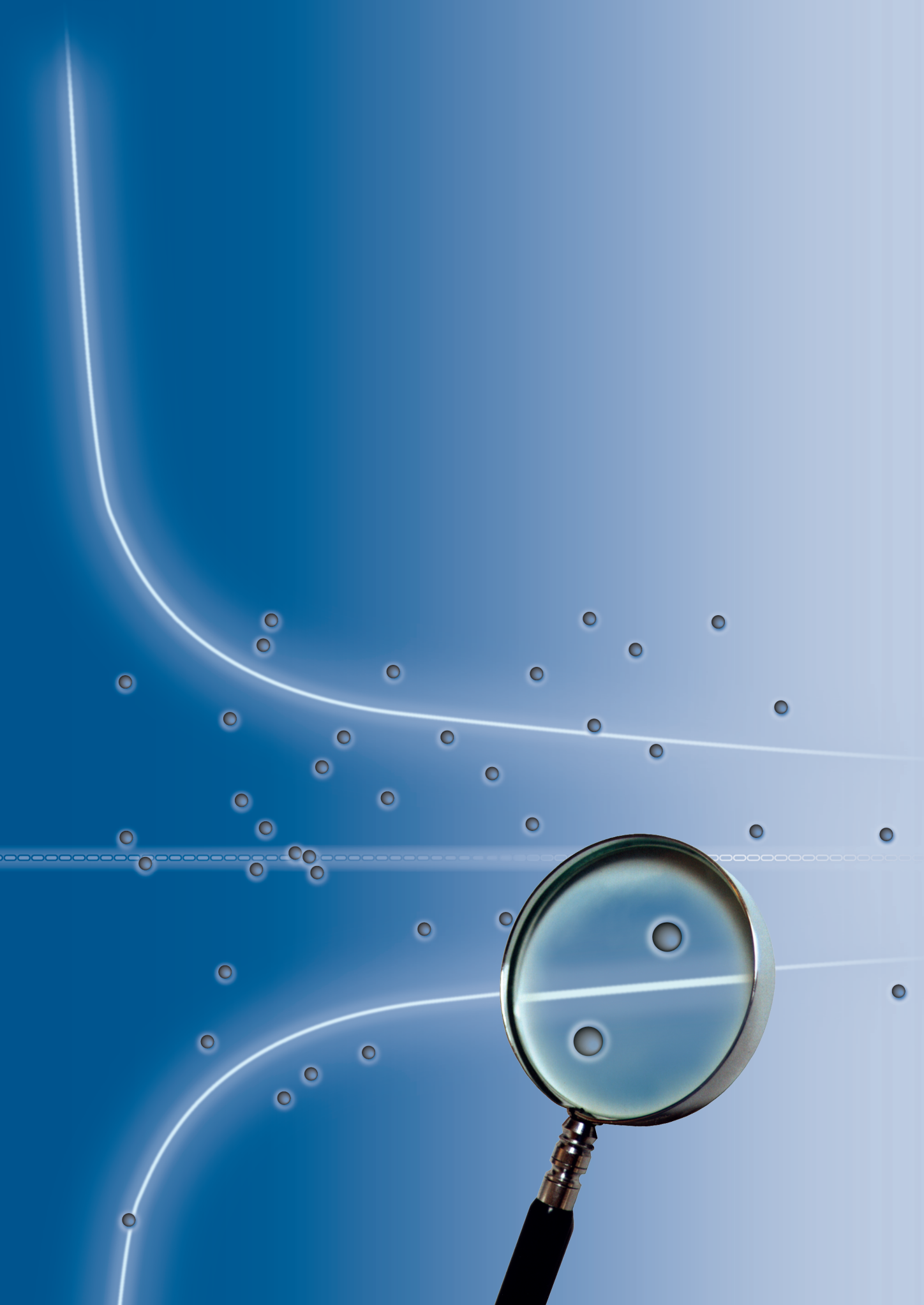
Measurement and evaluation of hip fracture care

Voeten, S.C.

Part 2

Evaluation of the quality of hip fracture care



7

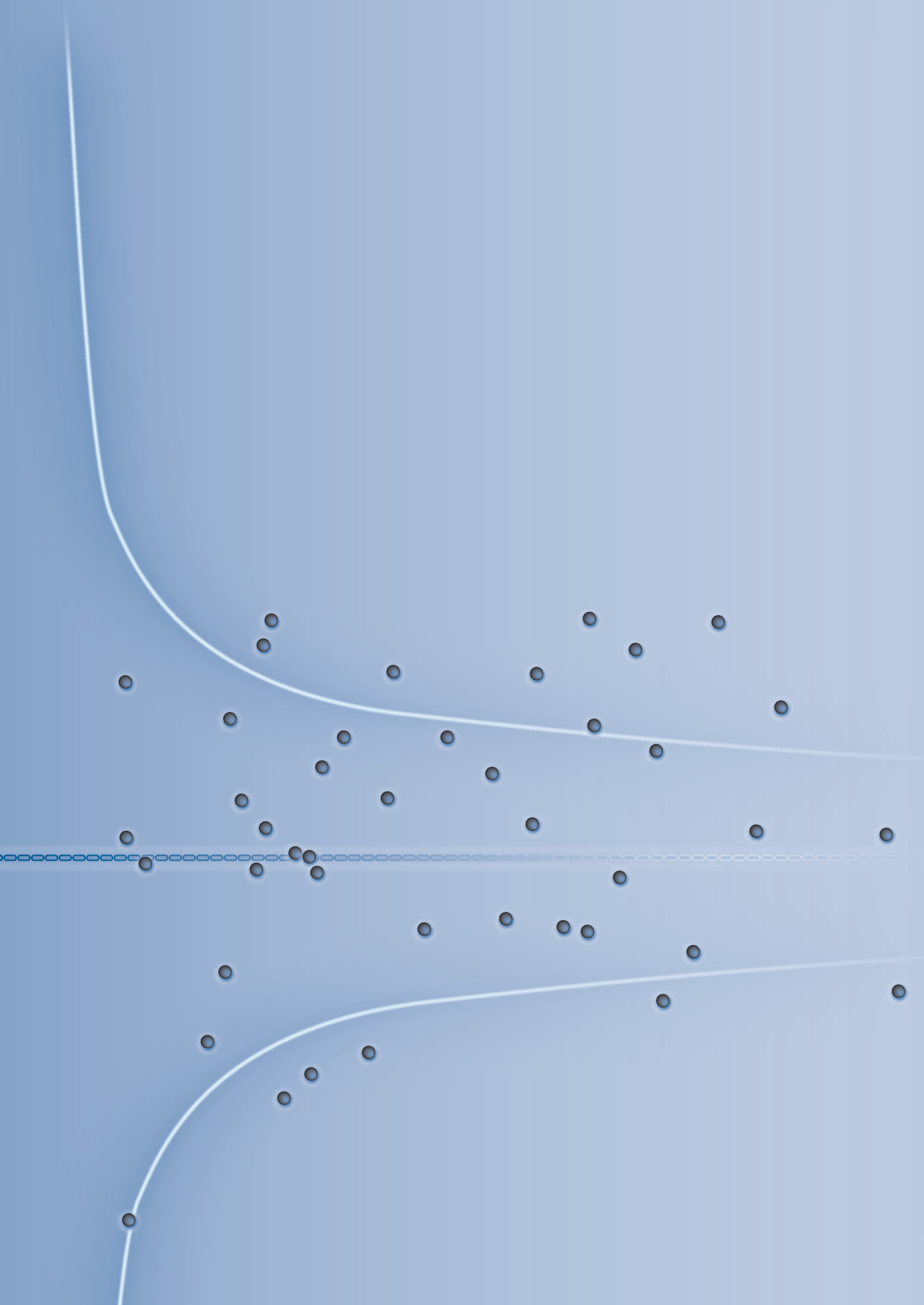
The Dutch Hip Fracture Audit: evaluation of the quality of multidisciplinary hip fracture care in the Netherlands

S.C. VOETEN [1,2]
A.J. ARENDS [3]
M.W.J.M. WOUTERS [2,4]
B.J. BLOM [5]
M.J. HEETVELD [6]
M.S. SLEE-VALENTIJN [7]
P. KRIJNEN [1]
I.B. SCHIPPER [1]
J.H. HEGEMAN [8]

ON BEHALF OF THE DUTCH HIP FRACTURE AUDIT (DHFA) GROUP

[1] Department of Trauma Surgery, Leiden University Medical Center, Leiden*
[2] Dutch Institute for Clinical Auditing, Leiden*
[3] Department of Geriatrics, Maasstad Ziekenhuis, Rotterdam*
[4] Department of Surgical Oncology, Netherlands Cancer Institute - Antoni van Leeuwenhoek Hospital, Amsterdam*
[5] Department of Orthopaedics, Flevoziekenhuis, Almere*
[6] Department of Surgery, Spaarne Gasthuis, Haarlem-Hoofddorp*
[7] Department of Geriatric Rehabilitation, Cordaan, Amsterdam*
[8] Department of Trauma Surgery, Ziekenhuisgroep Twente, Almelo-Hengelo*
* The Netherlands

Arch Osteoporos 2019;14(1):28



Abstract

Background

The aim of this study is to describe the development and initiation of the Dutch Hip Fracture Audit (DHFA). The secondary aim is to describe the hip fracture care in the Netherlands at the start of the audit and to assess whether there are differences in processes at baseline between hospitals.

