	-	17 (14%)	35 (39%)	24 (29%)

Number are presented as number (%) of patients who survived to the point of measurement.
ADL, Activities of daily living; KATZ-ADL score: KATZ score Activities of Daily Living; PMS, Prefracture Mobility scale.

patient (IQR 3-5). Patients were comanaged by geriatricians in all but two patients. In total 36% of the patients were screened and/or treated by a cardiologist, 21% by internists, 18% by an anesthesiologist (for judgment if patients were operable), 13% by a pulmonologist, 10% by a neurologist, 10% by an intensive care physician, and 7% by a urologist. A physical therapist was involved in 92% of the patients, a dietitian in 61%, occupational therapist in 9%, speech therapists in 9%, and spiritual caregivers in 13%. The palliative care team was involved in 15% of the cases of which 13 out of 21 consults were requested in surgically treated patients. In total, 17 (12%) patients required admittance in the post-anesthesia care unit, intensive care unit, or cardiac care unit.

Hospital care use post-discharge

Out of the 120 patients who survived to discharge, 33 (28%) were readmitted to the ED, and 29 (24%) were readmitted to the hospital during the study period. Reasons for hospital readmission are displayed in Table 3.

Sixty of the 120 (50%) patients revisited to the hospital for an outpatient follow-up. In 41 (68%) patients this was for a regular follow-up with the surgeon, in 10 (17%) patients because of adverse symptoms or follow-up of adverse events, and in 9 (15%) patients for a combination of both.

Residency

Table 4 provides an overview of the residency, ADL (in)dependency, and mobility. Out of the 120 patients who survived the index submission, 105 (87%) were institutionalized at discharge. Most patients were discharged to a rehabilitation center (73% of the cases). Seven (8%) patients were discharged to a hospice and one patient with palliative care to his own home. At three months and six months post-trauma, one-third (n=29) and 50% (n=41) of the patients returned to their community home after hospital discharge respectively. In total 59 out of the 120 (49%) patients returned to their own home at any time during the 6-month study period.

Mobility and ADL(in)dependency

At hospital discharge 42 (35%) patients were unable to ambulate. At six months post-trauma, 32 (39%) patients were able to achieve outdoor mobilization with or without aids versus 111 (79%) in the pre-fracture situation.

At discharge, only 14% (n=17/120) regained their previous level of mobility. After three months this was 39% (n=35/89). After six months only 29% (n=24/82) of the patients still alive achieved a recovery to their pre-trauma PMS. In total 39 out of the 140 patients (28%) regained their pre-trauma level of mobility at any time during the study period.

With regards to ADL, 36% of the patients who survived to three months regained their previous level of ADL (in)dependency. At three months, only 26 (30%) of the surviving patients lived completely ADL independent, compared to 70 (50%) at the pre-fracture level.

Predictors for mortality, institutionalization, and not regaining pre-fracture mobility

Univariate logistic regression showed that age (OR 1.07; 95% CI 1.01-1.12), ASA score of 4 (OR 3.47; 95% CI 1.65-7.27), PMS (mobile with aids (OR 2.04; 95% CI 0.88-4.71) and indoor confined (OR 2.73; 95% CI 1.00-7.48)), and patients who received home care prior to the trauma (OR 2.14; 95% CI 1.08-4.26) were predictive for death within 6 months post-trauma with a $p<0.10$ (Table V). Multivariable analysis only identified ASA class 4 (OR 4.27; 95% CI 1.90-9.61) and age (OR 1.07; 95% CI 1.00-1.14) as significant predictors for death within 6 months. With regards to extrinsic factors, the type of implant (p=0.095) and type of anesthesia (p=0.483) were not associated with an increased risk of mortality within 6 months. Time to surgery ≥48 hours was significantly associated with mortality compared to surgery <48 hours ((67% (n=7/11) vs 32% (n=36/114),p=0.024). However, three out of the 7 patients that had delayed surgery ≥48 hours were found to have infectious disease during pre-operative screening.

Table 5. logistic regression analysis for 6-month mortality, failure return to own residency, and unsuccessful return to pre-trauma PMS score.

Dependent variable	Characteristic	OR	95% CI	P-value
Six-month mortality				
Univariate logistic regression	Age (years)	1.07	1.01-1.12	**0.018***
	ASA (4 ≥ vs 2-3)	3.47	1.65-7.27	**0.001***
	Home care for ADL prior to trauma	2.15	1.08-4.26	**0.029***
	Gender (male)	0.78	0.39-1.55	0.470
	BMI (kg/m^2)	1.06	0.99-1.14	0.115
	Malnutrition (SNAQ/MUST ≥1)	1.00	1.00-1.00	0.417
	Charlson Comorbidity Index	1.08	0.94-1.25	0.294
	Prefracture Mobility Scale			
	Independently mobile	-	-	-
	Mobile with aids	2.04	0.88-4.71	**0.096***
	Indoors confined	2.73	1.00-7.48	**0.051***
	Fracture type (femoral head vs trochanteric/subtrochanteric)	0.67	0.34-1.33	0.251
Multiple logistic regression	Age (years)	1.07	1.00-1.14	**0.043**
	ASA (4 ≥ vs 2-3)	4.27	1.90-9.61	**<0.001**
	Home care for ADL prior to trauma	1.16	0.46-2.94	0.755
	Prefracture Mobility Scale			
	Independently mobile	-	-	-
	Mobile with aids	1.39	0.49-3.91	0.534
	Indoors confined	2.14	1.00-7.478	0.265
Failure to return to home				
Univariate logistic regression	Age (years)	1.13	1.07-1.20	**0.000***
	Gender (male)	0.75	0.38-1.50	0.410
	BMI (kg/m^2)	1.00	0.94-1.07	0.960
	Malnutrition (SNAQ/MUST ≥1)	1.00	1.00-1.00	0.683
	ASA (4 ≥ vs 2-3)	1.62	0.82-3.21	0.167
	Charlson Comorbidity Index	1.08	0.93-1.25	0.331
	Prefracture Mobility Scale			
	Independently mobile	-	-	-
	Mobile with aids	4.50	1.95-10.40	**<0.001***
	Indoors confined	5.91	2.04-17.06	**0.001***
	Home care for ADL prior to trauma	5.09	2.44-10.60	**0.000***
	Fracture type (femoral head vs trochanteric/subtrochanteric)	1.10	0.56-2.16	0.780
Multiple logistic regression	Age (years)	1.09	1.02-1.16	**0.009**
	Home care for ADL prior to trauma	2.60	1.01-6.68	**0.048**
	Prefracture Mobility Scale			
	Independently mobile	-	-	-
	Mobile with aids	1.95	0.73-5.19	0.183
	Indoors confined	1.78	0.46-6.84	0.404

Dependent variable	Characteristic	OR	95% CI	P-value
Failure to regain pre-trauma PMS score				
Univariate logistic regression	Age (years)	1.06	1.00-1.12	**0.046***
	Gender (male)	0.61	0.28-1.13	0.216
	BMI (kg/m²)	1.03	0.95-1.12	0.441
	Malnutrition (SNAQ/MUST ≥1)	1.00	1.00-1.00	0.500
	ASA (4 ≥ vs 2-3)	2.51	1.17-5.37	**0.018***
	Charlson Comorbidity Index	1.05	0.89-1.24	0.557
	Prefracture Mobility Scale			
	Independently mobile	-	-	-
	Mobile with aids	1.03	0.43-2.48	0.941
	Indoors confined	0.83	0.29-2.38	0.728
	Home care for ADL prior to trauma	1.59	0.75-3.38	0.225
	Fracture type (femoral head vs trochanteric/subtrochanteric)	0.79	0.38-1.66	0.532
Multiple logistic regression	Age (years)	1.06	1.01-1.13	**0.031**
	ASA (4 ≥ vs 2-3)	2.72	1.25-5.95	**0.012**

BMI, Body Mass Index; SNAQ, Short Nutritional Assessment Questionnaire; MUST, Malnutrition Universal Screening Tool; ASA-score, American Society of Anesthesiologists Score.
* included the multivariate regression analysis.

When these patients were excluded the effect of delayed surgery was no longer found to be statistically significant (p=0.574).

With regards to institutionalization at 6-months, univariate logistic regression showed that age (OR 1.13; 95% CI 1.07-1.20), pre-fracture PMS (mobile with aids (OR 4.50 95% CI 1.95-10.40) and indoors confined (OR 5.91; 95% CI 2.04-16.06)), and patients who received home care prior to the trauma (OR 5.09; 95% CI 2.44-10.60) were predictive factors (Table 5). Multivariate analysis only identified age (OR 1.09; 95% CI 1.02-1.16) and patients receiving home care for ADL prior to trauma (OR 2.60; 95% CI 1.01-6.68) as significant predictors for failing to return to their previous residency.

With regards to not regaining pre-fracture PMS, univariate logistic regression showed that only age (OR 1.06; 95% CI 1.01-1.13) and ASA class 4 (OR 2.72; 95% CI 1.12-5.95) were predictive factors (Table V). In multivariate analysis age (OR 1.06; 95% CI 1.01-1.13) and ASA class 4 (OR 2.72; 95% CI 1.25-5.95) remained significant predictors.

DISCUSSION

The results of this study show that the prognosis of frail older community-dwelling patients with a proximal femoral fracture is generally poor. Despite multidisciplinary efforts of

rehabilitation and significant health care consumption, one-third of the patients do not recover with regards to their pre-trauma PMS, high mortality rates are found, and only half of the patients who survived till hospital discharge returned home within six months post-trauma.

This suggests that these community-dwelling patients are at a crossroads; they either make a timely recovery to their pre-trauma functioning and are able to return to home or they experience progressive clinical deterioration with unsuccessful rehabilitation with a high risk of mortality. Presumably, for those patients who are physically frail, a proximal femoral fracture disturbs the delicate equilibrium of their residual independent mobility and could provoke a downwards spiral.

This study corroborates and extends the current, increasing evidence of the poor prognosis of frail older patients with a proximal femoral fracture. Whereas previous studies describing mortality in Dutch patients with a proximal femoral fracture aged over 65 years have shown mortality rates of 17.7% after one year, 23% for patients aged between 65-89, and 43% of patients aged ≥90 after one year, the mortality rate for this specific study was much higher (44% at 6-months).[19, 32] This excess mortality is most likely attributable due to the frailty of the patient population as previous studies have already shown an increased risk of adverse outcomes in frail patients.[11, 12, 21-23] In addition, the risk of mortality of the average 84-year old in 2020 in the Netherlands is about 7.6% per year, reiterating the significant effect of a proximal femoral fracture and frailty on the prognosis.[33]

The treatment of patients with a proximal femoral fracture typically entails hospitalization followed by an often lengthy rehabilitation period.[34] However, this rehabilitation period can be intensive while a return to previous levels of functioning is not a certainty. In addition, (temporary) institutionalization for community reintegration is often required. This pattern was also the case in our study, as the rate of institutionalization at discharge was almost 90%. Similar rates of institutionalization of approximately 70% and 85% in community-dwelling patients were found by previous studies in their cohorts.[35, 36] Despite the attempts of institutionalized rehabilitation, return to previous levels of functioning is not a given fact as results showed that approximately one-third did not return to their pre-trauma level of mobility and approximately 25% of the surviving patients were not mobile outdoors at 6 months post-trauma. Amongst others, Mariconde *et al*. reported unsuccessful recovery of 43% after one year.[37] These data and our key findings are in concordance with other current literature.[20, 32, 38]

As Brown *et al.* reported, improvement of functioning following a proximal femoral fracture mainly occurs within the first three months. After this period, only minimal improvements can be expected.[39] This timeframe of recovery was also reflected in the data in our study.

This stresses the importance of early mobilization and an early start of the rehabilitation process which mainly entails adequate pain control and the prevention of postoperative adverse events that hamper mobilization.

This retrospective study had some limitations. Important factors such as (HR)QoL, self-perceived level of recovery, pain, fear of falling and other dimensions (*e.g.*, social support) were not assessed. Furthermore, due to the retrospective nature of this study, no information on mobility and residence was available if patients did not re-visit the hospital, died in the follow-up period, or had missing data in the 3-month dataset in the DHFA. In addition, frailty criteria based on validated frailty scales or indices could not be used to identify frail patients within the study period due to the retrospective nature of this study. Although the described cohort formally cannot be described as frail, only a specific subset of older community-dwelling patients were included that represented only 7% of the total patient population with a proximal femoral fracture within the study period. The poor outcomes of this specific group were poor and therefore the described cohort is very likely to feature a high degree of frailty and was therefore labelled as frail. In addition, the separate indicators for frailty (comorbidities, BMI, and decreased mobility) have been described as separate risk factors for poor outcomes and are easily reproducible and quantifiable.

Even though this cohort is one of the larger cohorts featuring frail community-dwelling patients, multivariable logistic regression analysis was limited due to sample size and by the fact that only the frailest patients were included in this analysis. The multivariable analysis should therefore be interpreted with caution. Prediction of definitive institutionalization remains difficult. Previous data from the DHFA in the Netherlands showed that age, pre-fracture PMS, premorbid KATZ-ADL, surgical treatment, ASA score, type of anesthesia, history of dementia, and co-treatment by a geriatrician were independent early predictors for institutionalization.[40]

Despite these limitations, this study is unique in the way that it addresses a specific subpopulation of frail community-dwelling patients with a worse prognosis than described in previous studies addressing community-dwelling patients based on age or other frailty indicators.[5, 11, 12]

The findings have several implications. First, the results of this study can be used especially for realistic expectation management and aid in better decision making, since there is a high chance of unfavorable outcomes in this patient group. Realistic expectations by patients or caregivers will most likely result in higher treatment satisfaction and clearer goals of care. It must be made clear that recovery to previous levels of functioning is often not likely. Second, it is very important to identify those patients who are unlikely to (re-)obtain mobility and survive to a longer-term, not only to provide realistic expectations but also to timely engage in end-of-life conversation. Treatment options should be openly discussed for those

at high risk for not regaining mobility with consequent institutionalization, high risk of adverse events with the reduced quality of life, ADL dependence and the discomfort that it presumably results in. In this small subgroup within an already selected patient population, it should be questioned if surgery, or in case of postoperative clinical deterioration an intensive rehabilitation program, is the best treatment option depending on their goals of care and motivation. However, this only accounts for a very small subset of patients as a significant proportion of the surviving patients make a clinical recovery. Last, because of the high rate of institutionalization at discharge, requests for a transfer to a rehabilitation setting or ADL assistance should be timely arranged in this specific patient group to prevent unnecessary delays in transfers and unnecessary occupation of hospital beds.

CONCLUSION

Frail community-dwelling older patients with a proximal femoral fracture have a high risk of death, adverse events, and institutionalization and often do not re-obtain their pre-trauma level of mobility and independence at 6-months post-trauma. Foremost, the results can be used for realistic expectation management, improved shared decision making, advance care planning in the community, and healthcare planning.

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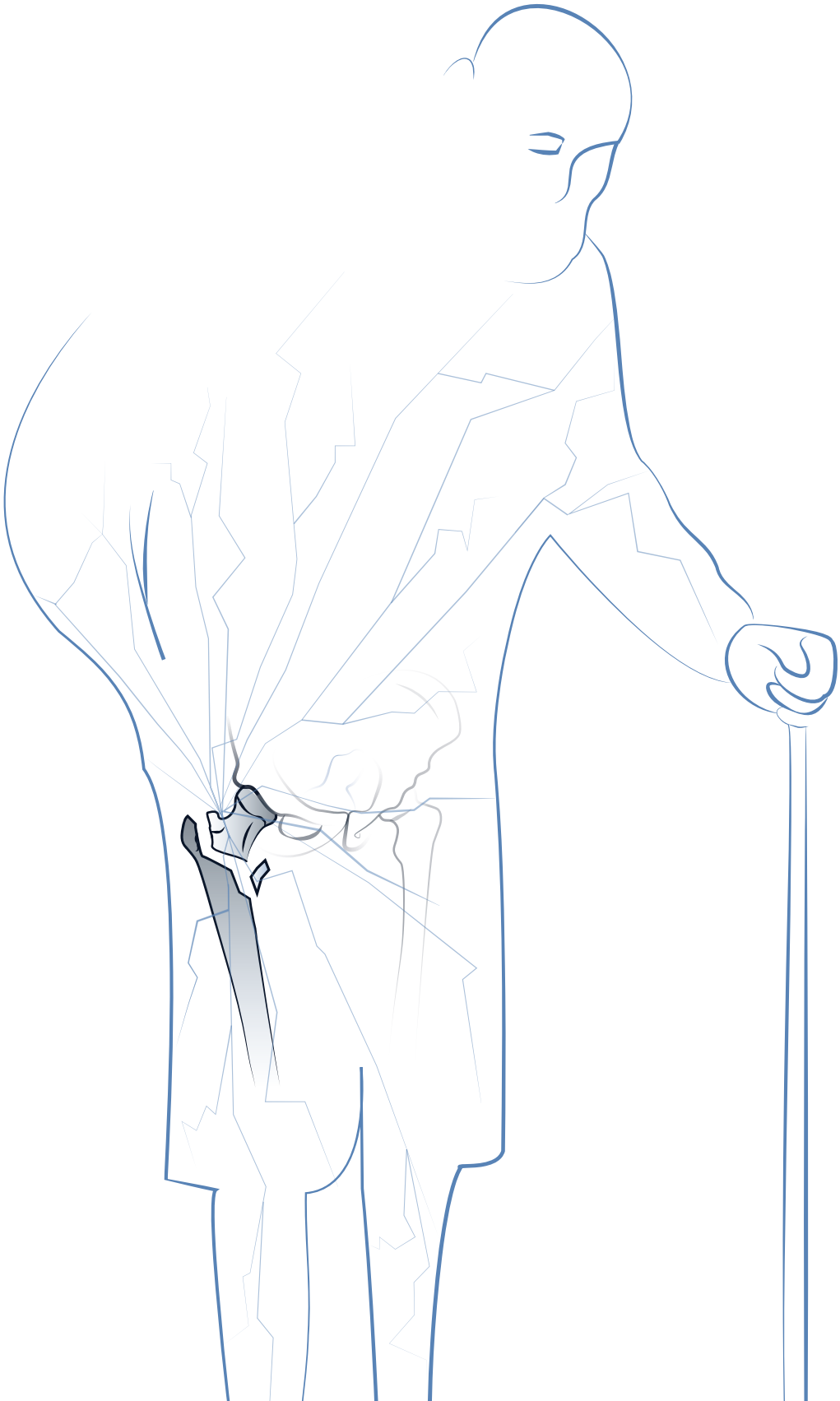
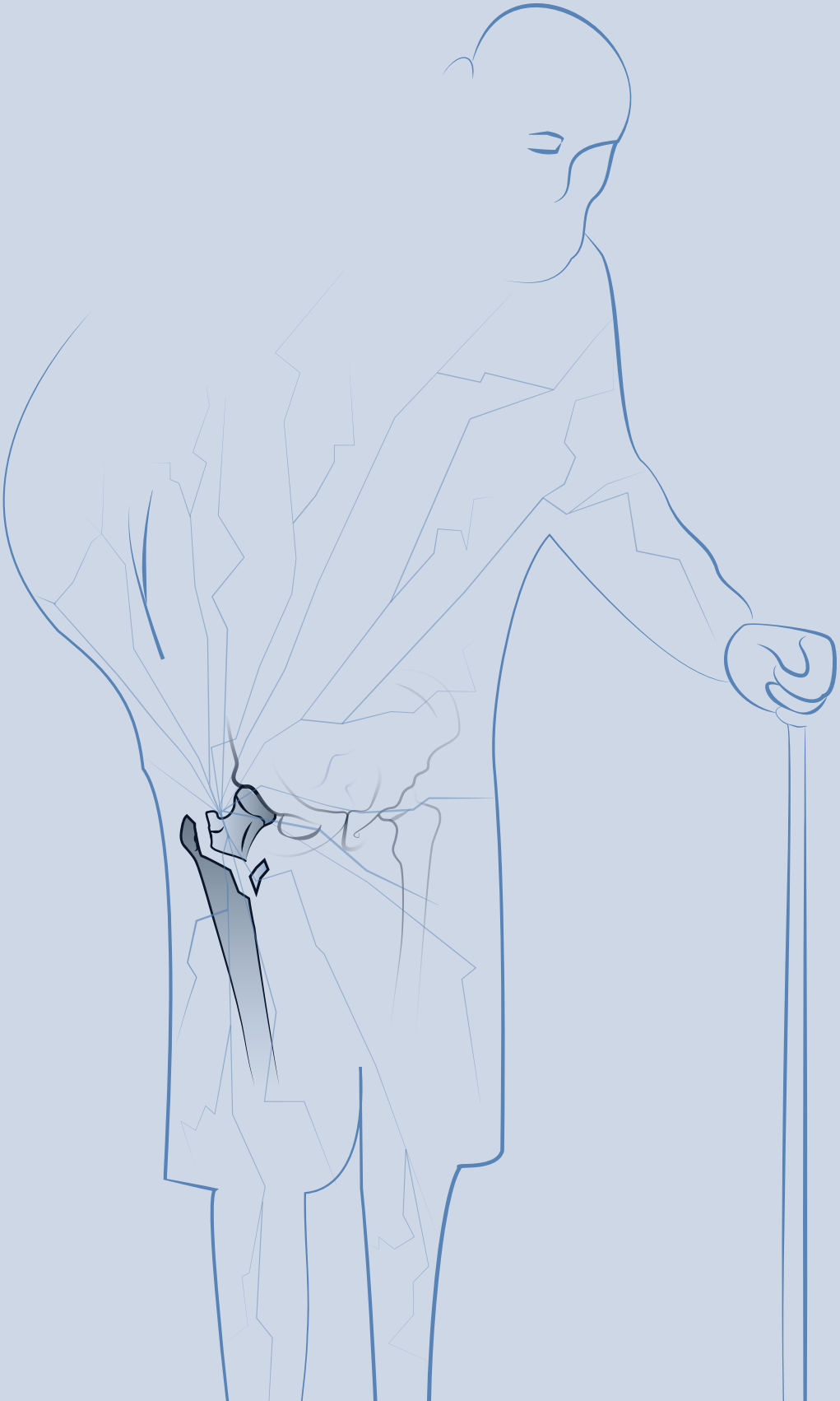


PART III

Palliative Care in Hip Fracture Management



CHAPTER 5

Proxy-reported experiences of palliative, non-operative management of geriatric patients after a hip fracture, a qualitative study

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ABSTRACT

Objective: The objective of this study was to explore the experiences from the period after the choice was made for palliative, non-operative management for geriatric patients with a hip fracture and the most important factors in the process, as reported by a proxy.

Design: Semi-structured interviews were conducted between August 1st 2020 and April 1st 2021 to investigate by-proxy reported patient experiences of non-operative management after hip fracture. Interviews followed a topic guide, recorded, and transcribed per word. Thematic analysis was used to identify themes in the data.

Setting & Participants: Patients were retrospectively identified from the electronic patient record. Relatives (proxies) of the patients who underwent palliative, non-operative management were contacted and were asked to participate in a semi-structured interview and were named participants. The participants were proxies of the patient since patients were expected to be deceased during the timing of the interview.

Results: A total of 26 patients were considered eligible for inclusion in this study. The median age of the patients was 88 years (IQR 83-94). The 90-day mortality rate was 92.3%, with a median palliative care period of 11 days (IQR 4-26). A total of 19 participants were subjected to the interview. After thematic analysis, four recurring themes were identified: 1) the decision-making process, 2) pain experience, 3) patient-relative interaction, and 4) the active-dying.

Conclusions: With the introduction of shared decision-making in acute setting for geriatric hip fracture patients, proxies reported palliative, non-operative management as an acceptable and adequate option for patients with high risk of adverse outcomes after surgery. The emerged themes in palliative care for hip fracture patients show great similarity with severe end-stage disease palliative care, with pain identified as the most important factor influencing comfort of the patient and their environment after hip fracture. Future research should focus on further improving targeted analgesia for these patients focusing on acute pain caused by the fracture.

Strengths and limitations of this study:

- The qualitative approach of this study is supported with quantitative data to gain more insight in the patients' palliative care process.
- Several doctors participated in drafting the topic list, and during the interviews, many open probes were used to obtain possible additional information.
- Participants were recruited from a small existing population of P-NOM patients since it is a relatively new option for geriatric hip fracture patients.
- Data saturation was reached in our relatively small group of P-NOM patients.
- First-hand patient experiences of the P-NOM are missing since more than 70 percent of the patients were already diagnosed with dementia, and most of the patients deceased shortly after hip fracture.

INTRODUCTION

The 1-year mortality rate following hip fracture surgery is 22-33%.[1,2] Due to an aging population, the absolute number of hip fractures is expected to rise globally to 4,5 million by 2050.[3,4] Surgery is the cornerstone of hip fracture treatment and is performed in almost all cases (98%).[5] Operative management stabilizes the fracture, allowing for early mobilization and direct start of rehabilitation.[6] However, the postoperative period after this curative treatment is associated with a substantial risk of severe complications such as pneumonia, delirium, and in-hospital mortality.[7,8] Several risk factors are identified with higher mortality risk after a hip fracture. These include older age, ASA Physical status, male sex, and decreased BMI.[9] In addition, multiple comorbidities further increase the mortality after hip fracture surgery.[10] For these patients with various risk factors, palliative, non-operative management (P-NOM) could provide a more peaceful last period of one's life. Currently, P-NOM is increasingly presented as an option for these patients with a high risk of adverse outcomes.[11–14] Early experiences after P-NOM were described in recent literature but little is known about the palliative care process of P-NOM for geriatric trauma patients.[15,16] The integration of palliative care for geriatric trauma patients represents a paradigm shift in hip fracture care from disease-oriented to patient goal-oriented management. The choice for palliative care is an emotion-charged subject and has a major impact on the patient and those around him.[17] An important objective in palliative care is to address supportive care needs early in the process to improve patients' experiences.[18] Physicians build on general palliative guidelines from experiences in other patient populations with chronic and oncological diseases.[19–21] The palliative care principles need translation and adaption into acute traumatic clinical practice since the hip fracture patient is usually unknown at presentation for the physician. Therefore, exploring key components, the impact of P-NOM on patients and relatives are critical. The objective of this study was to explore the experiences from the period after the choice was made for palliative, non-operative management for geriatric patients with a hip fracture and the most important factors in the process, as reported by a proxy.

MATERIAL & METHODS

Design

Semi-structured interviews were conducted to gain insight into the experience of P-NOM of patients who sustained a hip fracture through the experience of first- or second-degree relatives. The qualitative approach of this study was thematic content analysis.[22] A phenomenological approach was used, recognizing the fact that the experiences of the relative and patient regarding to the patients' injury exist in a reality outside of their own

perception(s).[23] The interviews were conducted with proxies of patients who had been admitted with a hip fracture in a level 2 trauma center in an urban setting between August 1st 2020 and April 1st 2021, with a minimum of 2 months and maximum of 8 months after injury. The "Standards for Reporting Qualitative Research" by O'Brien et al. was used to guide this article.[24]

Participant Identification

This study is part of a clinical audit of hip fracture treatment. Study participants were first- or second-degree relatives of the patient who underwent P-NOM, since patients were expected to have died during the timing of the interview. Participants were eligible for inclusion if they were able to give informed consent, were aged 18 years or above, had a relative in the first- or second degree who underwent P-NOM, and the eligible participant was the main caregiver. Participants were excluded if they did not speak Dutch or English fluently.

Sampling

Convenience sampling was used for this study. All patients who met inclusion criteria with P-NOM after hip fracture were eligible for inclusion. Participants were approached between two and eight months after presentation at the ED. The interview was not conducted in the acute phase of the grieving process, and also in our opinion an acceptable time frame for complete memory of details related to the P-NOM experience. The sampling strategy allowed for a diverse range of participants and patients with regard to age, sex, dementia, discharge destination, survival, time to death, and family connection between participant and patient.

Recruitment and consent

Patients were retrospectively identified from the Electronic Patient Record (EPR). Patients were considered suitable for inclusion when they received P-NOM, were 70 years of age or older, and had a hip fracture. Contact details from proxies of patients who underwent P-NOM were collected from the EPR. These proxies were screened by sampling attributes: age, sex, and relationship to the patient and were named the participants. Potential participants were contacted by phone and asked to participate in the study. Participants gave verbal informed consent for partaking in a semi-structured interview. Participants could withdraw from the study at any given time. After data collection, authors TN and DL considered that the data had enough rigor to perform a thorough analysis.

Data collection

The lead author (TN) conducted the interview from January 1st 2021 and June 31st 2021. TN is currently working as a medical doctor and PhD-candidate. He had no prior relationship with

the patients or participants. A topic guide was produced to guide the similar semi-structured interviews (Appendix A). Field notes regarding details of non-verbal communication or latent codes were taken during the interview.

Data analysis

The interviews were recorded with an encrypted digital audio device, only accessible to authors TN and DL. Recordings were extracted, transcribed per word, and uploaded to a secure server with a code only accessible to TN and DL. The transcripts were coded with a unique study number. Thematic analysis, according to Braun and Clarke, was used to analyze the data.[22] After coding all transcripts, differences in the codes were discussed among both authors until agreement was reached. Data analysis was performed concurrently with data collection until no new themes emerged from a new semi-structured interview. In addition to the qualitative data, quantitative data was extracted from the EPR for several patient characteristics. The patient characteristics included age (in years), sex, living situation (independent at home, home with ADL care, institutional care facility), diagnosis of dementia, Charlson Comorbidity Index (CCI), admittance to the geriatric trauma ward of our hospital, discharge destination (home, nursing home, or died in-hospital), 90-day mortality, and time from hospital admittance to death (in days). The municipal basic administration was consulted for data on mortality. Information from participants, including sex, relation to the patient and country of birth, were extracted from the interviews. Participants rated the decision-making process on a scale from 1 (very poor) to 10 (outstanding).

