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ORIGINAL ARTICLE - NEUROSURGERY GENERAL

Establishing risk-adjusted quality indicators in surgery using administrative data—an example from neurosurgery

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Abstract

Background The current draft of the German Hospital Structure Law requires remuneration to incorporate quality indicators. For neurosurgery, several quality indicators have been discussed, such as 30-day readmission, reoperation, or mortality rates; the rates of infections; or the length of stay. When comparing neurosurgical departments regarding these indicators, very heterogeneous patient spectrums complicate benchmarking due to the lack of risk adjustment.

Objective In this study, we performed an analysis of quality indicators and possible risk adjustment, based only on administrative data.

Methods All adult patients that were treated as inpatients for a brain or spinal tumour at our neurosurgical department between 2013 and 2017 were assessed for the abovementioned quality indicators. DRG-related data such as relative weight, PCCL (patient clinical complexity level), ICD-10 major diagnosis category, secondary diagnoses, age and sex were obtained. The age-adjusted Charlson Comorbidity Index (CCI) was calculated. Logistic regression analyses were performed in order to correlate quality indicators with administrative data.

Results Overall, 2623 cases were enrolled into the study. Most patients were treated for glioma ($n = 1055$, 40.2%). The CCI did not correlate with the quality indicators, whereas PCCL showed a positive correlation with 30-day readmission and reoperation, SSI and nosocomial infection rates.

Conclusion All previously discussed quality indicators are easily derived from administrative data. Administrative data alone might not be sufficient for adequate risk adjustment as they do not reflect the endogenous risk of the patient and are influenced by certain complications during inpatient stay. Appropriate concepts for risk adjustment should be compiled on the basis of prospectively designed registry studies.

Keywords Quality indicators · Neurosurgery · Readmission · Reoperation · Risk adjustment · Administrative data

Introduction

Due to rising costs in health care, the quality of services provided has become a central issue in all medical specialties. In this respect, the German Hospital Structure Act requires quality aspects to be taken into account for remuneration purposes. Consequently, the pressure is growing on creating a standardized framework for measuring the quality of care. This also applies to surgical specialties. The German Federal Joint Health Committee has therefore commissioned the Institute for Quality Assurance and Transparency in Health Care (IQTIG) to develop appropriate quality indicators.

However, these activities have not yet been extended to the neurosurgical discipline and quality indicators for neurosurgery specifically developed for the German health care context are currently not available. Analysing the literature on this topic, the data base to derive such indicators is manageable. Also, country-specific differences in care structures need to be considered.

Corresponding data have previously been collected in England where the post-procedural 30-day mortality is used as quality indicator. Risk adjustment used in England is

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largely based on the Charlson Comorbidity Index [25]. However, this index was developed 30 years ago and may not simply be transferable to current times and the German context.

The international literature discusses 30-day reoperation, readmission, and mortality rates, rates of nosocomial and surgical site infections and the length of stay as potential quality indicators for neurosurgery [6, 7, 18, 19, 21, 23]. These indicators are readily available but may be inaccurate in measuring the quality of the delivered care. An often very heterogeneous patient spectrum makes benchmarking processes between different neurosurgical departments difficult because of missing and differentiated risk adjustment. For risk adjustment, readily available measures from administrative and billing-specific data are often used. The purpose of this study is to examine whether these data are suitable for risk adjustment in a surgical specialty based on the example of neurosurgical tumour surgery, in order to enable later standardization and comparability. It would also be of interest to examine whether adjustment models from other countries (England, USA) are suitable for the German context.

Methods

All adult patients that were hospitalized between January 2013 and June 2017 in the Department of Neurosurgery of X for a malignant or benign tumour of the brain or spinal cord were included in this retrospective study. The search was carried out automatically using the following ICD codes (main diagnoses): C70.0–1, C70.9, C71.0–9, C72.0, C72.2–5, C72.8–9, C75.1–3, C79.3–4, D32.0–1, D32.9, D33.0–4, D33.7, D33.9 and D35.2–4. In addition to the main diagnoses, all coded secondary diagnoses (ICD codes) as well as the following parameters of the DRG data record were recorded in accordance with § 21 of the Hospital Remuneration Act: age, gender, number of secondary diagnoses, number of procedures, relative weight, PCCL (patient clinical complexity level) and length of stay. Analysing the number of secondary diagnoses, we distinguished between secondary diagnoses existing at admission and those documented during the course of inpatient stay.