Methods

Starting from April 2016, 81 hospitals were asked to register hip fracture patients. In 2017, the first full calendar year, the case ascertainment was determined at audit level. Three quality indicators were used to describe and assess the care process at audit and hospital level: the proportion of completed variables at discharge and at three months after surgery, time to surgery and orthogeriatric management.

Results

Sixty hospitals (74%) documented 14,274 patients in the DHFA by December 2017. In 2017, the case ascertainment was 58% and the average proportion of completed variables was 77%: 91% at discharge and 30% at three months after surgery. The median time to surgery was 18 hours (IQR 7 – 23) for ASA 1-2 patients and 21 hours (IQR 13 – 27) for ASA 3-4 patients. Of patients aged 70 and older, 78% received orthogeriatric management. At hospital level, all three indicators showed significant practice variance.

Conclusion

Not all hospitals participate in the DHFA and the data gathering process needs to be further optimized. However, the baseline results demonstrate an apparent variance in hip fracture practice between hospitals in the Netherlands, providing potential starting points to improve the quality of hip fracture care.

Introduction

Clinical audits or registries of processes and outcomes of care have proven useful to improve the quality of care [1,2]. The first audit for hip fracture care was established in Sweden, in 1988 [3]. Nowadays, several hip fracture audits exist [3-10]. As shown by the National Hip Fracture Database (United Kingdom minus Scotland) and the Scottish Hip Fracture Audit (Scotland), the implementation of an audit leads to improved adherence to national guidelines, a decline in practice variance and improved patient outcomes [11-13].

In the Netherlands, optimal hip fracture care is described in two evidence-based Dutch guidelines: the 'Proximal Femur Fracture' guideline, revised in 2016, and the 'Multidisciplinary Treatment of Frail Elderly During Surgical Procedures' guideline, first published in 2016 [14,15]. The presence of a national guideline does not, however, automatically imply overall adherence [16]. The need for guideline adherence, alongside the motivation to improve overall hip fracture care in the Netherlands, led to the initiation of a nationwide clinical hip fracture audit in 2016, the Dutch Hip Fracture Audit (DHFA). The DHFA aims to improve the quality of care by providing insight into the actual quality of hip fracture care in daily practice, and based on its results, to define targeted initiatives to be launched to improve the overall quality of hip fracture care.

Simultaneously, health care professionals are increasingly required to provide a growing amount of information about their performance to governmental institutions. In the Netherlands, the patient data for multiple hip fracture care quality indicators have to be reported to the National Health Care Institute (*Zorginstituut Nederland* – ZiNL) and the Health and Youth Care Inspectorate (*Inspectie Gezondheidszorg en Jeugd* – IGJ) [17,18]. As overall guidance is lacking, each hospital collects and calculates this data in its own way, a time-consuming procedure that may produce debatable results. Therefore, another goal of the DHFA was to enable hospitals to automatically deliver the results of these indicators to ZiNL and IGJ in a uniform manner.

The aim of this study is to describe the development and initiation of the Dutch Hip Fracture Audit. The secondary aim is to describe the hip fracture care in the Netherlands at the start of the audit and to assess whether there are interhospital differences in processes at baseline.

Methods

Initiation of the DHFA

The Dutch Association for Trauma Surgery (*Nederlandse Vereniging voor Traumachirurgie* – NVT) took the initiative to join forces with all medical associations involved in the care for patients with hip fractures in a multidisciplinary audit for hip fracture care. The DHFA was established with funding from the Dutch Federation of Medical Specialists (*Federatie Medisch Specialisten* – FMS).

The DHFA is overseen by a multidisciplinary clinical audit board in which medical associations involved in the hip fracture care process in the Netherlands are represented, including mandated members from the Dutch Association for Trauma Surgery (*Nederlandse Vereniging voor Traumachirurgie* – NVT), the Dutch Association of Surgeons (*Nederlandse Vereniging voor Heelkunde* – NVvH), the Dutch Orthopaedic Association (*Nederlandse Orthopaedische Vereniging* – NOV), the Dutch Geriatrics Society (*Nederlandse Vereniging voor Klinische Geriatrie* – NVKG) and the Dutch Society of Internal Medicine (*Nederlandse Internisten Vereniging* – NIV). The clinical audit board appointed a scientific committee, which decides on the contents of the DHFA and is responsible for the development of methodologically sound quality indicators.

The DHFA is part of the Dutch Institute for Clinical Auditing (DICA). DICA is an organization that facilitates nationwide audits in a uniform format for varying diseases [19]. It was founded in 2011 after colorectal surgeons initiated the Dutch Surgical Colorectal Audit (DSCA) [20]. At present, 22 nationwide clinical audits are facilitated by DICA [21-24].

The scientific bureau of DICA supports the scientific committee of DHFA with its expertise in clinical auditing and the methodologic issues involved. The data management unit of DICA provides a web-based feedback report in order to benchmark hospital performance using funnel plots.

Development of the DHFA

The dataset items are based on recommendations made in national and international guidelines, items used in other international hip fracture audits and quality indicators. Every year the dataset items are evaluated and, whenever necessary, updated or adjusted. The dataset currently includes 45 items recorded at three different moments: hospital discharge, three months after surgery and one year after surgery (see Appendix 1).

The DHFA data can be registered by authorized hospital employees (e.g. medical secretaries, data managers, nurse practitioners, physicians or medical specialists) in a secure web-based survey, but the medical specialist remains responsible for the completeness and correctness of the entered data. Owing to the quality improvement purpose of the audit, informed consent is not needed to register the DHFA data of a hip fracture patient in the secure web-based survey. To ensure that accurate data is entered, data verification is directly done in the web-based survey: unrealistic answers or missing fields are flagged. In addition, external data verification for a random sample of patients in each hospital will be performed every three years. For this purpose, an independent team of monitors will compare the source data in the Electronic Health Record (*Elektronisch Patiëntendossier* – EPD) with the data entered in the web-based survey. In line with privacy regulations in the Netherlands, only anonymized patient data are forwarded from the secure web-based DHFA survey to DICA for analysis by an independent data processor (Medical Research Data Management, MRDM) [25].

All 81 hospitals treating hip fracture patients in the Netherlands were asked to register the DHFA data of all patients admitted from 1 April 2016. The exclusion criteria were age under 18 years, pathologic fracture due to a malignant disease, and periprosthetic fracture. The case ascertainment was determined for the first full calendar year (2017). To assess the case ascertainment, the total number of operated patients (i.e. patients recorded as having been operated) in the DHFA was compared to the number of patients registered by the ZiNL. At audit level the completeness of variables recorded at hospital discharge and three months after surgery for patients who were still alive at that time, was described for the periods April - December 2016 and January - December 2017.

Quality indicators to assess the processes of hip fracture care at baseline

Three quality indicators were used to describe and assess the processes of hip fracture care at the start of the audit. The processes were evaluated at audit and hospital level for the calendar year 2017 (see Appendix 2 for definitions).

1. Data completeness of variables, determined as the proportion of completed variables for operated patients.
2. The median time to surgery, measured from admission to the emergency department to the start of surgery, was determined for ASA 1-2 and ASA 3-4 patients separately. Comparisons at hospital level included the number of ASA 1-2 and ASA 3-4 patients operated within the median time to surgery. Hospitals with > 10% of data missing on the 'time to surgery' variable were excluded from this analysis.
3. For operated hip fracture patients older than 70 years, the presence of orthogeriatric management during admission was described. The proportion of patients with orthogeriatric treatment during admission was compared at hospital level. Hospitals having a special comprehensive orthogeriatric ward were identified. To be identified as a hospital with an orthogeriatric ward, more than 50 percent of the orthogeriatric care had to be provided on the special ward. Hospitals with > 10% missing on the 'orthogeriatric management during admission' variable were excluded from this analysis.

Results

Case ascertainment

A total of 14,274 patients admitted in the period April 2016 - December 2017, of whom 3,188 in 2016 and 11,086 in 2017, were included by 60 hospitals (74%) in the DHFA. Of the included patients, 278 (1.9%) were treated non-operatively; for 341 patients (2.4%) the type of treatment was missing, while 148 patients (1.0%) had a second hip fracture and were entered twice in the DHFA. The case ascertainment of the operated hip fracture patients in 2017 was 58%, as 10,612 of the 18,385 operated hip fracture patients registered at the ZiNL were also registered in the DHFA.

