

ORIGINAL ARTICLE

The Quality of Acute Stroke Care— an Analysis of Evidence-Based Indicators in 260 000 Patients

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SUMMARY

Background: Stroke patients should be cared for in accordance with evidence-based guidelines. The extent of implementation of guidelines for the acute care of stroke patients in Germany has been unclear to date.

Methods: The regional quality assurance projects that cooperate in the framework of the German Stroke Registers Study Group (*Arbeitsgemeinschaft Deutscher Schlaganfall-Register*, ADSR) collected data on the care of stroke patients in 627 hospitals in 2012. The quality of the acute hospital care of patients with stroke or transient ischemic attack (TIA) was assessed on the basis of 15 standardized, evidence-based quality indicators and compared across the nine participating regional quality assurance projects.

Results: Data were obtained on more than 260 000 patients nationwide. Intravenous thrombolysis was performed in 59.7% of eligible ischemic stroke patients (range among participating projects, 49.7–63.6%). Dysphagia screening was documented in 86.2% (range, 74.8–93.1%). For the following indicators, the defined targets were not reached for all of Germany: anti-aggregation within 48 hours, 93.4% (range, 86.6–96.4%); anticoagulation for atrial fibrillation, 77.6% (range, 72.4–80.1%); standardized dysphagia screening, 86.2% (range, 74.8–93.1%); oral and written information of the patients or their relatives, 86.1% (range, 75.4–91.5%). The rate of patients examined or treated by a speech therapist was in the target range.

Conclusion: The defined targets were reached for most of the quality indicators. Some indicators, however, varied widely across regional quality assurance projects. This implies that the standardization of care for stroke patients in Germany has not yet been fully achieved.

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Stroke is one of the most common disorders in Germany, with an estimated 200 000 first events and 66 000 recurrent events in 2008 (1). Stroke is also one of the most common causes of morbidity and mortality in adults. More than 40% of patients have a poor outcome after three months after their first stroke—defined as “dead” or “dependent” (2). Evidence-based approaches to the early treatment, secondary prevention, and rehabilitation of stroke patients exist, such as:

- Thrombolysis for patients after cerebral infarction,
- Antiplatelet therapy in patients with cerebral infarction or transient ischemic attack (TIA),
- Anticoagulation for patients with atrial fibrillation (3).

Since 1994 a number of regional stroke registers have been established for the purpose of external quality assurance in acute inpatient stroke treatment.

Since 1999 these regional registers have been collaborating within the framework of the *Arbeitsgemeinschaft Deutscher Schlaganfall-Register* (ADSR, German Stroke Registers Study Group). The ADSR was established in order to standardize the collection of data in the area of acute hospital stroke care and in order to develop consistent, standardized quality indicators (5). Additionally, data from the participating registers are pooled regularly and jointly scientifically evaluated. The first data pooling exercise was undertaken for the years 2000 to 2005 and supported by the German stroke competence network (5).

This article aims to present the quality indicators for acute hospital care of stroke patients in Germany, on the basis of the pooled results from the ADSR from 2012.

Methods

The German Stroke Registers Study Group (ADSR)

The ADSR is a voluntary association of regional quality assurance projects regarding the disease entity that is stroke. Currently, nine regional quality assurance

projects are collaborating (the stroke registers for Bavaria, Baden-Württemberg, Berlin, Hamburg, Hesse, North Rhine, Northwest Germany, Rhineland-Palatinate, Schleswig-Holstein), as well as the population based stroke register Erlangen (www.adr.uni-wuerzburg.de). The registers participating in the ADSR compare the regional and supraregional stroke care of the participating hospitals under scientific, quality relevant, and epidemiological aspects, while anonymity is guaranteed. Furthermore, regular joint data poolings are undertaken under the auspices of the designated ADRS methodology center (*Institut für Klinische Epidemiologie und Biometrie [IKE-B], Universität Würzburg*—the Institute of Clinical Epidemiology and Biometry [ICE-B], University of Würzburg). The data are collected mainly electronically, with defined completeness and plausibility checks, by the respective quality assurance projects. Only data sets that have been checked for plausibility are submitted to the data pooling center.

