Measurement and evaluation of hip fracture care
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Textbook process as a composite quality indicator for in-hospital hip fracture care

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ON BEHALF OF THE DHFA INDICATOR TASK FORCE

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Submitted

Abstract

Background

Individual process indicators can be non-discriminative and often lack an association with outcomes of care. To overcome this problem, these can be combined into one composite quality measure called the textbook process (TP). The aim of this study is to determine hospital variation in quality of hip fracture care using a composite process indicator, and to evaluate at patient level whether a good score on this indicator is associated with better outcomes during hospital stay.

Methods

TP for hip fracture care was achieved when the care met the requirements of all four underlying process indicators: 1. assessment of malnutrition, 2. surgery within 24 hours, 3. orthogeriatric management during admission and 4. operation by a certified surgeon. Hip fracture patients aged 70 and older operated in five hospitals between 1 January 2018 and 31 December 2018 were included. These hospitals' TP compliance rates were adjusted for case-mix variety. In a multivariable logistic regression model, with correction for patient, treatment and hospital characteristics, the association between TP compliance and in-hospital complications and prolonged hospital stay was determined at patient level.

Results

Of the 1,371 included patients, 753 (55%) received care according to TP. At hospital level there was significant hospital variation in TP compliance. At patient level TP compliance was significantly associated with fewer complications (odds ratio 0.66, 95% confidence interval 0.52 – 0.84, $p < 0.01$), but not with hospital stay (odds ratio 1.01, 95% confidence interval 0.78 – 1.30, $p = 0.96$).

Conclusion

The TP indicator for hip fracture care can be used to identify hospital variation in quality of care. At patient level this quality indicator is associated with fewer complications during hospital stay.

Introduction

Society increasingly demands insight into the quality of care. To provide this insight, quality indicators are useful instruments [1]. In the Donabedian framework quality indicators are categorized into structure, process and outcome indicators [2]. Structure and process indicators reflect the care a patient receives, with the assumption that a good structure and process will lead to a good end result of care [3]. Outcome indicators directly reflect the end result of care.

When an outcome indicator is used to benchmark hospitals, adjustment for case mix is needed [4,5]. However, at the start of a clinical audit, a validated case-mix adjustment model is generally not available [3]. Therefore, in the start-up phase, process indicators are often used instead of outcome indicators, as process indicators are less influenced by case mix, and have a clear link with quality improvement strategies. This renders them more actionable than structure and outcome indicators [6]. A quality indicator can be qualified as adequate if it meets the following four criteria: clinically relevant, scientifically acceptable (valid and reliable), feasible and usable [1,7,8]. To be *clinically relevant*, an indicator must be discriminative in the sense that, for instance, it enables benchmarking of hospitals. Not all individual hip fracture process indicators have this discriminative capability [9]. With regard to the criterion of *scientific acceptability*, most individual hip fracture process indicators cannot be qualified as adequate because their validity is lacking or not tested at all [10,11]. The reason why individual hip fracture process indicators are non-discriminative (not *clinically relevant*) and have no association with outcomes of care (not *valid*), could be that their result reflects only a small part of the quality delivered in the entire cycle of hip fracture care.

Given these considerations on clinical relevancy and validity, individual hip fracture process indicators might better be combined into one composite process quality indicator: the indicator that is referred to as the textbook process (TP). As it reflects a larger part of the delivered quality of hip fracture care, this composite measure may have better discriminative capabilities (*clinically relevant)* and may be associated with outcomes of care (*valid)*. Two previous studies support this idea; they found that increased compliance with multiple hip fracture process indicators was associated with a lower 30-day mortality [12,13].

To the best of our knowledge, a composite measure of process indicators for the quality of hip fracture care has not yet been developed. The aim of this study is to determine hospital variation in quality of hip fracture care using a composite process indicator, and to evaluate at patient level whether a good score on this indicator is associated with better outcomes during hospital stay.

Methods

Data source

The Dutch Hip Fracture Audit (DHFA), a nationwide registry of hip fracture patients in the Netherlands, started in April 2016 [14]. In 2018, an expert group comprising both surgical and non-surgical hip fracture health care professionals from five hospitals formed the DHFA Indicator Task Force. This task force serves as a platform for the development and evaluation of new indicators to be implemented in the DHFA at nationwide level, if proven valid. At the five participating hospitals a set of extra variables was added to the original DHFA dataset. For this study the data of these five hospitals entered in the DHFA for 2018 was used.