The age-adjusted Charlson Comorbidity Index (CCI) was calculated from the secondary diagnoses. The CCI is the most commonly used comorbidity index and was originally designed to predict the 1-year mortality of patients based on their comorbidities [5, 8]. It contains 19 categories of comorbidities (see Table 1), which are weighted according to the potential impact on mortality and added to a total. In the modified version of the index used here, age was also enclosed [4].

The following outcomes were collected from the dataset using the hospital information system: 30-day reoperation rate, 30-day readmission rate, 30-day postoperative mortality rate, length of stay, nosocomial infection rate, and separately, the postoperative rate of surgical site infections. For the 30-day reoperation and readmission rate, we differentiated between planned and unplanned reoperations and readmissions. Only unplanned cases were included in the analysis. The median length of stay was 8 days. We therefore stratified between cases with a length of stay of less than and more than 8 days. Furthermore, a variable was calculated indicating the presence of one of these events. Inclusion and analysis were case-based and not patient-specific. The study was approved by the local ethics committee. Patient consent was obtained in each case.

Statistical analysis

IBM SPSS Statistics 24.0 software (IBM, Armonk, New York, USA) was used for statistical analysis. In order to evaluate differences between neurosurgical diagnoses, the chi-square test was used. Logistic regression models were calculated for the prediction of outcome values. All abovementioned parameters from the DRG data record according to § 21 of the Hospital Remuneration Act as well as age, sex, neurosurgical diagnosis group and the age-adjusted Charlson Comorbidity Index were included in the model as independent variables. A second analysis was performed, which included only variables that were present before hospitalization (age, sex, neurosurgical diagnosis, number of secondary diagnoses present before admission). The odds ratios were obtained from a binary logistic regression model. The β coefficients of this model were used to generate a score for the occurrence of an adverse event. All cases were divided into three risk groups corresponding to the total scores. Statistical significance was defined as the probability of a type one error below 5% ($p < 0.05$).

Results

Altogether, 2623 cases were included. The mean age was 55.29 years (range: 18 to 94 years). Of the patients, 50.2% ($n = 1316$) were female, and 49.8% ($n = 1307$) patients were male. Most cases were treated for glioma ($n = 1055$, 40.2%), and the second most common diagnosis was intracranial meningioma ($n = 519$, 19.8%). Of all included cases, 90% ($n = 2362$) were treated surgically. The median age-adjusted Charlson Comorbidity Index was three points ranging from 0 to 18. Further baseline characteristics can be obtained from Table 1.

Table 1 Included were 2623 cases. Detailed case characteristics can be found in this table. For metric variables (age, relative weight, number of procedures, secondary diagnoses, age-adjusted Charlson Comorbidity Index) median and range were reported, for the other categorical variables, the number (n) and percentage (%). The age-adjusted Charlson Comorbidity Index is composed of the specified 19 items and the age

		Number	Percentage
Age	*Mean. range*	55.29	18–94
Sex	Male	1307	49.8
	Female	1316	50.2
Diagnosis	Glioma	1055	40.2
	Meningioma cranial	519	19.8
	Metastasis cerebral	468	17.8
	Metastasis spinal	29	1.1
	Meningioma spinal	29	1.1
	Sellar tumour	279	10.6
	Other benign brain tumours	63	2.4
	Vestibular schwannoma	127	4.8
	Benign spinal tumour	54	2.1
Therapy	Surgical	2362	90
	Conservative	261	10
PCCL	0	957	36.5
	1	316	12
	2	292	11.1
	3	499	19
	4	505	19.3
	5	43	1.6
	6	11	0.4
Relative weight	*Median, range*	3.14	0–53.2
Number of procedures	*Median, range*	10	0–122
Number of secondary diagnoses	*Median, range*	4	0–43
Number of secondary diagnoses (on admission)	*Median, range*	0	0–26
Age-adjusted Charlson Comorbidity Index (CCI)	*Median, range*	3	0–18
Diagnoses CCI[3]	Myocardial infarction	6	0.2
	Congestive heart failure	33	1.3
	Peripheral arterial disease	15	0.6
	Cerebrovascular disease	36	1.4
	Dementia	4	0.2
	COPD[1]	48	1.8
	Connective tissue disease	19	0.7
	Gastric ulcer	11	0.4
	Liver disease	8	0.3
	Diabetes	165	6.3
	Hemiplegia	267	10.2
	Renal disease	122	4.7
	Diabetes with end organ damage	30	1.1
	Tumour	1602	61.1
	Leukaemia	7	0.3
	Lymphoma	54	2.1
	Severe liver disease	4	0.2
	Metastatic solid tumour	482	18.4
	AIDS[2]	0	0