Development of the quality indicators

In 2003 a multidisciplinary quality indicator board of the ADSR was founded. In 2006 this board for the first time published standardized, evidence-based indicators that had been developed using a standardized process for the purpose of measuring quality indicators of acute stroke care in Germany (5). Among others, this process entailed a systematic literature review, independent external validation, as well as a prospective pilot study (5). The data set specification and the accompanying

data collection manual were finalized on the basis of the pilot study's results. Since 2007 this manual has been consistently used by the regional registers (5). The developed quality indicators are regularly updated by the quality indicator board. In 2010, five additional patient-related quality indicators were introduced. Furthermore, target ranges for defined quality indicators were developed, using the results of the regional quality assurance projects and a standardized consensus process (1). The data specification, instructions for completion, and calculation rules for the quality indicators are regularly updated by the ADSR's technical committee. Currently a set of 19 evidence-based indicators is being used to monitor the quality of stroke care in the participating hospitals. The definitions of the quality indicators are listed in the *eBox*. The next update of the quality indicators is planned for 2014. The *eFigure* shows exemplarily how the results are reflected back to the participating hospitals.

Statistical analyses

The characteristics of the patients documented in the participating registers were extensively described (*Table 1*). The quality of acute hospital care was operationalized on the basis of standardized developed quality indicators. The definition of the quality indicators, including inclusion criteria and exclusion criteria and possible risk adjustment, is shown in the *eBox*. Multiple logistic regression analyses were performed, with the respective quality indicators as dependent variables and the registers, age, sex, and stroke subtype (if applicable) as independent variables, in order to calculate adjusted P values for differences between the participating registers (*Table 2*). As sensitivity analyses, the quality indicators were additionally calculated for registers that participated compulsorily in 2012 (Baden-Württemberg, Hamburg, Hesse, Rhineland-Palatinate) and compared with the overall average.

Results

Characteristics of participating registers

Nationwide in 2012, the registers collected the data of more than 260 800 stroke patients from 627 hospitals (*eTable*). Participation in the documentation in 2012 was extensively mandatory in Baden-Württemberg, Hamburg, Hesse, and Rhineland-Palatinate for hospitals treating stroke patients. Since 2006, participation in an ADSR quality assurance project has also been mandatory for hospitals that are certified regional or supraregional stroke units according to criteria of the German Stroke Society and the German Stroke Foundation (6). Since January 2012, a documentation rate in one of the quality assurance projects participating in the ADSR of >90% of all patients with acute stroke who were treated in the department has been a controlled criterion in the context of such stroke unit certification (see current certification criteria of the German Stroke Society, www.dsg-info.de [in German]).

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Patient characteristics

The mean patient age was 73 years, 50% were women (Table 1). The distribution of stroke subtypes, comorbidities, length of stay, admission times, and the proportion of patients receiving thrombolysis are shown in Table 1. Wide ranges in some of the individual parameters were observed between registers, especially in the proportions of different stroke subtypes and the admission and “door to needle” times.

Quality indicators

The ADSR’s quality indicator board defined in 2010 target ranges for most of the indicators. These target ranges, as well as overall means and the lowest and highest values achieved among participating registers, are shown in Table 2. For seven quality indicators the target ranges were achieved in the overall average. For four quality indicators the means of all registers achieved the target ranges (brain imaging, early physio-

TABLE 1

Patient characteristics

	Total	Range total		Data from quality assurance projects with mandatory documentation
		Minimum	Maximum	
Age, years, mean (SD)	72.5 (13.3)	71.6 (13.4)	73.6 (12.9)	73.2 (13.3)
Women %	49.5	48.9	50.4	49.6
Stroke type %				
Ischemic stroke	64.9	60.0	70.3	61.8
Intracranial hemorrhage	6.5	3.9	8.5	7.9
Subarachnoid hemorrhage	0.5	0.3	2.0	0.5
Transient ischemic attack (TIA)	26.6	24.6	33.0	27.2
Unknown	1.4	0.1	4.7	2.7
Comorbidities %				
Atrial fibrillation	25.6	22.8	28.1	24.3
Diabetes	26.0	21.0	28.4	23.8
Hypertension	80.5	62.7	84.6	75.2
Intravenous thrombolysis after cerebral infarction %	13.6	9.5	15.1	11.8
Door to needle time in hours %*				
≤ 0.5	30.7	15.1	51.1	28.4
>0.5–1	49.1	32.7	56.4	50.6
>1–2	14.7	10.7	24.9	13.7
>2–3	3.6	2.7	6.8	4.7
>3–6	1.6	0.4	2.9	1.9
>6	0.4	0.1	1.6	0.8
Time to admission in hours %				
≤ 2	27.4	24.0	31.1	27.8
>2–3	12.1	9.9	13.7	12.0
>3–6	20.0	16.9	22.3	20.3
>6–24	21.0	19.2	26.5	21.4
>24–48	7.5	7.3	8.4	7.6
>48	11.9	9.8	14.3	10.9
Length of stay. Days, mean (SD)	8.8 (7.5)	8.2	10.1	8.7 (8.0)