Patient and Public Involvement

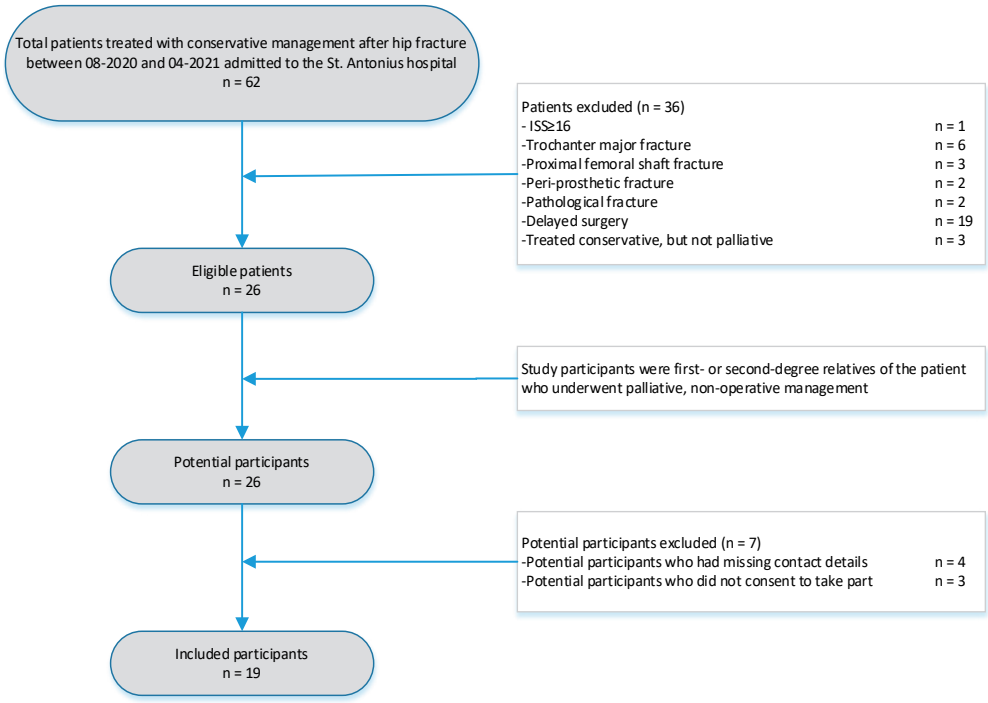
Patients or participants were not involved in the design, intervention, research question, or outcome measures of the current study.

Ethics

The study was conducted in accordance with the Declaration of Helsinki, and the study design was approved by The Medical Ethics Committee, MEC-U Utrecht, The Netherlands (W21.099).

RESULTS

A total of 62 patients presented with a hip fracture met the inclusion criteria in this study, as can be seen in the flowchart (Figure 1). From these patients, 36 were excluded, which resulted in 26 patients eligible for inclusion. As can be seen in the baseline table (Table 1), the median age of the total group was 88 years (IQR 83-94), with a median CCI of 6 (IQR 5-6). In this study, 19 (74%) of all patients had been diagnosed with dementia. After the hip fracture



Abbreviations: ISS = Injury Severity Score

Figure 1. Flowchart palliative management.

was diagnosed, 50% of patients were admitted to the geriatric ward with a median length of stay of 2 days (IQR 1-4). The 90-day mortality was 24 (92.3%), with a median palliative care period (from admission to death) of 11 days (IQR 4-26). Four patients could not participate in this study due to missing emergency contacts details. Three potential participants did not consent to take part in this study with unclear reasons. In total, 19 out of 26 participants were recruited and interviewed as part of this study.

During thematic analysis, four themes were identified: 1) the decision-making process, 2) pain experience, 3) patient-relative interaction, and 4) the active-dying.

The decision-making process

In the acute setting, the goals of care for the patient were assessed, including prognosis, patient goals, likelihood of recovery, and pain. The physician, the patient, and their relatives discussed the burdens and benefits of the treatment strategies with non-operative management as the preferred option. In fourteen (74%) cases, the participant outlined that Shared Decision-Making (SDM) was used. In those cases, the physician clearly

Table 1. Patient and participant characteristics.

PATIENT CHARACTERISTICS (n = 26)	
Female sex; n (%)	18 (69)
Age; years (IQR)	88 (83-94)
Living situation before fracture; n (%)	
Home, independent	2 (8)
Home, with ADL care	6 (23)
Institutional care facility	18 (69)
Charlson Comorbidity Index; median (IQR)	6 (5-6)
Dementia; n (%)	19 (73)
Discharge destination; n (%)	
Home, independent	1 (4)
Nursing home	23 (89)
Died in hospital	2 (8)
Admission in hospital; n (%)	13 (50)
90-day mortality; n (%)	24 (92)
Time from hospital admission to death (days); median (IQR)	11 (4-26)
PARTICIPANT CHARACTERISTICS (n= 19)	
Relation to the patient; n (%)	
Partner	3 (16)
Offspring	12 (63)
In-law	3 (16)
Legal representative	1 (5)
Female sex; n (%)	12 (63)
Country of birth	
The Netherlands	19 (100)

All variables are in total amount (percentage) or median (IQR). Abbreviations: ADL=Activities of Daily Living,. y/n = yes/no. LOS = Length of stay.

discussed the advantages and disadvantages of surgery and left the final decision to the patients and their relatives. These participants emphasized the value of being a part of the decision-making process. Few participants pointed out that they were fond of the approach the physician took with understandable language and a clear translation of medical terminology. In addition, the relatives were satisfied with the time they received to think about the treatment options. In one of those cases, the patient had already indicated that he no longer wanted to receive any surgery, before the families could participate in the decision-making process. In three cases, the physician directed firmly towards non-operative management based on medical grounds. However, the families felt like the official final judgment was with them, which was pleasant, according to the participants. In two other cases, the treating physician assessed the patient as unfit to undergo hip surgery, and therefore SDM was not applicable. Multiple participants addressed the fact that the potential for worse outcomes after surgery was unexpected and a lot to process in the acute setting. The relatives assumed that fixing a fractured hip was child's play for the surgeon without knowing the consequences of the surgical intervention for a geriatric

patient. Two participants pointed out the lack of written information about the palliative process after leaving the emergency department. This was experienced as unpleasant, where it felt like lots of questions remained unanswered after the physician left due to the unexpected possible adverse outcomes after hip fracture. Overall, the communication between the physicians and the families was rewarded with an average grade of 8 out of 10.
Pt.16: "It was not a difficult choice; we were all at peace with it."
Pt.20: "There was clear advice not to operate, and we supported that advice."
Pt.29: "No other relatives were present during the decision-making. It is favorable to involve the family in the decision to forgo surgery"
Pt.37: "We all thought fixing the hip would be child's play for the surgeon."
Pt.38: "Actually, these kinds of talks should be done beforehand, especially for people who fall frequently."

The experience of pain

The pain was experienced in different degrees by patients during P-NOM. In nine (47%) cases, patients seemed comfortable with morphine, experiencing little to no pain laying peacefully in bed. As a result, these patients seemed comfortable. Six patients initially used almost no painkillers. Pain increased over time, and their morphine was adjusted, with the downside of decreased consciousness. Two other patients appeared uncomfortable after bed transfers because of their facial expressions of pain. The relatives expressed lack of clarity regarding treatment between physicians after the transfer to the nursing home. While hospital physicians gave high doses of analgesic drugs for comfort, nursing home staff seemed reluctant to give higher doses of painkillers. This was confusing for patients and families. These issues were discussed with the nursing home staff, their analgesic regiment was adjusted, and patients were comfortable Participants reported analgesia to be key to comfort for caregivers, patients, and families in hospice care. As relatives described, increasing levels of pain for the patient, a domino effect in restlessness for the patient, panic for family and uncontrolled situations for health suppliers emerged.
Pt.12: "The pain relief in the hospital was good, but in the nursing home, the pain was not under control."
Pt.18: "She laid there quietly and comfortably."
Pt.20: "The morphine was useful for the pain but also induced drowsiness for mother."
Pt.21: "Is everybody on the same page when they say "palliative non-operative management?"
Pt.36: "The pain was well under control with the prescribed painkillers."

Patient-relative interaction

This interaction described the communication and interaction with the patient and their relatives between hip fracture and death. Cognitive impairment was mentioned by 11 participants as a pre-existing barrier for interaction between family and patient. Several

participants described the interaction during this period of time as inconsistent. Some days, communication and interaction were better than other days without an apparent reason. Almost all participants described consciousness as best in the first days after trauma and decreasing over time. The last moments with the patient were described as *'precious'* physical contact without any verbal communication. Many thought the increasing dosage of morphine over time was the reason for the declining possibility to communicate with their passing loved ones.'

Pt.12: "In the beginning communication was pretty good, in the hospice, the morphine was taking over, and her consciousness was fading"

Pt.17: "Her mind was clear for short periods of time when she was awake, most of the time she spent sleeping and resting."

Pt.21: "Due to dementia, adequate interaction has already been a problem for a long time."

Pt.26: "The most valuable memory in the last moment was to be there and hold hands before she passed away."

Pt.33: "Over time morphine dosage was increased, and communication seemed more and more difficult."

The active-dying

Almost all participants described the patients' active-dying process as calm and peaceful. The last clear moments together were already shared, and in the last period of time, the patient seemed comfortably asleep or less conscious, as observed by participants. Several mentioned adequate pain relief as the critical factor of comfort in this final stage. In addition, family members cherished the particular moment of passing that could be with all relatives and in a comfortable (home)setting. For three participants, the last moments related to the dying process were uncomfortable to witness. This was not related to discomfort after hip fracture. One of the participants reported that the family experienced the process as unpleasant. Mainly because she felt her mother was dying while her skin color turned grey and interaction was fading. The second patient developed Kussmaul breathing in the last hours before passing away. In these two cases, the participants emphasized that the patient's discomfort was not noticeable for the witnessing relatives. The last patient had a death rattle, and the family indicated that they felt that the patient suffered excessively.

Pt.11: "She passed away in peace after the morphine dosage was increased."

Pt.15: "She slipped away in a state of sedation."

Pt.21: "It is unbearable to see your parent choking on their saliva as they pass away."

Pt.29: "She had always hoped she would pass away peacefully in her sleep, and luckily that was exactly what happened."

Pt.36: "The last few hours mother was still breathing, but it was clear she was dying, that was unpleasant to witness, but luckily mother (patient) did not seem to suffer."

DISCUSSION

The results of this qualitative study show that participants have had a generally positive experience related to P-NOM for patients who sustained a hip fracture. Four recurring themes were identified in the interviews that were deemed most important to the proxies in the palliative process. The decision-making process was awarded with an 8 out of 10 on average, and SDM was present in most cases. Also, communication with the patients was most frequently hampered due to pre-existing dementia and was best in the first days after the trauma. Most participants described the final moments as calm and peaceful, and the presence of relatives was considered very valuable.

The participants reported that adequate pain medication was the most important aspect to keep the patient comfortable. However, they also indicated that increasing the morphine was often accompanied by adverse effects such as a decreasing level of consciousness which increasingly impeded the communication with the patient in the last days before passing away. This is in line with current literature for palliative care in severe end-stage disease where optimal pain management is stated as the most important element in the palliative care process.[15] To optimize pain relief, different anesthetic techniques are studied for hip fracture patients with long term and sometimes even irreversible effects.[25] These techniques include nerve blocks, ultrasound-guided pericapsular nerve group (PENG) hip joint phenol neurolysis and phenol neurolysis of L4.[26–28] Future studies must determine the applicability of these novel analgesic techniques for hip fracture patients receiving palliative care in order to identify long term outcomes. Further, our data showed a need for written information, confirming that short written materials can be a preferred method of information delivery for palliative patients since memory for verbal medical information, especially in older patients, can be very poor and inaccurate.[29,30] A brochure with information about P-NOM could be distributed at the emergency department to support verbal communication with additional information in a written brochure. Our data also revealed the importance of good communication between healthcare workers from the hospital and nursing homes. These results reflect Romoren et al. (2017), who also outlined the importance of good communication and improving information exchange between the nursing home staff and hospital doctors to optimize treatment and care for each individual patient.[31] To enable proper communication between healthcare providers, the term P-NOM could be used instead of conservative management, in order to be clear about the nature of the policy. Finally, our participants indicated that the choice between surgery or P-NOM came very unexpected in the hospital. The confrontation with the acute end-of-life choice came as a shock and was very unpleasant for patients and families. Perhaps ideally, SDM between geriatric patients and physicians should take place in a non-acute setting. Advance care planning ensures greater satisfaction with medical care for patients and their relatives.[32,33]

We would like to endorse the importance of advance care planning. We advise patients and physicians to discuss together what is important to them and how far they are willing to go for a certain outcome, including potential consequences of high-risk interventions such as hip fracture surgery.

One of the strengths of our study is that, to our knowledge, a qualitative approach to gather the experiences of the P-NOM process for hip fracture patients is not yet performed in literature since the questionnaire-based experience in the FRAIL hip study by Loggers et al..[14] Another strength is the reflection on the acute introduction of the palliative care process for geriatric patients at the emergency department. Since patients are relatively unknown to the physician in this situation, identification of the patients' needs in the short term seems critical. In addition, qualitative research provides concrete directions for improvement of palliative care in geriatric hip fracture management. In acute setting, SDM for geriatric hip fracture patients also shows good feasibility and acceptability when advance care planning is not yet performed. Also, all included patients were retrospectively identified in a single hospital, and little information was lost searching for data. Lastly, several doctors participated in drafting the topic list, and during the interviews, many open probes were used to obtain possible additional information. In general, it is essential to consider that thematic analysis has limited interpretative power when it is used outside of an existing theoretical framework.[22] Nevertheless, our results can provide the fundament for future prospective studies with yet promising and valuable insights in the P-NOM process. One of the limitations of our study is that our study was based on the experience of the relatives of the patient. First-hand patient experiences of the P-NOM are missing since more than 70 percent of the patients were already diagnosed with dementia, and most of the patients deceased shortly after hip fracture; this was the most viable method to gather the experience. The lead and second researcher are medical doctors (in training) and perform medical research. During the study, they aimed to be reflexive and minimize bias. However, the personal experiences and professional background of both researchers may have introduced bias throughout data collection, analysis and interpretation. At last, seven potential participants were lost to follow-up. It could be possible that additional participants would reveal new insights in the experience of P-NOM.

Four key themes could be of relevance in clinical practice for the geriatric trauma patient receiving palliative care after hip fracture. First, as the experience of pain was the most important theme, future research should focus on the application of novel analgesic techniques for P-NOM. Second, additional information in a brochure during the decision process was suggested to support verbal communication at the emergency department.. Third, we would like to endorse the importance of advance care planning prior to life-changing trauma events in geriatric patients to minimize the emotional impact of the

potential choice for a palliative trajectory after hip fracture, if not yet performed, the acute phase should be the designated time and place for this discussion when carried out appropriately by SDM with patient and family. Lastly, since themes in our study are in line with the key elements in previous studies of palliative care in end-stage disease, we believe the cause of death may be irrelevant once a patient has transitioned to palliative care. Even though the build-up to palliative care process might be different, expertise in the palliative care management could be directly applied to the patient with P-NOM after hip fracture.

CONCLUSION

With the introduction of shared decision-making in acute setting for geriatric hip fracture patients, proxies reported palliative, non-operative management as an acceptable and adequate option for patients with high risk of adverse outcomes after surgery. The emerged themes in P-NOM show great similarity with severe end-stage disease palliative care, with pain identified as the most important factor influencing comfort of the patient and their environment after hip fracture. Future research should focus on further improving targeted analgesia for these patients focusing on acute pain caused by the fracture. The participants clearly underlined the impact of the end-of-life choice in acute setting. Therefore, we should include advance care planning as a routine feature of general health care for geriatric patients to protect patients and families from these unanticipated situations.

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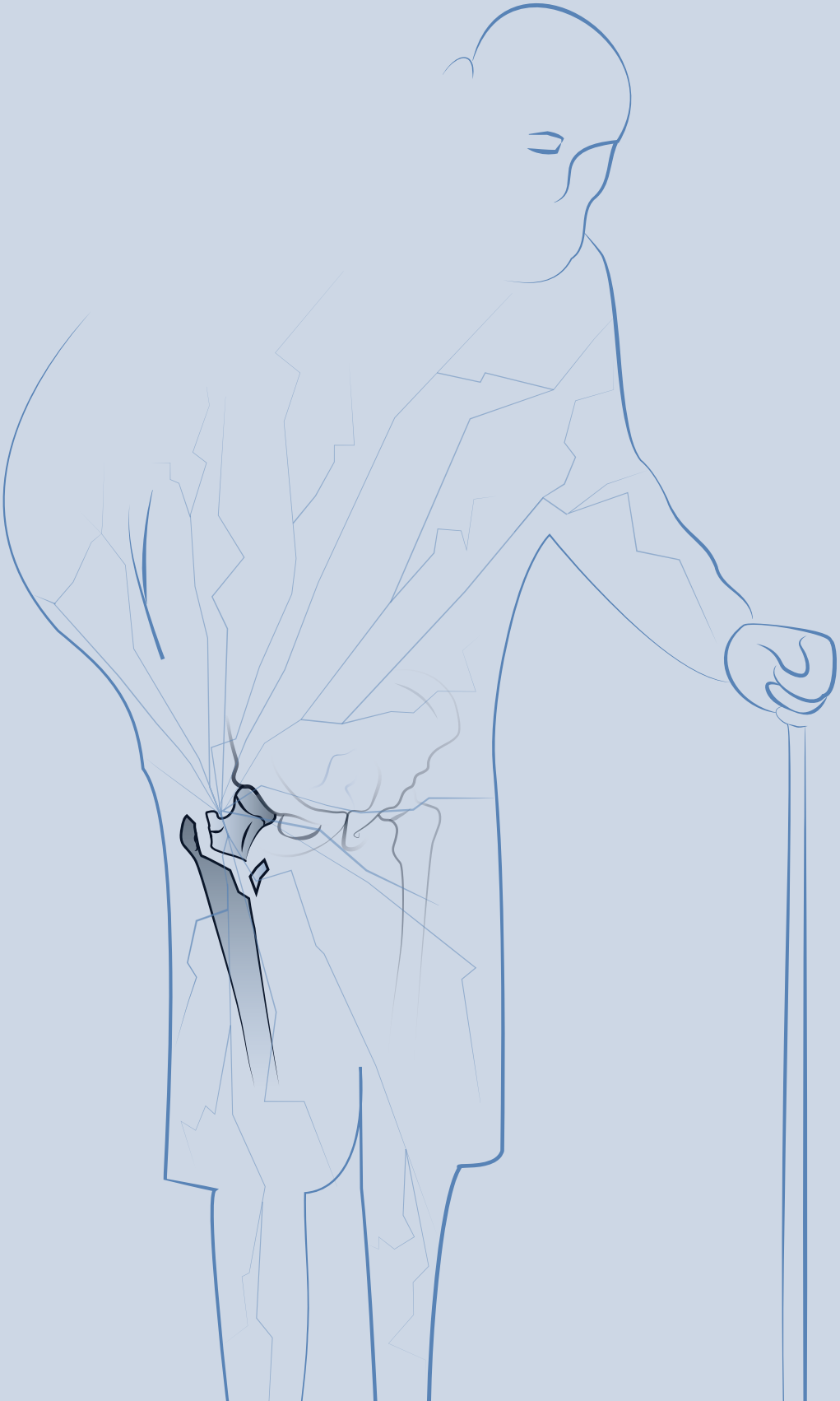

CHAPTER 6

The impact of palliative, non-operative management on mortality of operatively treated geriatric hip fracture patients

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ABSTRACT

Background: Since August 1st 2020, hip fracture patients with limited life expectancy can opt for palliative, non-operative management in our hospital, which could offer them a more peaceful last phase of life. The hypothesis is that these patients with a limited life expectancy affected the mortality of the operatively treated geriatric hip fracture population. This study aims to determine whether the operatively treated geriatric hip fracture population will have a lower in-hospital mortality rate and fewer postoperative complications after the introduction of palliative, non-operative management.

Methods: This retrospective cohort study analyzed patients aged 70 years or older admitted between February 1st 2019, and February 1st 2022, with a hip fracture undergoing operative management to give a comparison between hip fracture patients before and after implementation of the palliative, non-operative management. The primary endpoint was in-hospital mortality. Secondary endpoints were postoperative complications, ICU admissions, hospital length of stay, hospital readmission, and 1-year mortality.

Results: A total of 1035 surgically treated patients were included, 550 patients in the pre-implementation cohort and 485 patients post-implementation. After implementation, there was no significant difference in in-hospital mortality (2.9% vs 1.4%, p=0.139) and 1-year mortality (22.4% vs 20.2%, p =0.404). In the post-implementation cohort, significantly fewer operatively treated hip fracture patients had a prior diagnosis of dementia (15%) vs 21%, p=0.010). Furthermore, admissions to the Intensive Care Unit significantly decreased (3.5% vs 1.2%, p=0.025). There were no statistically significant differences in the incidence of postoperative complications, hospital length of stay, or hospital readmissions.

Conclusion: The introduction of palliative, non-operative management for frail geriatric hip fracture patients did not result in a significantly lower in-hospital mortality rate, fewer postoperative complications and hospital readmissions in the surgically treated geriatric hip fracture population. However, ICU admissions significantly decreased in the post-implementation cohort indicating that patients who opted for P-NOM affected the postoperative short-term outcomes requiring ICU admission.

In conclusion, the authors advocate to broadly implement an approach in geriatric hip fracture management that takes the patients goals of care into account. After the shared decision making, PNOM can be considered as a viable treatment modality for the most frail patients.

INTRODUCTION

Hip fractures in senior patients are increasingly prevalent in current trauma care and create a rising problem, with the global number of hip fractures expected to increase to 6.3 million annually in 2050.[1,2] Hip fractures are historically treated with operative management (OM); however, outcomes following OM remain very poor for specific phenotypes of geriatric patients with several risk factors associated with adverse outcomes.[3-6] For these frail geriatric hip fracture patients with very limited life expectancy, palliative, non-operative management (P-NOM) is increasingly offered as an option besides OM.[7,8] With P-NOM, patients can opt through shared decision-making for a more peaceful last phase of life compared to an uncertain period of invasive rehabilitation after hip fracture surgery.[9], [10] Current literature has focused on the mortality of the geriatric hip fracture population, including operatively treated patients with very limited life expectancy.[11-17] However, these mortality rates for geriatric hip fracture patients after OM could be skewed due to this group of frail patients with limited life expectancy. The hypothesis is that these patients, who only recently have other options than OM, influenced the previously reported mortality rate of the operatively treated hip fracture population and consequently made it appear worse. Therefore, after the introduction of P-NOM, the operatively treated hip fracture population might show fewer adverse outcomes after OM, resulting in a decrease in the burden of care at the trauma-geriatric ward. This study aims to determine whether the operatively treated geriatric hip fracture population will have a lower in-hospital mortality rate and fewer postoperative complications after the introduction of palliative, non-operative management.

MATERIAL & METHODS

Study Design

This retrospective cohort study was performed on geriatric hip fracture patients that were presented to the ED of a large regional teaching hospital in the Netherlands between February 1st, 2019 and February 1st 2022. Patients were identified from the electronic medical records through Diagnosis Related Groups (in Dutch Diagnose Behandel Combinatie); 218; hip fracture. Patients were eligible for inclusion if they were aged 70 years or older and were admitted to the trauma-geriatric ward after OM for a hip fracture. Patients with a pathological hip fracture, an injury severity score of 16 or higher, or a periprosthetic hip fracture were excluded.

Palliative, Non-Operative Management (P-NOM)

P-NOM was introduced in this center as an option through shared decision-making on August 1st 2020 for geriatric hip fracture patients considered frail and with limited life expectancy. Patients were considered frail with one or more Frailty Criteria; (Body Mass

Index (BMI) of 18.5 kg/m^2 or lower, Functional Ambulation Category (FAC) of 2 or lower pre-trauma, American Society of Anesthesiologists (ASA) score of 4 or 5) or on the indication of the physician when thought of limited life expectancy without meeting the frailty criteria.[10] With P-NOM, specific attention is paid to analgesia and patient comfort without aiming the patient to regain mobility and start the active rehabilitation program. Since P-NOM is not curative management, patients are likely to die within weeks after hip fracture (median survival 11 days (IQR 4-26)).[9] The renewed hip fracture pathway for geriatric patients is shown in **Supplemental Figure 1**.

Study Variables

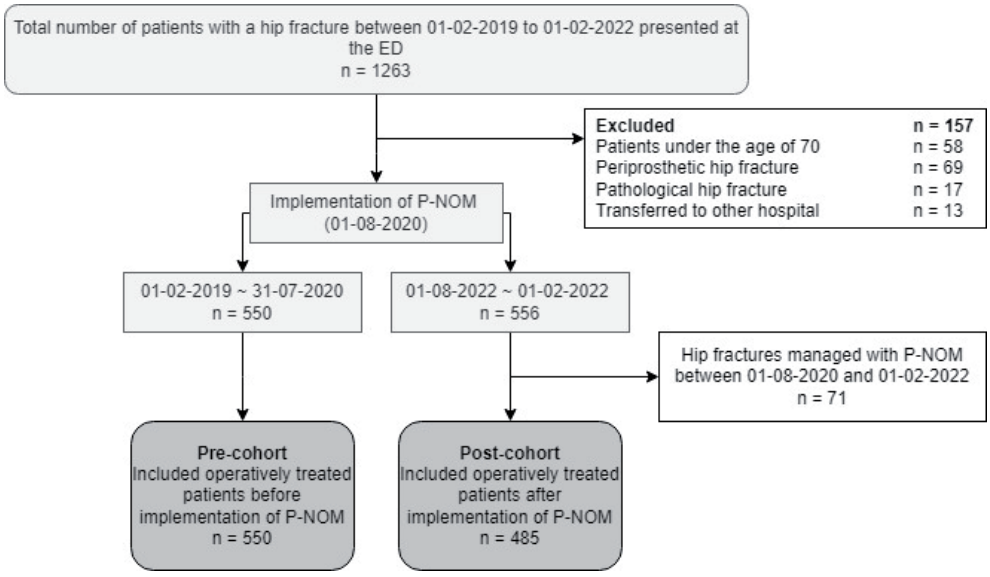
The following baseline characteristics were collected from electronic medical records: age, sex, prior diagnosis of dementia (diagnosed by a geriatrician or general practitioner), Body Mass Index (BMI), pre-fracture living situation (independent at home, at home with assistance for activities of daily living, institutionalized care facility), pre-fracture mobility (freely mobile without aids, mobile with one aid, mobile with two aids or frame, indoor mobility but outdoor immobile, no functional mobility), type of fracture (femoral neck fracture or trochanteric fracture), type of surgical procedure (sliding hip screw, proximal femoral nail anti-rotation, hemiarthroplasty, cannulated hip screw, hip arthroplasty).

Outcome Measures

The primary outcome of this study was in-hospital mortality. Secondary outcomes were postoperative complications (surgical and non-surgical complications), admission to an Intensive Care Unit (ICU), hospital length of stay, hospital readmission within 30 days after discharge, 30-day mortality, 90-day mortality, and 1-year mortality. Surgical complications included wound infection, postoperative hemorrhage, or secondary surgical intervention, such as wound rinsing and prosthesis revision. Non-operative complications included thrombo-embolic events (cerebrovascular accidents, deep venous thrombosis and pulmonary embolisms), cardiac complications (myocardial infarction, arrhythmia and congestive heart failure), pneumonia, urinary tract infection, delirium, pressure ulcer, need for blood transfusion, and urinary retention. Data on mortality was acquired by consulting the municipal citizen registry, and data on complications, when diagnosed by an attending physician, were extracted from electronic medical records.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows 20.0 (IBM, Chicago, Illinois). Differences between patients admitted before and after the implementation of P-NOM were analyzed using descriptive statistics. Continuous variables were tested for differences between groups with an unpaired t-test or Mann-Whitney U test, depending on normality. Normality was tested using the Shapiro-Wilk test. All categorical and dichotomous data



ED = Emergency Department. P-NOM = palliative, non-operative management.

Figure 1. Flow chart of the selection process of included patients who underwent operative treatment of a hip fracture.

were tested with a chi-square test. Kaplan-Meier curves were constructed to compare survival between the two cohorts, and a Mantel-Cox (log-rank) test was performed to test the similarity between the two groups. Descriptive statistics have been presented as mean with standard deviation or median with interquartile ranges, depending on the distribution. For all statistical tests, *p*-values less than or equal to 0.05 are considered significant.

RESULTS

Patient Demographics

In total, 1263 patients presented at the ED with a hip fracture. After exclusion, 1035 were included in the analysis. A total of 550 patients were included in the pre-cohort, and 485 patients were included in the post-cohort (**Figure 1**). The study population had a median age of 82 years (IQR 76-87), consisted of 688 females (66.5%), and had a median BMI of 24.0 (IQR 21.7-26.7). A femoral neck fracture was diagnosed in 588 (56.8%) of the patients, whereas 447 (43.2%) patients sustained a trochanteric fracture. The majority of 666 patients (64.3%) lived independently at home without additional care before admission, 206 patients (19.9%) lived at home with Activities for Daily Living (ADL) support, and 163 patients (15.7%) were admitted to an institutionalized care facility **(Table 1).**

Table 1. Baseline characteristics of hip fracture patients who underwent operative treatment.