Data completeness of variables

The proportion of completed variables recorded at hospital discharge was 95% in 2016 and 91% in 2017. Average data completeness of the variables recorded three months after surgery was much lower, 37% in 2016 and 30% in 2017 (Table 1). The proportion of completed variables in 2017 was 77% at audit level and differed significantly at hospital level, ranging from 39% to 99%. For nine hospitals data completeness of the variables was significantly lower compared to the audit average (Figure 1a).

Table 1. Data completeness of variables of DHFA-registered patients: clinical and 3-month section

	2016[Δ]		2017	
Completeness clinical section, n (%)	**n = 3,188**		**n = 11,086**	
Date of birth	3,185	(99.9)	11,081	(100,0)
Gender	3,183	(99.8)	11,072	(99.9)
Fracture type	2,792	(87.6)	9,127	(82.3)
Type of fracture treatment	3,113	(97.6)	10,820	(97.6)
ASA grade*	2,763	(90.8)	9,013	(84.9)
Time of arrival at emergency department	3,013	(94.5)	10,720	(96.7)
Date of surgery*	3,029	(99.5)	10,596	(99.8)
Anaesthesia type*	2,841	(93.4)	9,466	(85.4)
Consultation of geriatrician	2,887	(90.6)	9,184	(82.8)
Date of discharge	2,843	(89.2)	9,179	(82.8)
Complications*	2,996	(98.5)	10,235	(96,4)
Mobility score	3,000	(94.1)	9,213	(83.1)
KATZ-6 ADL score	2,989	(93.8)	10,176	(91.8)
Residence	2,902	(91.0)	8,743	(78.9)
Completeness 3-month section, n (%)	**n = 2,847[‡]**		**n = 10,038[‡]**	
Follow-up section created[‡]	1,246	(43.8)	3,823	(38.1)
Reoperation[‡]	1,104	(38.8)	2,970	(29.6)
Mobility score[‡]	1,059	(37.2)	3,053	(30.4)
KATZ-ADL score[‡]	929	(32.6)	2,727	(27.2)
Residence[‡]	1,053	(37.0)	2,850	(28.4)

ASA American Society of Anesthesiologists physical status classification system

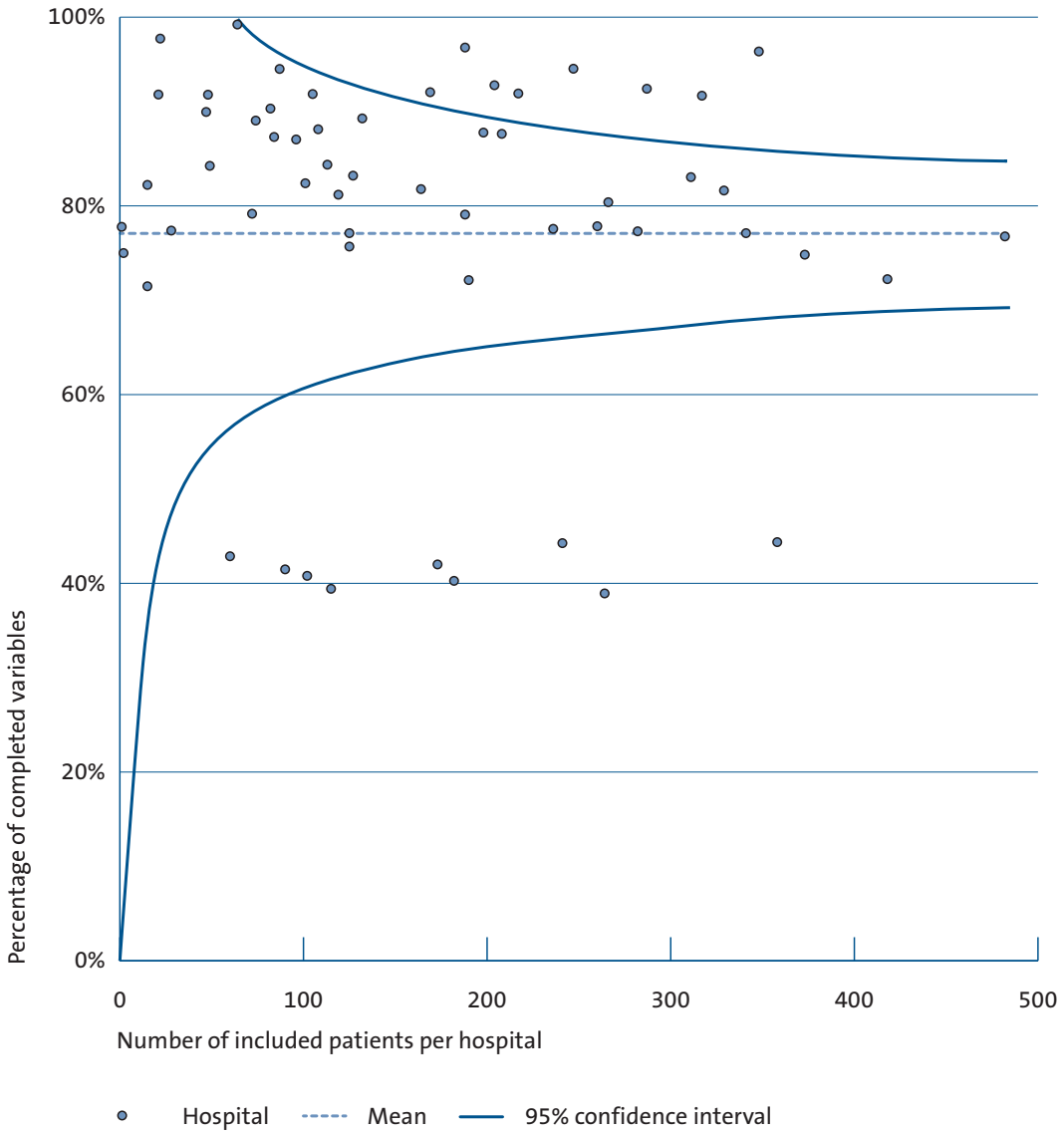
KATZ-6 ADL KATZ Index of Independence in Activities of Daily Living

[Δ] From April to December 2016.

* These variables can only be recorded in the DHFA if indicated that surgery was performed; n = 3,043 for 2016 and n = 10,612 for 2017.

[‡] Includes only patients who were alive four months after surgery.

Figure 1a. Funnel plot of proportion of variables completed per hospital in Dutch Hip Fracture Audit in 2017*



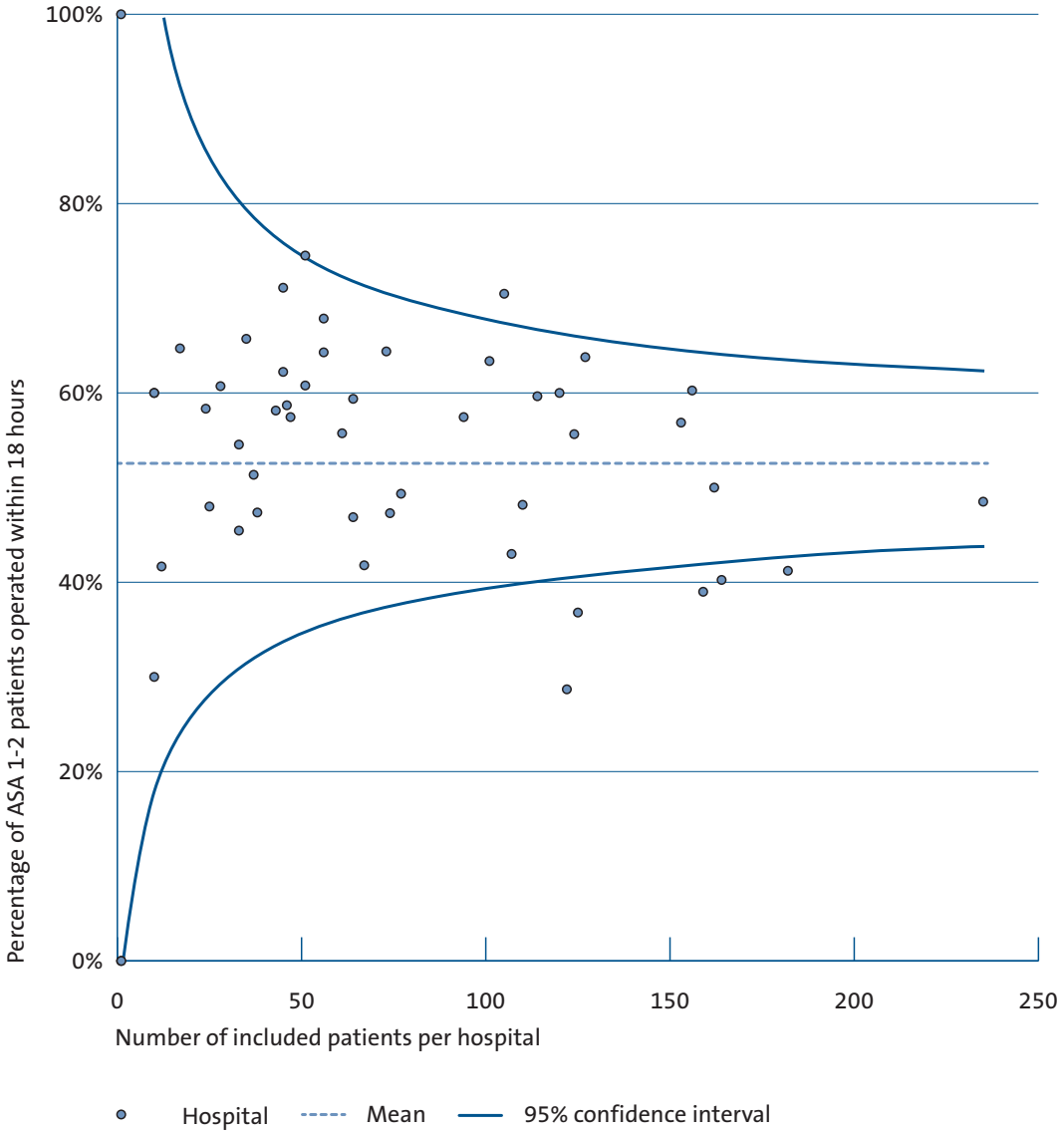
* Variables included date of birth, gender, type of fracture, type of treatment, ASA grade, date and time of arrival at emergency department, date and time of surgery, consultation of geriatrician, date of discharge, type of anaesthesia, complications, Katz Index of Independence in Activities of Daily Living at admission, mobility score at admission, residence before admission, reoperations, 3-month Katz Index of Independence in Activities of Daily Living, 3-month mobility score, 3-month residence.