*Data not consistently documented in one quality assurance project

therapy, early speech therapy, brain imaging within 1 h of admission in patients admitted within 2 h after stroke onset). All quality indicators varied significantly in terms of the extent to which they were met across the different registers. Considerable differences between individual quality assurance projects were seen especially in:

- The proportion of eligible patients who received thrombolysis (target: $\geq 60\%$, total: 59.7%; range 49.7–63.6%),
- The proportion of patients who were screened for dysphagia (target: $\geq 90\%$; total: 86.2%; range 74.8–93.1%),
- The administration of indicated anticoagulants in patients with atrial fibrillation (target: $\geq 80\%$; total: 77.6%; range: 72.4–80.1%).

Not achieved in all of Germany were in particular the defined target ranges in:

- The administration of anticoagulants in atrial fibrillation (target: $\geq 80\%$; total: 77.6%; range 72.4–80.1%),
- Standardized screening for dysphagia (target: $\geq 90\%$; total: 86.2%; range 74.8–93.1%),
- Verbal and written information for the patients or their relatives (target: $\geq 90\%$; total: 86.1%; range: 75.4–91.5%).

With regard to the treatment of dysphagia, the rate of patients examined or treated by a speech therapist was in the target range (target: $\geq 80\%$; total: 88.5%; range: 81.7–91.3%). No big differences were found between quality assurance projects with mandatory documentation compared with the overall average.

Discussion

The present study describes the quality of acute stroke care in 627 hospitals in Germany in 2012 on the basis of standardized quality indicators that are documented in the framework of regional quality assurance projects. The target ranges defined for the quality indicators are often already achieved at register level. By contrast, however, large differences exist between individual registers. The indicators in which the defined target ranges are currently not yet achieved nationwide include in particular: administration of anticoagulants in atrial fibrillation, standardized screening for dysphagia, and verbal and written information provided to the patients and their relatives. For all quality indicators, significant differences exist in terms of the extent to which they were met across the participating registers.

International comparison

Comparable data for 2012 from other European countries are currently lacking. A comparison with data from the Minnesota Stroke Registry Program from the US, in which 44 hospitals documented the quality of care in 2013, shows comparable results for antithrombotic therapy at discharge (Minnesota: 98.2%, ADSR: 95.2%) as well as for antithrombotic therapy during the first 48 hours (Minnesota: 97.6%; ADSR: 93.4%). The proportion of patients with atrial fibrillation and anti-

coagulation is notably higher in Minnesota (Minnesota: 94.6%, ADSR: 77.6%), whereas the proportion of patients receiving standardized screening for dysphagia is higher in Germany (Minnesota: 70.8%, ADSR: 86.2%) (7).

Data from earlier years with a standardized extensive quality assurance program—such as Britain (excluding Scotland) or Catalonia/Spain—indicate that in Germany, comparable or higher proportions of patients had received appropriate secondary prevention or were screened for dysphagia. In Britain in 2010, 84% of patients were screened for the presence of dysphagia, and in Catalonia/Spain in 2007, 45.8% of patients were screened (ADSR: 86.2%). 77% of patients with ischemic stroke received antithrombotic therapy in Catalonia/Spain during the first 48 hours; in Britain, that proportion was 93% (ADSR: 93.4%) (8, 9). In the area of secondary prevention at discharge from acute hospital care, the ADSR results are also comparable with earlier rates from Britain and Catalonia/Spain or substantially higher—for example, with regard to anti-aggregation at discharge from acute hospital care (Catalonia/Spain: 96.6%; ADSR: 95.2%) or administration of anticoagulants in atrial fibrillation (Catalonia/Spain: 66.2%; ADSR: 95.2%) (8, 9).

