Data-driven improvement of hip fracture care

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INTRODUCTION
AIM & OUTLINE

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1. INTRODUCTION, AIM & OUTLINE OF THIS THESIS

1. INTRODUCTION

One out of five women and one out of ten men will likely sustain a fractured hip after reaching the age of 50. [1] In the Netherlands, hip fracture patients make up 24% of all non-severely and singular injured trauma patients (Injury Severity Score (ISS) ≤ 15). [2] The Dutch Trauma Registry documented 17,237 hip fracture patients in 2015 and 18,438 hip fracture patients in 2019, indicating an increase in hip fractures of 7% in four years. [2] The increase in hip fractures is presumably the result of the aging population, as hip fractures most often occur in frail elderly with untreated osteoporosis. This increased hip fracture incidence is not unique for the Netherlands; studies both in and outside Europe also predict the hip fracture-related burden and associated costs to increase even further in the coming decades. [1, 3, 4] Therefore, effective and efficient treatment for hip fracture patients leading to the best achievable outcome is of high importance. [1,4]

1.1 Clinical Auditing

Insight into desired and undesired medical outcomes is a necessity to improve the quality of care. Over a century ago, Dr. Ernest Amory Codman introduced the 'end-result theory', following up on treatment of patients, to evaluate whether a treatment was successful and if not, analyzing the process and using gained insights as a starting point for improvement of care in future patients. This end-result theory may be seen as the basis of the current quality of care registries and clinical audits. [5, 6]

The quality of care metrics used in clinical audits are called quality indicators. Three types of metrics, or quality indicators, can be distinguished according to the Donabedian framework. [6, 7] Codman's theory described the measurement of '*outcomes'*. Examples in hip fracture care are postoperative complications, mobility, or independence in daily living several months after the fracture was initially treated and mortality. Outcomes may reflect the overall quality of care and can be seen as the ultimate measurement. However, the measurement of the outcome alone does not give insight into the causative factors to which the outcome might be attributed. For the latter, the care '*process'* must be analyzed. The third and last domain of the Donabedian framework of quality assessment contains '*structural'* factors, which support and direct the provision of care, such as the availability of a dedicated ortho-geriatric ward, but also: the participation within a quality of care registry. In clinical auditing, data on all of these domains are collected in a standardized manner.

1.2 *Dutch Institute for Clinical Auditing (DICA) and the maturation of quality of care registries*

Clinical auditing has shown to be effective in improving the quality of care in numerous health care domains. [8–10] However, this effect does not occur directly at the start of a registry. The first clinical audit in the Netherlands was the Dutch Surgical Colorectal Audit, initiated in 2009. After that, several other audits were started under the umbrella of the Dutch Institute for Clinical Auditing. [11, 12, 21–24, 13–20] As a result, the DICA has gained a lot of technical and methodological knowledge on running nationwide clinical audits. From this knowledge, a model for the maturity of a clinical audit was built.

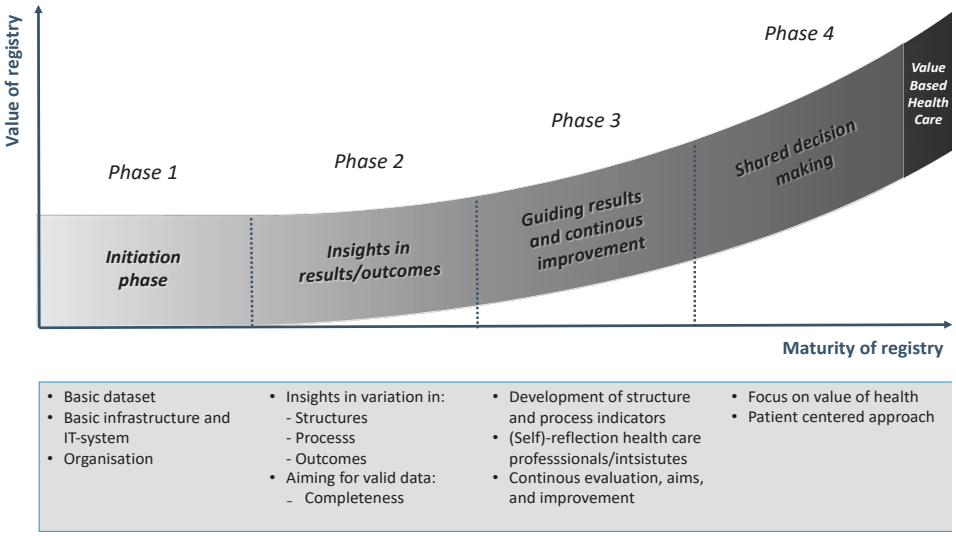

Figure 1. Maturation phases of quality of care registries according to the Dutch Institute of Clinical Auditing. Source: Dutch Institute of Clinical Auditing – Scientific Bureau.