[1] Chronic obstructive pulmonary disease

[2] Acquired immune deficiency syndrome

[3] Charlson Comorbidity Index

Table 2 Results of multivariate analysis. Parameters of the DRG dataset have been included in the regression analysis. The odds ratios (OR), the 95% confidence intervals (95%-CI) and the associated *p* values are presented

		30-day unplanned reoperation rate			30-day unplanned readmission rate			30-day postoperative mortality rate		
		OR	95%-CI	*p* value	OR	95% CI	*p* value	OR	95% CI	*p* value
Sex	Female	Ref	–	–	Ref	–	–	Ref	–	–
	Male	–	–	n.s.	–	–	n.s.		–	n.s.
Age		–	–	n.s.	–	–	n.s.	–	–	n.s.
PCCL	0	Ref	–	–	Ref	–	–	Ref	–	–
	1	2.942	1.593–5.431	0.001	2.434	1.362–4.351	0.003	–	–	n.s.
	2	3.724	2.005–6.918	< 0.001	2.048	1.106–3.793	0.023	–	–	n.s.
	3	3.883	2.277–6.619	< 0.001	2.292	1.307–4.018	0.004	–	–	n.s.
	4	8.099	4.653–14.096	< 0.001	3.371	1.744–6.514	< 0.001	9.645	1.112–83.683	0.040
	5	11.288	4.408–28.907	< 0.001	–	–	n.s.		–	n.s.
	6	23.145	3.794–141.185	0.001	–	–	n.s.		–	n.s.
Relative weight		1.189	1.103–1.281	< 0.001	0.692	0.601–0.796	< 0.001	1.194	1.077–1.323	0.001
Length of stay		–	–	n.s.	1.081	1.048–1.116	< 0.001	0.880	0.826–0.937	< 0.001
Age-adjusted Charlson Comorbidity Index		–	–	n.s.	–	–	n.s.	–	–	n.s.
Number of procedures		1.059	1.036–1.083	< 0.001	0.924	0.889–0.961	< 0.001	1.056	1.008–1.107	0.022
Number of secondary diagnoses		–	–	n.s.	–	–	n.s.	1.116	1.032–1.208	0.006
Neurosurgical diagnosis	Glioma	Ref	–	–	Ref	–		Ref	–	–
	Meningioma cranial		–	n.s.		–	n.s.	–	–	n.s.
	Metastasis cerebral	0.612	0.391–0.958	0.03	0.314	0.17–0.577	< 0.001	–	–	n.s.
	Metastasis spinal		–	n.s.	–	–	n.s.	–	–	n.s.
	Meningioma spinal		–	n.s.	–	–	n.s.	–	–	n.s.
	Sellar tumour		–	n.s.	–	–	n.s.	–	–	n.s.
	Other benign brain tumours		–	n.s.	–	–	n.s.	–	–	n.s.
	Vestibular schwannoma		–	n.s.	–	–	n.s.	–	–	n.s.
	Benign spinal tumour		–	n.s.	–	–	n.s.	–	–	n.s.
		Nosocomial infection rate			Surgical site infection rate			Length of stay		
		OR	95% CI	*p* value	OR	95% CI	*p* value	OR	95% CI	*p* value
Sex	Female	Ref	–	–	Ref	–	–	–	–	n.s.
	Male	–	–	n.s.	–	–	n.s.	1.281	1.048–1.565	0.01
Alter		–	–	n.s.	–	–	n.s.	1.018	1.009–1.027	< 0.001
PCCL	0	Ref	–	–	Ref	–	–	Ref	–	n.s.
	1	–	–	n.s.	–	–	n.s.	–	–	n.s.
	2	3.756	2.144–6.58	< 0.001	4.440	2.013–9.791	< 0.001	1.551	1.120–2.149	.008
	3	3.774	2.269–6.278	< 0.001	5.146	2.489–10.639	< 0.001	2.022	1.499–2.728	< 0.001
	4	8.272	4.894–13.981	< 0.001	9.882	4.531–21.554	< 0.001	2.797	1.827–4.281	< 0.001
	5	16.513	7.079–38.52	< 0.001	13.350	3.416–52.177	< 0.001	–	–	n.s.
	6	–	–	n.s.	17.912	1.609–199.438	0.02	–	–	n.s.
Relative weight		–	–	n.s.			n.s.	–	–	n.s.
Length of stay		1.042	1.021–1.063	< 0.001	1.107	1.071–1.144	< 0.001	–	–	–
Age-adjusted Charlson Comorbidity Index		–	–	n.s.	0.502	0.312–0.807	0.004	–	–	n.s.
Number of procedures		0.966	0.947–0.987	.001	0.895	0.859–0.932	< 0.001	1.307	1.262–1.353	< 0.001