Regarding recanalization therapy after ischemic stroke, the Swedish register RIKS-Stroke reports rates of 13.3%/10.4% for all men/women younger than 80 with ischemic stroke who were treated in Swedish acute hospitals and received recanalization treatment (thrombolysis/thrombectomy) in 2012 (10). In ADSR in 2012, an average of 13.6% of all ischemic strokes were treated with systemic thrombolysis, with the rates between the quality assurance projects ranging from 9.5% to 15.1%.

The usefulness of routine data for quality assurance purposes

The use of so-called routine data (“diagnosis-related groups” [DRG], billing data) to describe quality of care is increasingly the subject of discussion (11). Using routine data for quality assurance has the advantage that these data are easily available and complete. However, in spite of these advantages, in the area of complex disorders—for example, stroke—there are arguments in favor of the additional effort of the independent collection of data that are not included in routine documentation (especially in the acute treatment of stroke) (12, 13). These include the collection of stroke severity data for the purposes of adjusting for case mix, and the standardized documentation of complications or of multidisciplinary measures, such as dysphagia screening. Furthermore, in a prospective data collection of stroke-specific information, certain imprecisions will not occur, such as can happen when using routine data. These include the incorrect coding of diagnoses in the hospital’s billing system (14), the frequently non-standardized documentation of comorbidities or risk factors, as well as lacking data on defined, stroke-related neurological deficits that necessitate certain diagnostic/therapeutic approaches

(for example, early mobilization in impaired mobility) (14). Because of the comprehensive data collection and the large number of documented patients, the ADSR's data pool is one of the largest national quality assurance projects in the area of acute stroke care (15).

To improve the relevance of the ADSR data further, a number of improvement measures are required. It is estimated that in Germany, about 70% of first or recurrent strokes are documented in the ADSR's collaborating quality assurance projects (11). The completeness of the documentation in the participating hospitals can be determined by using a so-called quality assurance filter, which also enables a comparison between billed and transmitted data sets. This is already being successfully used in a number of registers, such as Hesse (16), Hamburg, Rhineland–Palatinate, and Baden–Württemberg. Similarly, in some registers, data validation procedures were implemented—for example, checking the reliability of the data on a random basis by on-site monitoring. The standardized implementation of quality assurance filters in the

remaining registers should be a further objective for the future development of standardized data documentation.

In future, further phases of stroke care should be added to the data collection and comparative evaluation in acute care after stroke, in order to enable cross-sectoral quality assurance. Recently, 18 quality indicators for the area of rehabilitation of stroke patients were proposed in the framework of a model project by the Berlin Stroke Alliance's working group "core data set" (17). Since January 2012, these indicators for the specific description of stroke treatment during the rehabilitation phase have been documented in 10 institutions participating in the Berlin Stroke Alliance (see Dohle et al, Evidenzbasierte Qualitätsindikatoren in der neurologischen Rehabilitation – Erfahrungen aus der Berliner Schlaganfallallianz. 86. Kongress der Deutschen Gesellschaft für Neurologie 2013). Comparable projects have also successfully been established in other regions. Data on inpatient rehabilitation after stroke have been collected and evaluated for quality