Patient selection

All patients of 70 years and older with a date of surgery between 1 January 2018 and 31 December 2018 were included. Excluded were patients with a pathologic or periprosthetic fracture. To be eligible for analysis, the following items needed to be recorded at patient level as a minimum: date of birth, date of arrival at the emergency department and surgery date. Two time frames (time to surgery and length of hospital stay) were checked. Time to surgery beyond two weeks and hospital stay longer than one year were considered as data entry errors, and coded as missing values.

Recommended process indicators

In the systematic review of Voeten et al. [10] a set of seven process indicators was recommended: assessment of malnutrition, time to surgery, orthogeriatric management during admission, time to mobilization after surgery, fracture prevention assessment, systematic pain assessment and prevention/assessment of pressure ulcer. In addition, operation by a trauma certified surgeon is also used as an indicator in the Netherlands. Data on only four of these eight indicators was collected at the five participating hospitals in 2018. None of these four indicators meets the criteria for being labelled as adequate, i.e. none of them is both clinically relevant and scientifically acceptable (see Box 1). In this study, the composite process indicator (TP) for hip fracture care was defined as: 1. assessment of malnutrition, 2. surgery within 24 hours ('time to surgery'), 3. orthogeriatric management during admission and 4. operation by a certified surgeon. If the care that a hip fracture patient received covered all these four indicators, the TP indicator was met. If one or more of the four underlying indicators of TP was not met, or data on any of them was missing, the patient was considered not to have received TP-based care.

Box 1: The underlying indicators of 'textbook process'

Assessment of malnutrition
This indicator is not used by the two health care regulators in the Netherlands. It is therefore unknown whether this is a discriminative indicator *(unknown clinical relevancy)*. No correlation is found with outcomes of care *(not scientifically acceptable – not valid)*[10].

Surgery within 24 hours
In the Netherlands this indicator was used till 2012, and again since 2017. Of all ASA 1-2 patients, 93% was operated on within one calendar day after admission, and one hospital only differed significantly from this nationwide average. As a result, this indicator does not have discriminative value in detecting variation between Dutch hospitals *(not clinically relevant)*[9]. Regarding validity, the indicator is correlated with return to pre-fracture mobility and mortality *(scientifically acceptable – valid)*[10].

Orthogeriatric management during admission
In the Netherlands this process indicator was used from 2014 till 2018[15]. In 2014, the nationwide average of orthogeriatric management was 67%, and this increased to 80% in 2018, with 13 hospitals performing significantly worse than the mean[16]. An average of 80% enables to detect underperformers, but is not discriminative in identifying outperformers *(not clinically relevant)*. In the literature, orthogeriatric management in elderly hip fracture patients is associated with fewer complications, better functional outcomes and improved 30-day and 1-year mortality rates *(scientifically acceptable – valid)*[17-19].

Operation by a certified surgeon
In 2017, three hospitals indicated that either a certified surgeon or a geriatrician was not available. In 2018 this was the case in two hospitals. However, it is unknown at patient level how often both a certified surgeon and a geriatrician is available *(unknown clinical relevancy)*[20]. Treatment by a trauma certified surgeon is associated with fewer reoperations and surgical site infections compared to treatment by a general surgeon *(scientifically acceptable – valid)*[21].

Statistical analysis

The overall compliance with TP-based care and the achievement of the four individual indicators were calculated at both patient and hospital level.

At patient level, the baseline characteristics of patients that received TP-based care ('TP group') were compared to those of patients that did not receive TP-based care ('non-TP group'). To assess differences between these groups, the independent sample

T-test was used for continuous normally distributed variables, the Mann-Whitney U test for non-normally distributed variables and the Chi-square test for categorical variables. Patient characteristics and fracture / treatment characteristics included age, gender, American Society of Anesthesiologists (ASA) physical status classification score, cognitive status, KATZ Index of Independence in Activities of Daily Living (KATZ-6 ADL) score, pre-fracture living situation, type of fracture and type of surgery. If one or more of the baseline characteristics was univariably associated with TP care ($p < 0.10$), hospital TP compliance rates were adjusted for these case-mix variables. This was done by computing an observed / expected ratio (O/E ratio) for TP at hospital level. The expected TP compliance rate for each hospital was the mean of the predicted probabilities of TP compliance for the patients of that hospital, which were derived from a multivariable logistic regression analysis including all relevant case-mix variables. When a hospital's observed TP compliance rate was equal to the expected TP compliance rate based on the hospital's case-mix, the O/E ratio was equal to 1. An O/E ratio greater than 1.0 implied that TP compliance was higher than would have been expected based on the hospital's case-mix, and an O/E ratio less than 1.0 implied that TP was achieved less often than expected. For each hospital the 95% confidence interval was calculated for O = E, using the formula $(((\sqrt{(E)} \pm (1.96/2))^2) / E)$. Hospitals with O/E outside the confidence interval performed significantly better or worse than could be expected, based on the hospital's case-mix[22].