Table 2 (continued)

		30-day unplanned reoperation rate			30-day unplanned readmission rate			30-day postoperative mortality rate		
		OR	95%-CI	*p* value	OR	95% CI	*p* value	OR	95% CI	*p* value
Number of secondary diagnoses		1.073	1.038–1.109	< 0.001	–	–	n.s.	1.136	1.086–1.189	< 0.001
Neurosurgical diagnosis	Glioma	Ref	–	–	Ref	–	–	–	–	–
	Meningioma cranial	2.126	1.479–3.056	< 0.001	3.902	2.367–6.432	< 0.001	1.611	1.172–2.213	0.003
	Metastasis cerebral	–	–	n.s.	–	–	n.s.	–	–	–
	Metastasis spinal	–	–	n.s.	3.569	1.086–11.728	0.03	–	–	–
	Meningioma spinal	–	–	n.s.	–	–	n.s.	–	–	–
	Sellar tumour	–	–	n.s.	–	–	n.s.	1.556	1.070–2.263	0.02
	Other benign brain tumours	–	–	n.s.	–	–	n.s.	–	–	n.s.
	Vestibular schwannoma	–	–	n.s.	–	–	n.s.	1.826	1.127–2.960	0.02
	Benign spinal tumour							–	–	n.s.

The 30-day unplanned readmission rate was 5.5% for all tumour groups. Of all patients, 9.9% underwent neurosurgical reoperations within 30 days. The 30-day mortality was low, at 1.1%. Surgical site infections occurred in 4.2% of all cases. The nosocomial infection rate was 12.2%, including surgical site infections. The median length of stay was 8 days (range: 1–122 days).

A first regression model included all variables according to § 21 of the Hospital Remuneration Act as well as age, sex, diagnosis group and the age-adjusted Charlson Comorbidity Index. The results of the regression analyses are shown in Table 2.

Age and sex were not associated with the measured quality indicators in the regression model. Only length of stay was significantly longer in male and elderly patients (OR: 1.281, 95% CI: 1.048–1.565, $p = 0.01$, OR: 1.018, 95% CI: 1.009–1.027, $p < 0.001$).

PCCL correlated very well with the probability of a 30-day unplanned reoperation rate. A PCCL of 6 was associated with an OR of 23.145 (95% CI: 3.794–141.185, $p = 0.001$) for unplanned reoperation. Higher PCCL levels were also associated with an increased risk of unplanned readmission within 30 days (Table 2). A PCCL of 4 was associated with a 9.6-fold increased risk of 30-day mortality (95% CI: 1.112–83.683, $p = 0.04$). In addition, we found positive correlations between nosocomial and surgical site infection rates and length of stay and the level of PCCL. Overall, the neurosurgical diagnosis had little effect on the measured outcome values. Cases with intracranial meningiomas or spinal metastases had an increased risk of developing postoperative wound infections compared to patients with other tumours. The age-adjusted Charlson Comorbidity Index did not correlate with the measured quality indicators (Table 2).