Figure 1 shows the phases of maturation of clinical audits according to the DICA. The maturity of a clinical audit has implications for the quality indicators that can be measured and the research that can be performed using the registry's data. Logically, in the start-up phase of a registry, more actionable feedback is needed, which process indicators may provide. Before using outcome data in the later phases, data quality must be optimized. Using outcome data implies the need for more complex feedback tools such as case-mix corrected quality indicators. A hospital's case mix is defined as the characteristics of the treated patient population. The case mix differs between hospitals and may therefore affect the results of outcome quality indicators. In a mature registry, when the quality of data of both baseline characteristics and outcomes are sufficient, clinical auditing on outcomes may be performed.

Clinical auditing entails identifying outlier hospitals. For this, the DICA uses funnel plots with the mean indicator value as national benchmark. A 95%-Confidence Interval is plotted, and hospitals outside this interval are considered outliers. Positive outlier hospitals perform

significantly better than their peer hospitals, and their standards of care may serve as an example. Negative outlier hospitals perform significantly worse and should investigate the cause of their seeming underperformance and, if necessary, how to improve their standards of care. In this way, a clinical audit may help hospitals to improve the quality of care.

1.3 The Dutch Hip Fracture Audit

For the treatment of hip fracture patients, clinical auditing is a tool to assess and improve the quality of care also. After the initiation of the first hip fracture registry in Sweden in 1988, Rikshöft, at least ten registries have followed in several countries. [25–27] In 2016, the registry of hip fracture patients in the Netherlands in the Dutch Hip Fracture Audit (DHFA) was initiated under the umbrella of the DICA. [28]

The DHFA aims to improve the quality of care for hip fracture patients in the Netherlands by providing hospitals with information to mirror and benchmark their performance. Furthermore, centralized registration facilitates uniform calculation of quality indicators on hospital-level, which are mandatory and used by the Health Care Inspectorate (Inspectie voor Gezondheidszorg en Jeugd - IGJ) and the National Health Care Institute (Zorginstituut Nederland – ZINL). In addition, it provides researchers with data of a large national cohort of patients to find leads for further improvement of hip fracture care. The DHFA is a multidisciplinary registry in which all medical specialties involved in the care for hip fracture patients are included: geriatrics, internal medicine, elderly/nursing home specialists and orthopedic surgery and general (trauma) surgery.

At the start of the DHFA in 2016, a dataset was composed based on expert opinion and in accordance with the common minimal dataset for hip fractures published by the fragility fracture network. [29] A summary of the data registered within the DHFA is shown in Figure 2. Currently, the DHFA has reached a level of maturity in between phases 2 and 3. This means that the DHFA can be used to derive the first insights into structure, processes, and outcomes from the collected data. Aims for improvements can be deducted while working on the audit's development and further maturation.

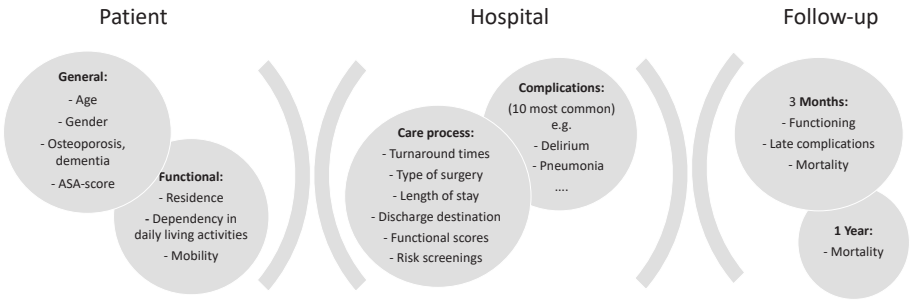

Figure 2. Summary of data registered within the DHFA.

2. AIM AND OUTLINE

2.1 General aim

Using data of the first years of the DHFA, identifying determinants for quality of hip fracture care and improving measurement of the quality of care provided, form the basis of this thesis. Therefore, this thesis consists of two parts. Part I describes research conducted *with* the data of the DHFA and studies determinants of outcomes in hip fracture care. Part II focusses on research *about* the data and studies the maturation of the audit.