TABLE 2

Target ranges and results of the 15 quality indicators

Quality indicator	Target range %	Total, %	Quality assurance projects with mandatory participation, %	Total range		p value* ¹
				Minimum	Maximum	
Antiaggregation ≤ 48 h after stroke	≥ 95	93.4	91.7	86.6	96.4	<0.0001
Antiaggregation as secondary prevention	≥ 95	95.2	93.7	87.4	98.0	<0.0001
Anticoagulation in atrial fibrillation	≥ 80	77.6	75.2	72.4	80.1	<0.0001
Brain imaging in patients with suspected stroke* ²	≥ 95	99.4	99.0	98.6	99.9	<0.0001
Vascular imaging in cerebral infarction and transient ischemic attack (TIA)	≥ 90	93.8	89.8	84.8	96.7	<0.0001
Dysphagia screening	≥ 90	86.2	88.4	74.8	93.1	<0.0001
Early rehabilitation—physiotherapy/occupational therapy	≥ 90	94.4	93.3	90.4	97.8	<0.0001
Early rehabilitation—speech therapy	≥ 80	88.5	85.9	81.7	91.3	<0.0001
Early mobilization* ³	≥ 90	91.4	91.3	86.8	92.7	<0.0001
Information for patients and their relatives* ³	≥ 90	86.1	87.6	75.4	91.5	<0.0001
Patients with brain imaging within 1 h of admission in patients admitted within 2 h after stroke onset* ³	≥ 90	95.5	95.1	93.5	96.0	<0.01
Early systemic thrombolysis in eligible patients*³	≥ 60	59.7	56.9	49.7	63.6	<0.0001
Door to needle time ≤ 60 min, when interval onset/admission ≤ 2 h	–	98.7	98.3	95.6	99.2	<0.001
Treatment in a stroke unit* ⁴	–	77.2	68.0	65.9	84.1	<0.0001
Discharge destination rehabilitation of patients with disabilities impairing everyday activities* ⁴	–	75.1	64.9	54.7	80.1	–

In bold print: quality indicators for which target ranges were not achieved in the nationwide mean 2012

*¹ p values each relate to one test for significant differences between registers with regard to likelihood of success of achieving one quality indicator

*² Computed tomography or magnetic resonance imaging

*³ Data not consistently documented in one quality assurance project

*⁴ Data not included in the following registers: Hamburg, Schleswig–Holstein, Rhineland–Palatinate

assurance purposes in Hesse since 1998 and in Hamburg since 2012 (18) (see Seidel G et al, Qualitätsmanagement in der neurologischen Frührehabilitation für Schlaganfallpatienten. *Neurol Rehabil* 2013; 347). Furthermore, only few data are available to date on the care of stroke patients and outcomes after discharge from acute hospital care and inpatient rehabilitation. Some regional registers have performed follow-ups after three months or six months (19–22). Further follow-up projects on outcomes and quality of care are in the planning stages, based on jointly developed standards (1). Especially as far as the long-term sequelae of stroke are concerned, hardly any data exist in Germany, and the same is true for further outpatient treatment. The Erlangen Stroke Register is currently the ADSR's only quality assurance project that collects data on long-term outcomes (23). In order to answer further research questions—such as the identification of predictors for the long-term outcome after stroke—with regard to morbidity and mortality, additional follow-up projects will need to be set up. To this end, relevant data on health and mortality after discharge from the acute hospital will have to be collected in a standardized way using a uniform methodology.

Limitations of the study

The data used in the study were documented primarily for the purpose of quality assurance. They were checked for plausibility before they were sent to the data pooling center, but possible coding errors at hospital level cannot be ruled out since no consistent monitoring of the data was being undertaken. Not all registers implemented a quality assurance filter in 2012 in order to ensure completeness of the documentation. In four registers, documentation is mandatory, whereas this is otherwise required only for the stroke units certified according to the requirements of the German Stroke Society/German Stroke Foundation. In registers without mandatory participation, “hospitals with regional or supraregional stroke unit” are probably over-represented because of the above-mentioned certification requirement. For this reason, registers with mandatory documentation might reflect the German care situation more precisely (at least in the less densely populated states). In spite of all this, no major differences were observed with regard to patient characteristics or the results between registers with mandatory participation and all registers.

Conclusion

Acute hospital care for stroke patients in Germany is excellent, according to data from the ADSR for 2012. The defined target ranges are already being achieved for many of the standardized quality indicators. The wide ranges with significant differences in the degree to which individual quality indicators have been met between individual quality assurance projects show, however, that stroke care in Germany has not been fully standardized yet. No major differences exist for the quality of care between quality assurance projects with

mandatory documentation compared with the overall average. The data from the ADSR's regional quality assurance projects are a unique data source for finding answers to further scientific questions regarding the improvement of care for stroke patients in Germany—for example, regarding the identification of institutional factors for the quality of care or the investigation of time trends in stroke care.