Baseline variable	Data missing	Total (n=1035)	Pre-cohort (n=550)	Post-cohort (n=485)	*p*-value
Age (in years)	0 (0)	82 (76-87)	82 (77-88)	82 (76-87)	0.893
Female sex	0 (0)	688 (66.5)	379 (68.9)	309 (63.7)	0.086
Prior diagnosis of dementia	0 (0)	188 (18.2)	116 (21.1)	72 (14.8)	**0.010**
BMI in kg/m²	27 (2.6)	24.0 (21.7-26.7)	23.9 (21.6-26.2)	24.2 (21.9-27.0)	0.095
Living situation before fracture	0 (0)				0.151
Home, independent		666 (64.3)	341 (62.0)	325 (67.0)	
Home, with ADL care		206 (20.0)	112 (20.4)	94 (19.4)	
Institutionalized care facility		163 (15.7)	97 (17.6)	66 (13.6)	
Pre-fracture mobility	2 (0.2)				0.147
Freely without aids		467 (45.1)	243 (44.2)	224 (46.2)	
Outdoors with 1 aid		47 (4.6)	27 (4.9)	20 (4.1)	
Outdoors with 2 aids or frame		496 (47.9)	272 (49.5)	224 (46.2)	
Indoor, but immobile outside		18 (1.7)	4 (0.7)	14 (2.9)	
No functional mobility		5 (0.5)	3 (0.5)	2 (0.4)	
Fracture type	0 (0)				0.314
Femoral neck fracture		588 (56.8)	304 (55.3)	284 (58.6)	
Trochanteric fracture		447 (43.2)	246 (44.7)	201 (41.4)	
Surgical procedure	0 (0)				0.136
Sliding Hip Screw		69 (6.7)	41 (7.5)	28 (5.8)	
Proximal Femoral Nail Anti-		443 (42.8)	246 (44.7)	197 (40.6)	
rotation		462 (44.6)	237 (43.1)	225 (46.4)	
Hemiarthroplasty		6 (0.6)	4 (0.7)	2 (0.4)	
Cannulated Hip Screw		55 (5.3)	22 (4.0)	33 (6.8)	
Total hip arthroplasty					

All variables are in total amount (percentage) or median (interquartile range, IQR). BMI = Body Mass Index. ADL = Activities of Daily Living.

In the pre-cohort, 379 patients (68.9%) were female, and the post-cohort consisted of 309 female patients (63.7%) (p = 0.086). The post-cohort had significantly fewer patients diagnosed with dementia than the pre-cohort (72 (15%) vs 116 (21%), p = 0.010). No significant difference between the pre-cohort and post-cohort was measured in the living situation and pre-fracture mobility before the hip fracture. Also, there were no significant differences between the two cohorts at baseline regarding age, BMI, fracture type or surgical procedure.

Mortality and Postoperative Complications

After the implementation of P-NOM, no statistically significant difference was observed in in-hospital mortality (2.9% vs 1.4%, p = 0.139). Additionally, the 30-day (6.4% vs 4.7%, p = 0.281), 90-day (10.9% vs 10.3%, p = 0.763) and 1-year (22.4% vs 20.2%, p = 0.404) mortality follow-up periods also showed no statistical significance in mortality between the two cohorts. Significantly more postoperative hemorrhages occurred in the post-cohort (0.2% vs 1.9%, p = 0.018). Admissions to the ICU showed a significant decrease in the post-cohort

Table 2. Patient outcomes of operatively treated hip fracture patients.

Patient outcomes	Pre-cohort (n=550)	Post-cohort (n=485)	*p*-value
Mortality			
In-hospital	16 (2.9)	7 (1.4)	0.139
30-day	35 (6.4)	23 (4.7)	0.281
90-day	60 (10.9)	50 (10.3)	0.763
1-year	123 (22.4)	98 (20.2)	0.402
Patients with complications	286 (52)	272 (56)	0.190
Surgical complications	28	31	
Wound infection	24 (4.4)	20 (4.1)	0.878
Secondary hemorrhage	1 (0.2)	9 (1.9)	**0.018**
Re-intervention	3 (0.5)	2 (0.4)	1.000
Non-surgical complications	418	416	
Thrombo-embolic	8 (1.5)	8 (1.6)	0.807
Cardiac	42 (7.6)	40 (8.2)	0.731
Pneumonia	48 (8.7)	41 (8.5)	0.912
UTI	37 (6.7)	35 (7.2)	0.807
Delirium	149 (27.1)	138 (28.5)	0.627
Pressure ulcer	26 (4.7)	30 (6.2)	0.336
Anemia	70 (12.7)	77 (15.9)	0.154
Urinary retention	30 (5.5)	40 (8.2)	0.083
Sepsis	8 (1.5)	7 (1.4)	1.000
Admission to ICU	19 (3.5)	8 (1.2)	**0.025**
Readmission	26 (4.7)	32 (6.6)	0.223
Hospital length of stay (in days)	6 (4-9)	6 (5-9)	0.053

All variables are in total amount (percentage) or median (interquartile range, IQR). UTI = urinary tract infection. ICU = intensive care unit.

(3.5% vs 1.2%, $p = 0.025$). There were no significant differences in the incidence of other complications, readmissions, or hospital length of stay (**Table 2**).

DISCUSSION

This study retrospectively analyzed elderly patients admitted to the trauma-geriatric ward after OM. The results of this study showed no significantly lower mortality rate or fewer postoperative complications for the post-cohort after the introduction of P-NOM for hip fracture patients. However, significantly fewer operatively treated demented patients and significantly fewer ICU admissions in the post-cohort indicate that the burden of care at the trauma-geriatric ward decreased to a certain extent.

This study observed an in-hospital mortality risk of 2.9% pre-implementation and 1.4% post-implementation, which corresponds with recent studies showing in-hospital mortality rates for geriatric hip fracture patients ranging from 1.5%-5.0%.[11,14-17] Although the difference

between the two cohorts in this study was not significant, a decrease can be seen in the percentage of in-hospital deceased patients. Subsequently, there are indications of a lower mortality rate with the absence of high-risk patients opting for P-NOM. 1-year mortality rates of 22.4% pre-implementation and 20.2% post-implementation also showed no significant decrease but did show lower mortality rates than recent literature, which ranges from 23.2% to 35.1%.[18-21] Compared with a 2018 cohort study in our center with a reported mortality rate of 27.0%, this study found substantially lower 1-year mortality rates.[18] This could be explained by the recent introduction of trauma-geriatric units and their subsequent improvement over the years.[21-23] One possible explanation for the minor impact on mortality rates could be that the clinical outcomes of the post-cohort were affected by the COVID-19 pandemic since these two periods largely coincided. The interference of the pandemic cannot be ruled out and possibly led to an overestimation of mortality, especially in the post-cohort, since the geriatric population is particularly at risk of dying from COVID-19.[24-26] Recent studies report that COVID-19 more than doubles the 90-day mortality rate after hip fracture and show a 30-day mortality rate of 34% in hip fracture patients with a COVID-19 infection.[27,28]

In the post-cohort (14.8%), there were significantly fewer patients with a prior diagnosis of dementia compared to the pre-cohort (21.1%). The incidence of the post-cohort is lower than earlier studies, showing an incidence of 20-28%, which is more in line with the incidence of the pre-cohort.[18,23,29,30] In recent literature, a high percentage (73%) of patients diagnosed with dementia opted for this palliative management after hip fracture, which probably explains the significant decrease in demented patients undergoing OM.[9] In a survey to investigate the general public's view on life-sustaining treatment in the case of dementia, 72.9% expressed a preference for a peaceful passing, and 68.9% expressed a preference for their partner to have a peaceful passing.[31] Therefore it is possible that patients with dementia or those who care for them are more likely to opt for P-NOM. [31]

Although dementia has also been identified as a risk factor for early mortality after hip fracture, this does not imply that all dementia patients are at high risk of adverse outcomes after OM since this is a heterogeneous population with a wide range of physical and cognitive conditions resulting in a variable outcome. [32] Therefore, in the dementia population, it remains essential to include individual risk assessments in the decision-making process.

A possible explanation that the post-cohort did not show fewer postoperative complications could be due to the introduction of an automated complication registration method in our hospital in January 2021, as it is previously studied that automation of the registration process results in a rise in the incidence of registered complications without the increase of relative complications.[33]

The postoperative incidence of secondary hemorrhage even increased significantly in the post-cohort. This result may be due to an increase in the usage of Direct Oral Anticoagulants (DOAC) over the last few years.[34] Using a DOAC will not result in an unnecessary surgical

delay in our center. There is evidence that wound complications, including secondary hemorrhage, have a higher incidence in geriatric hip fracture patients using DOACs.[35],

Contrarily, ICU admissions showed a significant decrease in the post-cohort to 1.2%, which is also lower than that of previously reported incidence rates of 3-4%%, which is again more in line with the incidence of the pre-cohort of 3.5%.[29,36] It seems possible that the incidence of patients with severe adverse outcomes requiring ICU admission after OM significantly decreased due to the identification of frail patients performed in acute settings resulting in a decrease in hip OM in the frailest patients.

One of the strengths of this study, since palliative non-operative management is relatively new in hip fracture management, we are the first to study the impact of P-NOM introduction on operatively treated hip fracture patients in terms of mortality and morbidity. The main limitation was this study's retrospective nature, resulting in difficulty acquiring follow-up data for geriatric patient populations and, therefore, minor complications after admission or cause of death. Consequently, information on postoperative outcomes after discharge was only available if patients revisited the hospital. In addition, changes in management and protocols over time could also have affected the primary and secondary outcomes. Therefore, potential confounding due to the effect of time could exist. Furthermore, this study only collected clinical data as outcome measures without functional or psychological outcomes. Future studies with prospective designs could give more insight into a possible improvement in these outcomes.

With the results of this study, it is tempting to speculate that in the post cohort, there is no direct decrease in the overall frailty of the operatively treated hip fracture population. However, with a significant decrease in postoperative ICU admissions and signs of a decreased in-hospital mortality rate, there are indications that those with a high risk of short-term adverse outcomes are more likely to opt for P-NOM. These results suggest a decrease in the burden of care since ICU admissions are both costly and labor-intensive.[37,38] Furthermore, since patients opting for P-NOM stay significantly shorter in the hospital and often (35.0%) return directly from the ED to their place of origin, fewer complex hip fracture patients are admitted to the trauma-geriatric ward, which further decreases the burden of care.[10] It is worth mentioning that although costs should not influence the choice of treatment, the introduction of P-NOM has significantly lowered healthcare costs compared to OM, primarily due to shorter hospital length of stay and costs related to surgery and readmissions.[41] However, most importantly, with the introduction of P-NOM, a shift in thinking from disease-oriented to a patient-goal oriented paradigm is ensured. This will provide better person-centered care for geriatric patients with limited life expectancy.

CONCLUSION

The introduction of palliative, non-operative management for frail geriatric hip fracture patients did not result in a significantly lower in-hospital mortality rate, fewer postoperative complications and hospital readmissions in the surgically treated geriatric hip fracture population. However, ICU admissions significantly decreased in the post-implementation cohort indicating that patients who opted for P-NOM affected the postoperative short-term outcomes requiring ICU admission.

In conclusion, the authors advocate to broadly implement an approach in geriatric hip fracture management that takes the patients goals of care into account. After the shared decision making, PNOM can be considered as a viable treatment modality for the most frail patients.

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SUPPLEMENTAL FIGURE 1.

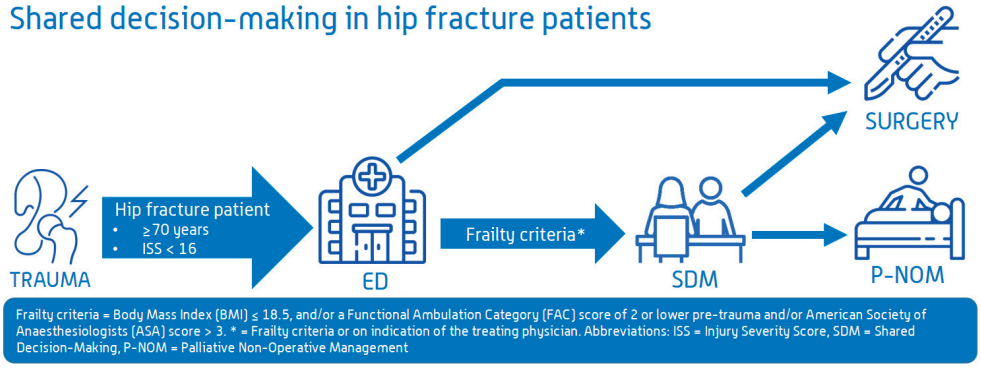
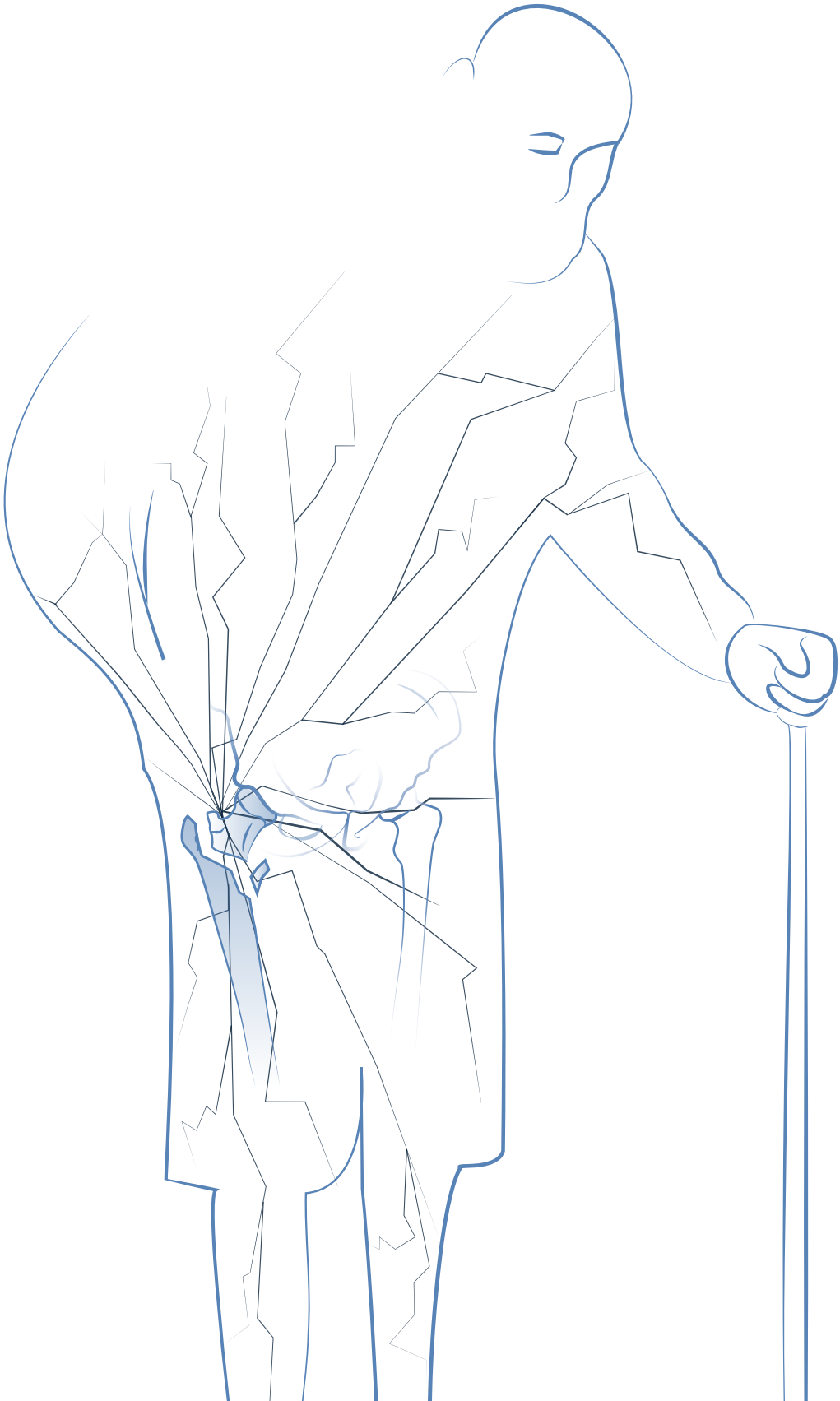
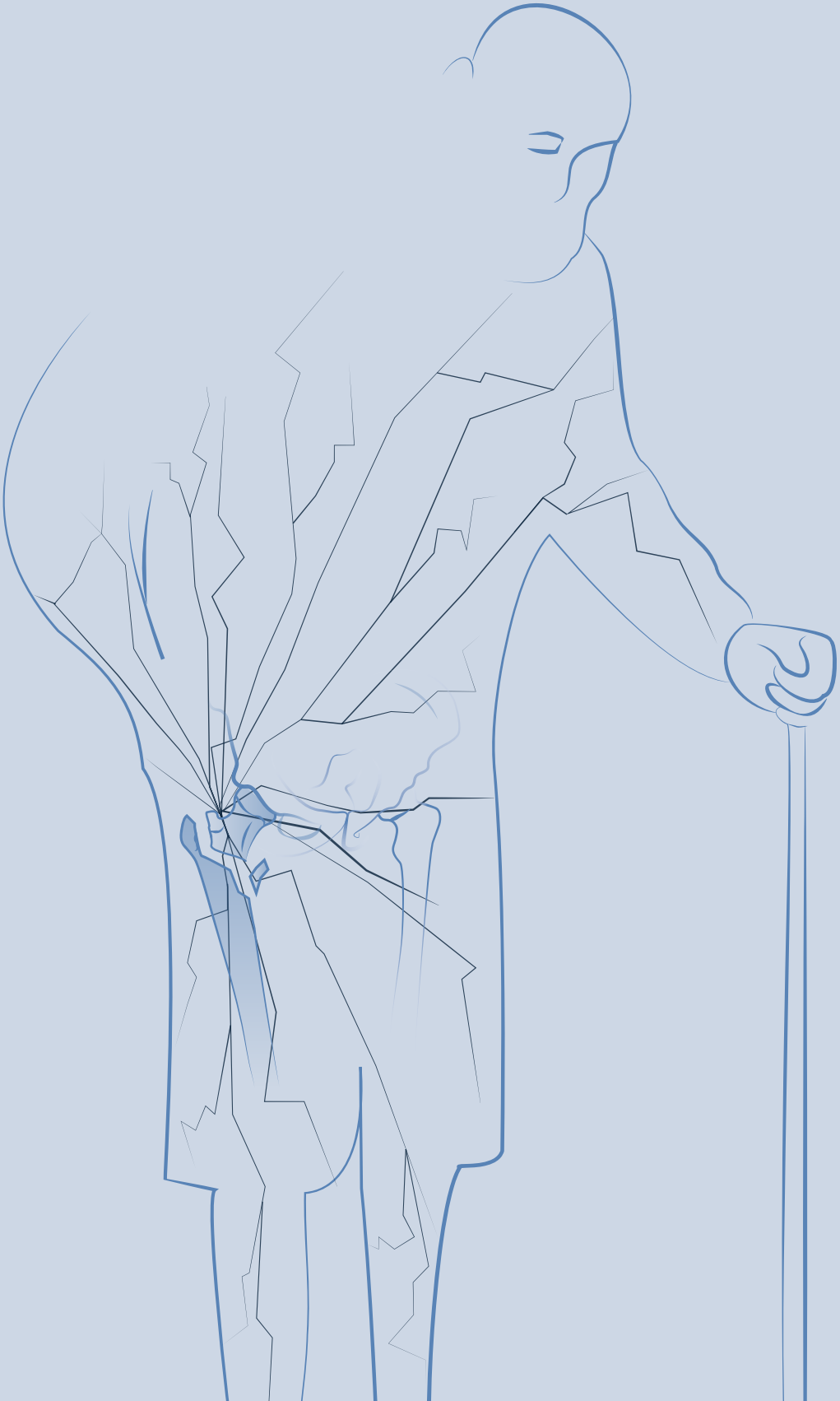


Figure 1. Pathway for the hip fracture patient at the emergency department.



PART IV

Enhanced Tools for Shared Decision Making



CHAPTER 7

What are the Goals of Care in Acute Setting for Geriatric Patients in Case of a Hip Fracture?

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ABSTRACT

Introduction: For geriatric hip fracture patients with very short life expectancy, the decision between surgery and palliative, non-operative management is made through shared decision making. For this conversation, a physician must be familiar with the patient's goals of care (GOC). These are predominantly unknown for hip fracture patients and challenging to assess in acute setting. The objective of this study was to explore the most relevant GOC of geriatric patients in case of a hip fracture.

Material & Methods: An expert panel gathered possible outcomes after a hip fracture, which were transformed into statements where participants could indicate their relative importance on a 100-point scoring scale during interviews. These GOC were ranked using medians (interquartile ranges (IQR)) and deemed important if the median score was 90 or above. Patients were aged 70 years or older, presented with a suspected hip fracture diagnosed with a contusion. Patients were divided in three cohorts (A, B and C) based on frailty criteria and the diagnosis of dementia.

Results: For patients considered non-frail patients, the most important GOC were; 'being with partner', 'preserving cognitive function', 'being with family', 'maintaining independence', 'return to pre-fracture mobility', 'maintain Quality of Life', 'starting intensive rehabilitation', and 'admission to the hospital'. For the frail patients, the most important GOC were 'preserving cognitive function', 'being with partner', 'being with family', 'maintaining independence', and 'being able to walk again'. For patients with a pre-existing diagnosis of dementia, the most important GOC scored by proxies were; 'not experiencing pain', 'maintain Quality of Life', 'being with partner', 'being with family', and 'preserving cognitive function'.

Conclusion: This study explored the most important GOC for geriatric patients in hip fracture setting. Non-frail patients, frail patients and proxies of patients with dementia all scored preserving cognitive function, being with family and being with partner among the most important GOC. The most important GOC should at least be discussed when a patient is presented at the ED with a hip fracture. In addition, since patients preferences vary, a patient-centered assessment of the GOC remains essential during SDM.

INTRODUCTION

The prevalence of hip fracture is increasing due to ageing of the Western population.[1,2] Hip fracture patients are most commonly treated with operative management (OM) for early mobilisation and rehabilitation.[3-5] For geriatric hip fracture patients with limited life expectancy, palliative, non-operative management is an alternative option, which aims not to restore mobility or independence, but to focus on palliative care and pain management.[5-8] Recently, it has been shown that this non-operative option is non-inferior to OM in terms of quality of life for geriatric patients with limited life expectancy.[7] Since palliative, non-operative management is a viable treatment option, physicians have to discuss it in the acute setting through Shared Decision Making (SDM).[5] This decision-making process starts with the identification of the patient's Goals of Care (GOC) which enables a tailor-made SDM discussion considering the patient clinical and personal needs.[5,9-14] These GOC can vary significantly between patients. For example, the urge to rehabilitate or undergo life-prolonging interventions may not be the same for every geriatric patient sustaining a hip fracture. For oncological and chronic diseases, patients' future palliative needs can be discussed at earlier timepoints before the disease reaches an end state.[15] On the contrary, geriatric trauma patients and family members have not thought about them before being confronted with palliative treatment options at the emergency department. Furthermore, the trauma physicians usually have no previous treatment relationships with hip fracture patients, which makes identification of the GOCs challenging in the relative short time window to surgery.[16-19] Since Advance Care Planning (ACP) is often still lacking, patients have not explicitly considered their GOCs in case of a hip fracture.[5, 20] Exploring general GOCs of hip fracture patients could help physicians to discuss and assess the individual preferences for future patients at the Emergency Department (ED). Therefore, this study aims to investigate the most relevant GOCs of geriatric patients in case of a hip fractur

MATERIAL & METHODS

Study design

A cross-sectional survey study was conducted to obtain important GOC for geriatric patients in hip fracture setting. Patients with a hip contusion were deemed as most appropriate study population because this population is similar in characteristics to hip fracture population but cannot have been influenced by experiences with OM.[21] Patients were eligible for inclusion when diagnosed with a hip contusion at the ED of a large regional teaching hospital between January 1st 2021 and September 1st 2022. The study design was approved by the Medical Ethics Committee, Utrecht (MEC-U), The Netherlands (W22.149). The Checklist for Reporting of Survey Studies was used to guide this article.[22]

Survey design

The survey was constructed using Passmore's guidelines.[23] To complement the survey, an expert panel (consisting of a trauma surgeon, orthopedic surgeon, clinical geriatrician and a nursing home physician) was consulted to identify additional desirable and undesirable outcomes associated with a hip fracture. These outcomes were transformed into statements, which were organized into three themes: treatment, rehabilitation and quality of life (QoL). To ensure validity, one statement was added which should be scored oppositely to the statement maintain QoL (is more important than prolonged life): length of life is more important than QoL. As a final question, participants were asked if important outcomes not mentioned during the interview were missing. All participants received similar information before conducting the interview. The structured interview is attached as appendix 1. Pretesting on completeness and understanding of the interview was performed by conducting the interview in three patients aged 70 years or above who were admitted to the trauma geriatric ward with a hip fracture. The pre-test patients were deemed similar to the sample population. All pre-test patients indicated the statements were comprehensible and complete.

Participants

Patients were eligible for inclusion if they were aged 70 years or above, presented at the ED with a suspected hip fracture after falling from a standing position, received imaging which did not show a fracture and were subsequently diagnosed with a hip contusion. Patients with previous hip surgery were excluded due to prior positive or negative experiences with the rehabilitation process. Patients were divided in three cohorts based on frailty criteria and the presence of a pre-existing diagnosis of dementia. Patients were considered frail if they met one of the frail hip criteria of Loggers et al.; BMI lower than 18.5, and/or a pre trauma Functional Ambulation Category (FAC) score of 2 or lower, and/or American Society of Anaesthesiologists (ASA) score of 4 or 5.[6] Patients in cohort A contained patients who did not meet the frailty criteria (hereafter referred to as 'non-frail'), cohort B contained patients who did meet the frailty criteria (hereafter referred to as 'frail') and cohort C contained patients with a pre-existing diagnosis of dementia. Due to the presence of a pre-existing diagnosis of dementia in patients in cohort C, the questionnaire was conducted in proxies. Convenience sampling was used, where only patients who were known in one hospital were contacted. All participants gave informed consent before conducting the structured interview.

Outcome parameters

The primary outcome was the ranking of the most important GOC in all cohorts. In the structured interview, participants were asked to indicate the relative importance of GOC on a 100-point scoring scale, from 0 (totally unimportant) to 100 (utmost importance).

GOC were ranked using medians, with the highest median classified as the most important GOC. A GOC was considered most important when scored with a median of 90 or higher. A secondary outcome was the extent to which our participants had engaged in ACP. This required asking, by means of affirmative questions, the level of ACP in patients.

Data collection

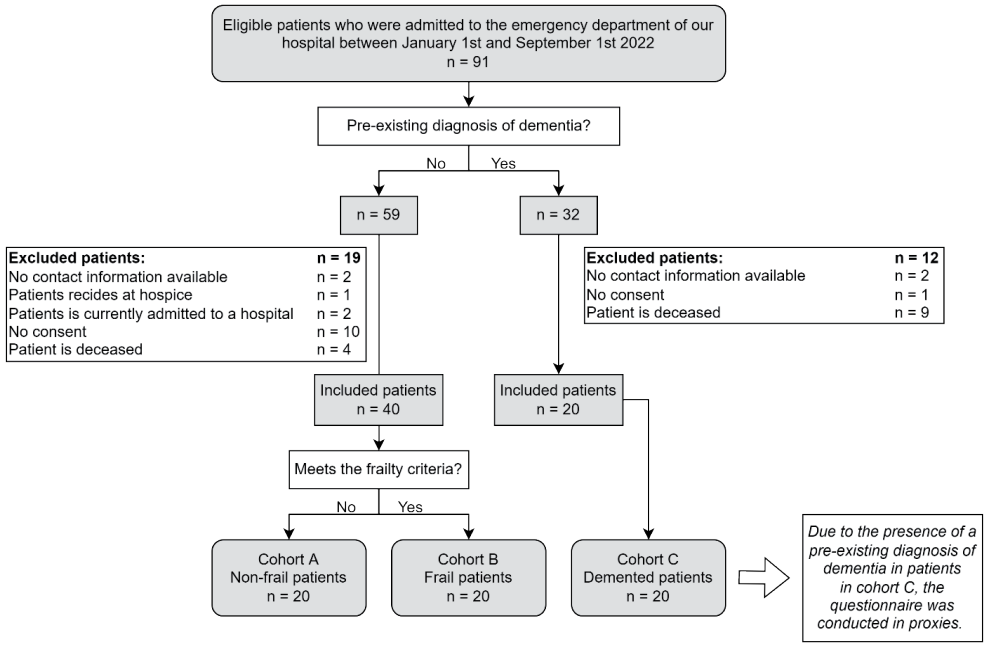
TN and DL conducted the interviews in October 2022. Both authors (TN and DL) had prior experience in conducting interviews and qualitative research. The answers of the participants were coded and uploaded to a secure server with a key accessible to TN and DL. Patient characteristics were collected from the electronic medical records: including age (in years), sex, presence of a pre-existing diagnosis of dementia diagnosed by a physician, living situation (independent at home, home with activities of daily living care, institutional care facility), Charlson Comorbidity Index (CCI), body mass index (BMI), Functional Ambulation Category (FAC) and American Society of Anaesthesiologists Classification (ASA). From the proxies, data were collected during the interview including age (in years), sex and relationship with the patient (spouse, partner, offspring, and caregiver).