At patient level, patient, fracture and treatment characteristics and TP were entered in a univariable logistic regression analysis with the outcome measures. The primary outcome was complication and the secondary outcome was prolonged length of hospital stay. Complication was defined as one or more complications not being present before admission, but arising during hospital stay, and included anaemia, delirium, pneumonia, urinary tract infection, in-hospital fall, heart failure, renal insufficiency, pulmonary embolism, wound infection and pressure ulcer. Reoperation was excluded from this definition, as it was not registered in the DHFA dataset. Prolonged length of hospital stay was defined as hospital stay of 6 days or more after surgery. This cut-off point was defined based on the expert opinion of the DHFA Indicator Task Force. Patient characteristics associated with the outcome measures ($p < 0.10$) were entered into a multivariable logistic regression model; TP, type of surgery (prosthesis or osteosynthesis) and hospital were always kept as independent variables in the multivariable model. Patients with missing outcome values were excluded from the analyses.

The data was analyzed using IBM SPSS Statistics® version 22. A $p < 0.05$ was regarded as statistically significant.

Results

A total of 1,377 patients of 70 years and older were operated at the five participating hospitals, of which 1,371 (99.6%) were eligible for analysis. Patient, fracture and treatment characteristics are shown in Table 1.

Table 1. Baseline patient characteristics

	Total		Textbook process				
			No		Yes		*p**
Total	1,371	(100%)	618	(45%)	753	(55%)	
Gender							0.06
Female	943	(69%)	408	(43%)	535	(57%)	
Male	426	(31%)	208	(49%)	218	(51%)	
Missing*	2	(0.1%)	2	(100%)	0	(0%)	
Age							0.48
Mean age in years (SD)	84	(7.1)	84	(7.3)	84	(7.0)	
ASA grade							*0.01*
1-2	467	(34%)	180	(39%)	287	(61%)	
3-4	859	(63%)	412	(48%)	447	(52%)	
Missing*	45	(3%)	26	(58%)	19	(42%)	
Dementia							0.92
No	1.004	(73%)	446	(44%)	558	(56%)	
Yes	313	(23%)	138	(44%)	175	(56%)	
Unknown*	33	(2%)	19	(58%)	14	(42%)	
Missing*	21	(2%)	15	(71%)	6	(29%)	
KATZ-6 ADL score							0.05
Median score (IQR)	1	(0–4)	1.31	(0–4)	0.91	(0–4)	
Missing*	66	(5)					
Living situation							0.43
Living independently	955	(70%)	424	(44%)	531	(56%)	
Not living independently	411	(30%)	192	(47%)	219	(53%)	
Missing*	5	(0.4%)	2	(40%)	3	(60%)	
Type of fracture							0.14
Femoral neck fracture non-dislocated	169	(12%)	84	(50%)	85	(50%)	
Femoral neck fracture dislocated	567	(41%)	243	(43%)	324	(57%)	
Intertrochanteric AO – A1	197	(14%)	101	(51%)	96	(49%)	
Intertrochanteric AO – A2	279	(20%)	112	(40%)	167	(60%)	
Intertrochanteric AO – A3	103	(8%)	47	(46%)	56	(54%)	
Subtrochanteric	31	(2%)	14	(45%)	17	(55%)	
Missing*	25	(2%)	17	(68%)	8	(32%)	
Type of treatment							0.83
Osteosynthesis	750	(55%)	340	(45%)	410	(55%)	
Prosthesis	621	(45%)	278	(45%)	343	(55%)	

Data is presented as number (with corresponding percentage between brackets), unless stated otherwise.

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

ASA American Society of Anesthesiologists physical status classification system

SD Standard deviation

IQR Interquartile range

* Chi-squared analysis; if the missing category was < 5%, patients labeled as 'missing' on that variable were not included in the analysis.

Textbook process

In total 1,371 patients were included, of whom 753 (54.9%) received care according to our TP definition. A group of 553 patients (40.3%) did not receive care according to the TP definition, and 65 patients (4.7%) had a missing value on one or more underlying indicators, resulting in 618 patients (45.1%) in the non-TP group. Of the underlying indicators, the 'assessment of malnutrition' indicator was achieved most often (1,301 patients, 94.9%), while the indicator least achieved was 'surgery within 24 hours' (940 patients, 68.6%) (Figure 1). Of the baseline patient characteristics gender, ASA grade and KATZ-6 ADL score had a univariable association with TP ($p < 0.10$) (Table 1). The hospitals' TP observed rates ranged from 38.1% (hospital 1) to 75.6% (hospital 2). Adjusted for gender, ASA grade and KATZ-6 ADL score, hospital 2 treated more and hospital 1 fewer patients according to the TP than expected based on the hospital's case-mix (see Table 2). The differences between the five hospitals in the fulfillment of all the individual indicators and TP are shown in Figure 1.