2.2 Part I: Determinants of treatment and outcomes in hip fracture surgery

The first determinant of quality of care for hip fracture patients analyzed in this thesis is hospital volume. One might hypothesize that higher hospital volumes affect outcomes positively. It may allow for organizational benefits, such as a specific timeslot for hip fracture surgery, a dedicated hip fracture treatment team, a specialized ward, and the implementation of evidence-based hip fracture care pathways. On the other hand, higher patient volumes could also lower the quality of care as they pose a risk for a greater workload than the organizational structure can handle. Evidence for the relationship between hospital volume and hip fracture care quality is inconclusive. Thus far, the evidence is mainly limited by the use of varying volume thresholds in the study designs. It was attempted to overcome the problem of volume thresholds by using the DHFA data in an analysis that included hospital volume as a continuous parameter. **Chapter 2** shows whether annual hospital volume affects hospitals processes and outcomes of hip fracture care in the Netherlands.

Another determinant of the hip fracture care is the outcome of fracture fixation, as implant failure might have large implications for the patient's functioning. The femoral neck fracture is sometimes described as the 'unsolved fracture' as implant failure rates remain as high as 20-40%. Patient and fracture-related factors that influence failure rates in hip fracture fixation have been thoroughly examined. The fracture type- or pattern is one of the most critical determinants of the failure of the bone-implant construct. A previous study showed right-sided trochanteric fractures treated with a sliding hip screw to be more rotationally stable than similarly treated left-sided fractures. Making use of DHFA data combined with data from the FAITH trial, **Chapter 3** evaluates the failure rates of left and right-sided femoral neck fractures treated with a sliding hip screw, in order to determine the clinical relevance of the clockwise rotational torque in sliding hip screw implants.

It may be assumed that treatment outcomes are affected by variability in treatment strategies. The outcomes of hip fracture surgery may be related to the choice of implant, and the choice of implant may be related with medical specialty training. Two medical specialties, general surgery and orthopedic surgery, with different training programs but matching trauma certification requirements, provide hip fracture surgery in the Netherlands. **Chapter 4** analyses

treatment preferences and guideline adherence of Dutch surgeons with different surgical backgrounds to see if the surgeon's background might also be a determinant of the treatment of hip fractures in the Netherlands.

2.3 Part II: Maturation of the Dutch Hip Fracture Audit

Entering a new phase in the registry's maturation comes with new challenges in measuring quality of care and making between-hospital comparisons, especially when focusing on outcome data. When analyzing hip fracture patients' outcomes, patient demographics and disease burden come into play. Differences in patient demographics and disease burden may affect between-hospital variation in outcomes; for example, hospitals with a relatively frail patient population may have higher complication rates. Therefore, correction for the hospitals' case-mix is a prerequisite when comparing hospitals' mortality rates. **Chapter 5** describes the development of a case-mix adjustment model that enables fair comparisons of hospital-specific mortality rates. Adjusted mortality may now serve as a starting point for improving hip fracture care using DHFA data.

Quality of care registries should strive for renewal. Clinical registries help improve quality of care but also come at the cost of registration load. If this load is unnecessarily high, this could lead to (selective) missing of data with consequences for the analysis of the quality of care. When improvements in domains of hip fracture care have reached a plateau phase, a need for new data in the registry arises. New variables are to be used to develop new quality indicators or improve applied calculations, for example, by developing or expanding case-mix correction models. When adding extra variables to a registry dataset, one should question its use and informative value in order to keep the dataset as compact as possible. **Chapter 6** describes a structural approach for evaluating potential variables to extend and improve the DHFA dataset.

Finally, **Chapter 7** shows the evaluation of five years of data acquisition within the DHFA: trends in the implementation and data completeness as well as trends over time for several designated quality indicators. This evaluation indicates which improvements have been made and which points of attention for improving the quality of care for Dutch hip fracture patients remain. Additionally, it sheds light on the future perspectives of the audit.

Box 1. Primary research questions per chapter.

Part I: Determinants of treatment and outcomes in hip fracture surgery

Chapter 2	Is there a hospital-volume effect on the quality of hip fracture care domains: turnaround times, ortho-geriatric co-treatment, case-mix adjusted in-hospital and thirty-day mortality, and the quality of registration in the quality-of-care registry the DHFA?
Chapter 3	Do patients with a left-sided hip fracture treated with a sliding hip screw have a higher failure rate than patients treated with the same implant for a right-sided hip fracture?
Chapter 4	Are there specific treatment preferences and differences in guideline adherence between Dutch surgeons with different surgical backgrounds?

Part II: Maturation of the Dutch Hip Fracture Audit

Chapter 5	Are there differences in hospital variation regarding patient demographics and disease burden? And can we develop a case-mix adjustment model to calculate case-mix adjusted hospital-specific mortality rates?
Chapter 6	Can we identify potential variables with additional value and associations with outcomes to improve the nationwide DHFA?
Chapter 7	Are there trends in the data quality during the first five years of data acquisition within the DHFA, and are there trends over time for designated quality indicators?

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