A second regression model only contained variables that were already present before admission and were not influenced by the course of the inpatient stay. The results are presented in Table 3. The number of secondary diagnoses on admission correlated significantly with an increased risk for 30-day reoperations, readmissions, mortality, and infections as well as a longer length of stay (see Table 3). Neurosurgical diagnosis had little effect on the measured quality indicators.

The main factors influencing the occurrence of one of the measured outcome rates were male sex (OR: 1.219, 95% CI: 1.015–1.463, $p = 0.03$) and the number of secondary diagnoses on admission (one secondary diagnosis: OR: 1.539, 95% CI: 1.217–1.948, $p < 0.001$, ≥ 2 secondary diagnoses: OR: 2.975, 95% CI: 1.681–2.563). A score was calculated with regard to these risk factors to predict the risk for occurrence of one of the measured adverse events (Tables 4 and 5). A score of > 2 was associated with a 2.4-fold increased likelihood of the occurrence of one of these events.

Discussion

Performing risk adjustment with the help of routinely collected administrative data from the DRG dataset appears to be attractive per se, since the data are already ubiquitously

Table 3 Results of multivariate analysis. Only parameters that were present at the time of admission and that were not influenced by the course of the inpatient stay were included in the analysis. The odds ratios (OR), the 95% confidence intervals (95% CI) and the associated *p* values are presented

		30-day unplanned reoperation rate			30-day unplanned readmission rate			30-day postoperative mortality rate		
		OR	95% CI	*p* value	OR	95% CI	*p* value	OR	95% CI	*p* value
Sex	Female	Ref	–	–	Ref	–	–	Ref	–	–
	Male	–	–	n.s.	1.439	1.010–2.048	.04		–	n.s.
Age		–	–	n.s.	0.985	0.974–0.996	.006	1.028	1.001–1.056	.04
Number of secondary diagnoses on admission		1.044	1.000–1.089	.05	1.067	1.013–1.124	.01	1.099	1.023–1.180	.009
Neurosurgical diagnosis	Glioma	Ref	–	–		–		Ref	–	–
	Meningioma cranial		–	n.s.	–	–	n.s.	–	–	n.s.
	Metastasis cerebral		–	n.s.	0.425	0.231–0.781	< 0.001	–	–	n.s.
	Metastasis spinal		–	n.s.	–	–	n.s.	–	–	n.s.
	Meningioma spinal		–	n.s.	–	–	n.s.	–	–	n.s.
	Sellar tumour		–	n.s.	–	–	n.s.	–	–	n.s.
	Other benign brain tumours		–	n.s.	–	–	n.s.	–	–	n.s.
	Vestibular schwannoma		–	n.s.	–	–	n.s.	–	–	n.s.
	Benign spinal tumour		–	n.s.	–	–	n.s.	–	–	n.s.
		Nosocomial infection rate			Surgical site infection rate			Length of stay		
		OR	95% CI	*p* value	OR	95% CI	*p* value	OR	95% CI	*p* value
Sex	Female	–	–	–	Ref	–	–	Ref	–	–
	Male	–	–	-.	–	–	n.s.		–	n.s.
Age		1.011	1.003–1.019	0.009	–	–	n.s.	1.018	1.013–1.024	< 0.001
Number of secondary diagnoses on admission		1.079	1.044–1.116	< 0.001	–	–	n.s.	1.173	1.129–1.218	< 0.001
Neurosurgical diagnosis	Glioma	Ref	–	–		–		Ref	–	–
	Meningioma cranial	1.569	1.138–2.165	0.006	3.377	2.111–5.401	< 0.001	0.756	0.603–0.948	0.01
	Metastasis cerebral	–	–	n.s.	–	–	n.s.	1.272	1.001–1.617	0.04.
	Metastasis spinal	6.611	3.074–14.218	< 0.001	5.565	1.974–15.686	0.001	–	–	n.s.
	Meningioma spinal	–	–	n.s.	–	–	n.s.	0.29	0.114–0.738	0.009
	Sellar tumour	–	–	n.s.	–	–	n.s.	0.721	0.542–0.958	0.02
	Other benign brain tumours	–	–	n.s.	–	–	n.s.	–	–	n.s.
	Vestibular schwannoma	–	–	n.s.	–	–	n.s.	–	–	n.s.
	Benign spinal tumour	–	–	n.s.	–	–	n.s.	–	–	n.s.

available, readily retrievable and evaluable without additional financial outlay [12, 13].