Table 2. Adjusted textbook process (TP) scores per hospital

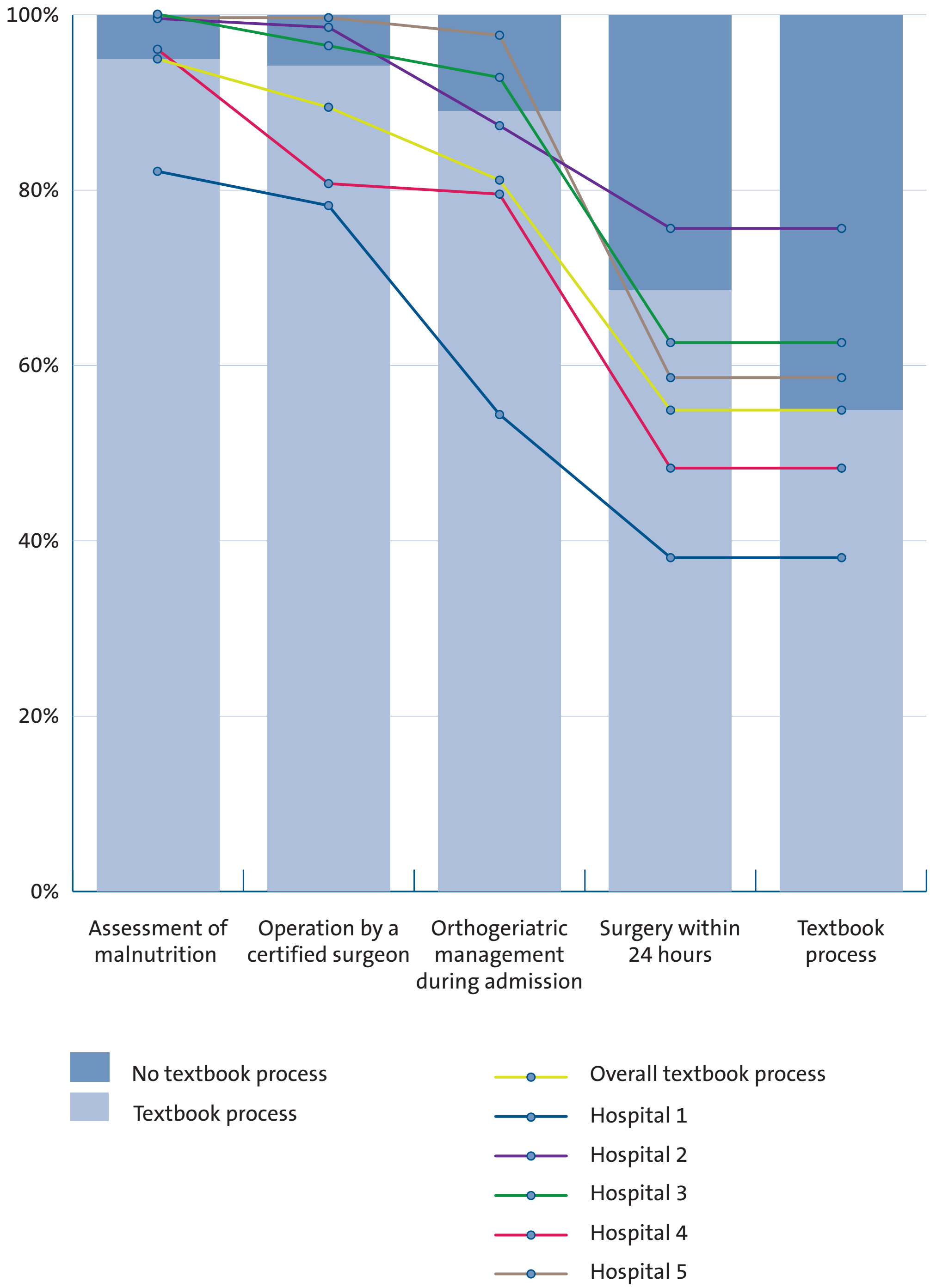
Hospital	Number of patients	TP rate	Observed TP	Expected TP	O/E ratio	95% CI lower*	95% CI upper*
1	307	38.11%	117	177.35	0.66	0.86	1.15
2	205	75.61%	155	117.75	1.32	0.83	1.19
3	281	62.63%	176	159.01	1.11	0.85	1.16
4	327	48.32%	158	184.41	0.86	0.86	1.15
5	251	58.57%	147	141.37	1.04	0.84	1.17