KEY MESSAGES

- Data on acute inpatient care given to more than 260 000 stroke patients were collected in 2012 by 627 hospitals in the participating registers of the German Stroke Registers Study Group (ADSR)
- Nationwide, the target ranges were achieved for 7 of 15 quality indicators; for 4 quality indicators the mean values of all registers reached the target ranges.
- For all quality indicators, significant differences were observed across the different registers with regard to the degree to which the individual indicators were met.
- Considerable differences between the quality assurance projects were observed for intravenous thrombolysis, screening for dysphagia, and anticoagulation in atrial fibrillation.
- The defined target ranges were not reached on a nationwide basis for antiplatelet therapy within 48 h, administration of anticoagulants in atrial fibrillation, screening for dysphagia, and information for patients and their relatives. With regard to treatment for dysphagia, the rate of patients examined or treated by a speech therapist was within the target range.

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eTable and eFigure:
www.aerzteblatt-international.de/14m0759

ORIGINAL ARTICLE

The Quality of Acute Stroke Care— an Analysis of Evidence-Based Indicators in 260 000 Patients

Silke Wiedmann, Peter U. Heuschmann, Steffi Hillmann, Otto Busse, Horst Wiethölter, Georg M. Walter, Günter Seidel, Björn Misselwitz, Alfred Janssen, Klaus Berger, Christoph Burmeister, Christine Matthis, Peter Kolominsky-Rabas, Peter Hermanek for the German Stroke Registers Study Group (ADSR)

eFIGURE

QI 13: Early thrombolysis

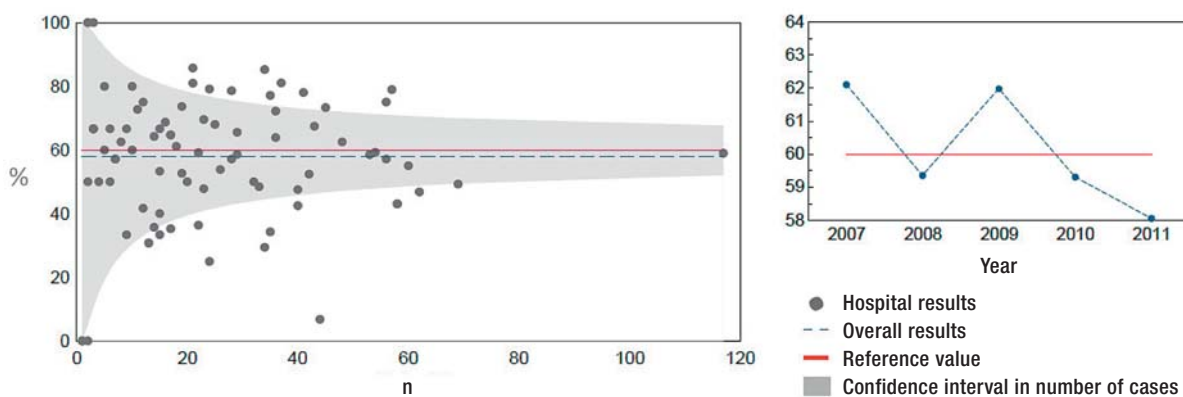
Reference: ADSR 14

Objective: The highest possible proportion of patients who—if suitable—receive early intravenous thrombolysis

Result: (Current) 58.1%
(Previous year) 59.3%
Reference value: ≥ 60.0% results ≥ 60% were defined as reference/target range

Numerator: Patients receiving intravenous thrombolysis treatment

Denominator: Patients aged 18–80 with cerebral infarction, with an interval from onset to admission of ≤ 2 h between event and admission and severity NIHSS 4–25, excluding patients receiving intra-arterial thrombolysis treatment



Exemplary illustration of the quality indicators (QI) in registers' reports using the example of QI early thrombolysis in Bavaria in 2011 on the basis of a funnel plot (www.baq-bayern.de). QI, quality indicator; ADSR: German Stroke Registers Study Group; NIHSS, National Institutes of Health Stroke Scale

eTABLE

Characteristics of participating quality assurance projects (2012)