Our analysis showed that PCCL correlated well with the measured quality indicators. However, it must be considered that complications that occur during inpatient stay, e.g. nosocomial infections, postoperative haemorrhage or internal medical complications such as renal failure, etc. influence the overall PCCL. For that reason, the PCCL does not reflect the endogenous risk of each case. The same applies to the relative weight and the number of procedures and secondary diagnoses. The distinction between co-morbidities, which primary manifest as a complication during inpatient treatment, and those that are already pre-existent finds little or no consideration in administrative data. This is problematic for risk-adjusted outcome analysis among different health care providers, as hospitals that treat sicker patients would be rated worse in this case. Ghali et al. underlined this aspect by distinguishing between the two variants of comorbidities

Table 4 Calculation of the score to predict the occurrence of the monitored adverse events. These events comprise 30-day reoperation, readmission, mortality and nosocomial and surgical site infections and length of stay >8 days

Variable	Category	*ß*-coefficient	*p* value	Score
Sex	Female	0		0
	Male	0.202	0.003	2
Number of secondary diagnoses on admission	0	0		0
	1	0.432	< 0.001	4
	≥ 2	0.735	< 0.001	7

(pre-existent and total number), showing a significant influence on the outcome results in comparative analyses [10].

The age-adjusted Charlson Comorbidity Index also showed no significant correlation with the measured quality indicators. The CCI has been used as a good measure of patients' comorbidities and can be calculated from the secondary diagnoses [9, 16, 28], and is also part of the risk stratification protocol of the National Neurosurgical Audit Program in the UK. It should be noted, however, that the score was developed 30 years ago, and medical progress may have influenced the weighting of individual co-morbidity items, which is no longer up-to-date.

The data used in this study for risk adjustment were originally collected for billing purposes only. Coding of comorbidities, on which the Charlson Comorbidity Index is based, depends on coding quality, responsibility, supervision and training of medical controllers. This aspect should be considered in the analysis of coded secondary diagnoses when using secondary diagnoses for risk adjustment [20]. Furthermore, the validation of an independent collective is necessary.

In this study, all potential risk factors that were already present at the day of admission were integrated into a model. The aim was to evaluate the endogenous patient risk. Two variables, male sex and the number of secondary diagnoses on admission could be identified as relevant for risk stratification for the occurrence of one of the investigated events. However, a detailed prognostic analysis for each outcome measure cannot be achieved with this model. Based on the score developed here (see Table 5), male patients have a higher risk of developing an adverse event (OR: 1.623), as well as patients with multiple secondary diagnoses, that are already present before neurosurgical admission. These data should be considered for risk adjustment so that the patient's individual risk can be taken into account when comparing outcome rates between different health providers.

A risk adjustment based solely on administrative data, in our view, does not seem to adequately reflect the actual risk of patients. Nevertheless, administrative data provide a very good data basis for the establishment of models for risk adjustment.

On the one hand, scores should be calculated that reflect the individual risk of the patient for readmission or reoperation, etc. On the other hand, the data should be used for benchmarking between different providers of health care. Only with a suitable strategy for risk adjustment are the discussed quality indicators usable and sustainable.

There are hardly no standard of care procedures for treatment of tumour cases, especially in gliomas. The surgical approach, e.g. whether only a biopsy is taken or tumours in near eloquent regions are being operated using advanced neuromonitoring, mapping or awake craniotomy, is not standardized between different institutions. Consequently, in case of aiming at higher amounts of resection in glioma surgery, the risk for short-term complications within 30 days—the time period mainly suggested by health care politicians for measurement of outcome—might be worse than in patients, where only a biopsy has been taken. But the long-term benefit in patients after resection is higher. Therefore, common surgical parameters, e.g. LOS may not easily apply to neurosurgery as well.