O/E Observed / Expected

CI Confidence interval

* Confidence interval per hospital for Observed = Expected

Figure 1. Textbook process: a composite measurement of four individual indicators – score on each indicator per hospital



Textbook process and complications

For one patient it was unknown whether a complication had occurred. This patient was excluded from analysis. The complication rate was 284/753 (37.7%) in the TP group, and 284/617 (46.0%) in the non-TP group.

Table 3a. Regression analysis – complications

	n = 1,370		Univariable analysis			Multivariable analysis		
			OR	95% CI	*p*	OR	95% CI	*p*
Textbook process					*< 0.01*			*< 0.01*
No (ref)	617	(45%)						
Yes	753	(55%)	0.71	0.57–0.88		0.66	0.52–0.84	
Age					*< 0.01*			*< 0.01*
Mean age in years (SD)	84	(7.1)	1.06	1.04–1.09		1.06	1.04–1.07	
Gender					0.15			
Female (ref)	942	(69%)				*		
Male	426	(31%)	1.19	0.94–1.49				
ASA grade					*< 0.01*			*0.02*
1-2 (ref)	466	(34%)						
3-4	859	(63%)	1.74	1.38–2.21		1.37	1.06–1.78	
Dementia					0.34			
No (ref)	1,004	(73%)				*		
Yes	312	(23%)	1.13	0.88–1.47				
KATZ-6 ADL score					*< 0.01*			0.49
Median score (IQR)	1	(0–4)	1.08	1.03–1.14		1.02	0.96–1.08	
Living situation					0.42			
Independently (ref)	955	(70%)				*		
Institutionalized	411	(30%)	1.10	0.87–1.39				
Type of treatment					0.30	*		0.90
Osteosynthesis (ref)	749	(55%)						
Prosthesis	621	(45%)	0.89	0.72–1.11		0.90	0.71–1.15	
Hospital					*< 0.01*			*< 0.01*
1	306	(22%)	0.91	0.66–1.25		0.99	0.68–1.43	
2	205	(15%)	0.41	0.28–0.61		0.52	0.35–0.79	
3	281	(21%)	1.27	0.92–1.75		1.39	0.99–1.95	
4 (ref)	327	(24%)						
5	251	(18%)	1.28	0.92–1.78		1.43	1.01–2.01	

Data is presented as number (with corresponding percentage between brackets), unless stated otherwise. If the missing category was < 5%, patients labeled as 'missing' on that variable were not included in the analysis.

CI	Confidence interval
OR	Odds ratio
SD	Standard deviation
IQR	Interquartile range
ASA	American Society of Anesthesiologists physical status classification system
KATZ-6 ADL	KATZ Index of Independence in Activities of Daily Living
*	Not entered in the multivariable analysis (univariable $p > 0.10$)

At patient level, the univariable logistic regression analysis showed a significantly lower risk of complications in the TP group compared to the non-TP group (odds ratio [OR] 0.71, confidence interval [CI] 0.57 – 0.88, $p < 0.01$). Of the patient characteristics, age ($p < 0.01$), ASA grade ($p < 0.01$) and KATZ-6 ADL score ($p < 0.01$) were univariably associated with complications, and entered in the multivariable model (see Table 3a). Corrected for differences in patient, treatment and hospital characteristics, TP was also significantly associated with fewer complications at patient level (OR 0.66, 95% CI 0.52 – 0.84, $p < 0.01$). Lower age, lower ASA grade and hospital were also associated with fewer complications.

At hospital level, the hospital with the largest TP group (hospital 2 – 75.6%) had the lowest complication rate (23.4%) (see Figure 2).

Textbook process and length of hospital stay

For seven patients (0.5%) the length of hospital stay was missing. These patients were excluded from analysis. The median length of hospital stay was 5 days in both groups (interquartile range 2 – 8), which is a univariable non-significant difference (OR 0.98, 95% CI 0.79 – 1.22, $p = 0.87$). Of the patient characteristics, age ($p = < 0.01$), ASA grade ($p = 0.03$), KATZ-6 ADL score ($p = 0.04$), dementia ($p = < 0.01$) and living situation ($p = < 0.01$) were univariably associated with a prolonged length of hospital stay. In the multivariable model (see Table 3b), TP was also not associated with length of hospital stay at patient level (OR 1.01, 95% CI 0.78 – 1.30, $p = 0.96$). Age, ASA-score, KATZ-6 ADL score, living situation and hospital were associated with length of hospital stay.