Data analysis

Continuous data were reported as median and interquartile ranges (IQR) due to non-normal distribution. In absence of relative weights attached to the possible outcomes after a hip fracture, a formal power analysis was considered inappropriate, therefore no statistical comparison was made between GOCs. A pragmatic sample size of 20 participants in each cohort was deemed sufficient to achieve data saturation. For each participant, the range between the highest and lowest score was calculated, to assess dispersion in the valuation by individual participants.

RESULTS

Of the 91 eligible patients, 60 patients were included, 20 in each cohort (Figure 1). All interviews were conducted within 18 months after presentation at the ED with a hip contusion. The included patients had a median age of 83 (IQR 78-88) years, 42 patients (70%) were female with a median CCI of 5 (IQR 4-7) and 22 patients (37%) lived in an institutional care facility (Table 1). In cohort B and C, respectively 20 and 19 patients met the frailty criteria. In total 39 (65%) eligible patients met the frailty criteria, 38 based on their functional ambulation category and one patient with a BMI lower than 18.5. Overall, 50 (83%) patients had discussed with their relatives what they would want in the event of an acute illness, and 25 (42%) also discussed treatment preferences when sustaining a hip fracture (Table 2).



Frailty criteria = BMI lower than 18.5, and/or a Functional Ambulation Category (FAC) score of 2 or lower pre-trauma and/or American Society of Anaesthesiologists (ASA) score > 3 [6]
Cohort A = Non-frail patients with no pre-existing diagnosis of dementia
Cohort B = Frail patients who meet the frailty criteria of Loggers et al. with no pre-existing diagnosis of dementia
Cohort C = Patients with a pre-existing diagnosis of dementia, where the interview was conducted by proxies

Figure 1. Flowchart of selection process of study population.

Validity and completeness

Overall the validity statement was scored 50 points lower on average than the QoL statement. With a median score of 90 (IQR 80-100) on the QoL and the validity statement with an overall median score of 40 (IQR 20-60). All answers on the validity statement were deemed sufficient to include the interviews in the analysis. After completing the interview, all participants indicated no additional or missing goals of care in the questionnaire.

Non-frail patients (cohort A)

Non-frail patients in cohort A had a median age of 78 (IQR 75-83) years, 9 patients (45%) were female and 18 patients (80%) lived independently at home (Table 1). Median scores for the GOC were presented in Table 3. For non-frail geriatric patients, eight GOC were ranked as most important (with a median score of 90 or higher): being with partner 100 (IQR 100-100), preserving cognitive function 100 (IQR 90-100), being with family 100 (IQR 90-100), maintaining independence 90 (IQR 80-100), return to pre-fracture mobility 90 (IQR 80-100), maintain QoL 90 (IQR 80-100), starting intensive rehabilitation 90 (IQR 70-99) and admission to the hospital 90 (IQR 80-98) (Figure 2).

Table 1. Baseline characteristics of included patients and proxies.

PATIENT CHARACTERISTICS				
	Total (n=60)	**Cohort A Non-frail patients (n=20)**	**Cohort B Frail patients (n=20)**	**Cohort C Demented patients (n=20)**
Age (Y), median (IQR)	83 (78-88)	78 (75-83)	86 (78-89)	85 (83-93)
Female sex, n (%)	42 (70)	9 (45)	14 (70)	19 (95)
Pre-existing dementia, n (%)	20 (33)	0 (0)	0 (0)	20 (100)
Living situation, n (%)				
Home, independent	19 (32)	16 (80)	3 (15)	0 (0)
Home, with ADL care	19 (32)	4 (20)	13 (65)	2 (10)
Institutional care facility	22 (37)	0 (0)	4 (20)	18 (90)
CCI, median (IQR)	5 (4-7)	4 (3-7)	4 (4-6)	6 (5-7)
BMI, median (IQR)	25.6 (21.7 – 29.6)	25.8 (22.2-29.1)	27.4 (24.1-34.7)	24.4 (20.4 – 27.7)
FAC, n (%)				
FAC 0	4 (7)	0 (0)	0 (0)	4 (20)
FAC 1	12 (20)	0 (0)	3 (15)	9 (45)
FAC 2	23 (38)	0 (0)	17 (85)	6 (30)
FAC 3	3 (5)	2 (10)	0 (0)	1 (5)
FAC 4	8 (13)	8 (40)	0 (0)	0 (0)
FAC 5	10 (17)	10 (50)	0 (0)	0 (0)
ASA, n (%)				
ASA 1	2 (3)	1 (5)	1 (5)	0 (0)
ASA 2	14 (23)	6 (30)	4 (20)	4 (20)
ASA 3	44 (73)	13 (65)	15 (75)	16 (80)
Meets the frailty criteria*, n (%)	39 (65)	0 (0)	20 (100)	19 (95)
BMI lower than 18.5	1 (2)	0 (0)	0 (0)	1 (5)
FAC 2 or lower	38 (63)	0 (0)	20 (100)	18 (90)
ASA 4 or higher	0 (0)	0 (0)	0 (0)	0 (0)
PATIENT CHARACTERISTICS				
Age (Y), median (IQR)	-	-	-	59 (54-62)
Female sex, n (%)	-	-	-	14 (70)
Relationship with patient, n (%) *Offspring*	-	-	-	20 (100)

All variables are in total amount (percentage) or median (interquartile range, IQR)
Frailty criteria* = BMI lower than 18.5, and/or a Functional Ambulation Category (FAC) score of 2 or lower pre-trauma and/or American Society of Anaesthesiologists (ASA) score > 3[6]
Y = years
ADL = Activities of Daily Living
BMI = Body Mass Index
FAC = Functional Ambulation Classification
ASA = American Society of Anesthesiologists Classification
CCI = Charlson Comorbidity Index[36].

Frail patients (cohort B)

Frail patients in cohort B had a median age of 86 (IQR 78-89) years, 14 patients (70%) were female and sixteen patients (80%) lived at home including 13 (65%) patients of whom

Table 2. The extent of Advance Care Planning in geriatric patients.

	Total (n=60)	Cohort A Non-frail patients (n=20)	Cohort B Frail patients (n=20)	Cohort C Demented patients (n=20)
ACP, n (%)				
"I have thought about treatment options for when I become very ill"	50 (83)	15 (75,0)	17 (85,0)	18 (90,0)
"I shared my thoughts with my surroundings"	43 (72)	10 (50,0)	15 (75,0)	18 (90,0)
"I have thought about treatment options for when I sustain a hip fracture"	25 (42)	6 (30,0)	9 (45,0)	10 (50,0)

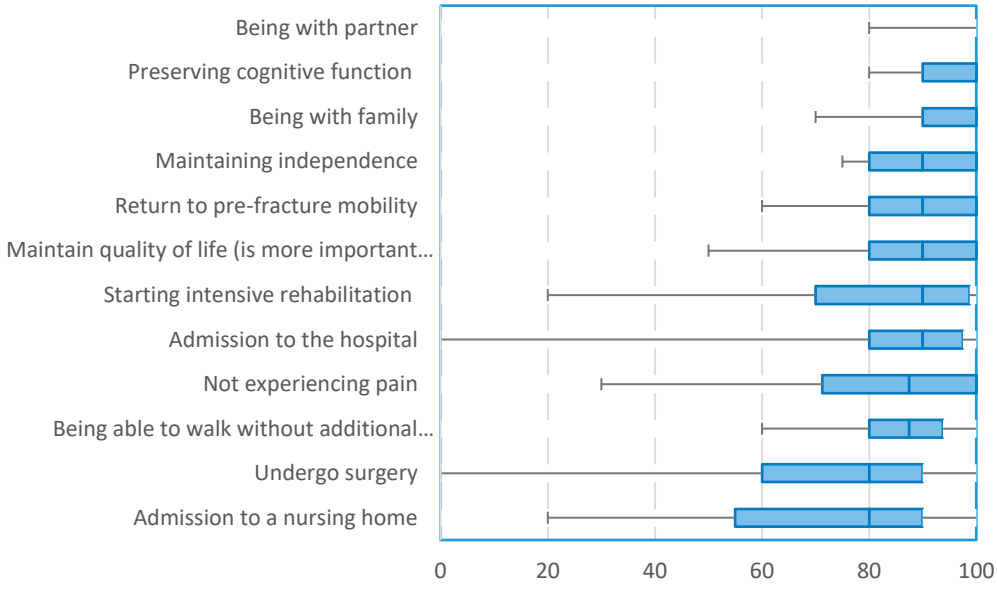
All variables are in total amount (percentage), ACP = Advance Care Planning.

Table 3. Ranking of Goals of Care for all cohorts.

	Cohort A Non-frail patients (n=20)		Cohort B Frail patients (n=20)		Cohort C Proxy-reported (n=20)	
	Median	**Rank**	**Median**	**Rank**	**Median**	**Rank**
Treatment of hip fracture						
Not experiencing pain	88 (71-100)	9	83 (63-98)	9	100 (96-100)	1
Admission to the hospital	90 (80-98)	8	83 (71-98)	8	55 (13-80)	10
Undergo surgery	80 (60-90)	11	70 (50-88)	12	28 (10-50)	12
Return to pre-fracture mobility	90 (80-100)	4±	90 (73-100)	5	70 (43-90)	8
Rehabilitate						
Maintaining independence	90 (80-100)	4±	90 (80-100)	4	75 (50-88)	7
Being able to walk without additional assistance of walking aids	88 (80-94)	10	83 (63-100)	7	80 (53-90)	6
Starting intensive rehabilitation	90 (70-99)	7	78 (61-90)	10	50 (19-75)	11
Admission to a nursing home	80 (55-90)	12	75 (53-90)	11	55 (21-80)	9
Quality of life						
Maintain quality of life (is more important than prolonged life)	90 (80-100)	4±	83 (80-100)	6	100 (75-100)	2
Preserving cognitive function	100 (90-100)	2*	100 (90-100)	1	93 (76-100)	5
Being with family	100 (90-100)	2*	98 (85-100)	3	98 (83-100)	4
Being with partner	100 (100-100)	1	100 (84-100)	2	100 (60-100)	3
Validation question						
Length of life is more important than quality of life	50 (33-68)		50 (33-60)		30 (16-40)	

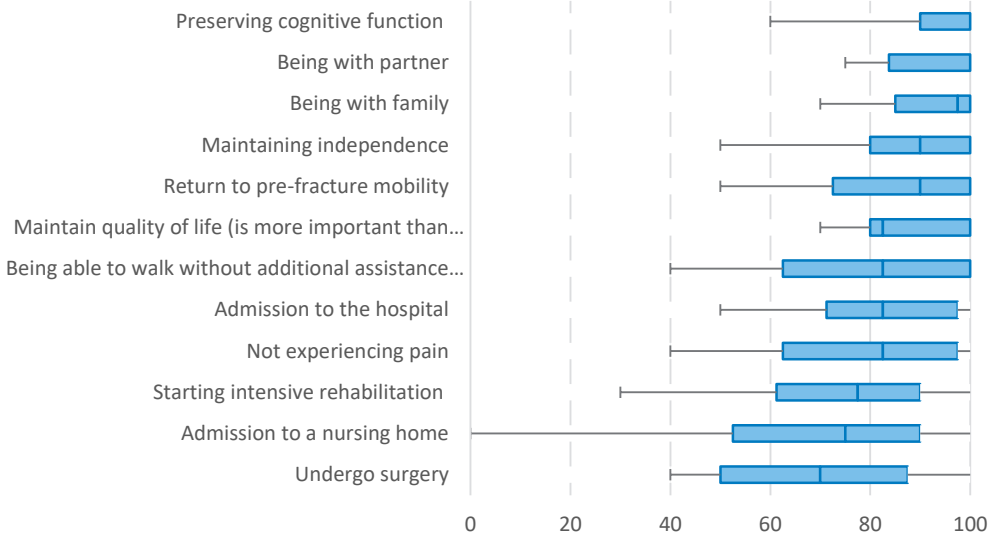
Outcomes are in median (interquartile range, IQR), Frailty criteria = BMI lower than 18.5, and/or a Functional Ambulation Category (FAC) score of 2 or lower pre-trauma and/or American Society of Anaesthesiologists (ASA) score > 3[6]*,± = Ex aequ.

received additional ADL care (Table 1). Median scores for the GOC were presented in Table 3. For frail geriatric patients, five GOC were ranked as most important (with a median score of 90 or higher): preserving cognitive function 100 (IQR 90-100), being with partner 100 (IQR 84-100), being with family 98 (IQR 85-100), maintaining independence 90 (IQR 80-100), and being able to walk again 90 (IQR 73-100) (Figure 3).



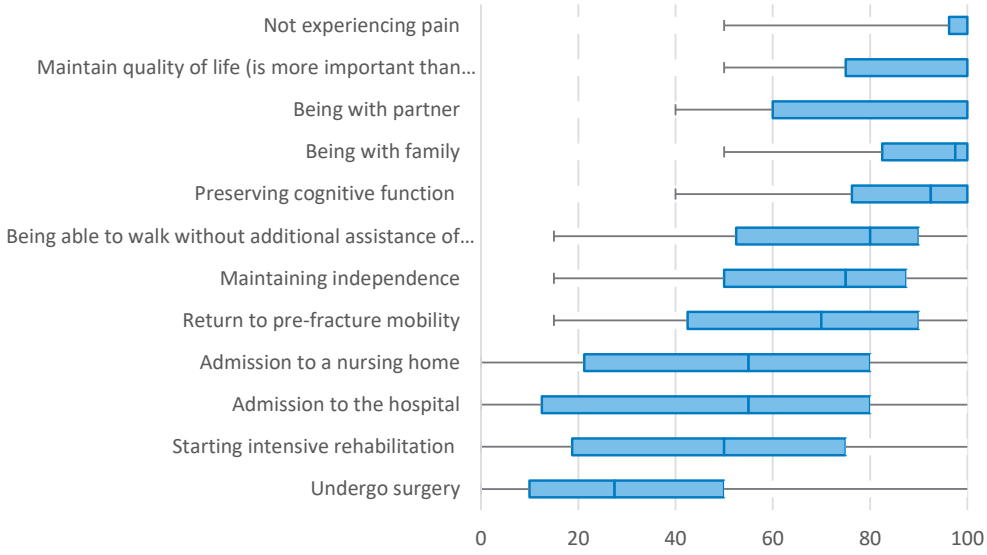
0 = totally unimportant
100 = utmost importance

Figure 2. Boxplot of Goals of Care of non-frail, patients (cohort A).



0 = totally unimportant
100 = utmost importance

Figure 3. Boxplot of Goals of Care of frail, patients (cohort B).



0 = totally unimportant
100 = utmost importance

Figure 4. Boxplot of proxy-reported Goals of Care of patients with a pre-existing diagnosis of dementia (cohort C).

Proxies of patients with a pre-existing diagnosis of dementia (cohort C)

Patients with a pre-existing diagnosis of dementia in cohort C had a median age of 85 (IQR 83-93) years, 19 patients (95%) were female and 18 (90%) of patients lived in an institutional care facility. Proxies interviewed were all offspring from the included patients. Proxies had a median age of 59 (IQR 54-62) years and 14 proxies (70%) were female (Table 1). Median scores for the GOC were presented in Table 3. For proxies of patients with a pre-existing diagnosis of dementia, five GOC were ranked as most important (with a median score of 90 or higher): not experiencing pain 100 (IQR 96-100), maintain QoL 100 (IQR 75-100), being with partner 100 (IQR 60-100), being with family 98 (IQR 83-100), and preserving cognitive function 93 (IQR 76-100) (Figure 4).

DISCUSSION

A cross-sectional survey study was conducted to obtain the most important GOC for geriatric patients in hip fracture setting. Non-frail geriatric patients, frail geriatric patients and proxies of geriatric patients with a pre-existing diagnosis of dementia all scored preserving cognitive function, being with family and being with partner among the most important GOC. Both non-frail and frail geriatric patients scored return to pre-fracture mobility and maintaining independence among the most important GOC, where proxies of patients with

a pre-existing diagnosis of dementia scored not experiencing pain as the most important GOC. These most important GOC may guide a physician at the ED, ultimately allowing SDM to be more efficient for these complicated patient populations.

Preserving cognitive function scored high across all cohorts, with non-frail and frail patients scoring it with a median of 100 and proxies scoring it with a median of 93. This reflects the results of Steinhauser et al., who described being mentally aware as highly important for patients.[24] Since patients value preserving cognitive function so highly, it is import to inform patients during SDM that there is a risk of cognitive dysfunction after surgery.[25-27] 'Undergo surgery' is scored relatively low compared to the other GOC, with frail, geriatric patients considering hip fracture surgery as least important. This corresponds with recent studies describing that GOC of the frailest patients focus more on QoL and comfort rather than physical performance.[5,28] Similarly, proxies of patients with dementia scored hip fracture surgery the least important. Also, a recent study investigating the public's opinion on life-sustaining treatment supported this finding, in which the majority (68.9%) of the participants wanted no life-sustaining treatment for their partners in the case of dementia.[28] Relatives described adverse affection regarding suffering, decay, or pain for their demented loved ones which probably explains why life prolonging surgery is considered least important by these proxies.[29,30] With regards to pain, proxies scored not experiencing pain the most important GOC, with a median of 100. A recently published qualitative study into the proxy-reported experiences of palliative, non-operative management, supports proxies valuing being pain free most important for the patients comfort.[8] Remarkably, not experiencing pain is only ranked 9th by non-frail and frail geriatric patients, with a median score of respectively 88 and 83, while other studies have emphasized the importance of being pain free to maintain QoL.[24,29] In this study, twelve GOC were identified for geriatric hip fracture patients. This discriminates us from the Outcome Prioritization Tool, which was developed for geriatric patients in general. In the Outcome Prioritization Tool, patients rank four health outcomes: extending life, maintaining independence, reducing pain and reducing other symptoms.[14] Recent studies showed that the majority of patients ranked maintaining independence as most important.[30-32] In this study, maintaining independence was the fourth most important GOC. However, the Outcome Prioritization Tool did not include the top 3 GOC of this study ('being with partner', 'maintaining cognition' and 'being with family'). Geriatric patients ranked admission to a nursing home as least or second-least important GOC. Several studies have shown health expectancies of geriatric patients can be strongly influenced by several factors, for example health status of peers suffering from worse health.[33-35] Therefore, it is tempting to speculate geriatric patients do not want to be admitted to a nursing home because they consider themselves vital and independent enough returning home instead of receiving nursing care.

One of the strengths of this study was that the composition of the GOC was developed by a multidisciplinary team consisting of four physicians with different geriatric focus areas and all directly involved in the management of geriatric hip fracture patients. In addition, the GOC were patient-centered and pretesting ensured that the interview was complete and comprehensible. A hypothetical situation regarding a hip fracture was presented without the need of recalling information from the past to avoid any forms of recall bias. The validity statement showed patients understood the questionnaire. Patients reported no missing GOC at the end of the interview, indicating that the questionnaire was complete. The inclusion of hip contusion instead of hip fracture patients could be a limitation for assessing GOC. Inclusion of patients after operative or non-operative management of a hip fracture could be biased due to treatment choices, experienced adverse events and their experience with the admission or rehabilitation process. Another possible limitation is that geriatric patients without a diagnosis of dementia could have signs of mild cognitive impairment, this study did not include cognitive assessment during the interviews and only a validity statement was included to assess comprehension of the interview.

The results of this study are directly applicable in clinical practice. Since the decision for operative management is usually made within a short period of time, implementation of these GOC during the pre-operative SDM process will allow further validation of their individual importance for each patient category. The post-operative period following hip fracture surgery may be complicated by cognitive dysfunction, therefore the possibility of cognitive decline should always be discussed with patients undergoing surgery. Since there is a discrepancy between the ranking of not experiencing pain between geriatric patients and proxies, proxies could be better informed about the expected hip fracture related pain of their relatives.

CONCLUSION

This study explored the most important GOC for geriatric patients in hip fracture setting. Non-frail patients, frail patients and proxies of patients with dementia all scored preserving cognitive function, being with family and being with partner among the most important GOC. The most important GOC should at least be discussed when a patient is presented at the ED with a hip fracture. In addition, since patients preferences vary, a patient-centered assessment of the GOC remains essential during SDM.

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APPENDIX 1: STRUCTURED INTERVIEW

Abbreviations:
Q = Question
O = Outcome
S = Statement
GOC = Goal of Care

"First, a few general questions follow. You may answer with yes or no."

Questions regarding advanced care planning
Q1: Did you think about what you would want to happen tomorrow you suddenly become very sick?

Q2: Did you share the above with your family, or with your family doctor?

Q3: Did you think about what you would want to happen in the case you sustain a hip fracture?

"Now try to imagine coming back to the emergency room after a fall, and now you do have a broken hip. I will list 13 possible outcomes after a broken hip. Please rate on a scale of 0-100 how important you think these outcomes are. A 0 can be given if the outcome is not important to you at all, and 100 should be given to the most important outcome according to you."

Questions regarding possible outcomes after surgery
GOC1: Not experiencing pain
S1: Experiencing no pain

GOC2: Admission to the hospital
S2: Become admitted to a hospital

GOC3: Undergo surgery
S3: Undergo hip fracture surgery, with the risk of complications

GOC4: Return to pre-fracture mobility
S4: Return to pre-fracture mobility, even if I need surgery to do so

Questions regarding rehabilitation
GOC5: Maintaining independence
S5: Maintain independence

GOC6: Being able to walk without additional assistance of walking aids
S6: To be able to walk as long as possible without additional aids

GOC7: Starting intensive rehabilitation
S7: Start intensive rehabilitation to return to pre-fracture situation.

GOC8: Admission to a nursing home
S8: Rehabilitation, even if it means admission to a nursing home temporarily

Questions regarding quality of life
GOC9: Maintain quality of life (is more important than prolonged life)
S9: Maintain quality of life is more important than the length of my life.

GOC10: Preserving cognitive function
S10: Maintain cognition

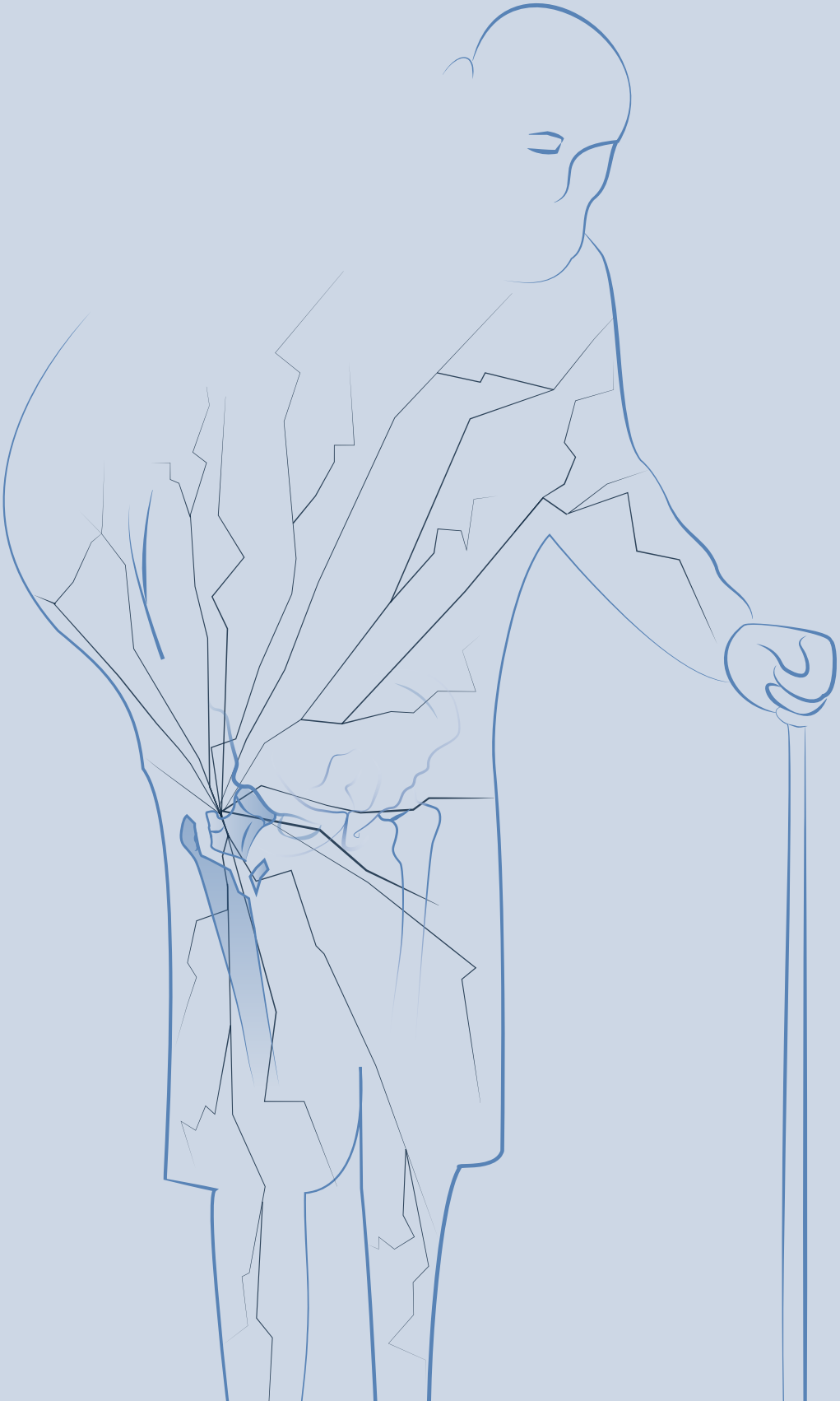
GOC11: Length of life is more important than quality of life
S11*: Prolonged life is more important than quality of life
*= validation question, the opposite of statement 9

GOC12: Being with family
S12: To have final moments with family regardless of the length of my life.

GOC13: Being with partner
S13: I would like to stay together with my partner

Final question
After rating all these goals of care, did you miss any important goals of care in this interview?

If so, what goal of care did you miss, and how important is it to you?



CHAPTER 8

Geriatric patient and proxy perspectives on decision-making for hip fracture, a qualitative study

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ABSTRACT

Background: Depending on the patient goals and preferences, palliative, non-operative management may provide an alternative when limited added value of hip fracture surgery is expected. The decision-making process between surgery and palliative, non-operative management is complicated. The objective of this study was to evaluate the experiences with the decision-making process between surgery and palliative, non-operative management of geriatric hip fracture patients and their proxies.

Methods: A qualitative cohort study was performed where patients and proxies were asked to participate in semi-structured interviews. In hip fracture patients with a pre-existing diagnosis of dementia and/or who were treated with palliative, non-operative management, proxies were asked to participate in the semi-structured interview. Patients and proxies were allocated between four cohorts based on the type of treatment (surgery or palliative, non-operative management) and the presence of a pre-existing diagnosis of dementia. The interviews were transcribed verbatim and analysis was done according to Braun and Clarke's six-step guide.

Results: A total of 16 patients and 12 proxies were included. The median age of the patients was 84 (interquartile range 80-91), 10 (63%) patients with female sex, and the patients had a median Charlson Comorbidity Index of 6 (interquartile range 5-6). Proxies had a median age of 62 (interquartile range 56-69), 8 (67%) were female, and 11 (92%) were offspring. During thematic analysis, five themes were identified: 1) Underlying patient values, 2) The provision of information, 3) Reasons to consider either P-NOM or surgery, 4) Involvement in decision and 5) Realization of expectations. Several crucial aspects were identified which come into play during shared decision-making for hip fractures.

Conclusions: In this study, in-depth analysis provided a comprehensice overview and unique insight in the patient and proxy perspectives in shared decision-making for geriatric hip fracture management in the acute setting. The crucial aspects of SDM for geriatric hip fracture patients were; addressing underlying patient values, providing information, discussing both treatment options, involving patients and proxies in the decision, and evaluating expectations. The importance of patient-centered approach was emphasized, where physicians should be informative and guiding, using a personalized communication style and providing opportunities for reflection during the decision-making process.

INTRODUCTION

Geriatric hip fractures are becoming increasingly prevalent.[1–3] Generally, hip fractures are treated with surgery. However, when limited added value of surgery is expected, palliative, non-operative management (P-NOM) may provide an alternative which is more in line with patients goals and preferences.[4–7] With P-NOM, the focus lies primarily on the patients' preferred last stage of life, comfort and adequate analgesia. When P-NOM was previously evaluated, the decision-making process emerged as a fundamental theme for satisfaction with treatment.[5] This decision between surgery and P-NOM for geriatric patients with a limited longevity is complicated due to the uncertainty in forecasting a patient-specific prognosis.[8–11] Making the choice together with the patient, i.e. shared decision-making (SDM), is impeded further by the absence of a pre-existing patient-physician relationship combined with time pressure due to an optimal window of surgery of 24-28 hours.[11–15] Moreover, it is well known that the acute hip fracture setting is demanding, which entails that not all provided information is be retained by patients and their proxies.[8,11,16] With the aging population discussing P-NOM has become more common, creating a novel dimension of SDM within the field of trauma geriatrics. In an acute setting, patients and proxies are now offered a choice between a curative treatment or palliative treatment, where the choice is made based on goals of care and with a great deal of uncertainty about the expected individual outcomes with either option.[10,11] Since it is known that involvement in treatment decision is strongly related to satisfaction with the decision, it is desirable to evaluate the current experiences of geriatric hip fracture patients and proxies with SDM.[17] The objective of this study was to evaluate the experiences with the decision-making process between surgery and P-NOM of geriatric hip fracture patients and their proxies to provide a foundation for further SDM improvements.