Quality assurance project	Region	Mandatory participation	Number of participating institutions	Number of patients	Responsible body	Contact
Baden-Württemberg	Entire federal state	Yes	149	39 756	Office for Quality Assurance in Hospitals (GeQik) Stuttgart at Baden-Württembergische Hospital Federation	Dr. Ingo Bruder
Bavaria	Entire federal state	No	82	41 034	Bavarian Permanent Working Party for Quality Assurance (BAQ), Bavarian Hospital Federation	Dr. Melanie Eßer
Berlin	Entire federal state	No	17	11 011	Berlin Stroke Register, Berlin Medical Association	Dr. Barbara Hoffmann
Hamburg	Entire federal state	Yes	16	8488	Association for Quality Assurance Hamburg (EQS)	Ralf Hohnhold
Hesse	Entire federal state	Yes	86	23 916	Institute of Quality Assurance Hesse (GQH); Hesse Hospital Federation	Dr. Björn Misselwitz
North Rhine	Parts of North Rhine-Westphalia	No	35	21 528	The Quality Assurance in the Care of Stroke Patients Project, North Rhine Medical Association	Dr. Alfred Janssen
Northwest Germany	Parts of North Rhine-Westphalia, Lower Saxony, Mecklenburg-Western Pomerania, Saxony, Thuringia, Saxony-Anhalt, Saarland, Brandenburg	No	155	89 438	The Quality Assurance in Stroke Care for Northwest Germany Project, Institute of Epidemiology and Social Medicine, University of Münster	Prof. Klaus Berger
Rhineland-Palatinate	Entire federal state	Yes	74	19 114	Institute of Quality Assurance Rhineland-Palatinate / SQMed	Dr. Christoph Burmeister
Schleswig-Holstein	Entire federal state	No	13	6563	Quality Association for Acute Stroke Treatment Schleswig-Holstein (QugSS), University Hospital Schleswig-Holstein, Institute of Social Medicine and Epidemiology	Dr. Christine Matthis
ADSR	All quality assurance projects	–	627	260 848		

ADSR, German Stroke Registers Study Group

eBOX

Definition of quality indicators

1. Antithrombotic therapy—antiaggregation ≤ 48 h after stroke

Numerator: Number of patients receiving platelet inhibitors within the first 48 hours after the stroke

Denominator: All patients with TIA or cerebral infarction. Excluded are: patients receiving anticoagulation, patients <18 years, and patients with interval onset to admission >48 h.

Reference/target range: ≥ 95%

2. Antithrombotic therapy—antiaggregation as secondary prophylaxis

Numerator: Number of patients receiving platelet inhibitors at discharge

Denominator: All patients with TIA or cerebral infarction. Patients receiving anticoagulation, patients <18 years, and patients with discharge status "deceased" are excluded.

Reference/target range: ≥ 95%

3. Antithrombotic therapy—anticoagulation in atrial fibrillation

Numerator: Number of patients receiving therapeutic anticoagulation at discharge or with a recommendation for anticoagulation in their discharge notes

Denominator: All patients with TIA or cerebral infarction and atrial fibrillation, who are discharged home or to a rehabilitation hospital and are mobile (operationalized by using categories 10–15 in item "change of position from bed to chair" and categories 10–15 in item "locomotion" in the Barthel index at discharge) and minimally impaired (operationalized by using Rankin scale 0–3 at discharge); patients <18 are excluded.

Reference/target range: ≥ 80%

4. Brain imaging in patients with suspected stroke

Numerator: Number of patients receiving brain imaging (CCT and/or NMR)

Denominator: All documented patients

Reference/target range: ≥ 95%

5. Vascular imaging in cerebral infarction and TIA

Numerator: All patients with extracranial vascular imaging (Doppler ultrasound and/or duplex sonography and/or digital subtraction angiography and/or magnetic resonance/computed tomography angiography)

Denominator: All patients with cerebral infarction or TIA

Reference/target range: ≥ 90%

6. Screening for dysphagia

Numerator: All patients with swallowing test according to protocol with minimal requirements (for example, "includes stepwise water swallowing test of at least 50/mL")

Denominator: All patients with stroke and a minimum stay ≥ 1 day; patients with TIA and patients with impaired consciousness are excluded

Reference/target range: ≥ 90%

7. Early rehabilitation—physiotherapy/occupational therapy

Numerator: Number of patients examined by and/or receiving treatment from a physiotherapist and/or occupational therapist ≤ day 2 after admission

Denominator: All patients with documented paresis and notable functional impairment (Rankin scale ≥ 3 and/or sum Barthel index ≤ 70 within the first 24 hours after admission) with a minimum stay of ≥ 1 day; patients who are comatose at admission and patients with a diagnosis of TIA are excluded