Time to surgery

The median time to surgery for ASA 1-2 hip fracture patients was 18 hours (IQR 7 – 23). Two hospitals performed significantly more surgeries within the median time of 18 hours, and five hospitals performed significantly fewer surgeries within this time frame, with hospital

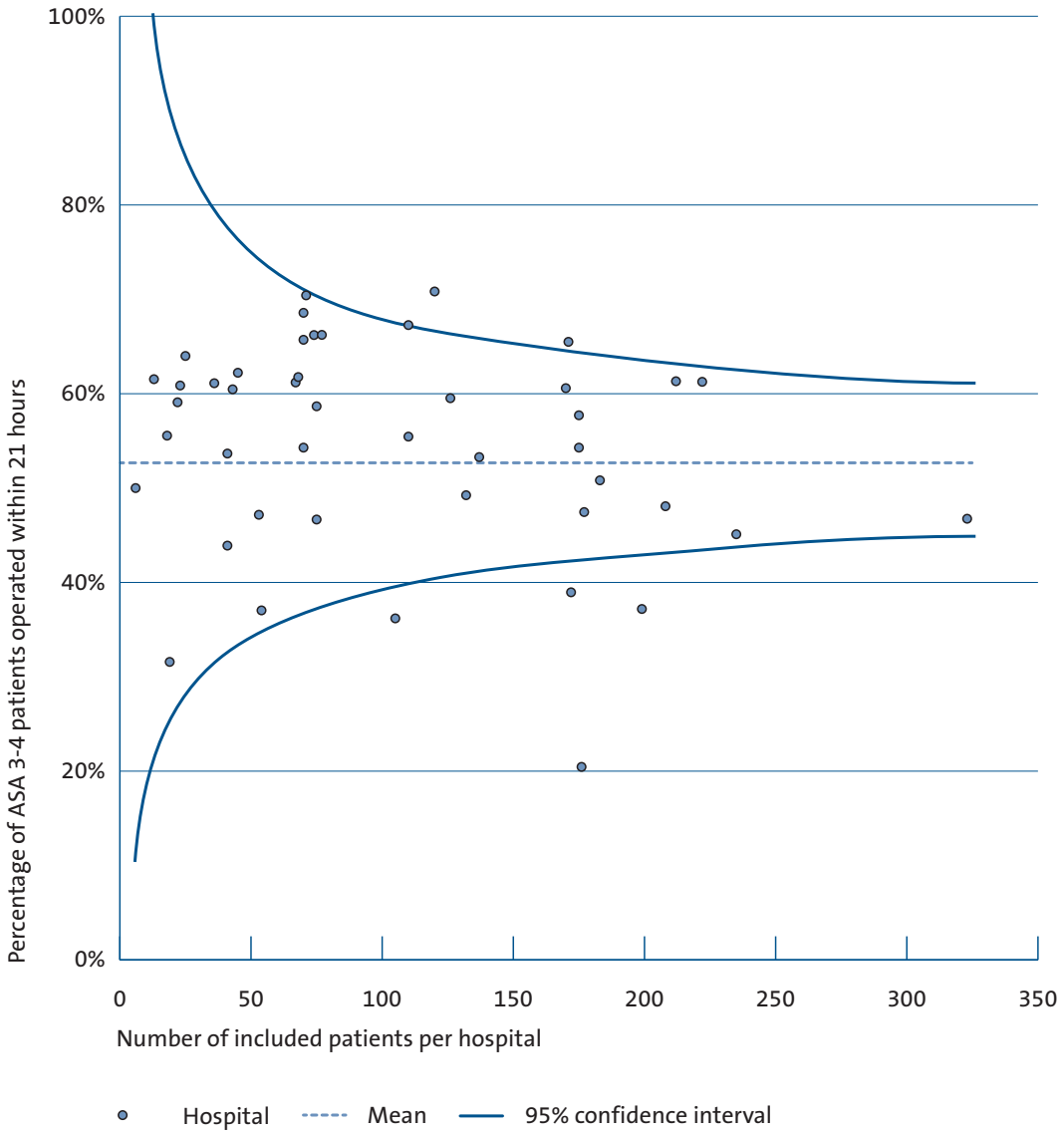
variation ranging from 29% to 75% (Figure 1b). For ASA 3-4 hip fracture patients the median time to surgery was 21 hours (IQR 13 – 27), with two hospitals operating significantly more patients within this time frame, while four hospitals operated significantly fewer patients within 21 hours. The variation between the hospitals was 20% – 71% (Figure 1c). Two hospitals had > 10% missing on the 'time to surgery' variable for ASA 1-2 patients and five hospitals for ASA 3-4 patients, and were therefore excluded from these analyses.

Figure 1b. Percentage of ASA 1-2 patients operated within nationwide median time to surgery per hospital in 2017



The horizontal line represents the mean proportion of all ASA 1-2 patients who were operated within the median time to surgery of 18 hours. Each dot represents the proportion of patients operated within the median time in a specific hospital.

Figure 1c. Percentage of ASA 3-4 patients operated within nationwide median time to surgery per hospital in 2017