METHODS

Design

To explore the experiences of geriatric hip fracture patients and their proxies regarding the decision-making process between surgery and P-NOM, a qualitative cohort study was performed in a large regional teaching hospital between December 1st 2022 and February 1st 2023. Patients and proxies were asked to participate in semi-structured interviews within a year after the presentation at the emergency department with a hip fracture. The study design was approved by the Medical Ethics Review Committee Utrecht (MEC-U), the Netherlands (W22.233). The "Standards for Reporting Qualitative Research" by O'Brien et al. guided this article.[18]

Type of treatment	Pre-existing diagnosis of dementia? Yes	Pre-existing diagnosis of dementia? No
Surgery	**Cohort A** Demented, Surgery	**Cohort D** No dementia, Surgery
P-NOM	**Cohort B** Demented, P-NOM	**Cohort C** No dementia, P-NOM

Figure 1. The formation of the cohorts.

Participants

Hip fracture patients were retrospectively identified from the electronic patient file and eligible for inclusion if they were 70 years or above. They were diagnosed with a femoral neck, intertrochanteric or subtrochanteric fracture and were treated with surgery or P-NOM. In hip fracture patients with a pre-existing diagnosis of dementia and/or who were treated with P-NOM, proxies were asked to participate in the semi-structured interview. Proxies were eligible for inclusion if they were an offspring, partner or caregiver of a patient who met the inclusion criteria. Patients and proxies were excluded if they did not speak Dutch or English fluently. Patients and proxies were allocated between four cohorts based on the type of treatment (surgery or P-NOM) and the presence of a pre-existing diagnosis of dementia (Figure 1). Drop-outs were defined as patients and proxies who did not want to complete the semi-structured interview.

Recruitment and consent

Convenience sampling was used to include patients and proxies. Patients and proxies were recruited by calling the patient or their proxy as registered in the electronic patient file. All eligible patients and proxies were given an informative introduction about the study over the phone. All patients and proxies received the same information. When possible, patients and proxies gave verbal informed consent; then, a call was scheduled for a researcher to interview by phone. All patients and proxies gave verbal informed consent. Patients and proxies could choose to opt out of the interview at any time.

Data collection

The semi-structured interviews were conducted over the telephone between December 2022 and February 2023. The interviews were recorded, and the audio recordings were anonymously stored in a secured server. DL, AvdB and TN conducted the interviews. TN is a medical doctor, and DL is a medical student. Both have performed multiple qualitative studies in trauma geriatrics in the past two years. AvdB is an intern at our trauma geriatric

research department. In addition to the qualitative data on patient and proxies' experience, baseline characteristics of patients and proxies were collected from the electronic health records and the interviews. In patients, data were collected on age (in years), sex (male/female), the presence of a pre-existing diagnosis of dementia, Charlson Comorbidity Index (CCI), level of education (high, middle, low), living situation (independent at home, home with activities of daily living care, institutional care facility), type of management (OM, P-NOM), admittance to our hospital, mortality and time from hospital admission to death (days). In proxies, data were collected on age (in years), sex (male/female), relation to the patient (spouse, offspring or acquaintance) and level of education (high, middle, low).

Data analysis

Thematic analysis was done according to Braun and Clarke's six-step guide.[19] The study adopted a phenomenological approach, acknowledging that the perceptions of both the relative and the patient concerning SDM surrounding the hip fracture exist within a reality beyond their individual experiences.[20] After conducting four interviews in each cohort, DL and AvdB transcribed the audio recordings verbatim. After transcribing all the audio recordings, DL and AvdB formulated preliminary themes. DL and an independent medical researcher (TK) thematised half of the transcripts based on these preliminary themes. DL and TK then compared the themes and the content of those themes, complementing each other where necessary. After DL and TK reached consensus on thematization, themes were discussed with TN and AvdB. DL, TK, TN and AvdB considered that the data had enough rigour to perform a thorough analysis. Afterwards, DL and TK finalised the codes and themes before the final thematization took place using ATLAS.ti (version 23.1.1.0).

RESULTS

A total of sixteen patients and twelve proxies were included in this study (Figure 2). The baseline characteristics of all patients and proxies are presented in Table 1. The median age of the patients was 84 (IQR 80-91), ten (63%) patients with female sex, and a median CCI of 6 (IQR 5-6). All patients (100%) were admitted to the hospital, with a median length of stay of 6 (IQR 3-10) days. Of the patients whom received P-NOM, six (75%) were deceased at the time of the interview, with a median time from hospital admission to death of 14 (7-48) days. The included proxies had a median age of 62 (56-69), eight (67%) were female, and eleven (92%) were offspring. The level of education was middle or high in eleven proxies (92%).

Patients were allocated between four different cohorts, with four patients in each cohort. Cohort A contained surgically treated patients with a pre-existing diagnosis of dementia, who had a median age of 88 (IQR 84-90) and where two (50%) patients lived in an institutional care facility. Cohort B contained palliative-treated patients with a pre-existing

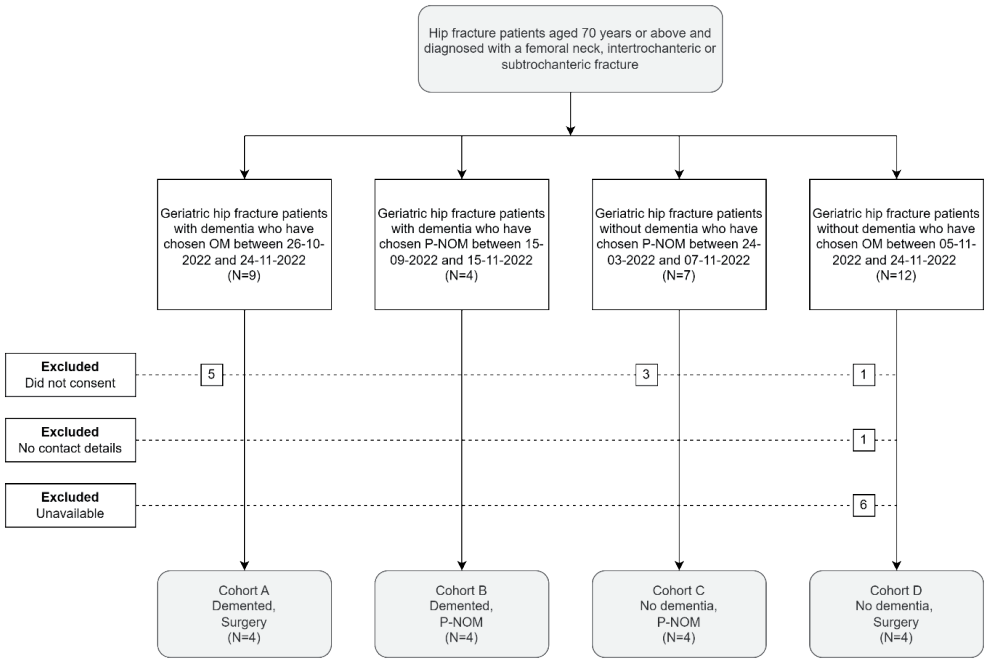

Figure 2. Flowchart of the selection process of included patients and proxies.

diagnosis of dementia, with a median age of 83 (IQR 90-91) and where three (75%) patients lived in an institutional care facility. Cohort C contained palliative-treated patients without a pre-existing diagnosis of dementia. Their median age was 94 (IQR 81-101) and two (50%) patients lived in an institutional care facility. Cohort D contained surgically treated patients without a pre-existing diagnosis of dementia. In this cohort, patients had a median age of 75 (IQR 71-81) and all patients (100%) lived at home without needing additional ADL care.

During thematic analysis, five themes were identified: 1) Reasons to consider either P-NOM or surgery, 2) The provision of information, 3) Expectation management, 4) Shared decision-making and 5) Quality of life.

Theme 1: Reasons to consider either P-NOM or surgery

A major part of the decision-making process is discussing the reasons to consider, i.e. advantages and disadvantages, of either P-NOM or surgery. Discussed risks of surgery were urinary tract infection, pneumonia, delirium, aggravated dementia, and mortality. In five out of eight patients who underwent surgery, patients or proxies indicated that complications associated with surgery had been discussed before surgery. Important considerations for choosing surgery were: “being able to walk again”, “having a better longevity”, compared to choosing P-NOM, “being able to return home”, and “being relieved of pain”. When P-NOM was discussed, proxies indicated that they were told that the doctors would make sure the

Table 1. Baseline characteristics of included patients and proxies.

Patient characteristics	**Total N = 16**	**Cohort A Demented, Surgery N = 4**	**Cohort B Demented, P-NOM N = 4**	**Cohort C No dementia, P-NOM N = 4**	**Cohort D No dementia, Surgery N = 4**
Age (Y), median (IQR)	84 (80-91)	88 (84-90)	83 (80-91)	94 (86-101)	75 (71-81)
Female sex, n (%)	10 (63)	4 (100)	3 (75)	1 (25)	2 (50)
Dementia, n (%)	8 (50)	4 (100)	4 (100)	-	-
CCI, median (IQR)	6 (5-6)	6 (5-6)	7 (5-7)	5 (4-10)	4 (3-4)
Level of education					
High					1 (25)
Middle					1 (25)
Low					-
Unknown					2 (50)
Living situation, n (%)					
Home, independent	5 (31)	-	1 (25)	-	4 (100)
Home, with ADL care	4 (25)	2 (50)	-	2 (50)	-
Institutional care facility	7 (44)	2 (50)	3 (75)	2 (50)	-
Management					
OM	8 (50)	4 (100)	-	-	4 (100)
P-NOM	8 (50)	-	4 (100)	4 (100)	-
Admittance in hospital, n (%)	16 (100)	4 (100)	4 (100)	4 (100)	4 (100)
Length of stay (d), median (IQR)	6 (3-10)	10 (4-15)	4 (2-12)	6 (2-10)	54 (50-60)
Deceased at the time of the interview, n (%)	7 (44)	1 (25)	2 (50)	4 (100)	-
Time from hospital admission to death (d), n (%)	14 (7-48)	48 (48-48)	15 (10-15)	10 (3-91)	-
Time to interview (d), median (IQR)	61 (53-141)	59 (50-69)	85 (53-113)	320 (188-342)	5 (3-7)
Proxy characteristics	**Total N = 12**	**Cohort A N = 4**	**Cohort B N = 4**	**Cohort C N = 4**	
Age (Y), median (IQR)	62 (56-69)	63 (53-66)	59 (55-79)	66 (57-71)	
Female sex, n (%)	8 (67)	3 (75)	3 (75)	2 (50)	
Relationship with patient, n (%)					
Spouse	1 (8)	-	1 (25)	-	
Offspring	11 (92)	4 (100)	3 (75)	4 (100)	
Level of education					
High	6 (50)	1 (25)	2 (50)	3 (75)	
Middle	5 (42)	2 (50)	2 (50)	1 (25)	
Low		-	-	-	
Unknown	1 (8)	1 (25)	-	-	

Cohort A: Geriatric hip fracture patients with dementia who have chosen OM (interview with proxy)
Cohort B: Geriatric hip fracture patients with dementia who have chosen P-NOM (interview with proxy)
Cohort C: Geriatric hip fracture patients without dementia who have chosen P-NOM (interview with proxy)
Cohort D: Geriatric hip fracture patients without dementia who have chosen OM (interview with patient)
Y: years, IQR: interquartile range, CCI: Charlson Comorbidity Index, OM: operative management
P-NOM: palliative, non-operative management, d: days
High level of education: Associate degree programmes, bachelor or master degree programmes at universities of applied sciences and at research universities, doctoral degree programmes at research universities
Middle level of education: Upper secondary education, basic vocational training, vocational training and middle management and specialist education
Low level of education: All years of primary and special primary education plus the first three years of senior general secondary education and pre-university secondary education

patient would have "as little pain as possible" to ensure that the patient was as comfortable as possible. However, this also meant that the patient would no longer be able to walk and could pass away soon. In terms of prognosis, there were wide variations between predicted prognoses, from death within 1 year to death within 10 days. Proxies of patients who opted for P-NOM indicated that they did so primarily on the following considerations: the lack of added value of surgery if a patient already had impaired mobility or short longevity, the desire to be pain-free, anaesthesiologic objections based on medical history, cognitive problems that would make rehabilitation more challenging or a completed life wish of the patient. Prior to surgery, the option of P-NOM was discussed with three out of eight surgically treated patients. Within these patients, the patients without dementia declared that there was no need for discussing P-NOM as surgery was absolutely preferred.
Participant 2: "I remember very well that it (discussing P-NOM) overwhelmed me; I thought "Oh dear, what now?"."
Participant 4: "To operate or not to operate means to have mobility or not to have mobility."
Participant 10: "He has [been] telling for a couple of years saying he does not want to continue."
Participant 13: "I just wanted surgery; I was not nervous about that."
Participant 16: "The more information you get, I think, the more worried you can get."

Theme 2: The provision of information
The content and the amount of information provided by the physician, i.e. the provision of information, emerged as an important theme. All patients interviewed indicated they had "enormous" trust in the medical staff and consequently relied on the information provided by the medical staff and had little need for additional information. For 14 of the 16 patients and proxies, the conversations with the doctor were the most important source of information. Only two proxies indicated they still had questions about precisely what P-NOM entails, such as "how to proceed" and "who ultimately arranges for the patient to be comfortable and how that will happen". These two proxies looked up this additional information online. The desired level of details in the provision of information varied. Two patients indicated they would like information about the specific surgical technique and expectations about the rehabilitation process. On the contrary, all four interviewed patients indicated that "while they wanted surgery anyway, they would only get nervous about possible complications". Essential questions that patients and proxies had in the process of choosing between surgery or P-NOM concerned the treatment options, the added value of surgery, timing and logistics of surgery, revalidation process and pain management.
Participant 2: "That choice has to be made very quickly. And that, yes, how would you, how would you prepare other people for that? That, of course, is just very difficult. And, of course, every situation is different."

Participant 5: "They could explain that more clearly, this palliative care."
Participant 13: "I was just like, guys, throw me into that operating room, get busy!"
Participant 14: "I was already happy to be there and believed everything I was told."
Participant 15: "How long before I could do anything again?"

Theme 3: Expectation management

Misaligning patients' expectations had a negative impact on patients and proxies' experiences, hence the management of participant expectations is hereafter elaborated. Overall experiences regarding rehabilitation process, pain, cognitive decline, longevity and P-NOM varied widely among different patients and proxies. Several findings stand out. Regarding the rehabilitation process, in four of the eight surgically treated patients the rehabilitation process was going slower than expected. Regarding the pain experience, patients and proxies appreciated acting quickly with analgesia, and adequate pain relief contributing to the patients' comfort. A PENG block with the neurolytic agent (phenol 5%) was administered locally to four of the eight patients who received P-NOM. In three of these patients, proxies indicated that the patient was still very painful after the PENG block, after which additional oral analgesia was needed. The combination of a PENG block with oral analgesia eventually put three out of four patients treated with the PENG block in a state of comfort. The importance of not experiencing pain is stressed further in theme 5 "Quality of life". Regarding cognitive decline, three operated patients with a pre-existing diagnosis of dementia showed a substantial cognitive decline since the operation. Especially the swiftness of this development was unexpected by patients and proxies. Regarding the experience with longevity, three proxies indicated the expectation was that the patient would die within a few weeks. However, the patient survived longer than three months, which was not expected. One participant indicated that the longer-than-expected lifespan in retrospect would have led to a different decision regarding hip fracture treatment. Regarding proxy expectation with P-NOM compared to the reality, proxies indicated the following issues were perceived as pleasant with P-NOM: the patient passing away in their own home or hospice, unburdening of the family members by the hospital, the opportunity for proxies to express their final goodbyes. Issues that were perceived as unpleasant with P-NOM were: the absence of contact with the patient in the last days of life, the development of a death rattle in the dying process and unavailability of palliative care team on weekends.
Participant 3: "That she would deteriorate so incredibly mentally, we did not expect that."
Participant 8: "We were both worried once we made that decision that day of not operating; how long will this process take?"
Participant 8: "I found those last few days in the nursing home extremely heavy."
Participant 10: "We could sometimes hear him, when we came to visit, a long way down the hall screaming in pain."
Participant 14: "I do not walk charmingly, but I do walk."

Theme 4: Shared decision-making

As a patient or proxy, making the choice together with the physician, i.e. SDM, emerged as an important theme in all transcripts. Of all patients and proxies, fifteen out of sixteen reported a form of SDM. One participant indicated that the decision was communicated without having a choice. In five patients and proxies, the course of treatment (surgery) was so clear that only brief attention was given to SDM to provide insights in the treatment and rehabilitation process. Patients and proxies highly valued the physician's role, describing it as informative and guiding, based on professional experience and knowledge. Personal experiences of healthcare professionals were prioritized over the presentation of statistical data. The identity of the decision-maker differed, ranging from patients making independent decisions from the physician, to joint decision-making with a proxy or family members deciding on behalf of a proxy. Alternatively, some patients left the decision entirely to the physician. Time and space to make a decision together with the treating physician with opportunity for reflection was considered essential, in particular engaging in multiple dialogues was deemed valuable. Interpersonal interaction and patient centeredness were considered indispensable, where the seating posture of the physician was perceived as positive, while the standing position of the physician was regarded as unfavourable. A similar sentiment was expressed regarding communication about the end of life, where a direct approach was perceived as inappropriate. Deciding on P-NOM was reported as carrying a "substantial emotional burden", arising from the sudden nature of a hip fracture combined with confrontation with an unfamiliar poor prognosis. The decision-making itself added to the emotional load through the time pressure and the final nature of the decision. The majority of patients and proxies expressed no regret regarding their treatment decision. Patients and proxies perceived it as challenging to reflect on their decision while simultaneously experiencing acquiescence.

Participant 5: "During the conversation, we had the space to express that we would prefer her to undergo surgery. (...) We have no experience, so we rely on those people and hold them in high regard."

Participant 8: "We always stood behind that decision afterwards. That sounds contradictory because we did lose our mother because of it.."

Participant 15: "I think it is important to have a say in the decision-making process, not just the doctor or the patient deciding everything (...) You listen most to the doctor. I am not an expert, but I can discuss and think about what the doctor says and talk about it."

Participant 6: "When we discovered his hip was broken, we knew it was a downhill battle. However, that it would happen so quickly, that had to sink in at first."

Participant 11: "Just making contact with the patient's family, telling them how things are going, always being available for questions, is incredibly important."

Theme 5: Quality of life

Patients and proxies described quality of life as a state of happiness, with a various individual interpretation encompassing activities such as: "reading, having conversations", "just going his way", but also participating in society and "helping others". Both patients and proxies addressed independence and adequate self-reliance as an essential contributor to quality of life. In response to the question about what patients did not want, patients and proxies offered various descriptions of a state characterised by complete dependency on care devoid of happiness, referring to it as a "vegetative state" or "greenhouse plant". Mobility was described as a prerequisite for engaging in activities with a certain degree of independence. All surgically treated patients and proxies expressed a strong desire to return to their pre-fracture level of mobility, as being unable to be as active as before made them feel like "bystanders in life". Even minor improvements in mobility could contribute to the quality of life, such as sitting in a chair or participating in activities. Also, preserving every last bit of cognitive function was deemed very valuable in the last phase of life. However, the impact of cognitive impairment depended on the patient's state of mind: a patient unaware of her Alzheimer's diagnosis still exhibited happiness, while another patient displayed aggressive behaviour. The absence of pain was deemed of utmost importance for the quality of life, as patients and proxies mentioned pain as a determining factor in "letting life go".

Participant 9: "You can be very healthy, but if you become as demented as possible, then it is of little use as far as I am concerned. So it is also about the quality of your relationships, the quality of your contacts."

Participant 2: "Overall, things are going quite well, and she still enjoys the moments when we are together. She also continues engaging in enjoyable activities in her home, and she generally remains cheerful."

Participant 1: "If a phase comes where mom deteriorates significantly, and I will call it vegetating, for lack of a better term, then surgery will no longer be pursued."

Participant 11: "If the pain continues like this, I do not want it. She has expressed this to several people in different circumstances."

Participant 4: "Well, let us say that she does not know, I do not think she knows anymore, that she has Alzheimer's, but she is still happy. Moreover, that is actually what she indicated recently: "I am still glad to be here."

DISCUSSION

This study evaluated SDM for geriatric hip fracture patients in the acute setting. Five important themes were distinguished from the interviews: 'reasons to consider either P-NOM or surgery', 'provision of information', 'expectation management', 'shared decision-

making' and 'quality of life'. Opting for P-NOM was based on the patients preferences and goals of care which did not comply with the goals and risks of surgery. Prior to surgery, P-NOM was not discussed with five out of eight patients, where patients without dementia who received surgery indicated that there was no need for SDM regarding P-NOM. Important information regarding the treatment decision was characterized by a reliance on medical staff, variation in information needed and unclarity regarding the practical implications of P-NOM. In both surgery and P-NOM expectations were expressed regarding the rehabilitation process, pain experience and cognitive decline. Additionally, in P-NOM there were also expectations regarding longevity. The extent to which expectations corresponded with reality varied greatly regarding both physical recovery, cognitive decline and longevity, where in retrospect misalignment by the physician was perceived as unpleasant by proxies. Varying degrees of decision-maker identity were reported, from independent decision-making by the patient to leaving the decision to the physician, although all patients and proxies reported a guiding and informative role for the treating physician. In eventually making the decision, patients and proxies expressed the need for patient-centred personal communication, where engaging in multiple dialogues provided the opportunity for reflection and was deemed more valuable than the solitary presentation of statistical values by the physician. Proxies of patients associated a significant emotional burden with the decision. In all cases the treatment was aimed to achieve the most optimal quality of life for the specific patients, which was interpreted by patients and proxies as a state of happiness, with a considerate amount of independence, supported by pleasant cognitive function, sufficient mobility and bearable or absent pain.

The identified reasons to opt for P-NOM were consistent with earlier findings where refraining from surgery was not purely driven on comorbidity, but also on severe advanced dementia, poor functional status and patients' wish.[21–23] Novel findings supporting opting for P-NOM were the desire to reduce pain of the hip fracture and the expected influence of cognitive impairment on future rehabilitation. The desire to reduce pain was not reported in previous studies and could be explained by a recent innovation in hip fracture pain management through a local Pericapsular Nerve Group (PENG) block.[24] This novel anatomic approach for local pain management of the hip was used in 4 of 8 PNOM patients and scientifically shows promise in providing long term pain relief in P-NOM.[25–27] The importance of pain management in hip fracture patients is underlined by the emotional load described by patients and proxies and its emergence in both theme "Expectation management" and theme five "Quality of life", which is consistent with previous research that emphasizes the importance of pain management.[5] Patients and proxies indicated that the PENG block provided less pain relief than expected. In previous studies a satisfaction rate of 83% with PENG block was reported, which is higher than this study, were 3 out of 4 patients (75%) reported full satisfaction with PENG block.[25] Theme three 'Expectation management' is

characterized by a great variety between participant expectations and reality, which is in line with previous articles which state that decision-making within the field of trauma geriatrics is accompanied by a great degree of uncertainty.[11] In terms of prognosis regarding longevity, there were wide variations in longevity from 10 days to a year. Previous scholars attribute this variation to the current limitations in predicting the prognosis of patients, although the 1-year survival is reported to be longer after surgery when compared to P-NOM.[4,28,29] Discrepancies between expectation and reality of longevity were perceived as unpleasant, with one proxy even expressing regret regarding the decision because of a longer duration of life than expected. This is different from earlier scholars longevity to be less important for refraining from surgery than pain and comorbidity.[6] Although longevity appears to be longer when patients receive surgery, patients and proxies attribute great importance to quality of life, which is reported to be non-inferior in P-NOM.[4] In theme four "Shared decision-making", a variation of "sharedness" in the decision-making was reported, this is consistent with recommendation to "tailor the sharedness of the decision to the needs of patients and their family".[11] Patients and proxies reported that time to reflect in between consultations with their treating physician was valuable, this is consistent with previous research, where iterative communication is suggested to encourage dialogue and focus on patients' goals and values.[15] Furthermore, proxies reported a significant emotional burden associated with making the decision for treatment, this was attributed due to the unexpected nature of the event and making a life changing decision for another human being. This is not addressed by previous scholars, although the importance of Advanced Care Planning in the geriatric population is stressed.[22,30]

One of the strengths of the study was that it was the first study to examine the patient and proxy experiences of the decision-making process following hip fracture. More specifically, the first study to assess the experiences with SDM in an acute setting with a geriatric population regarding palliative care. To aid geriatric patients and their proxies during this demanding SDM process, a patient decision aid might be useful. For several life-threatening diseases, such as stroke, breast cancer, ovarian tube cancer and renal failure, a decision tool has already been developed to aid in SDM.[31–34] This study could serve as the foundation for the development of such a tool, due to the robust qualitative design which provides in depth insight in experiences with SDM, with clear implications to implement in clinical practice. The inclusive study design includes different patient categories and proxies, providing a comprehensive overview of experiences with SDM of hip fracture treatment in acute situations. The study design has several possible limitations. By the use of convenience sampling, no lower educated patients and proxies were included in the sample. This could have led to bias in the reported experiences regarding information need and experience with the physician. However, 2 proxies refused to provide information regarding their education level, possibly these proxies had a lower education level. In development of the decision

aid, this limitation has to be taken into account by tailoring the information on B1 language level. During the study all quantitative data was collected retrospectively, which could be a limitation. However, since all data were included in one hospital with a protocoled trauma geriatric care pathway, there was no missing data. Furthermore, because of the nature of the palliative treatment and inclusion of patients with cognitive impairment, not all participants were patients and proxies represented them. This is a relative limitation as proxies are involved in or fully responsible for the decision, making their experience essential in this regard. Another limitation to this study is the relative over-representation of PNOM in study sample. Although the sample was divided proportionally, in the general population the vast majority of patients undergoes surgery, this was accounted for by consulting the coders group to agree on data saturation of the OM group in the study sample. The study was conducted in the context of the development of a decision aid, although the researchers have no conflict of interest, the responses of the patients and proxies could have been colored by this background knowledge. This was accounted for by the semi-structured nature of the interviews, where patients and proxies received extensive space to elaborate on their experiences.

Several direct clinical implications can be derived from this study. Firstly, this study forms the foundation for the development of a patient decision aid which supports geriatric hip fracture patients during SDM. During this SDM, this study indicates physicians should be informative and guiding and use a personal approach in sitting position based on professional experiences instead of presenting statistical data. Furthermore, they should engage in multiple dialogues to provide opportunity for reflection. Advantages and disadvantages of surgery and P-NOM should be discussed where deemed relevant by the physician. Physicians should assess each patient's need for extensiveness of information and assess the need for discussing P-NOM. With regards to expectation management, physicians should treat burdensome topics with care and emphasis the uncertainty of topics such as cognitive decline and longevity. Lastly, this study underscores the need for physicians to recognize and address the emotional and psychological challenges faced by patients and proxies. Implementing these clinical implications in everyday practice could improve patient experience with this previously undescribed application of SDM in the acute geriatric hip fracture setting.

CONCLUSION

Five important themes were identified in SDM for geriatric hip fracture treatment in the acute setting. These themes are: 'reasons to consider either P-NOM or surgery', 'provision of information', 'expectation management', 'shared decision-making' and 'quality of life'.

Moreover, in each theme, specific components of SDM that are well appreciated or that can be improved are discussed, through which concrete areas for improvement emerged. These findings will provide direction to the development of a decision aid for future geriatric patients with a hip fracture, which can support clinicians further in a structured and balanced approach to SDM for hip fracture treatment in the acute setting.