Table 3b. Regression analysis – prolonged length of hospital stay (≥ 6 days)

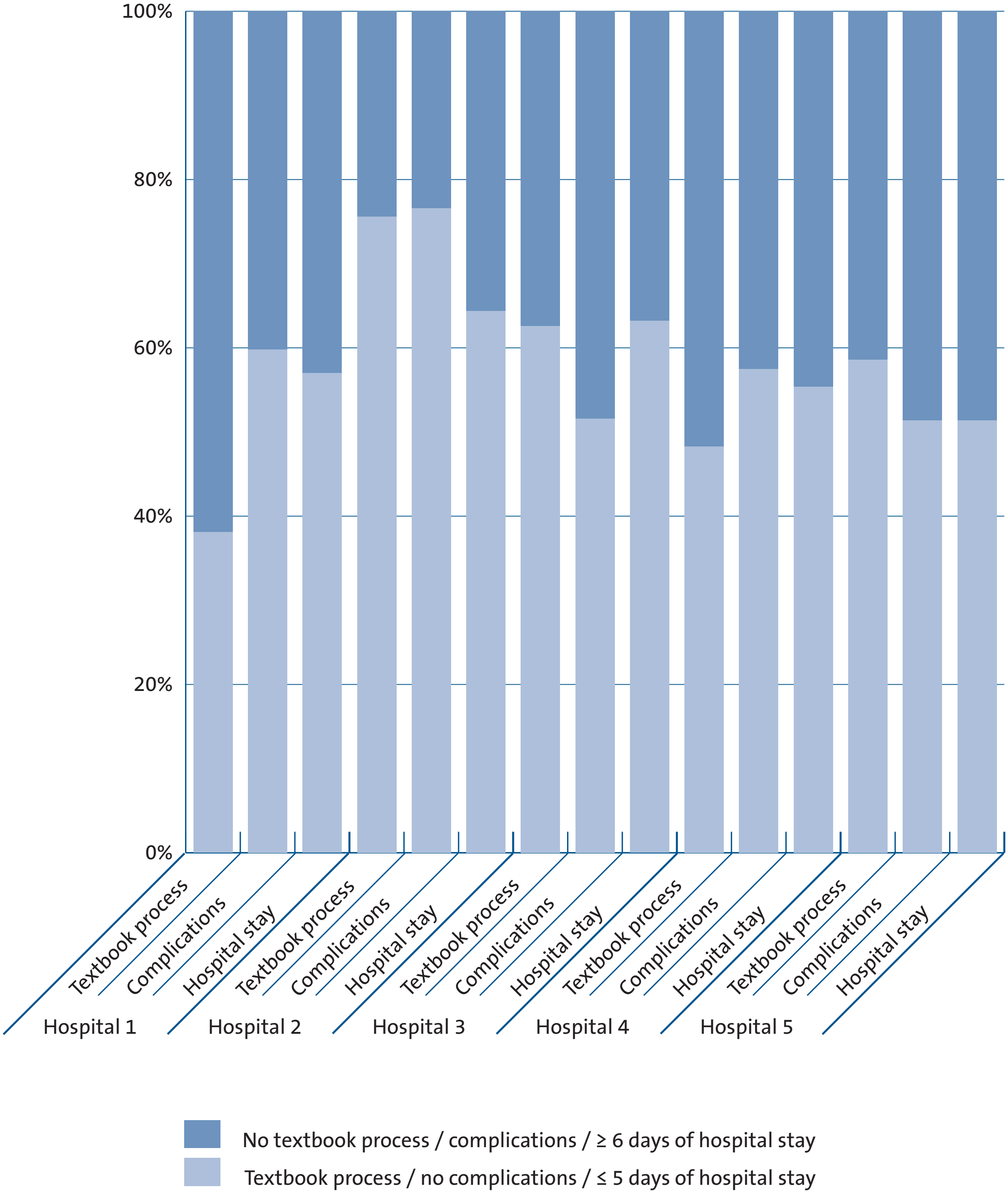
	n = 1,364		Univariable analysis			Multivariable analysis		
			OR	95% CI	*p*	OR	95% CI	*p*
Textbook process					*0.87*			0.96
No (ref)	613	(45%)						
Yes	751	(55%)	0.98	0.79–1.22		1.01	0.78–1.30	
Age					*0.01*			*< 0.01*
Mean age in years (SD)	84	(7.1)	1.02	1.00–1.04		1.05	1.03–1.07	
Gender					0.23			
Female (ref)	939	(69%)				*		
Male	423	(31%)	1.15	0.91–1.45				
ASA grade					*0.03*			*< 0.01*
1-2 (ref)	465	(34%)						
3-4	854	(63%)	1.29	1.02–1.62		1.48	1.13–1.93	
Dementia					*< 0.01*			0.25
No (ref)	998	(73%)						
Yes	312	(23%)	0.42	0.32–0.55		0.79	0.53–1.18	
KATZ-6 ADL score					*0.04*			*0.01*
Median score (IQR)	1	(0–4)	0.95	0.90–0.97		1.10	1.02–1.19	
Living situation					*< 0.01*			*< 0.01*
Independently (ref)	949	(69%)						
Institutionalized	410	(30%)	0.28	0.22–0.37		0.16	0.11–0.23	
Type of treatment					*0.04*			0.10
Osteosynthesis (ref)	746	(54%)						
Prosthesis	618	(45%)	0.80	0.64–0.99		0.81	0.63–1.04	
Hospital					*0.02*			*0.03*
1	305	(22%)	0.94	0.68–1.28		0.82	0.55–1.22	
2	205	(15%)	0.69	0.48–0.98		0.62	0.42–0.93	
3	280	(20%)	0.72	0.52–1.00		0.62	0.42–0.90	
4 (ref)	325	(24%)						
5	249	(18%)	1.17	0.84–1.63		0.98	0.67–1.42	