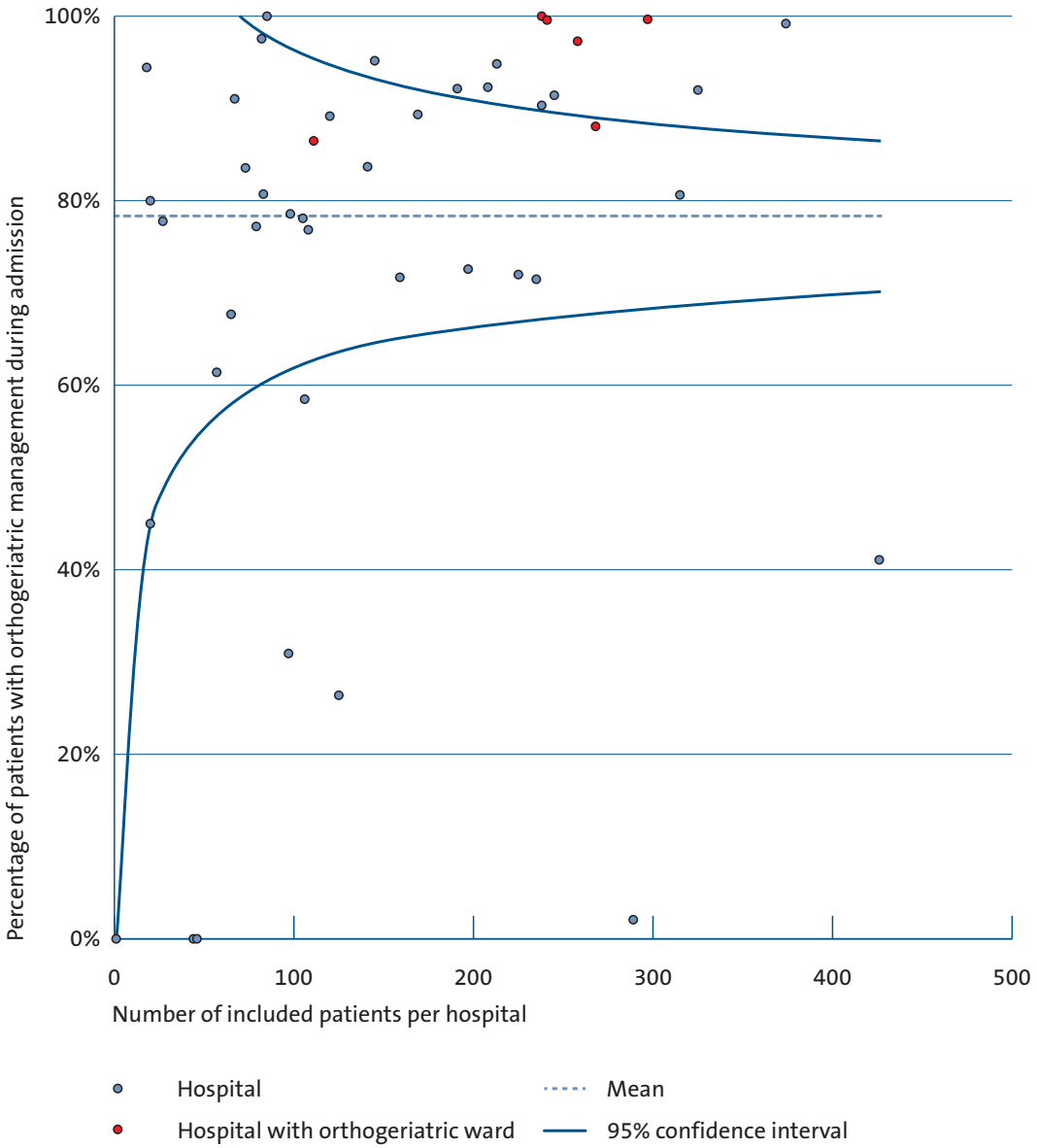
The horizontal line represents the mean proportion of all ASA 3-4 patients operated within the median time to surgery of 21 hours. Each dot represents the proportion of patients operated within the median time in a specific hospital.

Orthogeriatric management during admission

Orthogeriatric management during admission was provided to 78% of the operated patients aged 70 and older. There was significant hospital variation in the availability of comprehensive orthogeriatric management during admission, with 13 hospitals performing significantly

better, and seven hospitals significantly worse than the mean (Figure 1d). Orthogeriatric care in a special comprehensive orthogeriatric ward was provided to only 23% of the elderly patients. Six hospitals were identified as having a special comprehensive orthogeriatric ward, with four of these hospitals providing significantly more orthogeriatric management than the mean (Figure 1d). Thirteen hospitals had > 10% of data missing on the 'orthogeriatric management' variable and were excluded from these analyses.

Figure 1d. Orthogeriatric management during admission of patients 70 years and older with a surgically treated hip fracture



Discussion

This study describes the development and initiation of a nationwide hip fracture audit. Although the audit has not yet been implemented in all hip fracture operating hospitals in the Netherlands, and the participating hospitals do not yet register all of their patients, the audit already shows hospital variation on the three quality indicators for hip fracture care that were studied. This variation can serve as a starting point for targeted interventions to improve the quality of hip fracture care in the Netherlands.

Data completeness of the DHFA compared to other hip fracture audits

Two recent reviews identified other hip fracture audits, to which the data completeness in the DHFA can be compared [26,27]. In its first full calendar year of registration the DHFA achieved a nationwide case ascertainment of 58%. In the most recent annual reports of other hip fracture audits the case ascertainment ranged from 19% to 100% [3-9]. To the best of our knowledge, five hip fracture audits exceeded the 58% case ascertainment of the DHFA: Rikshöft in Sweden, The National Hip Fracture Database (NHFD) in the United Kingdom minus Scotland, the Danish Multidisciplinary Hip Fracture Registry (DMHFR), the Irish Hip Fracture Database (IHFD) and the Scottish Hip Fracture Audit (SHFA) [3-6,8]. A possible explanation for the higher case ascertainment in these audits is that they are running longer than the DHFA. The scores in the first and second years of the NHFD, which now has a 100% case ascertainment, are comparable to those of the DHFA. In the first and second NHFD years, 20% and 56% of the patients respectively were included [4,28,29]. The implementation of the NHFD improved when the Best Practice Tariff was introduced, a financial reward for hospitals meeting six targets [30,31]. In the first full year of the patient level audit of the Australian and New Zealand Hip Fracture Registry (ANZHFR) 3,519 patients were registered, which translated in a case ascertainment of approximately 14% [32]. In the second full year, this increased to 23% [9]. The IHFD did better, with a case ascertainment of 78% in the first year and 84% in the second year [8,33].

The average completeness of DHFA variables recorded after hospital discharge of 95% in the first year and 91% in the second year is comparable to that of other hip fracture audits. The NFHD had an average variables completeness of 92% in the first year and 98% in the second year, and the IHFD 88% in the first year and 93% in the second year, while the ANZHFR had a completeness of over 95% in both its first and second year [8,9,28,29,33]. The drop in the average variables completeness in the second year in the DHFA was also seen in the ANZHFR [9]. A possible explanation is that in the second year of the DHFA almost 2.5 times more patients were registered, which implied an increased risk of missing variables.

In 2017, the average completeness of variables recorded three months after surgery was 30% in patients who were then still alive. In other hip fracture audits the collection of follow-up data is difficult as well [34]. The ANZHFR accomplished a follow-up data collection rate of 50% in the fourth registration year (48% in Australia and 64% in New-Zealand), but had a low

case ascertainment [9]. The NHFD had a 120-day follow-up of 32% [4]. However, high follow-up rates are not beyond reach, as two hospitals in the NHFD managed to have follow-up data of 90% of the patients and the SHFA reported a 120-day follow-up rate of 92% [35].

Improving the data completeness of the DHFA

Since 2017 hospitals can use the DHFA to calculate and deliver the results of some of the mandatory national hip fracture quality indicators to two institutions that require this information: ZiNL and IGJ. This may explain the high proportion (91%) of completed variables recorded at hospital discharge and the increase in case ascertainment to 58%. As of 2018, it is possible to deliver the results of all mandatory hip fracture quality indicators as demanded by ZiNL and IGJ through the DHFA. It is expected that this will further improve case ascertainment and data completeness in 2018. A financial reward, like the Best Practice Tariff for the NHFD, was and is not available for the DHFA [30,31].

The operating hospital is responsible for retrieving and registering the data, both in-hospital and after discharge. But many hospitals do not see their patients back after discharge, unless a complication occurs during the recovery process which cannot be taken care of by, for example, an elderly care physician. A possible solution to improve the three-month follow-up data collection is to make this a joint responsibility of hospitals, nursing homes and home care organizations. The scientific committee of the DHFA aims to establish an integrated transmural hip fracture care path in the Netherlands, with firmer integration of hospital care, nursing home care and home care. In this situation, the data is collected at the place where the patients are at the intended follow-up moment. This integrated care would not only increase the number of patients registered in the DHFA, but would also provide better insight into the overall quality of hip fracture care.

Comparison of the proportion of completed variables between hospitals provides insight into the data collection process. Hospitals where the data collection is well organized can serve as best practice for hospitals where this is not yet organized adequately.

Differences in hip fracture care processes between hospitals

We observed significant differences in time to surgery and orthogeriatric management during admission between hospitals in the Netherlands. Other hip fracture audits have shown that these differences will reduce when feedback is provided to the hospitals about their performances [11,13]. Farrow et al. used data from the Scottish Hip Fracture Audit to demonstrate that adherence to quality standards was associated with better patient outcomes [35].

The average time to surgery was three hours longer for the ASA 3-4 group compared to the ASA 1-2 group. This was to be expected, since this patient category can benefit from optimization of their physical status before surgery, with a maximum delay of five days [36].

More interesting is that five hospitals operated significantly fewer ASA 1-2 patients within the nationwide median time to surgery, even though this group does generally not need to be optimized before surgery. As shown by the study of Hawkes et al. practice variance on time to surgery can be an incentive for an underperforming hospital to make targeted interventions to improve the time to surgery [37]. However, the use of 'time to surgery' as a quality indicator remains questionable [26].