Reference/target range: ≥ 90%

8. Early rehabilitation—speech therapy

Numerator: Number of patients who were examined by and/or received treatment from a speech therapist ≤ day 2 after admission

Denominator: All patients with documented aphasia and/or dysarthria and/or dysphagia at admission and a minimum stay of ≥ 1 day. Patients who are comatose at admission and patients with TIA are excluded

Reference/target range: ≥ 80%

9. Early mobilization

Numerator: Number of patients who were mobilized within 2 days after admission

Denominator: All patients who changed position from bed to chair "with support" or found it "impossible" (operationalized by categories 0–10 in item "change of position from bed to chair" in the Barthel index within the first 24 hours after admission) with a minimum stay ≥ 1 day; patients with TIA and/or intracranial pressure and/or ventilation and/or coma at admission are excluded

Reference/target range: $\geq 90\%$

10. Information for patients and their relatives

Numerator: Number of patients (or their relatives) who received verbal and written information before discharge

– On the disease course/prevention by the doctor

– On support offers by social/care services

Denominator: Patients with a minimum length of stay ≥ 1 day; patients with a diagnosis of TIA and patients with a discharge status "deceased" were excluded

Reference/target range: $\geq 90\%$

11. Patients with brain imaging within 1 h of admission in patients admitted within 2 h after stroke onset

Numerator: All patients with interval admission to first imaging procedure (CCT and/or MRI) ≤ 1 h

Denominator: All patients with interval between onset and admission ≤ 2 h and sufficient stroke severity to receive intravenous thrombolysis (NIHSS 4–25) and age between 18 and 80 years

Reference/target range: $\geq 90\%$

12. Early systemic thrombolytic therapy in eligible patients

Numerator: All patients receiving intravenous thrombolysis

Denominator: All patients with cerebral infarction and a time interval between onset and admission of ≥ 2 hours, as well as sufficient stroke severity to conduct intravenous thrombolysis (NIHSS 4–25), aged between 18 and 80 years. Patients with intra-arterial thrombolysis are excluded.

Reference/target range: $\geq 60\%$

13. Pneumonia rate after stroke

Numerator: Number of patients with pneumonia as a complication

Denominator: All patients with cerebral infarction

Reference/target range: —

14. In-hospital mortality after acute stroke

Numerator: Number of patients with discharge status deceased on day 7

Denominator: All patients with cerebral infarction. Patients with length of stay ≤ 7 days and who were discharged into another acute hospital, other department, rehabilitation ward, or care home are excluded

Reference/target range: —

15. Mortality after thrombolysis (since 2010)

Numerator: Patients who died within 7 days after thrombolysis

Denominator: All patients receiving thrombolysis

Reference/target range: —

16. Revascularization of carotid artery stenosis (since 2010)

Numerator: Patients with a recommendation for revascularization in their referral letter, or referral to revascularization, or who have undergone revascularization

Denominator: All patients with cerebral infarction/TIA and symptomatic carotid artery stenosis $\geq 70\%$

Reference/target range: —

17. Door to needle time ≤ 60 min if time between onset and admission ≤ 2 h (since 2010)

Numerator: Patients with a time window from admission to start of thrombolysis ≤ 60 minutes

Denominator: All patients receiving thrombolysis

Reference/target range: —

18. Treatment in stroke unit (since 2010)

Numerator: Patients admitted to stroke unit

Denominator: All patients with stroke/TIA who were admitted to the hospital

Reference/target range: —

19. Discharge destination rehabilitation of patients with impairments affecting everyday life (since 2010)

Numerator: All patients with the discharge destination of outpatient or inpatient rehabilitation (to start imminently, organized and registered by the hospital, not necessarily direct transfer to rehabilitation)

Denominator: All patient with stroke, mRS 2–5 at discharge, without prior stay in a care home, age <80. Patients transferred to another acute hospital or ward are excluded

Reference/target range: —

CCT, cranial computed tomography
 NIHSS, National Institutes of Health Stroke Scale
 MRI, magnetic resonance imaging
 NMR, nuclear magnetic resonance
 mRS, modified Rankin scale
 TIA, transient ischemic attack