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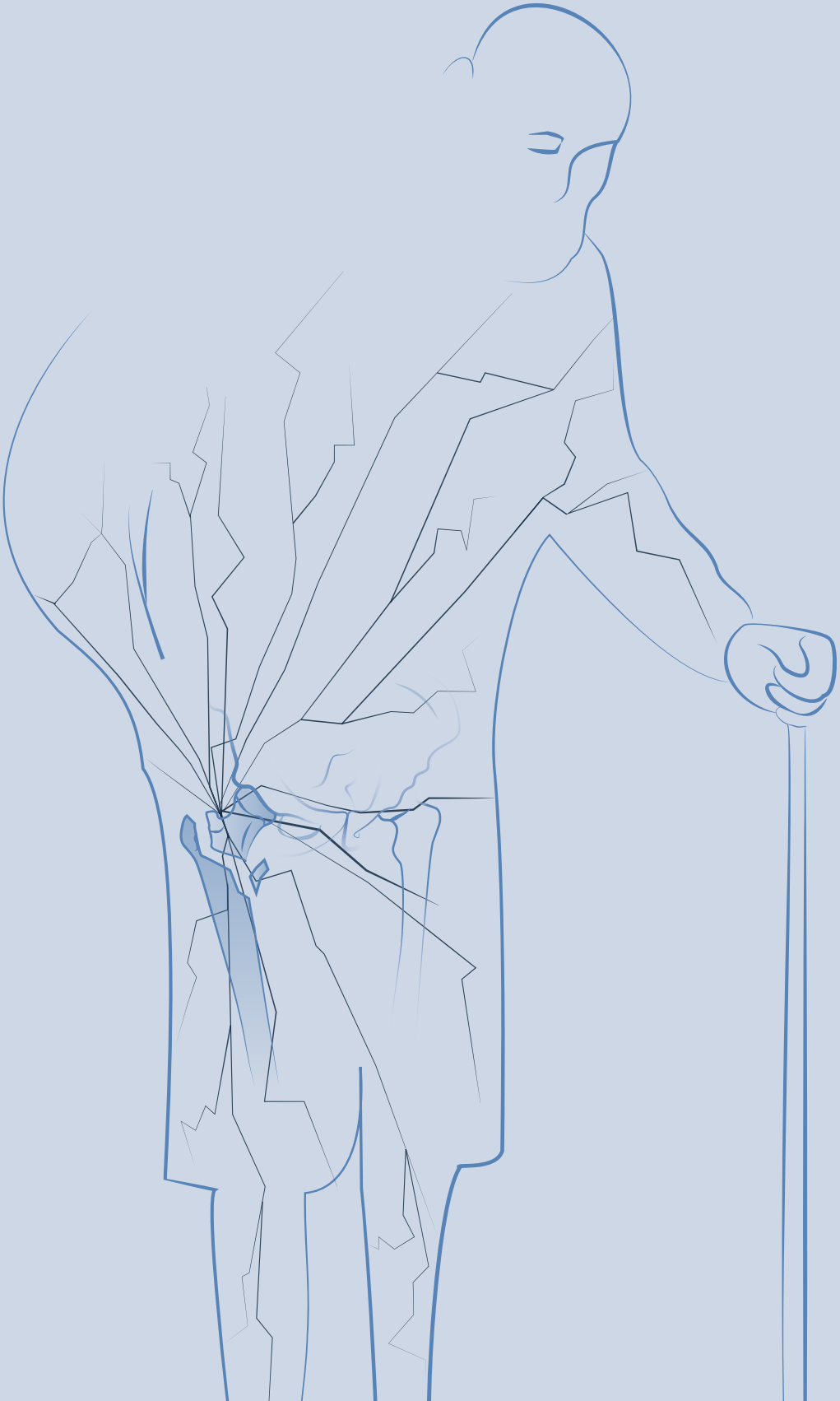

CHAPTER 9

Identification of Frail Geriatric Trauma Patient at Risk for Adverse Outcomes after Hip Surgery by Point-of-Care Neutrophil Activation Analysis

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ABSTRACT

Background: Geriatric patients with hip fracture are at risk for adverse outcomes after hip surgery. Identification of an imbalance in the innate immune response to injury, as measured by neutrophil phenotype and responsiveness, could help identify frail patients that might not benefit from surgical treatment of a hip fracture. This pilot study aimed to investigate post hip fracture changes in the neutrophil compartment at the emergency department (ED) for geriatric hip fracture patients.

Methods: Geriatric trauma patients with a hip fracture presented at the ED of a large regional teaching hospital, had one extra blood tube withdrawn and analyzed by a Point-of-Care flow cytometer. Neutrophil responsiveness to fNLF of geriatric hip fracture patients was compared to healthy controls. Patients with severe adverse events (30 day mortality or sepsis) were compared with patients without adverse events.

Results: In total, 45 (94%) out of 48 blood samples were analyzed within 30 minutes. Compared to healthy controls, geriatric trauma patients showed elevated baseline CD10 and CD11b ($p = 0.007$ and $p = 0.003$, resp.) and decreased CD62L levels ($p < 0.001$). Neutrophils were decreased responsive to fNLF-activation regarding CD10 and CD11b upregulation ($p < 0.001$ and $p < 0.001$, resp.). Patients that developed severe adverse outcomes have decreased responsiveness of CD10 and CD11b on admission at the ED ($p < 0.077$ and $p < 0.133$, resp.).

Conclusions: This study showed that the implementation of a fully automated flow cytometer for the assessment of the neutrophil compartment in geriatric hip fracture patients is feasible and revealed distinct activation patterns. Although power for statistical, clinical relevance is missing and should be investigated in a larger trauma geriatric cohort, this study is a first step toward immuno-based precision medicine for identifying frail patients with a high risk of severe adverse outcomes after surgery.

INTRODUCTION

Geriatric hip fracture patients are a fast-growing and heterogeneous group.[1,2] Due to an aging population, the absolute number of hip fractures is expected to rise globally to 4,5 million per year by 2050.[3,4] Many geriatric hip fracture patients are considered frail and therefore at risk for adverse outcomes. The 1-year mortality rate following hip fracture surgery is 22-33%[5,6] and the postoperative period after a curative treatment is associated with a substantial risk of infectious complications such as pneumonia, urinary tract infection, wound infection, and even septic shock.[7,8] Next to curative and sometimes palliative treatment by means of hip fracture fixation, some patients might be best suited with non-operative management. In order to manage optimal treatment strategies for the geriatric patient with a hip fracture, it is of utmost importance to early identify these high-risk patients for adverse outcome. However, a point-of-care clinical parameter to distinguish these patients remains elusive.

Prior research in polytrauma patients has focused on the immune system for early identification of patients at risk for serious infectious complications. Trauma leads to a complex inflammatory cascade that can cause an acquired immunodeficiency.[9] It is known that the innate immune system plays an essential role in the defense mechanism against invading pathogens.[10–12] An imbalance in the neutrophil compartment after trauma makes patients prone to develop infectious complications the days following after trauma.[12] In polytrauma patients, a correlation was found between neutrophil phenotype after trauma and the risk of late onset (>5 days) infectious complications.[13–16] Recently, it became possible to determine the neutrophil functional phenotype in the acute, point-of-care setting by using an automated flow cytometry approach.[17]

Neutrophil phenotype analysis could aid in early identification of frail patients with a geriatric hip fracture. An immunological imbalance could be an early predictor to identify patients at risk for a complicated course which could support the clinician in personalized and shared decision making. This could have clinical implications, as for some patients with limited life expectancy non-operative treatment can be favorable.[18,19]

The aim of this pilot study was to assess changes in neutrophil phenotype and responsiveness, as measured by a Point-of-Care fully automated flow cytometer and the feasibility of the analysis in a large regional teaching hospital for geriatric hip fracture patients.

MATERIALS AND METHODS

Study Design

This prospective study was conducted at a major regional teaching hospital, St. Antonius Ziekenhuis, Utrecht, The Netherlands. All geriatric patients (age ≥70 years), presented at the emergency department of the hospital, from August 1st, 2021, to February 1st, 2022 with a hip fracture were screened for inclusion. Exclusion criteria were as follows: polytrauma (injury severity score (ISS≥16)), transferred from another hospital, no diagnostic blood sampling needed, and a preexistent blood disease. If a patient was eligible for inclusion, blood was drawn and analyzed within 60 minutes.

The medical ethical committee MEC-U, Utrecht, The Netherlands, approved this study under protocol no.R20.054. The study was approved and registered by the Central Committee on Research Involving Human Subjects in The Netherlands under protocol no. NL76875.100.21 and was performed in accordance with the ethical standards laid down by the declaration of Helsinki and its later amendments.

Study Procedure

At presentation, blood was drawn for the standard-of-care geriatric blood panel diagnostic workup. After written consent was obtained, one extra 4-mL sodium heparin blood collection tube (Becton Dickinson, Oakville, ON) was drawn specifically for this study. The blood collection tube was immediately placed in the automated AQUIOS CL® "Load & Go" Flow Cytometer (Beckman Coulter, Indianapolis, IN, USA), which is located at the ED.

Healthy control cohort

Blood from healthy controls was obtained from healthy individuals participating in the Nijmegen Exercise Study 2021.The blood of the healthy control cohort was drawn at baseline, several days before the event. The blood was analyzed by AQUIOS CL® using the same protocol as used for the blood of the patient cohort in this study. The median age of the control cohort was 69 years (IQR 66-74). This healthy control cohort was chosen because their relative high age provides the best possible comparison with the geriatric patients cohort.

Neutrophils get easily activated by ex vivo manipulation in a time dependent manner.[20] Therefore, the time of venipuncture till analysis was registered for both the patients and healthy controls. The healthy control cohort was matched to the patients based on this time till analysis range (analysis within 60 minutes). To rule out time till analysis-bias, healthy control samples that were analyzed beyond this timeframe were excluded. Eventually, 58 healthy controls could be included in the study.

Automated flow cytometry analysis

The AQUIOS CL® combines automatic sample preparation and flow cytometry analysis of the blood samples. First, the blood collection tube is placed into a cassette into the machine. Next, the machine pipettes the blood into a 96-deep well plate. The blood is then stained for 15 minutes with 18uL customized antibody mix for neutrophils. Cell reactivity is tested by analyzing each sample both in the absence and presence of the bacterial/mitochondrial derived stimulus N-Formyl-norleucyl-leucyl-phenylalanine (fNLF; end concentration 10^{-5} M; BioCat GmbH, Heidelberg, Germany) in the deep well plate. The customized antibody mix contained contains the following antibodies from Beckman Coulter: CD16-FITC (clone 3G8), CD11b-PE (clone Bear1), CD62L-ECD (clone DREG56), CD10-PC5 (clone ALB1), CD64-PC7 (clone 22). After staining, the red blood cells are lysed by adding 335 µl AQUIOS Lysing Reagent A (a cyanide-free lytic). The lysis is stopped after 30 seconds by adding 100 µl AQUIOS Lysing Reagent B, followed by aspiration and analysis through the flow cell.

Analysis of Flow Cytometry Data

AQUIOS CL flow cytometry data is exported from the device as FCS 3.1 High Res Listmode Files (.lmd). The data is imported and analyzed with an automated clustering (FlowSOM) analysis on the web-based flow cytometry analysis platform Cytobank (Beckman Coulter, Indianapolis, IN, USA). FlowSOM is a high-dimensional clustering and visualization algorithm, based on a self-organizing maps. Neutrophils were identified as follows: 1) Granulocytes were gated based on forward-/sideward-scatter2) The granulocytes were analyzed through FlowSOM by using 6 metaclusters and 64 clusters. 3) The neutrophil metacluster was identified by CD16/CD11b expression. For this analysis all markers of the flowcytometry panel were used (CD10, CD11b, CD16, CD62L, CD64). For each marker, the MFI of the neutrophil population as a whole is exported with and without the addition of fNLF and ratios were calculated.

Clinical Data

The following patient characteristics were collected at baseline: age, sex, trauma mechanism, serum Albumin at presentation (g/L), pre-existent diagnosis of dementia (from medical records), ASA Physical Status Classification (I to V), treatment (intramedullary osteosynthesis, hemiarthroplasty, total hip arthroplasty, or conservative) and, type of hip fracture (femoral neck, intertrochanteric and subtrochanteric).[8] Data were collected from the electronic patient record by the treating clinician and anonymously analyzed. Severe adverse outcomes were defined by sepsis and 30-day mortality. Mild infectious complications were definite infections without turning into sepsis.

Table 1. Geriatric hip fracture patient characteristics (AQUIOS Pilot)

PATIENT CHARACTERISTICS	Pilot
Age (years)	83 (78-86)
Sex (female%)	34 (71%)
Analyzed samples	52
Successfully analyzed	48
Insufficient blood	2
Wrong barcode on blood collection tube	1
Analyzed without activator agent	1
Time to analysis	
<30 min	45 (94%)
<60 min	3 (6%)
>60 min	0 (0)
Dementia	8 (16%)
Admission in hospital	47 (98%)
Albumin	42.6 (40.8-44.1)
Hypoalbuminemea (<35 g/l)	2 (4%)
Treatment	
Conservatively	2 (4%)
Hemiarthroplasty	22 (46%)
Total hip arthroplasty	5 (10%)
Intramedularry osteosynthesis	19 (40%)
Additional injuries	
no additional injury	42 (84%)
distal radial fracture	4 (8%)
pubic bone fracture	1 (2%)
fracture of the olecranon	1 (2%)
contusio cerebri	2 (4%)
LOS (days)	6 (4-9)
Complications	12 (25%)
Postoperative minor complications	6 (12%)
Severe infectious complications	6 (12%)
30-day mortality	
Yes	3 (6%)
No	45 (94%)
Time from hospital admission to death (days)	18 (3-55)

All variables are in total amount (percentage) or median (IQR), Abbreviations: LOS = Length of stay.

Statistical Analysis

Baseline characteristics and clinical data were analyzed with SPSS statistical software (version 25.0, IBM Inc. Armonk, New York, USA). Distribution was determined with the Shapiro–Wilk test for normality. Normally distributed continuous data were presented as mean with standard deviation (SD). Non-normally distributed continuous data were presented as median with interquartile range (IQR). Clinical outcomes and demographics were compared between geriatric patients with a hip fracture developing severe infectious complications and those who did not. GraphPad Prism (version 8.3.0; Graphpad software, Inc, Sand Diego, Ca, USA) was used to analyze and visualize flowcytometry data. A P-value of <0.05 was considered statistically significant.

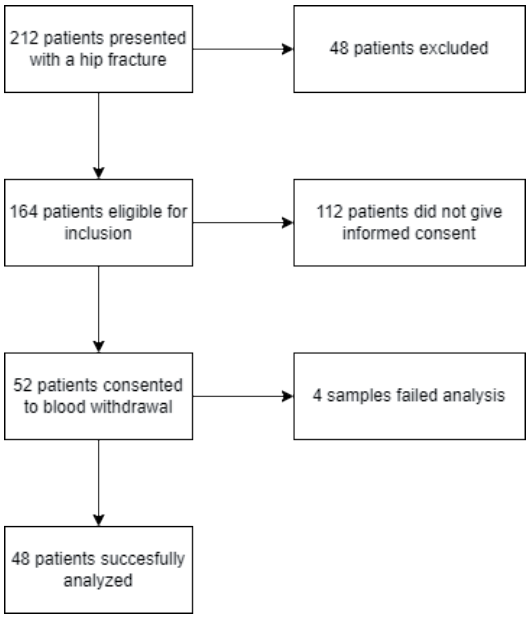

Figure 1. Flowchart patients inclusion.

RESULTS

In total, 212 patients with a hip fracture were presented at the ED between August 1st, 2021, and February 1st, 2022. Of these patients, 48 (23%) were excluded based on the exclusion criteria. This resulted in 164 patients with a hip fracture who were eligible for inclusion. Of these patients, a total of 52 (32%) consented to blood withdrawal for this study. Due to human error, four samples failed analysis. (**Table 1**) Finally, a total of 48 patients (92% success rate) were successfully analyzed within 60 minutes. Figure 1.

Baseline Patient Characteristics

The study population consisted of 34 (71%) females and 14 males with a median age of 83 years (IQR 78-86). All patients sustained a hip fracture after low-energy trauma with ISS < 16. Of these patients, 42 (88%) were presented with an isolated hip fracture, whereas 6 patients had additional injuries after trauma. Baseline characteristics are shown in **Table 1**.

Study population

48 patients received operative treatment of the hip fracture and 2 patients were treated non-operatively. During hospital admission, 12 (24%) patients developed complications. Of these complications 6 (12%) were post-operative infectious complications and 6 (12%) consisted of severe infectious complications. The 30 day mortality rate was 6% (3 patients)

Table 2. Characteristics of hip fracture patients with severe infectious complications/adverse events

Patient	Age (Y)	Sex (M/F)	Albumin	Operative treatment	Infectious complications	LOS (days)	30 day mortality
1	77	M	36.3	Yes	Urosepsis	17	No
2	86	M	35.9	Yes	Septic shock	24	No
3	83	M	41.7	Yes	Urosepsis	7	No
4	79	M	36.4	No	-	3	Yes, 3 days
5	93	F	**34.5**	Yes	Sepsis	16	Yes, 16 days
6	86	M	38.5	Yes	COVID-19	7	Yes, 18 days

Abbreviations: (Y) = years, (M/F) = Male or Female, LOS = Length of stay .

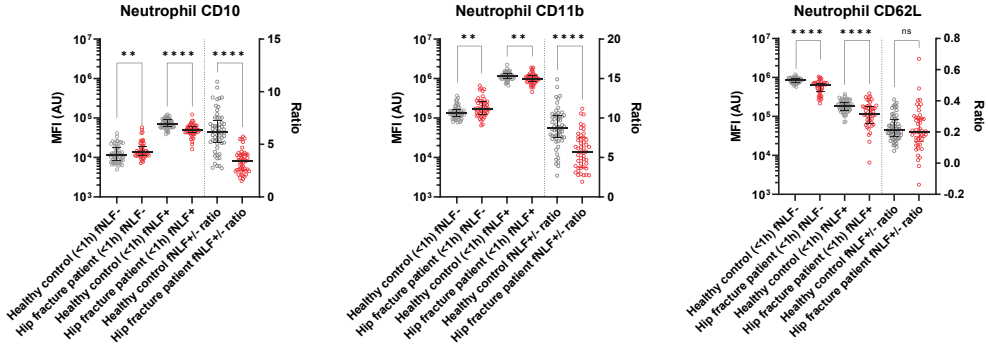

Figure 2. Median fluorescence intensity (MFI) in arbitrary units (AU) of neutrophil activation markers in geriatric hip fracture patients and healthy controls. Markers are depicted for both unstimulated (fNLF-) and fNLF-stimulated (fNLF+) samples. Neutrophil responsiveness (MFI fNLF+/MFI fNLF-) is depicted as a ratio for each marker. Statistical significance was tested using the Mann-Whitney U test.

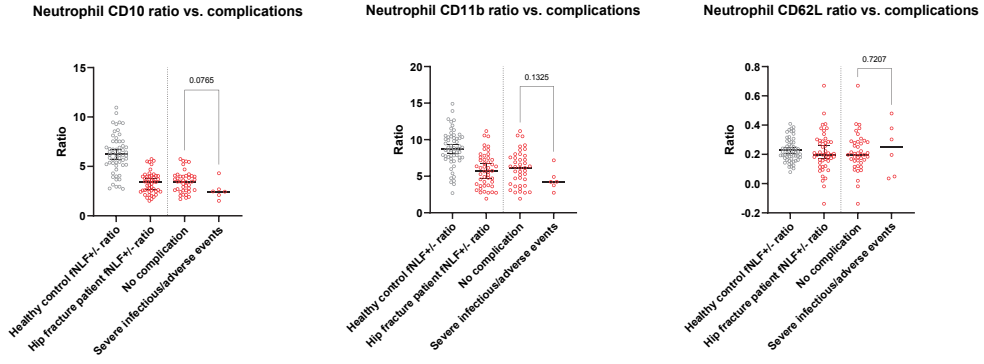

Figure 3. Neutrophil responsiveness (MFI fNLF+/MFI fNLF-) is depicted as a ratio for geriatric hip fracture patients and healthy controls for neutrophil activation markers. Subgroup analyses was done to compare patient with severe infectious complications vs patient without severe infectious complications. . Statistical significance for the subgroup analysis was performed using the Mann-Whitney U test test.

including patients managed non-operatively. Patients with severe infections complications or died within 30 days after hip fracture were presented in detail in **Table 2**.

Baseline neutrophil activation

Geriatric hip fracture patients neutrophils had baseline elevated expression of CD10 (median MFI, 14 x 10^3 (IQR 11 – 19 x 10^3) vs. 11 x 10^3 (IQR 8 - 17 x 10^3), p = 0.0070) and CD11b (median MFI, 17 x 10^4 (IQR 13 – 26 x 10^4) vs. 13 x 10^4 (IQR 11 – 16 x 10^4), p = 0.0028) compared to healthy controls. Baseline CD62L expression was lower (median MFI, 64 x 10^4 (IQR 45 – 72 x 10^4) vs. 86 x 10^4 (IQR 75 – 96 x 10^4), p < 0.0001) in geriatric hip fracture patients compared to healthy controls (**Figure 2**).

Neutrophil responsiveness

Neutrophils stimulated with fNLF showed lowered CD10 expression (median MFI, 50 x 10^3 (IQR 43 – 61 x 10^3) vs. 72 x 10^3 (IQR 60 – 89 x 10^3), p < 0.0001), lowered CD11b expression (median MFI, 10 x 10^5 (IQR 8 – 12 x 10^5) vs. 11 x 10^5 (IQR 10 – 14 x 10^5), p = 0.0026) and decreased CD62L expression (median MFI, 12 x 10^4 (IQR 7 – 18 x 10^4) vs. 18 x 10^4 (IQR 14 – 23 x 10^4), p < 0.0001) when compared to healthy controls.

Neutrophil responsiveness was assessed by calculating a ratio: fNLF-stimulated MFI/ baseline MFI. Geriatric hip fracture patients showed reduced neutrophil responsiveness regarding the upregulation of CD10 (median ratio, 2.5 (IQR 2.0 – 3.1) vs. 6.2 (IQR 5.2 – 7.5), p < 0.0001) and CD11b (median ratio, 5.7 (IQR 3.8 – 7.5) vs. 8.8 (IQR 7.5 – 10.3), p < 0.0001) compared to healthy controls. Regarding CD62L downregulation, neutrophil responsiveness was similar for the study cohort and healthy controls.

Neutrophil responsiveness and clinical outcome

No significant differences were found regarding baseline and stimulated neutrophil activation markers expression (CD10, CD11b and CD62L) in patients with severe infectious complications compared to patient without severe infectious complications. Also no significant differences were found in neutrophil responsiveness for the subgroups with and without severe infectious complications(CD10 (p=0.0765), CD11b (p=0.1325) and CD62L (p=0.7207)). (**Figure 3**)

DISCUSSION

This pilot study aimed to assess if geriatric trauma patients at risk of adverse outcomes after hip surgery could be identified by analyzing the neutrophil compartment. The feasibility of Point-of-Care fully automated flow cytometry at the ED to analyze neutrophil activation in geriatric hip fracture patients was demonstrated. This is in line with a previous feasibility study with automated point-of-care flow cytometry in poly trauma population that described a 95% success rate.[21] Geriatric hip fracture patients had distinct neutrophil activation patterns when compared to healthy controls. Furthermore, our data suggested that patients that develop severe adverse outcomes displayed decreased neutrophil responsiveness on admission at the ED.

Point-of-care fully automated flow cytometry

In previous studies it is shown that *ex vivo*/artificial neutrophil activation occurs rapidly over time in the blood collection tube, resulting in a significant bias of neutrophil activation markers[20] The effect of *ex vivo* activation was overcome by minimizing the time until analysis delay by placing the AQUIOS CL® Point-of-Care at the ED. The feasibility of rapid Point-of-Care fully automated neutrophil activation analysis in a geriatric trauma population was also tested. In this study a total of 4 cases exceeded the 30 minute timeframe. Unfortunately. the total included patients was a fraction of the eligible patients for the pilot, this was caused mainly because the informed consent process was challenging to complete in the acute setting in this geriatric population before the primary blood sampling at the ED. Therefore, many patients would need a second venipuncture, solely for this study's purpose. The majority of the eligible patient choose not to participate due to the unfavorable second venipuncture.

The need of biomarkers in the clinical decision making of the geriatric trauma patient

In the acute setting, predicting adverse outcome after hip fracture, objective markers are used for clinical decision making. In the shared decision making process these markers could be functional to determine whether operative treatment is favorable for the geriatric patient. Pre-operative serum albumin is a known clinical marker in the geriatric trauma population to determine frailty, predict short term mortality, or predict a complicated course after hip fracture surgery.[27,28] Five out of six patients with severe adverse outcome showed mild hypoalbuminemia (<40g/L) and of which one with hypoalbuminemia (<35g/L). However, not every patient with (mild) hypoalbuminemia had a severe adverse outcome. Measuring neutrophil activation with point-of-care fully automated flow cytometry potentially helps to determine the patients' acute frailty as a result of an imbalance of the immune responses caused by trauma. As the patients with severe adverse outcome also

showed decreased neutrophil responsiveness it's tempting to speculate serum albumin and neutrophil responsiveness could be used complementary in the future for determination of patients' fragility. Together with other known clinical markers, this will possibly improve clinical decision making for geriatric trauma patients.

Neutrophil activation and responsiveness

Compared to healthy controls, the geriatric hip fracture patients showed baseline increased CD10 and CD11b expression, whilst CD62L expression was lowered, illustrating neutrophil activation in situ.[21–23] The differences observed in baseline neutrophil activation between the study and healthy control cohort could be an effect of ageing related inflammation (inflammageing); a condition that most older individuals develop and is characterized by elevated levels of blood inflammatory markers, even in absence of active disease.[24] Due to the younger age of the healthy control cohort, it was not possible to perform age-matched analysis. However, the concept of inflammageing does not only depend on age, but on a wide range of host-dependent individual characteristics. Not every healthy individual aged 80 years or older would display signs of inflammageing in the blood, so age-matched analysis would not necessarily help to assess if the changes in the neutrophil compartment are caused by inflamm-ageing, by age or by the sustained trauma.

fNLF- stimulated neutrophils of geriatric trauma patients showed lowered CD10, CD11b and CD62L expression, when compared to healthy controls. Possibly, inflammageing would make the neutrophils in the geriatric hip fracture population more (or similarly) and not less responsive to (ex vivo) activation with fNLF, as these neutrophils are already activated (primed) by inflammatory markers.[15] The patterns of increased neutrophil activation, but reduced neutrophil responsiveness can most likely be contributed to hip fracture related tissue damage: neutrophils react to tissue damage where they pose a protective role in tissue regeneration and repair.[25]

Variety in the immune response after mono-trauma in the geriatric trauma patient

Previous research in poly trauma patients, presented with a large variety of injuries, described a great extent of heterogeneous subsequent inflammatory responses.[26] Undoubtedly, the amount of tissue damage among the geriatric hip fracture patients in this study is lower and more homogeneous than in polytrauma patients: almost all patients in this study were presented at the ED after low energy trauma (fall from stance) resulting in a hip fracture, when compared to a wide scale of high energy trauma in previous studies.[13–16,21] Nonetheless, a variety of immune activation was found between patients in this cohort. Therefore, it is tempting to speculate that neutrophil activation of the geriatric study population is dependent on the individual immune response to (the homogenous amount of) tissue damage and not so much on the amount of tissue damage as seen in major trauma.

Strengths and limitations

Our results demonstrated that the use of a point-of-care automated flow cytometer in the trauma geriatric unit is fast and reliable. In two cases, too little blood was drawn for analysis for flow cytometry and in two cases analysis failed due to human error. These errors cannot be contributed to the machine. Besides, this study rules out a possible manual gating strategy bias, as the data are analyzed with an automated clustering approach by FlowSOM. Although FlowSOM enables an automated gating strategy, it still requires an extra manual analysis step in a flow analysis program. The results are therefore not directly interpretable and applicable in the clinic.

There are some limitations to this pilot study. First, due to a small sample size and surpassing the scope of this study, analysis of neutrophil phenotype subsets was not performed. Earlier research in polytrauma patients showed that patients who developed infectious complications later on, displayed more young, banded neutrophils in the blood immediately after trauma.[21] Further research in a larger geriatric hip fracture cohort should not only focus on neutrophil functionality, but also on the presence of neutrophil phenotypes (in terms of subsets based on CD16/CD62L expression) immediately after trauma. Second, out of 164 patients with a hip fracture who were eligible for inclusion, only 52 patients (32%) gave written informed consent. Obtaining written informed consent was a barrier for the inclusion of eligible patients, because due to frequent delays between diagnostic venipuncture and informed consent procedure, a second venipuncture would be necessary, which most patients waived. The use of deferred consent could be a consideration to increase the number of included patients for further research within this field. Last, the study populations were compared to healthy controls with lower median age. Although it is highly unlikely that all reported differences are due to this difference is age, it is still preferable that future research with geriatric trauma patients will be compared to elderly volunteers with a similar age.

Future implications

This is the first work that studied neutrophil activation and responsiveness in a geriatric trauma unit. Recent research into shared decision making in the acute setting emphasizes that palliative, non-operative management is an acceptable an adequate option for geriatric hip fracture patients with high risk of adverse outcomes after surgery.[29] However, a point of care clinical parameter to distinguish these patients remains elusive. Recent research found increased presence of $CD16^{dim}$ and $CD62L^{dim}$ neutrophil subsets in trauma patients.[11] The presence of these subsets were correlated to clinical outcome.[20] Furthermore, this study found a potential future marker to distinguish these patient. However, future research with a larger cohort should investigate this part of neutrophil phenotyping in geriatric trauma patients. This study supports the possibility in future immune-based identification of geriatric trauma patients at risk for adverse outcome.

CONCLUSIONS

This study showed that the implementation of a fully automated flow cytometer for the assessment of the neutrophil activation in geriatric hip fracture patients is feasible and revealed distinct activation patterns. Although power for statistical, clinical relevance is missing and should be investigated in a larger trauma geriatric cohort, this study is a first step toward immuno-based precision medicine for identifying frail patients with a high risk of severe adverse outcomes after surgery.