The difference between hospitals in orthogeriatric management is interesting, as the national guideline states that every patient over 70 should receive orthogeriatric management during admission [15]. Now only 78% of the patients above 70 receive orthogeriatric management during admission, which is low compared to the 2016 NHFD in which 89% of the patients above 60 years of age received orthogeriatric management [4]. A study using NHFD data also demonstrated that an increase in orthogeriatric treatment hours per patient was associated with a 3.4% relative risk reduction of mortality [38]. In the DHFA only 23% of the patients is treated on a special ward with high orthogeriatrician hours per patient. Another recent study showed that a dedicated orthogeriatric ward lowered the 1-year mortality rate in frail elderly patients from 35.1% to 23.2% [39]. An additional analysis showed that patients receiving non-orthogeriatric treatment were significantly younger and had less comorbidities. It will be interesting to evaluate the effects of non-orthogeriatric treatment on the outcomes of care for this specific population. The data from the DHFA enables such a study.

In the start-up phase of the DHFA hospitals will be compared on process of care only. This will provide hospitals the opportunity to first optimize their hip fracture care process. Later, hospital performances will be compared on outcomes of care.

International benchmarking

In addition to benchmarking hospitals in the Netherlands, an audit can also provide insight into how treatment patterns differ between countries [40]. To enable international benchmarking Sáez-López et al. compared the content of existing hip fracture audits and proposed variables which should be collected in a hip fracture registry. Almost all of the proposed variables are collected by the DHFA [27]. In line with Sáez-López et al. and Johansen et al. case-mix and treatment characteristics of different nationwide hip fracture registries were compared (see Table 2) [27,41]. The DHFA seems comparable with other nationwide hip fracture audits in terms of case mix, as the common Dutch hip fracture patient is a female above 80 years of age with an ASA grade of 3 or higher. Compared to the other audits, in the Netherlands intramedullary fixation is used more often, whereas sliding hip screws are used less frequently. The Dutch 'Proximal Femur Fracture' guideline does not include definite recommendations as to the type of osteosynthesis to be used in case of a pertrochanteric femur fracture (31 – A1 / 31 – A2 / 31 – A3). It is up to the local protocol or surgeon to decide which type of osteosynthesis will be used. Apparently, there is a preference in the Netherlands

for using intramedullary fixation, since 73% of the type 31 – A1 fractures were treated in this way. This finding can serve as a starting point for further outcome studies to explain whether and how differences in treatment relate to differences in outcome of care.

Table 2. Comparison of implementation and patient characteristics in eight nationwide hip fracture audits

	Rikshöft	SHFA	DMHFR	NHFR	NHFD	IHFR	ANZHFR		DHFA
							AUS	NZD	
Initial year of audit	1988	1993[@]	2003	2005	2007	2012	2016		2016
Included number of patients[§]	15,062[*]	3,942	6,679	8,422	65,645	3,159	5,178	730	11,086
Estimated yearly number of hip fractures	18,000	6,000	6,679	-	65,645	3,650	22,000	3,803	19,000
Minimum age for inclusion (in years)	15	50	65	-	60	60	50	50	18
Average or median age (in years)	82	82	83	83	83[*]	81[#]	82	83	82
Female (%)	67	73	69	70	72[Δ]	69	70	68	67
ASA grade (%)									
1	39[*◊]	26[*◊]	-	3	2[Δ]	2	2	1	6
2			-	32	25[Δ]	39	20	22	30
3	53[*]	53[*]	-	56	54[Δ]	53	56	56	44
4 and 5	8[*]	15[*]	-	8	14[Δ]	7	22	20	5
Unknown / missing	-	-	-	1	4[Δ]	-	-	-	15
Fracture type (%)									
Femoral neck non-dislocated	13	17[*]	10[*]	13	9	9	17[*]	15[*]	14
Femoral neck dislocated	39	36[*]	45[*]	42	49	43	29[*]	37[*]	32
Intertrochanteric	37	38[*]	37[*]	30	32	36	46[*]	43[*]	33
Subtrochanteric	8	4[*]	7[*]	6	6	7	8[*]	5[*]	2
Other / unknown / missing	3	5[*]	1[*]	9	4	6	0[*]	0[*]	19
Type of anaesthesia (%)									
General anaesthesia	5[*]	50[*]	-	10	41[*]	11	70[*]	56[*]	30
Spinal anaesthesia	95[*]	44[*]	-	86	50[*]	58	27[*]	41[*]	45
Regional anaesthesia	-	-	-	-	-	-	3[*]	3[*]	1
Other / missing	-	6[*]	-	4	9[*]	28	-	-	24[^]
Fracture treatment (%)									
Conservative	-	-	-	-	2	-	-	-	2
Cannulated hip screw	17[*]	2[*]	10[*]	14	3	2	4[*]	13[*]	6
Sliding hip screw	22[*]	36[*]	22[*]	22	32	25	19[*]	22[*]	13
Intramedullary fixation	27[*]	7[*]	31[*]	17	12	21	36[*]	30[*]	38
Hemiarthroplasty	25[*]	44[*]	25[*]	41	43	45	33[*]	26[*]	34
Total hip replacement	9[*]	6[*]	10[*]	4	8	3	8[*]	9[*]	5
Other / unknown / missing	-	-	-	2	0	2	-	-	1

	Rikshöft	SHFA	DMHFR	NHFR	NHFD	IHFR	ANZHFR		DHFA
							AUS	NZD	
Pre-fracture mobility (%)									
Freely mobile without aids	43*	50	-	-	36Δ	46	47	43	37
Mobile outdoors with one aid	-	17	-	-	22Δ	-	12	11	5
Mobile outdoors with two aids or frame	-	22	-	-	15Δ	-	36	35	26
Some indoor mobility but never goes outside without help	-	10	-	-	24Δ	14	-	-	6
No functional mobility (when using lower limbs)	-	1	-	-	2Δ	2	2	2	2
Unknown / missing	-	-	-	-	1Δ	-	3	7	24
Pre-fracture residence (%)									
Living independently at home	70*	75	73*	-	81	81	71	76	44
Living independently but help with activities of daily living	-	-	-	-	-	-	-	-	16
Home care	26*	18	19*	-	11	-	28	24	7
Nursing home	-	-	-	-	8	9	-	-	10
Nursing home with rehabilitation	-	-	-	-	-	-	-	-	1
Other	-	-	-	-	-	9	-	-	2
Unknown / missing	-	-	-	-	-	-	-	-	21

@ 1993 – 2008, restarted 2016

§ Source is annual report of audit for 2017 or, if not available, for 2016. The year of annual report is stated after full audit name. Rikshöft (Sweden) 2016, SHFA = Scottish Hip Fracture Audit 2017, NHFR = Norwegian Hip Fracture Register 2017, NHFD = National Hip Fracture Database 2017 (United Kingdom minus Scotland), IHFD = Irish Hip Fracture Database 2016, ANZHFR = Australian and New Zealand Hip Fracture Registry 2017, DMHFR = Danish Multidisciplinary Hip Fracture Registry 2017, DHFA = Dutch Hip Fracture Audit 2017.

* Source: Johansen A, Golding D, Brent L, et al. Using national hip fracture registries and audit databases to develop an international perspective [41].

Δ Source: NHFD annual report 2016.

◊ ASA 1 and ASA 2 together.

Average age is 79 for men and 81 for women.

^ Other anaesthesia in the DHFA is: general and regional anaesthesia (2%), general and spinal anaesthesia (1.5%), spinal and regional anaesthesia (4.9%) and missing (15%).

Limitations

A limitation of the present study is that the DHFA has a current national audit case ascertainment of 58%. This percentage implies a possible bias in the audit population, as a certain population may not be included in the registration. However, in our opinion the missing patients are missing completely at random, the underlying reasons being most likely a

lack of staffing capacity for data collection and the fact that not all hospitals participate in the DHFA at present. Benchmarking hospitals is possible, but establishing differences between hospitals with low numbers of inclusion is difficult as they provide wide confidence intervals.

Another limitation could be the accuracy of the data. Two studies showed that data in hip fracture audits were sometimes incorrectly registered, and that it is important that entered data is validated [42,43]. When the data verification is directly done in the web-based survey, and when external data verification is performed every three years, we believe the registered data can be considered accurate.

Hospitals are required by law to report their results on quality indicators to the ZiNL and IGJ every calendar year. To ensure more objective and reliable data, the DHFA can be used to deliver the mandatory quality indicator results to the ZiNL and IGJ, but the use of the DHFA is not obligatory. As shown by another audit, obligatory data delivery leads to full participation [20].

Conclusion

Two years after the implementation of the DHFA not all hospitals participate in the audit, and the data gathering process within participating hospitals needs to be further optimized. Based on the results so far, there seems to be considerable practice variance between hospitals in the Netherlands concerning both time to surgery and orthogeriatric management. These differences illustrate the need for further development and implementation of the DHFA and provide potential starting points for improvements. The next step is achieving a higher case ascertainment so that hospitals can be benchmarked on outcomes of care and quality of care can be improved.