Data is presented as number (with corresponding percentage between brackets), unless stated otherwise.
If the missing category was < 5%, patients labeled as 'missing' on that variable were not included.

CI	Confidence interval
OR	Odds ratio
SD	Standard deviation
IQR	Interquartile range
ASA	American Society of Anesthesiologists physical status classification system
KATZ-6 ADL	KATZ Index of Independence in Activities of Daily Living
*	Not entered in the multivariable analysis (univariable p > 0.10)

At hospital level, the prolonged length of hospital stay was the lowest (35.6%) in the hospital with the largest TP group (hospital 2 – 75.6%) (see Figure 2).

Figure 2. Textbook process: complications and length of stay per hospital



Discussion

Textbook process is a new concept in the measurement of the quality of hip fracture care. It measures multiple aspects of hip fracture care during hospital stay by combining them into one composite quality indicator. In our study the composite measure leading to TP care comprised four individual hip fracture process indicators: 1. assessment of malnutrition, 2. surgery within 24 hours, 3. orthogeriatric management during admission and 4. operation by a certified surgeon. The aim of this study was to evaluate whether at patient level care according to the TP definition was associated with better outcomes during hospital stay, and if at hospital level there was variation in delivery of TP-based care. This study confirmed that at patient level delivering hip fracture care according to the TP definition is associated with fewer complications during hospital stay, but does not affect the length of hospital stay. At hospital level, there is significant practice variation in delivery of TP-based care. The hospital that most practiced hip fracture care in accordance with the TP, i.e. had the largest TP group, had the lowest complication rate and the shortest length of hospital stay.

Usage and interpretation of textbook process

Currently, hospital performance in hip fracture care in the Netherlands is mostly evaluated on the basis of a list of individual process indicators. Individual process indicators are not always associated with outcomes of care (*validity*), nor are they always discriminative (*clinical relevancy*) [9-11]. Individual hip fracture process indicators can be combined into one composite quality indicator. When its validity and clinical relevancy have been proven, such a measure can be of value in hip fracture audits to help evaluate individual hospital performance and identify hospital variation. However, when TP is used to benchmark hospitals, it should be kept in mind that in our study one specific patient characteristic, ASA grade, differed between the TP group and the non-TP group. This may be related to the 'surgery within 24 hours' indicator, as patients with higher ASA grades often require preoperative optimization [9]. Therefore, hospital variation could also be related to interhospital differences in ASA grade, rather than to differences in care. In our opinion, when a case-mix adjustment model is not available, the TP indicator proposed in this study is preferred over outcome indicators as the latter may be influenced by multiple patient and treatment characteristics. For example, the case-mix adjustment model for mortality used in the National Hip Fracture Database (United Kingdom minus Scotland) contains six patient characteristics: age, gender, ASA grade, ability to walk indoors, fracture type and source of admission [23].

For non-medical stakeholders (e.g. health care regulators) interpreting the TP indicator is easier (*usability)* than trying to detect and understand a possible trend in multiple individual quality indicators [24,25]. In terms of registration load (*feasibility)*, the composite measure does not differ from a set of individual quality indicators. However, TP should not replace but rather be used alongside the individual indicators, as the latter may provide health care professionals with information about where targeted quality improvements are feasible [3,26].