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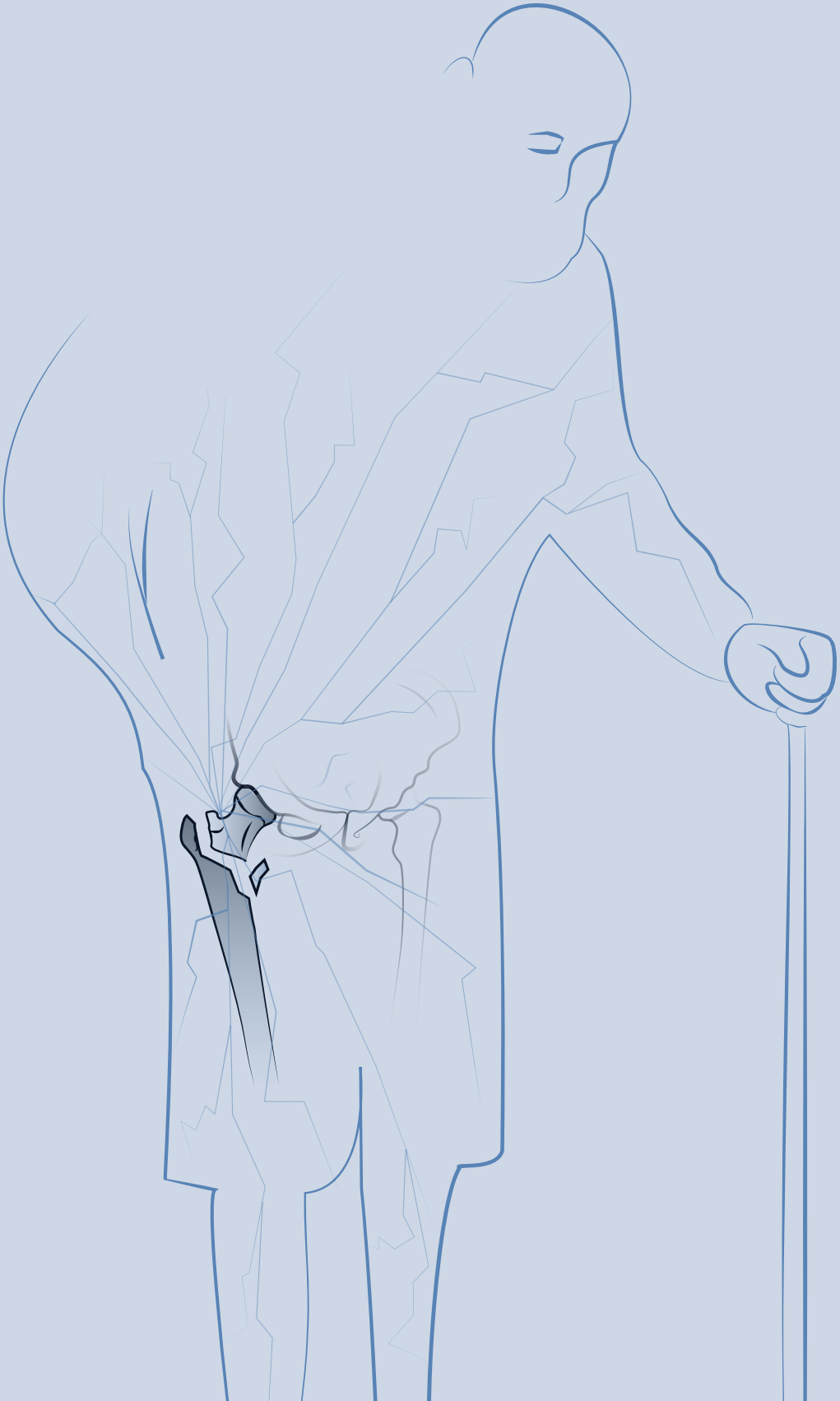


CHAPTER 10

Summary of the thesis

SUMMARY OF THE THESIS

Hip fractures

A hip fracture stands as one of the most frequent traumatic injuries among the geriatric population. With an expanding elderly demographic and an increasing prevalence of frail elderly individuals burdened by multiple comorbidities, the strain on an already overwhelmed healthcare sector is set to intensify. As the incidence of hip fractures coincides with the growing number of cases involving frail elderly individuals, the postoperative course is associated more frequent with serious adverse outcome with a 1-year mortality varying between 20-30%. For these patients with a limited life expectancy other options than surgery could be more in harmony with the patients preferences. This thesis studies the goals of care for the geriatric population and evaluates the integration of palliative care in hip fracture management. An introduction of the topic of this thesis is made in **chapter 1**.

Orthogeriatric Care

Part 1 of this thesis delved into the ramifications of the comprehensive geriatric pathways. In **chapter 2,** this practical application of the holistic geriatric approach is explored in the context of hip fracture patients. A systematic review was conducted to gather empirical evidence concerning the enhancements in in-hospital orthogeriatric care. These innovative alterations, broadly implemented internationally, already have proven their significance in terms of morbidity and mortality. The improvements gained in quality of life however, seems just as important for the geriatric hip fracture patient.

Frail hip fracture patient

In part 2, we present a comprehensive analysis of frail geriatric hip fracture patients and their associated characteristics. **Chapter 3** outlines the identification of short- and long-term predictors of mortality in hip fracture patients, subsequently utilized to construct multiple survival curves using the Kaplan Meier methodology. Within **chapter 4**, multiple healthcare centers across the Netherlands collaboratively collect detailed data from frail hip fracture patients, thereby clarifying complex prognostic factors and institutionalization patterns. A specific emphasis is placed on identifying frail patients who initially living at home and presented at the emergency department. The community-dwelling patients with a hip fracture show a high risk of death, adverse events, and institutionalization, and often do not re-obtain their pre-trauma level of mobility and independence. Both chapters provide insights into the postoperative trajectory of patients based on individual predictors. Ultimately offering patients and their families a more transparent source of information prior to hip surgery improving the shared decision-making process.

Palliative, Non-Operative Management (P-NOM)

Part 3 centers on the evaluation of newly introduced Palliative, Non-Operative Management (P-NOM) for hip fracture patients. P-NOM was introduced as an option through shared decision-making for geriatric hip fracture patients considered frail and with very limited life expectancy. Initially, patients were considered frail with one or more Frailty Criteria; (Body Mass Index (BMI) of 18.5 kg/m2 or lower, Functional Ambulation Category (FAC) of 2 or lower pre-trauma, American Society of Anesthesiologists (ASA) score of 4 or 5) or on the indication of the physician when thought of limited life expectancy without meeting the frailty criteria. With P-NOM, specific attention is paid to analgesia and patient comfort without aiming the patient to regain mobility and start the active rehabilitation program. Since P-NOM is not curative management, patients are likely to die within weeks after hip fracture (median survival 11 days (IQR 4-26)). The renewed hip fracture pathway for geriatric patients is shown below. Since 2020, P-NOM is also discussed on indication of the surgeon or treating physician given the greater difficulty assessing frailty with only three objective markers BMI, FAC, and ASA. This allows patients with very limited life expectancy to consider P-NOM over operative management in case of a hip fracture without meeting the frailty criteria

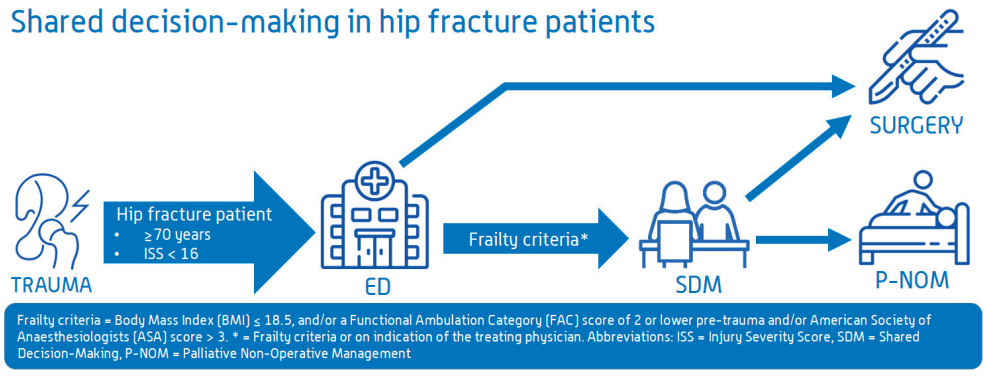


Figure. Pathway for geriatric hip fracture patients.

Chapter 5 initiates the first evaluation of P-NOM through semi-structured interviews to gather the earliest patients' experiences concerning the non-operative alternative. Four recurring themes were identified in the interviews that were deemed most important to the proxies in the palliative process. The decision-making process, communication with the patients, pain and passing away showed great similarity with severe end-stage disease palliative care. With pain identified as the most important factor influencing comfort of the patient and their environment after hip fracture, novel analgesia methods are requested and already available. Subsequently, future studies are needed for evaluation of clinical applicability. **Chapter 6** monitors and delineates the impact of P-NOM on surgically treated

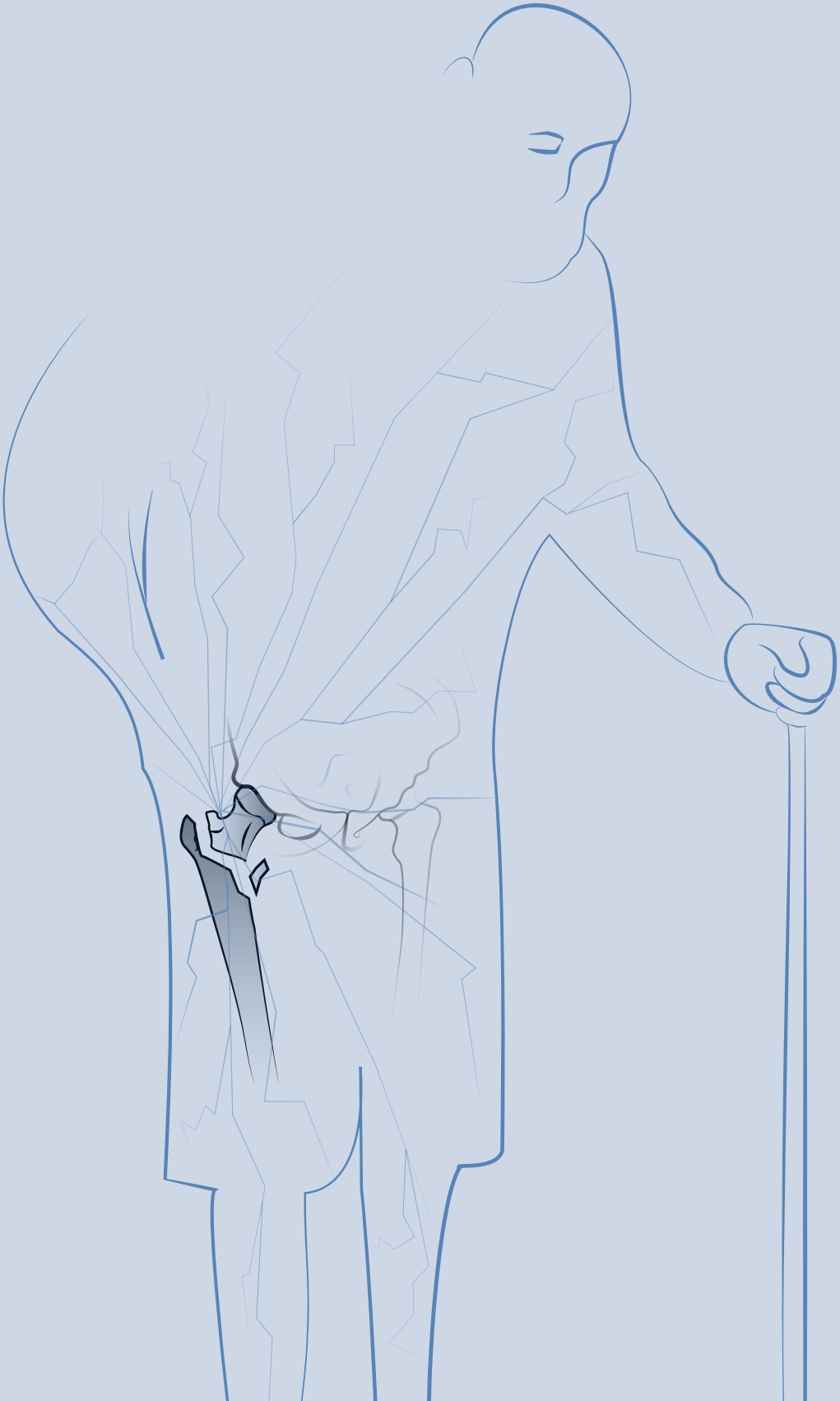
hip fracture patients, observing differences between pre-implementation and post-implementation cohorts in the surgical cohort. The integration of palliative, non-operative management for frail geriatric hip fracture patients did not show a direct significant decline in mortality rates or postoperative complications when compared to the surgically managed geriatric hip fracture group. However, there was a considerable decrease in ICU admissions in the post-implementation period, indicating that the decision for P-NOM by patients had an effect on the short-term outcomes requiring ICU admission.

Patient-centered approach

Part 4 describing the evaluation of P-NOM, yielding novel themes aimed at refining the method. These themes are further investigated to align with patient preferences. **Chapter 7** clarified the goals of care for geriatric patients who sustain a hip fracture, showing 'preserving cognitive function', 'being with family', and 'being with partner' among the most important GOC. The most important GOC should at least be discussed when a patient is presented at the ED with a hip fracture enhancing shared decision-making for patient and physicians in acute setting. **Chapter 8** examines patient preferences within this shared decision-making process, drawing on prior experiences in decision-making dialogues between medical professionals and hip fracture patients, specifically focusing on the choice between hip fracture surgery and (palliative) non-operative management. Important themes gathered requiring attention in the SDM process were; 'reasons to consider either P-NOM or surgery', 'provision of information', 'expectation management', 'shared decision-making' and 'quality of life'.

Finally, **chapter 9** introduces a pilot study aimed at testing a novel immunology method. This method involves the assessment of the geriatric immune response in the Emergency Department through the evaluation of neutrophil activation subsequent to a hip fracture. Potential future markers to distinguish the frail patient were observed, supporting the possibility in future immune-based identification of geriatric hip fracture patients at risk for adverse outcome.

In the future, predictive models, goals of care, and the immune system all could be useful as an addition in the patient-centered decision-making process. Ultimately, these subjects could aid the physicians, patients and family to give insights in the postoperative or palliative course after sustaining a hip fracture.



CHAPTER 11

General discussion, future perspectives, and conclusions

GENERAL DISCUSSION

The past (hopefully)

With surgery, the former unequivocal treatment option for hip fracture patients, shared decision-making was not common practice in hip fracture management. With limited options, even the most frail patients were guided to the operating room (OR) for hip surgery.[1,2] To provide adequate care, patients were operated for pain reduction through removal or stabilization of the fracture line, with the aim to optimize quality of life.[3] With the vast majority of the hip fracture patients dismissed to rehabilitate in good clinical conditions after surgery, the less fortunate patients could easily be overshadowed by those in good clinical condition.[4–6] However, the less fortunate patients, who more often had prolonged length of hospital stay, postoperative complications, and sometimes even death, seem to have common characteristics.[7,8]

"Decisions are more important than incisions" (Dr. R.B. Salter)

Surgeons are notorious for their expertise in operative management and their ability to be very decisive in acute settings. However, studies also described accompanying hazardous attitudes as a common characteristic of the trauma- and orthopedic surgeons influencing the decision-making process negatively.[9,10] Evidence raises that surgery provides little advantage over non-operative treatment in certain situations, indicating that surgeons might exhibit overly optimistic beliefs regarding the benefit of a surgical intervention when discussing treatment options with patients.[11] Also, these patients, do not always have a vote in the decision-making process. The quality of life and patients' preferences are regularly not taken into account before opting for operative management, which nowadays feels like an overlooked opportunity. The operative trajectory, namely, carries risks with increased odds of adverse outcomes, especially for frail geriatric patients.

The frail patient

Frailty is a complex and evolving condition. Reversing or halt the frailty progression in geriatric patients is an exceptionally arduous task for current healthcare.[12,13] However, early recognition of frailty goes beyond the fracture line. Instead, it involves managing the patient with enhanced orthogeriatric pathways and providing tailor-made rehabilitation, which can aid and support the frail patient in coping with their geriatric health limitations effectively.[14,15]

Instead of pursuing optimistic treatment for geriatric hip fractures, a more patient-centered approach involves investing in early recognition of frailty, enhanced secondary prevention of osteoporotic fractures, further propagate advance care planning, and investing in

adequate palliative hip fracture care programs. Even once frail patients are identified in the acute setting, the decision-making process remains significantly complex due to various factors. These include social and cultural issues, comorbidities, cognitive impairment, and other complicating medical or patient-specific challenges that can limit their decision-making capacity.[16]

Shared decision-making

Most hip fracture patient are healthy individuals, and do no not require an extensive shared decision-making process in the emergency department, as their treatment goals primarily center around rapid recovery, and surgery can expedite this process.[17–20] Therefore, the call for Shared Decision-Making (SDM), does not apply to every situation. With more qualitative studies on SDM and non-operative management in hip fracture management, the patients and proxy perspectives can be taken into account in future management and in future research.[21,22] These subjects show very important, new insights and causing accelerated changes in hip fracture management, both nationally and internationally.[23] For the frail patients with a very limited life expectancy fracturing a hip, operative treatment should not primarily be the first thought of the surgeon.[24] Basic instincts of the physician need to be involved, and the initial response should be identifying patients' preferences and treatment goals. These changes in attitude, would lead to a paradigm change in which SDM becomes fundamental in hip fracture care among geriatric patients.

Palliative hip fracture care

With the introduction of palliative care in hip fracture management, once again there is evidence of a misconception of what is best for the patient in one the most occurring common medical problems in patients aged 60 years and older at the emergency department.[25] Evidence supports the preference of most people to die in the comfort of their homes. However, statistics indicate that over half of all deaths happen in hospitals worldwide, with overuse of aggressive care for dying patients and simultaneous underuse of appropriate palliative care as recurring themes.[26–28] In cancer patients, several studies describe the increase of aggressive treatment, such as cardiopulmonary resuscitation, chemotherapy and intensive care utilization, performed near the end of life phase.[29–31] In general, the prevailing pattern in hospitals tends to involve a frequent overuse of aggressive care and a simultaneous underutilization of palliative care for patients approaching the end of their lives.

Partly, solutions in overtreatment could be found in adequate and early Advance Care Planning (ACP). By utilizing ACP, the goals of care for hip fracture patients ideally can be assessed before fracture occurs, recognizing that patients and their families have already indicated their preference to avoid this conversation in acute setting.[21] However, concerns

continue to be expressed that end-of-life services are primarily focused on the needs of patients with cancer.[32] In recent studies in the UK only 27% of all patients who died were included in the ACP register before death, of whom 77% had cancer, despite only 25% of UK deaths being from malignant disease.[33] Conversations about end-of-life care with frail and older people who have no overriding diagnosis seems just as important for improving health care. Also, with this important information gathered upfront, a substantial enhancement in patient-centered decision-making can be offered for this population.

Advance care planning

It has been five decades since legal frameworks for ACP were initially incorporated into healthcare during the mid-1970s. Nonetheless, although there is a rising adoption of advance care planning at a smaller scope, the absence of comprehensive ACP programs on a national or global level remains evident.[34,35] Transparency of patients' information between healthcare professionals give insight in patients' treatment preferences. Still the majority of geriatric patient with a hip fracture is not even aware of his own preferences when becoming acute ill, let alone shared them with their family, general physician or other healthcare workers.[17] We stand against a growing problem with the community becoming older and older, increasing workload in our hospitals and political pressure to reduce healthcare costs.[36] Overdiagnosing and overtreating our patients is a very common, preventable and harmful aspect in current healthcare.[37] Therefore we advocate for investing in advance care planning programs to address patients preferences early in the process, so we start taking care of good appropriate health care: ''no more and no less than necessary". This approach aligns with current political strategies to cope with strained, human and financial, resources. Currently, the Dutch healthcare system aims to be reorganized in such a manner that we provide the best fit of health care in terms of treatment, location and timing for patients ('Juiste Zorg, Juiste Plek, Juiste Kosten').[38]

Since large ACP programs need huge funding and political backing, improvement on national scale is a long time coming and very time consuming. Therefore improving the process for hip fracture patients in acute setting is just as important, whenever ACP information is lacking. After evaluation of SDM with hip fracture patients at the emergency department, written information is highly recommended to support the treating physicians' verbal information to aid patient and family in this precarious setting.[21] The decision-making process consist of periods of extensive discussions interspersed with moments of retraction of family and patients. In these particular moments, guidance should be available by an appropriately composed decision aid. Also addressing this problem and make the physician familiar with this knowledge gap could give the SDM process additional depth corresponding to the patients, preferences.

Future perspectives

Overall, we can state that Palliative Non-Operative Management (P-NOM) is well received by hip fracture patients and family providing a viable option for frail geriatric patients. Also, with growing both national and international awareness under surgeons, P-NOM experiences can further expand and evolve to an even more enhanced patient-centered approach. The patient-centered approach has gained substantial attention since the introduction of orthogeriatric pathways, which emphasize teamwork in the care of trauma patients. Valuable insights have been gained through the multidisciplinary perspective applied in hip fracture management. This holistic vision has been effectively employed as the foundation for P-NOM, a model tailored to the specific needs of the most frail geriatric hip fracture patients. Our studies nonetheless, also revealed important themes of improvement (**frailty, pain management**, **advance care planning** and the **holistic approach**) and will give direction for future P-NOM research.

First, the most common question obtained from physicians and other healthcare professionals evaluating P-NOM is: 'How do we identify the frail geriatric patient, and which patients are eligible for the palliative, non-operative management after hip fracture?'. Identification of **frailty** remains challenging and is best complemented with the use of reliable frailty scales or indexes.[39–41] However, these tools are time consuming and difficult to use in acute setting at the Emergency Department. With the introduction of the AQUIOS flow cytometer, the first step towards immune based decision making is set. This variable could be of great additional use in shared decision-making to deflect the patients' immune system and their potential response to physical traumatic actions such as surgery or battling potential infections in the peri-operative phase.

Second, since surgeons priorly addressed operative management as an adequate treatment modality to reduce pain for very frail hip fracture patients, other successful pain therapy seems necessary to maintain quality of life for patients opting for P-NOM. Also, in our qualitative studies 'pain' numerously was implicated as the most important theme where still a lot to be gained for the P-NOM patient in the end-of-life phase. With the undesired side effects of systemic opioids, local hip analgesia recently was introduced, such as a Pericapsular Nerve Block (PENG), as a promising and relatively non-invasive alternative to reduce pain to a minimum after hip fracture. However, evaluation of this seemingly viable option is necessary. Involving the anesthesiologists, optimizing **pain management** is highly recommended for improving quality of life and therefore quality of dying for the P-NOM patients.

Third, addressed before in this thesis concerning **advance care planning**, urgent action on this matter is asked. With our growing geriatric population, still the majority is not familiar with its personal preferences regarding treatment when becoming acutely ill. With a limited life expectancy, addressing this subject in non-acute setting gives patient

and family time and space to exchange thoughts about their preferences. Family of P-NOM patients clearly underlined the difficulty of the very unexpected turn after hip fracture. In order to avoid time pressured and unfavorable situations in the emergency department in case of a hip fracture. Clinicians should realize that fractures in frail geriatric patients are not just a diagnosis in isolation, but a symptom of multifactorial pathology, and therefore ones frailty ideally is addressed and documented at an earlier stage.[42,43]

Last, significant developments by super specialization have made major impact on the practice of surgery. While specialization is merely intended to improve the quality of care, excessive specialization resulting in separation into narrow areas can have a deleterious effect on the total care of the patient. Focusing solely on the fractured hip, the patient behind the fracture is sometimes neglected. Surgery *can* fix the fracture and regain its function, however the overall deterioration of the patients' condition is most often irrevocable. The **holistic approach** in hip fracture care is ought to be mandatory to compose a comprehensive treatment plan through shared decision-making which is in harmony with the goals of care and preferences of the geriatric hip fracture patient.

"I will remember that there is art to medicine as well as science, and that warmth, sympathy, and understanding may outweigh the surgeon's knife or the chemist's drug."

The Hippocratic Oath: Modern Version[44]

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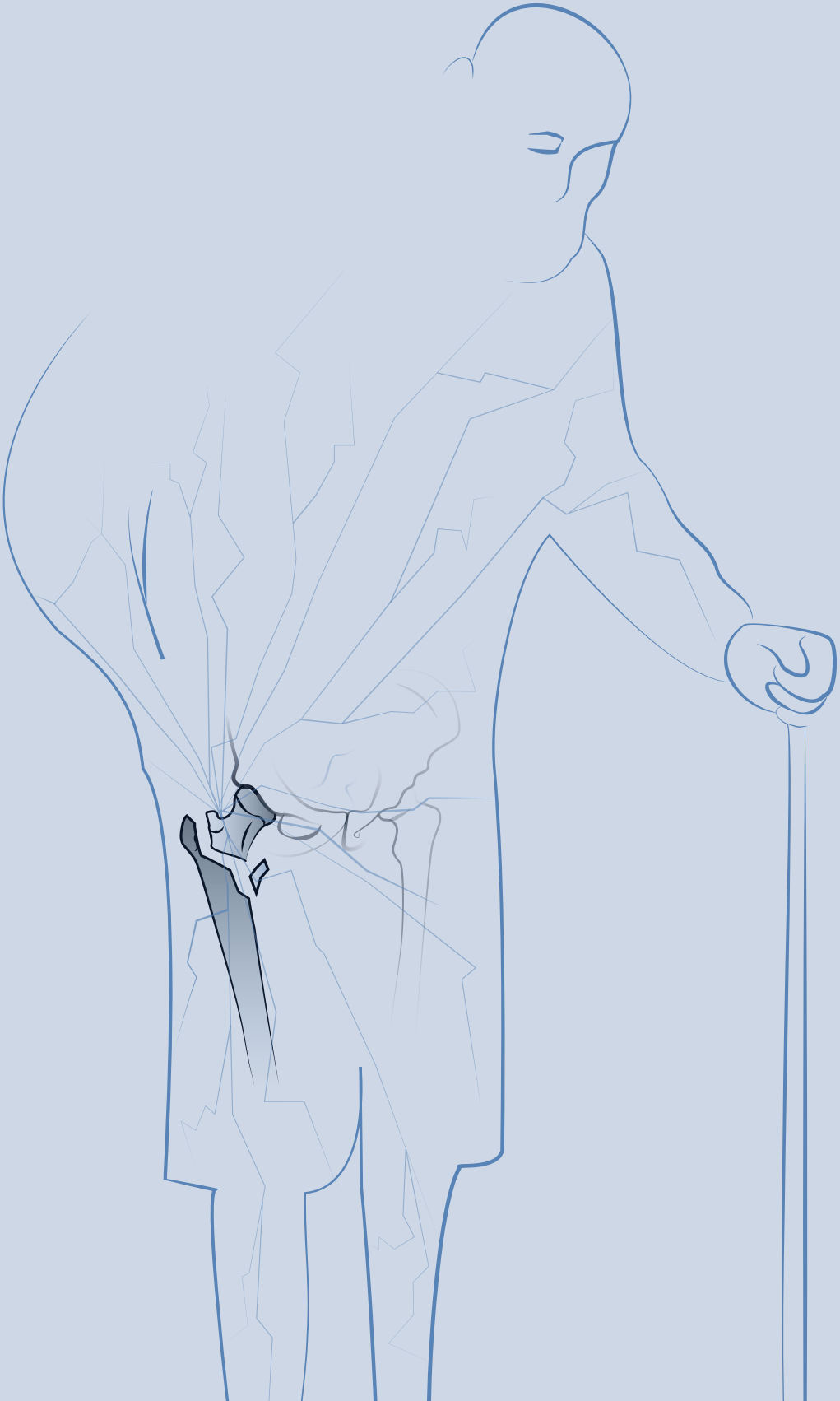


ADDENDA

Summary in Dutch (Nederlandse samenvatting)

Authors and affiliations

Acknowledgements (Dankwoord)

List of publications

Curriculum vitae auctoris

Summary in Dutch (Nederlandse samenvatting)

De gebroken heup

Het breken van de heup, staat bekend als een van de meest voorkomende traumatische letsels in de geriatrische populatie. Met een groeiende oudere bevolking en een toenemende prevalentie van kwetsbare ouderen met meerdere comorbiditeiten, zal de druk op een al overbelaste gezondheidssector naar verwachting toenemen. Aangezien het aantal heupfracturen gepaard gaat met het groeiende aantal gevallen van kwetsbare ouderen, heeft het postoperatieve traject vaker te maken met ernstige nadelige uitkomsten, met een 1-jaars sterftecijfer dat varieert tussen 20-30%. Voor geriatrische patiënten met een beperkte levensverwachting kunnen andere opties dan een heupoperatie meer in overeenstemming zijn met hun voorkeuren. Dit proefschrift onderzoekt de behandeldoelen (Goals of Care) voor de geriatrische populatie en evalueert de integratie van palliatieve zorg bij de behandeling van een gebroken heup. Een introductie van het onderwerp van dit proefschrift wordt gepresenteerd in **hoofdstuk 1.**

Orthogeriatrische zorg

Deel 1 van dit proefschrift onderzoekt de gevolgen van de multidisciplinaire geriatrische zorgpaden, tientallen jaren geleden geïntroduceerd met als doel de orthogeriatrische zorg te verbeteren. In **hoofdstuk 2** wordt de praktische toepassing van deze holistische benadering onderzocht in de vorm van patiënten met een gebroken heup. Een systematische review werd uitgevoerd om empirisch bewijs te verzamelen over de verbeteringen in de ziekenhuiszorg voor orthogeriatrische patiënten, met betrekking tot de kwaliteit van leven. Deze innovatieve veranderingen, internationaal reeds breed geïmplementeerd, hebben hun toepassing al bewezen op het gebied van morbiditeit en mortaliteit. De verbeteringen in de kwaliteit van leven lijken echter minstens zo belangrijk voor de oudere patiënt met een heupfractuur.