Acknowledgement

The Dutch Hip Fracture Audit (DHFA) Group: A.J. Arends, B.J. Blom, M. van Eijk, M.J. Heetveld, J.H. Hegeman, R.M. Houwert, M.C. Luyten, B.G. Schutte, M.S. Slee-Valentijn and S.C. Voeten.

Appendices

Appendix 1. Dutch Hip Fracture Audit dataset

General patient information		
Country		
Citizen service number		
Name		
Gender	❒ Male ❒ Female	
Date of birth		
Date of death (if applicable)		
Name of hospital		
Emergency Department (ED)		
Head practitioner	❒ Trauma surgeon	❒ Geriatrician
	❒ Orthopaedic trauma surgeon	❒ Internist-elderly
	❒ Surgeon	❒ Internist
	❒ Orthopaedic surgeon	❒ Elderly care physician
Fellow practitioner	❒ Trauma surgeon	❒ Geriatrician
	❒ Orthopaedic trauma surgeon	❒ Internist-elderly
	❒ Surgeon	❒ Internist
	❒ Orthopaedic surgeon	❒ Elderly care physician
Date and time of arrival at ED		
Date and time of departure from ED		
Admission		
Pre-fracture residence	❒ Living independently at home	❒ Nursing home
	❒ Living independently but help with activities of daily living	❒ Nursing home with rehabilitation
		❒ Other
	❒ Home care	
Involvement geriatrician / internist-elderly	❒ None	❒ Perioperative consultation
	❒ Postoperative consultation	❒ Treatment on orthogeriatric ward
Dementia	❒ No ❒ Yes ❒ Unknown	
Medication for osteoporosis	❒ No ❒ Yes	
Pre-fracture mobility	❒ Freely mobile without aids	
	❒ Mobile outdoors with one aid	
	❒ Mobile outdoors with two aids or frame	
	❒ Some indoor mobility but never goes outside without help	
	❒ No functional mobility (when using lower limbs)	
	❒ Unknown	

KATZ-6 ADL score	Bathing	❒ No ❒ Yes
	Dressing	❒ No ❒ Yes
	Going to toilet	❒ No ❒ Yes
	Continence	❒ No ❒ Yes
	Transferring	❒ No ❒ Yes
	Feeding	❒ No ❒ Yes
SNAQ score	Did you unintentionally lose more than 3 kg of weight over the last month?	
	❒ No ❒ More than 3 kg	
	Did you unintentionally lose more than 6 kg of weight over the last six months?	
	❒ No ❒ More than 6 kg	
	Did you experience a decreased appetite over the last month?	
	❒ No ❒ Yes	
	Did you use supplemental drinks or tube feeding over the last month?	
	❒ No ❒ Yes	
Surgery		
	❒ Femoral neck non-dislocated	❒ Intertrochanteric AO – A3
	❒ Femoral neck dislocated	❒ Subtrochanteric
	❒ Intertrochanteric AO – A1	❒ Not specified
	❒ Intertrochanteric AO – A2	
Fracture treatment	❒ Conservative	❒ Total hip replacement
	❒ Hemiarthroplasty	❒ Sliding hip screw
	❒ Cannulated hip screw	❒ Intramedullary fixation
Date and start time of surgery		
Side of fracture	❒ Right ❒ Left ❒ Both	
Bone grafting	❒ No ❒ Yes	
ASA grade	❒ 1 (normal healthy individual)	
	❒ 2 (mild systemic disease)	
	❒ 3 (severe systemic disease)	
	❒ 4 (systemic disease which is constantly life-threatening)	
	❒ 5 (moribund)	
General anaesthesia	❒ No ❒ Yes	
Spinal anaesthesia	❒ No ❒ Yes	
Regional anaesthesia	❒ No ❒ Yes	

Complications	
Did any complications occur?	❒ No ❒ Yes
	If yes, please specify:
	❒ Anaemia ❒ Hematoma
	❒ Cardiac arrhythmia ❒ Kidney failure
	❒ Chronic obstructive pulmonary disease ❒ Loosening of fixation material
	❒ Deep vein thrombosis ❒ Phlebitis
	❒ Delirium ❒ Pneumonia
	❒ Dislocation implant ❒ Pressure ulcer
	❒ Electrolyte disorder ❒ Pulmonary embolism
	❒ Epilepsy ❒ Stroke
	❒ Fall ❒ Urinary tract infection
	❒ Fracture around prosthesis ❒ Wound infection - deep
	❒ Heart failure ❒ Wound infection - superficial
	❒ Heart infarct ❒ Other
Discharge	
Died during hospital stay	❒ No ❒ Yes ❒ Unknown
Date of discharge	
Mobility at discharge	❒ Freely mobile without aids
	❒ Mobile outdoors with one aid
	❒ Mobile outdoors with two aids or frame
	❒ Some indoor mobility but never goes outside without help
	❒ No functional mobility (when using lower limbs)
	❒ Unknown
Osteoporosis medicine at discharge	❒ No ❒ Yes
Residence after discharge	❒ Living independently at home ❒ Nursing home
	❒ Living independently but help with activities of daily living ❒ Nursing home with rehabilitation ❒ Other
	❒ Home care
Follow-up	
Date of follow-up	
Timing of follow-up	❒ Three months after surgery ❒ One year after surgery
Side of fracture	❒ Right ❒ Left ❒ Both
Reoperation within 60 days	❒ No ❒ Yes ❒ Unknown
	If yes, date of reoperation:
Died before follow-up	❒ No ❒ Yes ❒ Unknown

Residence after 3 months	❒ Living independently at home	❒ Nursing home	
	❒ Living independently but help with activities of daily living	❒ Nursing home with rehabilitation	
		❒ Other	
	❒ Home care		
Mobility after 3 months	❒ Freely mobile without aids		
	❒ Mobile outdoors with one aid		
	❒ Mobile outdoors with two aids or frame		
	❒ Some indoor mobility but never goes outside without help		
	❒ No functional mobility (when using lower limbs)		
	❒ Unknown		
KATZ-6 ADL score after 3 months	Bathing	❒ No	❒ Yes
	Dressing	❒ No	❒ Yes
	Going to toilet	❒ No	❒ Yes
	Continence	❒ No	❒ Yes
	Transferring	❒ No	❒ Yes
	Feeding	❒ No	❒ Yes

Appendix 2. Definition of quality indicators

1. Data completeness of variables	
Operationalization	Proportion of completed variables per hospital.
Numerator	Number of variables that are completed per patient.
Denominator	Total number of eligible variables per patient.
Definition	Variables used: date of birth, gender, type of fracture, type of treatment, ASA grade, date and time of arrival at emergency department, date and time of surgery, consultation of geriatrician, date of discharge, type of anaesthesia, complications, Katz Index of Independence in Activities of Daily Living at admission, mobility score at admission, residence before admission, reoperations, 3-month Katz Index of Independence in Activities of Daily Living, 3-month mobility score, 3-month residence.
Inclusion criteria	Patients older than 18 with hip fracture who received an operative treatment.
Exclusion criteria	Patients not eligible for 3-month follow-up.
Inclusion period	1 January 2017 – 31 December 2017.
2. Time to surgery	
Operationalization	Median time to surgery from admission to the emergency department and start of surgery of ASA 1-2 and ASA 3-4 patients with a hip fracture.
Numerator	a. Number of ASA 1-2 patients operated within the audit median time in hours from admission to start of surgery. b. Number of ASA 3-4 patients operated within the audit median time in hours from admission to start of surgery.
Denominator	a. Total number of ASA 1-2 patients operated. b. Total number of ASA 3-4 patients operated.
Definition	-
Inclusion criteria	Patients older than 18 with hip fracture who received an operative treatment.
Exclusion criteria	Time to surgery of > 120 hours is defined as missing, hospitals with > 10% missing on the numerator are excluded.
Inclusion period	1 January 2017 – 31 December 2017.
3. Orthogeriatric management during admission	
Operationalization	Orthogeriatric management during admission for operated hip fracture patients.
Numerator	Number of patients with orthogeriatric treatment during admission.
Denominator	Total number of operated hip fracture patients older than 70.
Definition	Orthogeriatric treatment: peri-operative collaboration between geriatrician and surgeon.
Inclusion criteria	Patients 70 years and older with a hip fracture who received an operative treatment.
Exclusion criteria	Missing data is treated as non-orthogeriatric management, hospitals with > 10% missing on the numerator are excluded.
Inclusion period	1 January 2017 – 31 December 2017.