Hospital 5 in our study is a good example of the complementarity of the individual quality indicators and the overall TP. Hospital 5 achieved an above-average overall score of 59%, performing best on three of the four indicators, but lagging on the 'surgery within 24 hours' indicator (Figure 1). Following thorough analysis, the DHFA Indicator Task Force found that hospital 5 delayed surgery more often. To operate under spinal anaesthesia, patients who were on direct oral anticoagulants were often not operated until 48 hours after the last administration of medication. Hospital 5 has changed its anaesthesiologic strategy and now operates this patient group as soon as safely possible.

Textbook process going forward

Our study only focused on the hospital part of hip fracture care, and validated the TP indicator against short-term in-hospital outcomes. Further research is needed to examine whether care according to this TP definition also has a positive effect on the total rehabilitation process, with a better functional outcome in the long term. It would be even more interesting to develop a more complete TP indicator for hip fracture care that includes all eight quality indicators and evaluates the whole hip fracture rehabilitation process, from admission to hospital to optimal recovery of each individual patient.

In addition to quality, it might be interesting to evaluate TP-based care in terms of costs. Given the increase in health care expenses, a trend towards value-based health care is evolving: increasing the quality of care and reducing the costs [27]. In surgical procedures, postoperative complications are associated with an increase in costs [28]. In our study TP-based care is associated with lower complications at patient level. It might therefore be useful to examine whether hospitals treating a high percentage of patients according to TP also have lower cost levels.

Textbook outcome for hip fracture care

When an adequate case-mix correction model is in place, the quality of care can be measured by outcome indicators. A textbook outcome is a composite measure of desired multiple outcome indicators and has already been developed for various diseases [26,29-31]. To our knowledge, a textbook outcome for hip fracture care has not been developed yet. It should be composed of outcome indicators both during and after hospital stay. Indicators that can be used might be complications, reoperations, return to former functional mobility and living situation. We believe that mortality should not be included as an indicator in a textbook outcome for hip fracture patients. Although mortality is an unwanted outcome for most hip fracture patients, this may not apply to very frail patients with multiple comorbidities.

As a next step in this TP research for hip fracture patients, it would be interesting to see whether the delivery of TP-based care correlates with outcome at hospital level on a nationwide scale as well.

Limitations

Our study is subject to several limitations. First, the recommended composite measure comprises only four of the eight advised indicators. As our study was limited to the data collected for the five hospitals participating in the DHFA Indicator Task Force, the 'time to mobilization after surgery' process indicator was not included in the TP definition. In the literature, however, this indicator was described as being associated with a better clinical outcome [13]. As a result, the effect of TP-based care on the outcome of care may even be stronger when all eight indicators are included in the TP definition. Also, in the literature the 'orthogeriatric management during admission' indicator was classified as a structure indicator, but it actually was an overarching indicator of four structure and three process indicators. In this article orthogeriatric management during admission is considered as a process indicator.

Second, in-hospital complications were the primary outcome measure in our study. Adequate registration of these data is hard to validate and some complications, like pneumonia, anemia, or urinary tract infection, could have been incurred in the hospital, although they did not become visible until after discharge (e.g. at home or at the rehabilitation center). Reoperation was excluded from the definition of complication, as it was not registered in the DHFA dataset. Hospitals with a shorter length of hospital stay might also have a lower number of in-hospital complications. Including the number of readmissions could have provided better insight into this aspect, but one drawback would be the incomplete picture it would offer: some complications were possibly addressed by the rehabilitation center and patients might have been readmitted to another hospital [32].

Third, if one or more data on the TP indicator were missing, the patient was included in the non-TP group. The percentage of hip fracture patients that received TP-based care may therefore be underestimated.

And last, the design of the TP indicator does not take into account the possibility that different indicators may have an unequal impact on patient outcomes. As stated before, TP must be seen as an addition to rather than a replacement of individual quality indicators.

Conclusion

This study shows that the TP indicator for hip fracture care can be used to identify hospital variation in quality of care. At patient level this quality indicator is associated with fewer complications during hospital stay. The next step is to define whether TP is also correlated with long-term and functional outcomes of hip fracture care.

Acknowledgement

The DHFA Indicator Task Force: O. Geragthy, J. H. Hegeman, G. De Klerk, H.A.F. Luning, A.H.P. Niggebrugge, M. Regtuijt, J. Snoek, C. Stevens, D. van der Velde, E.J. Verleisdonk, S.C. Voeten and F.S. Würdemann.

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