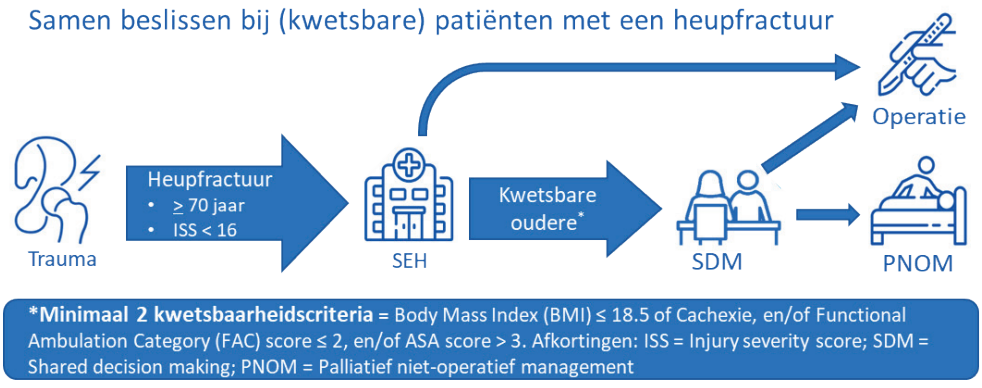
Kwetsbare patiënt met een gebroken heup

In **deel 2** wordt een uitgebreide analyse van kwetsbare geriatrische patiënten met een gebroken heup en hun kenmerken verricht. **Hoofdstuk 3** schetst de identificatie van korte termijn- en lange termijnvoorspellers van mortaliteit bij patiënten met een gebroken heup, die vervolgens worden gebruikt om meerdere overlevingscurves te construeren met behulp van de Kaplan Meier-methodologie. Deze grafieken bieden inzicht in het postoperatieve verloop van patiënten op basis van predictoren, waardoor patiënten en hun families uiteindelijk een grafische informatiebron hebben vóór de heupoperatie. In

hoofdstuk 4 verzamelen meerdere ziekenhuizen in Nederland gezamenlijk gegevens van kwetsbare patiënten met een gebroken heup. Er wordt specifiek aandacht besteed aan kwetsbare patiënten die aanvankelijk thuis woonden en mogelijk nog niet goed in beeld waren bij een behandeld arts. Thuiswonende patiënten met een gebroken heup vertonen een hoog risico op overlijden, complicaties en institutionalisering, en komen vaak niet terug op hun pre-trauma niveau van onafhankelijkheid. Beide hoofdstukken bieden inzicht in het postoperatieve beloop van patiënten op basis van individuele predictoren en bieden patiënten en hun families transparantere informatie vóór heupchirurgie, als verbetering van het gedeelde besluitvormingsproces.

Palliatieve, Niet-Operatief Management (P-NOM)

Deel 3 richt zich op de evaluatie van de nieuw geïntroduceerde Palliatief, Niet-Operatief Management (P-NOM) voor patiënten met een gebroken heup. P-NOM werd als optie geïntroduceerd via gedeelde besluitvorming (shared decision-making) voor geriatrische patiënten met een gebroken heup die als kwetsbaar worden beschouwd en een zeer beperkte levensverwachting hebben. Aanvankelijk werden patiënten als kwetsbaar beschouwd bij één of meer kwetsbaarheidscriteria; (Body Mass Index (BMI) van 18.5 kg/m2 of lager, Functionele Ambulantie Categorie (FAC) van 2 of lager voor het trauma, American Society of Anesthesiologists (ASA) score van 4 of 5) of op indicatie van de arts als er sprake was van beperkte levensverwachting zonder te voldoen aan de kwetsbaarheidscriteria. Bij P-NOM wordt specifieke aandacht besteed aan pijnstilling en patiëntcomfort, zonder dat het doel is om de mobiliteit te herstellen en het actieve revalidatieprogramma te starten. Aangezien P-NOM geen genezende behandeling is, zullen patiënten waarschijnlijk binnen enkele weken na de gebroken heup overlijden (mediane overleving van 11 dagen (IQR 4-26)). Het vernieuwde traject voor geriatrische patiënten wordt hieronder weergegeven in een afbeelding.



Figuur. Het zorgproces van patiënten met een gebroken heup.

A

Sinds 2020 wordt P-NOM ook besproken op indicatie van de chirurg of behandelend arts, gezien de grotere uitdaging bij het beoordelen van kwetsbaarheid met slechts drie objectieve markers: BMI, FAC en ASA. Dit stelt patiënten met een zeer beperkte levensverwachting in staat om P-NOM te overwegen boven operatief management in geval van een gebroken heup zonder aan de kwetsbaarheidscriteria te voldoen.

Hoofdstuk 5 initieert de eerste evaluatie van P-NOM middels semi-gestructureerde interviews om de eerste ervaringen van patiënten met de niet-operatieve alternatieve behandeling te verzamelen. Vier terugkerende thema's werden geïdentificeerd in de interviews die het meest belangrijk werden beschouwd voor de betrokkenen bij het palliatieve proces. Het besluitvormingsproces, de communicatie met de patiënten, pijn en het overlijden hadden grote gelijkenis met palliatieve zorg in ernstige chronische ziekten. Aangezien pijn werd geïdentificeerd als de meest belangrijke factor die het welzijn van de patiënt en omgeving beïnvloedt na een niet geopereerde gebroken heup, worden nieuwe pijnstillingsmethoden geadviseerd. Er wordt reeds geëxperimenteerd met lokale toediening van pijnmedicatie en toekomstige studies zijn nodig voor de evaluatie en klinische toepasbaarheid van deze innovaties. **Hoofdstuk 6** beschrijft de impact van P-NOM op chirurgisch behandelde patiënten met een gebroken heup, waarbij verschillen worden waargenomen tussen pre-implementatie en post-implementatie cohorten in de chirurgische groep. De integratie van het palliatief, niet-operatief management voor kwetsbare oudere patiënten met een gebroken heup liet geen directe significante daling zien in sterftecijfers of postoperatieve complicaties in vergelijking met de chirurgisch behandelde groep met heupfracturen bij oudere patiënten. Er was daarentegen wel een significante daling van het aantal IC-opnames in de post-implementatieperiode te zien. Daarbij lijkt het dat het besluit voor P-NOM door heupfractuur patiënten een effect heeft op de korte termijn uitkomsten in het ziekenhuis die IC-opname vereisen.

Patiëntgerichte behandeling

Deel 4 beschrijft de evaluatie van P-NOM, waarbij nieuwe thema's worden ontwikkeld om de methode te verfijnen. Deze thema's worden verder onderzocht om aan te sluiten bij de voorkeuren van de patiënt. **Hoofdstuk 7** beschrijft de behandeldoelen voor oudere patiënten die een gebroken heup oplopen, waarbij 'behouden van cognitie, 'bij familie zijn' en 'bij partner zijn' tot de belangrijkste doelen behoren na de breuk. De belangrijkste behandeldoelen moeten ten minste worden besproken wanneer een patiënt zich presenteert op de Spoedeisende Hulp (SEH) met een gebroken heup, mede ter verbetering van het gedeelde besluitvormingsproces in een acute setting. **Hoofdstuk 8** benadrukt de voorkeuren van patiënten binnen dit gedeelde besluitvormingsproces, gebaseerd op eerdere ervaringen tussen medische professionals en patiënten met een heupfractuur op de SEH, met een specifieke focus op de keuze tussen opereren en (palliatief) niet-operatief

beleid. Belangrijke thema's die aandacht vereisen in het gedeelde besluitvormingsproces zijn onder andere: 'redenen om P-NOM of operatie te overwegen', 'informatievoorziening op de SEH', 'verwachtingsmanagement', 'gedeelde besluitvorming' en 'kwaliteit van leven'. Tot slot introduceert **hoofdstuk 9** een pilotstudie met als doel een nieuwe immunologische marker te testen. Deze methode omvat de beoordeling van de immunologische reactie van geriatrische patiënten op de Spoedeisende Hulp door neutrofiel activatie in kaart te brengen bij een gebroken heup. Potentiële immunologische markers om de kwetsbare patiënt te onderscheiden van de fitte patiënt werden geobserveerd. Daarmee zijn we een stapje dichter bij de identificatie aan de hand van het immuunsysteem van een oudere patiënt met een gebroken heup en een verhoogde risico op complicaties.

In de toekomst kunnen voorspellende modellen, behandeldoelen en het immuunsysteem allen nuttig zijn als aanvulling in het proces van patiëntgerichte besluitvorming. Uiteindelijk kunnen deze thema's de artsen, patiënten en familie helpen om inzicht te krijgen in het postoperatieve of palliatieve traject na het oplopen van een gebroken heup.

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List of publications

Journal articles

1. **T.M.P. Nijdam**, D.W.P.M. Laane, T.E.E. Schiepers, D.P.J. Smeeing, D.H.R. Kempen, H.C. Willems, D. van der Velde - The goals of care in acute setting for geriatric patients in case of a hip fracture. – *European Journal of Trauma and Emergency Surgery (2023)* https://doi.org/10.1007/s00068-023-02258-0

2. J.F. Spierings, **T.M.P. Nijdam**, L. van der Heijden, H.J. Schuijt, M.C. Kokke, D. van der Velde, D.P.J. Smeeing - Cast versus removable orthosis for the management of stable type B ankle fractures: a systematic review and meta-analysis. - *European Journal of Trauma and Emergency Surgery (2022)* https://doi.org/10.1007/s00068-022-02169-6

3. **T.M.P. Nijdam**, D.W.P.M. Laane, J.F. Spierings, H.J. Schuijt, D.P.J. Smeeing, D. van der Velde -Proxy-reported experiences of palliative, non-operative management of geriatric patients after a hip fracture: a qualitative study. - *BMJ Open (2022)* https://doi.org/10.1136/bmjopen-2022-063007

4. S.A.I. Loggers, **T.M.P. Nijdam**, E.C. Folbert, J.H.H. Hegeman, D. Van der Velde, M.H.J. Verhofstad, E.M.M. Van Lieshout, P. Joosse - Prognosis and institutionalization of frail community-dwelling older patients following a proximal femoral fracture: a multicenter retrospective cohort study. - *Osteoporosis International (2022)* https://doi.org/10.1007/s00198-022-06394-y

5. R. Spijkerman, L.C.M. Bulthuis, L. Hesselink, **T.M.P. Nijdam**, L.P.H. Leenen, I.G.J.M. de Bruin - Management of pediatric blunt abdominal trauma in a Dutch level one trauma center. – *European Journal of Trauma Emerg Surg (2020)* https://doi.org/10.1007/s00068-020-01313-*4*

6. **T.M.P. Nijdam**, R. Spijkerman, L. Hesselink, L.P.H. Leenen, F. Hietbrink - Predictors of surgical management of high grade blunt splenic injuries in adult trauma patients: a 5-year retrospective cohort study from an academic level I trauma center. – *Patient Safety In Surgery (2020)*
https://doi.org/10.1186/s13037-020-00257-3

7. **T.M.P. Nijdam**, B.N. Jukema, E.J. de Fraiture, R. Spijkerman, H.J. Schuijt, C.C.W.G. Bongers, M.T.E. Hopman, L. Koenderman, F. Hietbrink, D. van der Velde. – Identification of neutrophil phenotype categories in geriatric hip fracture patients aids in personalized medicine – *OTA International (2023)* https://doi.org/10.0.4.73/OI9.0000000000000291

8. **T.M.P. Nijdam**, T.E.E. Schiepers, D.W.P.M. Laane, H.J. Schuijt, D.P.J. Smeeing, D. van der Velde - The impact of palliative, non-operative management on mortality of operatively treated geriatric hip fracture patients - *Submitted*

9. **T.M.P. Nijdam**, T. Kobes, M. van Baal, D.P.J. Smeeing, H.C. Willems, D. van der Velde - Impact of geriatric care interventions on Quality of Life for geriatric hip fracture patients; a systematic review - *Submitted*

10. D.W.P.M. Laane, T. Kroes, A. van de Berg, M.A.C. de Jongh, R. The, D. van der Velde, **T.M.P. Nijdam** - Geriatric patient and proxy perspectives on decision-making for hip fracture, a qualitative study – *Submitted*

11. H.A.J. Eversdijk, **T.M.P. Nijdam**, J.Q. Kusen, H.J. Schuijt, D.P.J. Smeeing, D. van der Velde - Predictors of short-and long-term Mortality in Geriatric Hip Fracture Patients - *Submitted*

12. **T.M.P Nijdam**, L. van den Boom, H.J. Schuijt, D.P.J. Smeeing, D. van der Velde - Osteoporosis screening after fracture in elderly- is the follow-up effective - *Submitted*

13. **T.M.P. Nijdam**, R. Spijkerman, L. Hesselink, T.C.Hardcastle, L.P.H. Leenen, F. Hietbrink- Angio-embolization in pediatric patients with blunt splenic injury: a systematic review. – *Submitted*

14. **T.M.P. Nijdam**, L.C.M. Bulthuis, R. Spijkerman, L.P.H. Leenen, I.G.J.M. de Bruin - Management of occult pneumothoraxes in pediatric patients after blunt thorax trauma. – *Submitted*

15. **T.M.P. Nijdam**, R. Spijkerman, M. Kip, M.P.J. Teuben, F. Hietbrink, L.P.H. Leenen. - The Additional Value of follow-up tests in the assessment of splenic function after blunt splenic injury in pediatric trauma patients. – *Submitted*

16. **T.M.P. Nijdam**, R. Spijkerman, R.P. Meijer, L.P.H. Leenen, F. Hietbrink - Management of renal and ureter trauma: the importance of retroperitoneal confinement. – *Submitted*

17. The COVPACH STUDY GROUP, COVID-19 UMCU study group (**e.g. Thomas Nijdam**) An increase in CD62Ldim neutrophils precedes the development of pulmonary embolisms in COVID-19 patients, *Scandinavian Journal of Immunology (2021)* https://doi.org/10.1111/sji.13023

18. The COVPACH STUDY GROUP, COVID-19 UMCU study group (**e.g. Thomas Nijdam**) Thrombotic Events in COVID-19 Are Associated With a Lower Use of Prophylactic Anticoagulation Before Hospitalization and Followed by Decreases in Platelet Reactivity, *Frontiers in Medicine (2021)* https://doi.org/10.3389/fmed.2021.650129

19. The COVPACH STUDY GROUP, COVID-19 UMCU study group (**e.g. Thomas Nijdam**) *Flow cytometric evaluation of the neutrophil compartment in COVID-19 at hospital presentation: A normal response to an abnormal situation, Journal of Leukocyte Biology (2021)* https://doi.org/10.1002/JLB.5COVA0820-520RRR

Congress abstracts

1. 20th European Congress of Trauma & Emergency Surgery 2019 (Prague, Czech Republic):
   T.M.P. Nijdam, R. Spijkerman, L. Hesselink, F. Hietbrink, L.P.H. Leenen. - Management of high grade blunt splenic injuries in a level one trauma centre.

2. 48th Congress of Surgery (Krakau, Poland):
   T.M.P. Nijdam, R. Spijkerman, L. Hesselink, F. Hietbrink, L.P.H. Leenen. - Management of high grade blunt splenic injuries in a level one trauma centre.

3. Nederlandse vereniging voor traumachirurgie, Traumadagen 2019 (Amsterdam, The Netherlands):
   T.M.P. Nijdam, R. Spijkerman, L. Hesselink, F. Hietbrink, L.P.H. Leenen. - Management of high grade blunt splenic injuries in a level one trauma centre.

4. Nederlandse vereniging voor traumachirurgie, Traumadagen 2019 (Amsterdam, The Netherlands):
   T.M.P. Nijdam, R. Spijkerman, L. Hesselink, F. Hietbrink, L.P.H. Leenen. - Angio-embolization in pediatric patients with blunt splenic injury: a systematic review.

5. 21st European Congress of Trauma & Emergency Surgery 2020 (Oslo, Norway): COVID
   T.M.P. Nijdam, R. Spijkerman, L. Hesselink, T.C.Hardcastle, L.P.H. Leenen, F. Hietbrink- Angio-embolization in pediatric trauma patients with blunt splenic injury: a systematic review.

6. 21st European Congress of Trauma & Emergency Surgery 2020 (Oslo, Norway): COVID
   T.M.P. Nijdam, R. Spijkerman, M. Kip, M.P.J. Teuben, F. Hietbrink, L.P.H. Leenen. - The Additional Value of follow-up tests in the assessment of splenic function after blunt splenic injury in pediatric trauma patients.

7. Nederlandse Vereniging voor Traumachirurgie, Traumadagen 2021 (Amsterdam, The Netherlands):
   T.M.P. Nijdam, R. Spijkerman, R.P. Meijer, F. Hietbrink, L.P.H. Leenen. - Management of renal and ureter trauma: the importance of retroperitoneal confinement

8. Nederlandse Vereniging Voor Heelkunde, Chirurgendagen 2021 (Veldhoven, The Netherlands):
   T.M.P. Nijdam, R. Spijkerman, R.P. Meijer, F. Hietbrink, L.P.H. Leenen. - Management of renal and ureter trauma: the importance of retroperitoneal confinement

9. Nederlandse Vereniging Voor Heelkunde, Chirurgendagen 2021 (Veldhoven, The Netherlands):
   T.M.P. Nijdam, D.W.P.M. Laane, H.J. Schuijt, D.P.J. Smeeing, D. van der Velde - Proxy-reported experiences of palliative, non-operative management from geriatric patients after hip fracture, a qualitative study

10. 21st European Congress of Trauma & Emergency Surgery 2022 (Oslo, Norway):
    T.M.P. Nijdam, B.N. Jukema, E.J. de Fraiture, R. Spijkerman, L. Koenderman, C. Bongers, M. Hopman, F. Hietbrink, D. van der Velde. - Point-of-Care Analysis of Neutrophil Activation in Geriatric Trauma patients with a Hip Fracture

11. 21st European Congress of Trauma & Emergency Surgery 2022 (Oslo, Norway):
    T.M.P. Nijdam, R. Spijkerman, R.P. Meijer, F. Hietbrink, L.P.H. Leenen. - Management of renal and ureter trauma: the importance of retroperitoneal confinement

12. 38th Annual meeting of Orthopaedic Trauma Association (OTA) 2022 (Tampa, United States of America):
    T.M.P. Nijdam, B.N. Jukema, E.J. de Fraiture, R. Spijkerman, L. Koenderman, C. Bongers, M. Hopman, F. Hietbrink, D. van der Velde. - Point-of-Care Analysis of Neutrophil Activation in Geriatric Trauma patients with a Hip Fracture

13. 1st International Orthopaedic Trauma Association (IOTA) Triennial Conference 2022 (Amsterdam, The Netherlands)

T.M.P. Nijdam, L. van den Boom, H.J. Schuijt, D.P.J. Smeeing, D. van der Velde - Osteoporosis screening after fracture in elderly- is the follow-up effective

14. 1st International Orthopaedic Trauma Association (IOTA) Triennial Conference (Amsterdam, The Netherlands) 2022
    T.M.P. Nijdam, B.N. Jukema, E.J. de Fraiture, R. Spijkerman, L. Koenderman, C. Bongers, M. Hopman, F. Hietbrink, D. van der Velde. - Point-of-Care Analysis of Neutrophil Activation in Geriatric Trauma patients with a Hip Fracture

15. 1st International Orthopaedic Trauma Association (IOTA) Triennial Conference (Amsterdam, The Netherlands) 2022
    T.M.P. Nijdam, H Jalazadeh, Apeldoorn, D. Van de Velde, H. Theeuwes, L.P.H. Leenen, J.G. Ten Brinke - Splenic abscesses after angio-embolization for blunt splenic trauma: A case series

16. 1st International Orthopaedic Trauma Association (IOTA) Triennial Conference (Amsterdam, The Netherlands) 2022
    S.A.I. Loggers, **T.M.P. Nijdam**, E.C. Folbert, J.H.H. Hegeman, D. Van der Velde, M.H.J. Verhofstad, E.M.M. Van Lieshout, P. Joosse - Prognosis and institutionalization of frail community-dwelling older patients following a proximal femoral fracture: a multicenter retrospective cohort study

17. 1st International Orthopaedic Trauma Association (IOTA) Triennial Conference (Amsterdam, The Netherlands) 2022
    J.F. Spierings, **T.M.P. Nijdam**, L. van der Heijden, H.J. Schuijt, M.C. Kokke, D. van der Velde, D.P.J. Smeeing - Cast versus removable orthosis for the management of stable type B ankle fractures: a systematic review and meta-analysis

18. 22nd European Congress of Trauma & Emergency Surgery 2023 (Ljubljana, Slovenia)
    T.M.P. Nijdam, D.W.P.M. Laane, T.E.E. Schiepers, D.P.J. Smeeing, D.H.R. Kempen, H.C. Willems, D. van der Velde - The goals of care in acute setting for geriatric patients in case of a hip fracture

19. 22nd European Congress of Trauma & Emergency Surgery 2023 (Ljubljana, Slovenia)
    T.M.P. Nijdam, T.E.E. Schiepers, D.W.P.M. Laane, H.J. Schuijt, D.P.J. Smeeing, D. van der Velde - The impact of palliative, non-operative management on mortality of operatively treated geriatric hip fracture patients

20. 22nd European Congress of Trauma & Emergency Surgery 2023 (Ljubljana, Slovenia)
    T.M.P. Nijdam, B.N. Jukema, E.J. de Fraiture, R. Spijkerman, L. Koenderman, C. Bongers, M. Hopman, F. Hietbrink, D. van der Velde. - Point-of-Care Analysis of Neutrophil Activation in Geriatric Trauma patients with a Hip Fracture

21. 24th EFORT Congress 2023 (Wenen, Oostenrijk)
    T.M.P. Nijdam, T.E.E. Schiepers, D.W.P.M. Laane, H.J. Schuijt, D.P.J. Smeeing, D. van der Velde - The impact of palliative, non-operative management on mortality of operatively treated geriatric hip fracture patients

Publicity/Media

1. Wat vinden ouderen met een heupfractuur belangrijk? Medical journal article - Ned Tijdschr Geneeskd.2023;167:C5423
   https://www.ntvg.nl/artikelen/wat-vinden-ouderen-met-een-heupfractuur-belangrijk

2. En wat nou als we die gebroken heup niet opereren? Newspaper article - Volkskrant 2023
   https://www.volkskrant.nl/nieuws-achtergrond/en-wat-nou-als-we-die-gebroken-heup-niet-opereren~b71ca54e/?

3. Patiënten met gebroken heup kiezen meer voor palliatieve zorg. Live radio broadcast - NOS Radio 1 2022
   https://www.nporadio1.nl/nieuws/binnenland/d2972a39-b0e5-48d3-891c-8be61cbc0841/patienten-met-gebroken-heup-kiezen-meer-voor-palliatieve-zorg

4. Minder zorg voor een hogere premie, hoe kan dat? Live radio broadcast – NPO Radio 1 'Dit is de Dag' 2022
   https://www.nporadio1.nl/fragmenten/dit-is-de-dag/bd02e0a0-e7cf-40ae-a3cf-3340662e0fa8/2022-12-02-minder-zorg-voor-een-hogere-premie-hoe-kan-dat

5. Afzien van een heupoperatie, ook al volgt de dood dan snel – Frontpage newspaper article - Trouw 2022
   https://www.trouw.nl/nieuws/afzien-van-een-heupoperatie-ook-al-volgt-de-dood-dan-snel~b36e2df6/

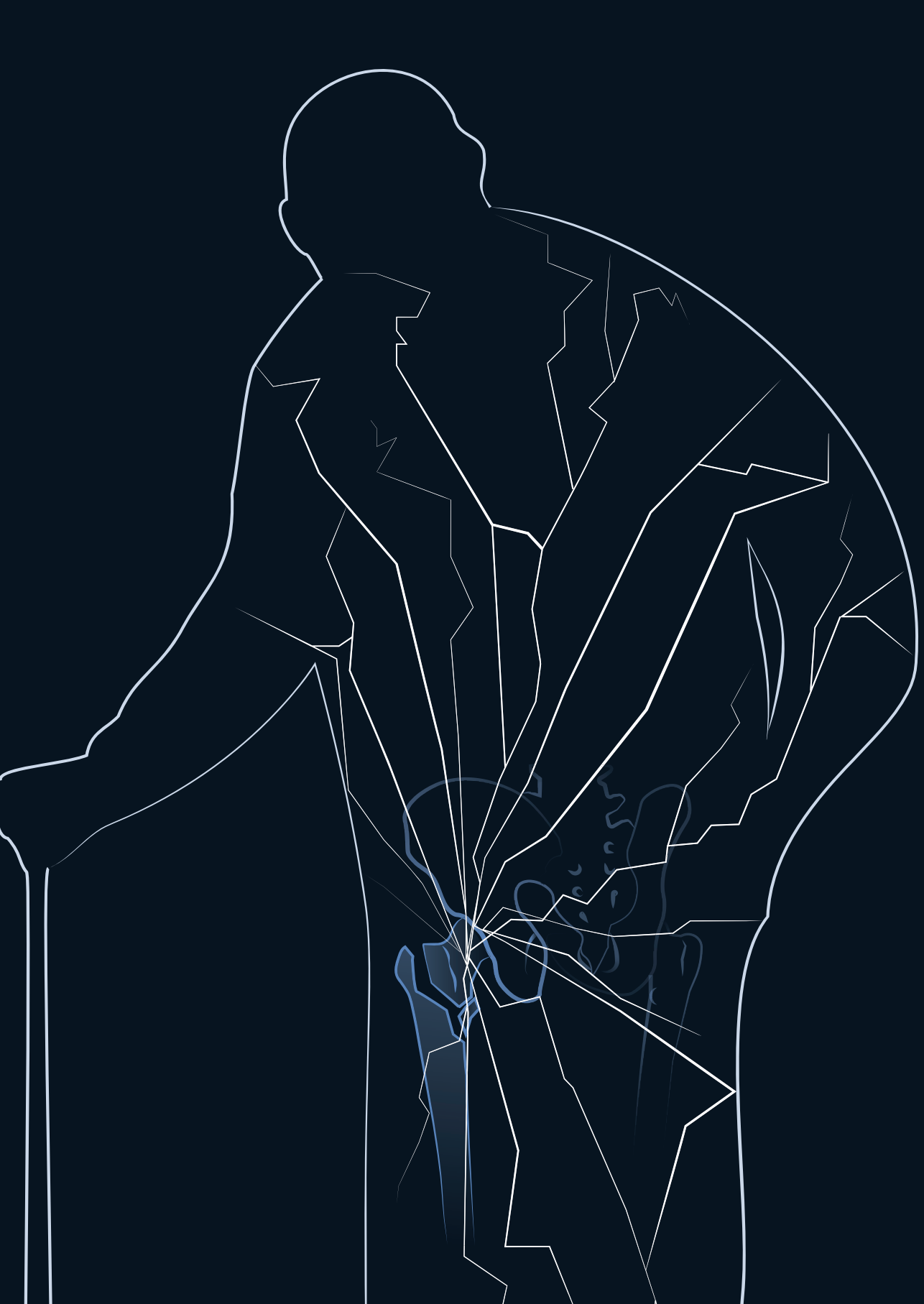
Foto Raymond Rutting / Volkskrant

Curriculum vitae auctoris

Thomas Nijdam was born on January 13th, 1993 in Son en Breugel, the Netherlands. Together with older sister Danique and younger sister Beau, he was raised by his parents Jolita Hagenaars and Mark Nijdam. The kids all went to the same public primary school 'the Gentiaan'. Thereafter, it was time to explore the 'big' city of Eindhoven and move to the regional secondary school 'Lorentz Casimir Lyceum' where he graduated in 2012.

In his hometown, he loved being outside and play sports with friends such as tennis and hockey. After making it to the national junior tennis team all efforts went into this sport where father Mark travelled together with Thomas all across the Netherlands to support him during training and tournaments.

When Thomas found out (around the year of 2009) that his father, who's Financial advisor by profession, once studied Medicine, he became more and more fascinated by the idea of becoming a doctor. Therefore, in secondary school, his programme profile (Nature & Health) was designed to pursue his dreams.

Eventually, Thomas was enlisted to start medical school at the University of Utrecht. Thomas participated from his third year as student-researcher in projects under supervision of dr. Roy Spijkerman, dr. Falco Hietbrink and prof. dr. Luke Leenen in the UMC Utrecht. The first projects focused on visceral trauma, primarily on traumatic splenic and kidney injuries. With the connections from the department of trauma surgery in the UMC, Thomas was able to perform an incredible instructive internship abroad in Durban, South-Africa at the trauma intensive care unit of the Inkosi Albert Luthuli Central Hospital. During COVID-19 in October 2020, Thomas obtained his medical degree and worked for three months as a physician at Municipal Health Services in the fight against the COVID virus. Hereafter, he got the opportunity to start as a PhD-candidate in Trauma Surgery at the St. Antonius Hospital, Utrecht under supervision of dr. Detlef van der Velde. With the main focus on traumageriatrics he investigated and evaluated the new insights of palliative, non-operative management for the most frail geriatric hip fracture patients.

Thomas started his clinical career in 2023 as surgical resident (not in training) at the Department of Surgery at the St. Antonius Hospital.