References

1. van Leersum NJ, Kolfschoten NE, Klinkenbijl JH, et al. 'Clinical auditing', a novel tool for quality assessment in surgical oncology. *Ned Tijdschr Geneeskd* 2011;155(45):A4136.
2. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *The Cochrane database Syst Rev* 2012:CD000259.
3. Rikshöft. Årsrapport 2016. [Available from: http://rikshoft.se/wp-content/uploads/2013/07/rikshoft_rapport2016.pdf, accessed 2018/07/06]
4. Royal College of Physicians. National Hip Fracture Database annual report 2017. [Available from: https://nhfd.co.uk/files/2017ReportFiles/NHFD-AnnualReport2017.pdf, accessed 2018/07/06]
5. National Services Scotland. Hip fracture care pathway report 2017. [Available from: http://www.shfa.scot.nhs.uk/_docs/2017/2017-08-22-SHFA-Report.pdf, accessed 2018/07/06]
6. Dansk Tværfagligt Register for Hoftenære Lårbensbrud. National årsrapport 2017. [Available from: https://www.sundhed.dk/content/cms/62/4662_hofte-fraktur-%C3%A5rsrapport_2017.pdf, accessed 2018/07/06]
7. Norwegian National Advisory Unit on Arthroplasty and Hip Fractures. Annual Report 2017. [Available from: http://nrlweb.ihelse.net/eng/Rapporter/Report2017_english.pdf, accessed 2018/07/06]
8. Irish Hip Fracture Database. National Report 2016: Better, safer care. [Available from: https://www.noca.ie/wp-content/uploads/2015/04/Irish-Hip-Fracture-Database-National-Report-2016-FINAL.pdf, accessed 2018/07/06]
9. Australian and New Zealand Hip Fracture Registry. ANZHFR Annual Report 2017. [Available from: http://anzhfr.org/wp-content/uploads/2017/08/ANZHFR-Annual-Report-2017.pdf, accessed 2018/07/06]
10. Kaiser Permanente National Implant Registries. Annual Report 2015. [Available from: https://national-implantregistries.kaiserpermanente.org/Media/Default/documents/Annual_Report_14_ext.pdf, accessed 2018/07/06]
11. Patel NK, Sarraf KM, Joseph S, et al. Implementing the National Hip Fracture Database: An audit of care. *Injury* 2013;44(12):1934-39.
12. Neuburger J, Currie C, Wakeman R, et al. The impact of a national clinician-led audit initiative on care and mortality after hip fracture in England: an external evaluation using time trends in non-audit data. *Med Care* 2015;53(8):686-91.
13. Ferguson KB, Halai M, Winter A, et al. National audits of hip fractures: Are yearly audits required? *Injury* 2016;47(2):439-43.
14. Nederlandse Vereniging voor Heelkunde. Richtlijn Proximale femurfracturen. Utrecht, 2016.
15. Nederlandse Vereniging voor Klinische Geriatrie. Richtlijn Multidisciplinaire behandeling van kwetsbare ouderen rondom chirurgische ingrepen. Utrecht, 2016.
16. Fishlock A, Scarsbrook C, Marsh R. Adherence to guidelines regarding total hip replacement for fractured neck of femur. *Ann R Coll Surg Engl* 2016;98(6):422-4.

17. Inspectie Gezondheidszorg en Jeugd. Basisset Medisch Specialistische Zorg 2018. [Available from: https://www.igj.nl/documenten/indicatorensets/2017/08/08/basisset-medisch-specialistische-zorg-2018, accessed 2018/10/30]
18. Zorginstituut Nederland. Indicatorengids Heupfractuur (DHFA) verslagjaar 2018. [Available from: https://www.zorginzicht.nl/bibliotheek/heupfractuur-dhfa/Paginas/Home.aspx, accessed 2018/10/30]
19. Dutch Institute for Clinical Auditing (DICA) 2018. [Available from: http://www.dica.nl/, accessed 2018/07/06]
20. van Leersum NJ, Snijders HS, Henneman D, et al. The Dutch surgical colorectal audit. *Eur J Surg Oncol* 2013;39(10):1063-70.
21. Busweiler LA, Wijnhoven BP, van Berge Henegouwen MI, et al. Early outcomes from the Dutch Upper Gastrointestinal Cancer Audit. *Br J Surg* 2016;103(13):1855-63.
22. van Bommel AC, Spronk PE, Vrancken Peeters MT, et al. Clinical auditing as an instrument for quality improvement in breast cancer care in the Netherlands: The national NABON Breast Cancer Audit. *J Surg Oncol* 2017;115(3):243-49.
23. Poelemeijer YQM, Liem RSL, Nienhuijs SW. A Dutch Nationwide Bariatric Quality Registry: DATO. *Obes Surg* 2017;28(6):1602-1610.
24. Karthaus EG, Vahl A, Kuhrij LS, et al. The Dutch Audit of Carotid Interventions: Transparency in Quality of Carotid Endarterectomy in Symptomatic Patients in the Netherlands. *Eur J Vasc Endovasc Surg* 2018;56(4):476-485.
25. Medical Research Data Management (MRDM). [Available from https://mrdm.nl/en/, accessed 2018/06/06]
26. Voeten SC, Krijnen P, Voeten DM, et al. Quality indicators for hip fracture care, a systematic review. *Osteoporos Int* 2018;29(9):1963-1985.
27. Sáez-López P, Brañas F, Sánchez-Hernández N, et al. Hip fracture registries: utility, description, and comparison. *Osteoporos Int* 2017;28(4):1157-66.
28. Royal College of Physicians. The National Hip Fracture Database Preliminary National Report 2009. [Available from: https://www.nhfd.co.uk/20/hipfracturer.nsf/945b5efcb3f9117580257ebb0069c820/6bac5303d25708ce80257d4f005190a8/$FILE/NHFD2009Report.pdf, accessed 2018/07/06]
29. Royal College of Physicians. The National Hip Fracture Database National Report 2010. [Available from: https://www.nhfd.co.uk/20/hipfracturer.nsf/945b5efcb3f9117580257ebb0069c820/7de8dac5ec3b468980257d4f005188f2/$FILE/NHFD2010Report.pdf, accessed 2018/07/06]
30. Khan SK, Weusten A, Bonczek S, et al. The Best Practice Tariff helps improve management of neck of femur fractures: a completed audit loop. *Br J Hosp Med (Lond)* 2013;74(11):644-47.
31. Royal College of Physicians. The National Hip Fracture Database National Report 2011. [Available from: https://www.nhfd.co.uk/20/hipfracturer.nsf/945b5efcb3f9117580257ebb0069c820/53e0ba402226ef27802578c500308c66/$FILE/NHFDNationalReport2011Final.pdf, accessed 2018/07/06]
32. Australian and New Zealand Hip Fracture Registry. ANZHFR Annual Report for Hip Fracture Care 2015. [Available from: https://anzhfr.org/wp-content/uploads/2016/09/ANZHFR-Annual-Report-2016.pdf, accessed 2018/07/06]

33. Irish Hip Fracture Database. National Report 2014: Better, safer care. [Available from: https://www.noca.ie/wp-content/uploads/2015/11/IHFD-National-Report-2014-Online-Version.pdf, accessed 2018/07/06]
34. Currie C. Hip fracture audit: Creating a 'critical mass of expertise and enthusiasm for hip fracture care'? *Injury* 2018;49(8):1418-23.
35. Farrow L, Hall A, Wood AD, et al. Quality of Care in Hip Fracture Patients: The Relationship Between Adherence to National Standards and Improved Outcomes. *J Bone Joint Surg Am* 2018;100(9):751-57.
36. Lewis PM, Waddell JP. When is the ideal time to operate on a patient with a fracture of the hip? : a review of the available literature. *Bone Joint J* 2016;98-b(12):1573-81.
37. Hawkes D, Baxter J, Bailey C, et al. Improving the care of patients with a hip fracture: a quality improvement report. *BMJ Qual Saf* 2015;24(8):532-8.
38. Neuburger J, Currie C, Wakeman R, et al. Increased orthogeriatrician involvement in hip fracture care and its impact on mortality in England. *Age Ageing* 2017;46(2):187-92.
39. Folbert EC, Hegeman JH, Vermeer M, et al. Improved 1-year mortality in elderly patients with a hip fracture following integrated orthogeriatric treatment. *Osteoporos Int* 2017;28(1):269-77.
40. Messager M, de Steur WO, van Sandick JW, et al. Variations among 5 European countries for curative treatment of resectable oesophageal and gastric cancer: A survey from the EURECCA Upper GI Group (EUropean REgistration of Cancer CAre). *Eur J Surg Oncol* 2016;42(1):116-22.
41. Johansen A, Golding D, Brent L, et al. Using national hip fracture registries and audit databases to develop an international perspective. *Injury* 2017;48(10):2174-79.
42. Cundall-Curry DJ, Lawrence JE, Fountain DM, et al. Data errors in the National Hip Fracture Database: a local validation study. *Bone Joint J* 2016;98-b(10):1406-09.
43. Hughes AJ, Hennessy O, Brennan L, et al. How accurate is the data provided to the Irish hip fracture database? *Ir J Med Sci* 2018;188(1):13-18.