Table 5 Classification of the risk groups based on the score and calculation of the odds ratios for the occurrence of one of the recorded events. For example, a male patient with three secondary diagnoses falls into the high-risk group at the time of admission with a score (see Table 4) of 9 and has an OR of 2.374 for the occurrence of an adverse event

Risk group	Score	Number of cases (*n*)	Number of events (*n*, %)	OR	95% CI	*p* value
Low-risk	0	713	106 (17.2%)	Ref		
Intermediate-risk	2	661	146 (23.6%)	1.623	1.232–2.14	0.001
High-risk	> 2	1249	366 (59.2%)	2.374	1.868–3.016	< 0.001

Our study shows that it is necessary to collect valid and reliable data to allow appropriate risk adjustment and benchmarking of the suggested quality indicators. This is of utmost importance for the usefulness of the discussed quality indicators. This aim can be achieved through the introduction and development of high-quality clinical data registries with prospective data entry [2]. The need for compulsory clinical neurosurgical registries collecting prospective data that are accessible, reliable and verifiable is therefore undeniable.

At present, there are good examples from other countries for such registries. In the UK, the National Neurosurgical Audit Program (NNAP) was launched to assess data on specific neurosurgical disorders with the aim of making quality measurable and comparable, as well as enabling country-wide risk adjustment and benchmarking [25]. In the USA, the National Neurosurgery Quality and Outcomes Database (N_2QOD) was introduced. Again, the aim is to provide nationwide benchmarks for e.g. perioperative mortality [1, 17].

Conclusion

Transferring risk assessment models to the German health care system developed in other countries is not directly possible as there are different accounting system and cultural differences between the countries that influence surgical indication making, the choice of surgical methods and patient admission and treatment conditions [11].

The development of large registries seems to be a good strategy to avoid the limitations of administrative data. An important advantage of administrative data, however, is the cost-effectiveness and wide availability. Therefore, these data will undoubtedly continue to be used for studies and the measurement of quality aspects. It is therefore essential that clinicians and medical informatics jointly develop ways to generate improved databases that make clinical data more clinically meaningful and useful, designed to be easily incorporated and transmitted into clinical registries [13].

The relationship between risk adjustment and quality indicators was discussed here on the example of neurosurgery. However, the proposed quality indicators affect all surgical subjects [14, 15, 24, 26], so with few exceptions the concepts are certainly transferable. The surgical societies are currently working on creating suitable framework conditions for the measurement of quality [3, 22].

For example, a marker called MTL30 (mortality, transfer and length of stay within 30 days) has been proposed as a surrogate parameter for surgical treatment quality in general and visceral surgery. This marker becomes positive as soon as the patient dies within 30 days, is admitted to another acute care hospital within 30 days or is still treated in the index clinic after 30 days [27]. Whether this parameter can also be transferred to neurosurgery remains to be discussed.

Compliance with ethical standard

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval This study was approved by the local ethic committee. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all participants included in the study.

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Comments:

In a reasonably large sample of neurosurgical tumour cases, the authors calculated outcome parameters commonly regarded by politicians as indicators of quality of surgical care. In regression models, those outcome data were adjusted to individual risk factors, both endogenous in patients and including some complications during in-hospital stay. All parameters were retrieved from administrative data primarily collected for billing purposes. They found mainly a dependence of outcome on patient-clinical-complexity-level (PCCL), comorbidities, and male gender in pre-hospital data. As quality measures are increasingly discussed in many health systems (this data was obtained from Germany) and thus also may affect neurosurgical care, this is an important contribution, which approaches the very complex question of how to measure surgical quality with the data most easily accessible to date. As the authors point out, the approaches from different other countries such as the UK and the US cannot be directly transferred to the situation in Germany, e.g. due to a lack of patient registries. Obviously, for serious quality assessment and benchmarking, there is a need for nationwide patient registries. Thus, this notion and also the limitations have impact on neurosurgical practice and political attitudes despite different systems in different countries. Another important issue is that for example in gliomas, the extent of the surgical approach must be determined in individual cases in a complex trade-off between short-term outcome and long-term benefit. Therefore, "outcome Parameters" such as duration of hospital stay may not easily tell the whole truth. This paper is a valuable contribution to illustrate potential, but also limitations of such administrative data based approaches.

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