

ORIGINAL ARTICLE

Trends in Acute Inpatient Stroke Care in Germany

An Observational Study Using Administrative Hospital Data From 2005–2010

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SUMMARY

Background: Administrative hospital data can be used to detect trends in the care of patients hospitalized with acute stroke.

Methods: The nationwide German DRG statistics for the years 2005 to 2010 were used to identify hospitalizations for acute stroke. All hospitalizations of patients with a principal diagnosis of acute stroke who were over 19 years old on admission were included in the analysis; admissions transferred from other acute care hospitals were excluded. The data were analyzed to determine annual hospitalization rates, characteristics of the patients and hospitals, patterns of care, and in-hospital mortality.

Results: The number of hospitalizations for acute stroke in Germany per year ranged from 235 000 in 2005 to 243 000 in 2010. After standardization for the age and sex structure of the population 2005, the annual hospitalization rate was found to have declined over the period of the study from 357 to 336 hospitalizations per 100 000 persons. The decline occurred mainly in older patients (in men from age 60 and in women from age 70 onward). The percentage of patients cared for in a stroke unit (“complex treatment” in the coding system of the German Classification of Operations and Procedures [Operationen- und Prozedurenschlüssel, OPS]) rose from 15% to 52%. The percentage of patients with cerebral infarction who received systemic thrombolytic treatment rose from 2.4% to 8.9%. In-hospital mortality declined from 11.9% in 2005 to 9.5% in 2010, with a standardized 2005-versus-2010 mortality ratio of 0.79.

Conclusion: The declining hospitalization rate of elderly patients might reflect the impact of better primary and/or secondary prevention. The findings also reveal a trend toward more specific care for acute stroke, which may be the cause of the observed decline in in-hospital mortality.

► **Cite this as:**

Nimptsch U, Mansky T: Trends in acute inpatient stroke care in Germany—an observational study using administrative hospital data from 2005–2010.

Dtsch Arztebl Int 2012; 109(51–52): 885–92.

DOI: 10.3238/arztebl.2012.0885

As a result of demographic changes and the financial significance of the high costs of treatment and follow-up, care for stroke patients poses a major challenge to the German health care system. Previous analyses of stroke care are mostly based on registry data (1, 2). However, these can only provide a picture of the situation in the regions covered by the registries or participating institutions, and conclusions drawn from them on the subject of the overall health care situation are based on projections. This is also true for care studies based on health insurers’ data (3, 4). Although these do take into account care throughout Germany, provided the health insurers concerned are supra-regional, they are nevertheless limited to a specific population, namely the customers of those insurers.

This article investigates care for stroke patients in German acute care hospitals, on the basis of administrative data from all acute care hospitals that use the DRG (diagnosis-related group) classification system. This means that it covers inpatient cases including the entire population, regardless of type of insurance. As the available figures cover six years, developments over time can be analyzed.

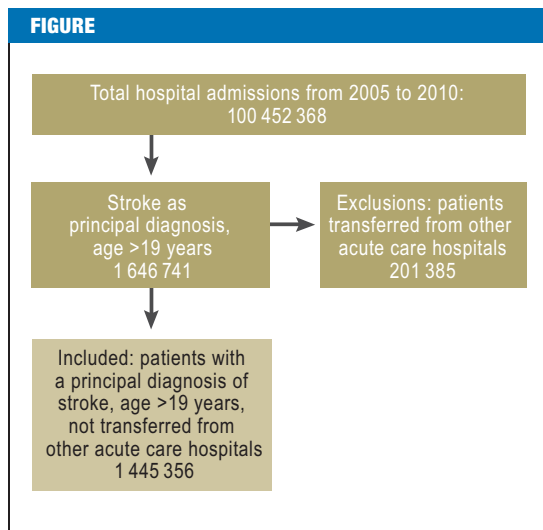
Methods

DRG statistics from Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder (federal states) for 2005 to 2010 (5) were used for the investigation (*eMethods*). As the German DRG system is an all-patient/all-payer system, these data include all cases treated in hospitals and classified according to the DRG system with the only exception of psychiatry and some special services like military hospitals (6,7). They contain information on age, sex, diagnoses, procedures, and source of admission and discharge status of treated patients, in addition to other details. Cases can be assigned to the respective treating hospital via a pseudonymized hospital identifier.

Patients included were those aged over 19 years with the principal diagnoses cerebral infarction, intracerebral hemorrhage, subarachnoid hemorrhage, or stroke of un-specified type identified using the codes of the German version of the International Classification of Diseases (ICD-10, codes I60, I61, I63, and I64). To focus on the episode in the first admitting hospital, patients transferred from other acute care hospitals

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Selected cases
from national German data included in the research



(identified via the source-of-admission code) are excluded (Figure). Since the data do not contain a patient identifier, it is impossible to distinguish between first-time and recurrent strokes, so the analyses cover all first-time and recurrent strokes.

Hospitals with stroke units were classified using the relevant procedure codes of the German Classification of Operations and Procedures (Operationen- und Prozedurenschlüssel, OPS). Existence of a stroke unit in a hospital is assumed when at least ten episodes with coded stroke unit care are present within a calendar year.

Annual hospital admission rates were calculated in relation to the residential population for the year in question (9). The following information is given:

- Crude rates
- Rates directly standardized on the basis of distribution by sex and five-year age groups in 2005
- Age- and sex-specific rates for 10-year age groups.

For calculation of hospital mortality rates, demographic changes were controlled for using indirect standardization based on five-year age groups and sex. The mortality distribution in 2005 was used as the reference. The standardized mortality ratio (SMR) is shown. In order to assess trends over time, two-sided p-values were calculated using linear regression. Analyses were performed using SAS 9.1. A detailed description of the methods used can be found in the supplementary *eMethods*.

Results

Hospital admission rates

Between 2005 and 2010, hospitals treated a total of 1 445 356 patients with a principal diagnosis of stroke aged over 19 years and admitted from “outside” (i.e. not transferred from another acute care hospital). The annual number of hospitalizations for stroke was

between approximately 235 000 (2005) and 243 000 (2010). This corresponds to rates of between 357 and 365 per 100 000 inhabitants.

No significant trend was seen in the crude hospital admission rate per 100 000 inhabitants during the observation period. Standardized for the 2005 population structure, a decrease from 357 to 336 cases per 100 000 inhabitants was observed.

Turning to age- and sex-specific rates, significant decreases were clear in older age groups. Rates per 100 000 inhabitants fell in age groups above 60 years for men and 70 years for women. This decrease did not begin until 2006 except in women aged between 70 and 79.

No trend was seen in the rates in younger age groups during the observation period (Table 1).

Patient characteristics

The percentage of stroke patients aged over 85 years increased steadily over the observation period from 15.7% in 2005 to 18.6% in 2010. The percentage of women fell from 52.9% to 51%.

The percentage of hospital admissions with principal diagnosis I64 (stroke, not specified as haemorrhage or infarction) fell from 12.7% to 4%. The percentage of hospital admissions due to subarachnoid or intracerebral hemorrhage also fell, and the percentage of hospital stays with the principal diagnosis cerebral infarction rose correspondingly from 71.2% to 82.2%.

Examination of selected secondary diagnoses revealed an increase in the percentage with codes for hypertension (67.3% in 2005 versus 71.4% in 2010) and atrial fibrillation (23.8% versus 26.1%). In contrast, the secondary diagnosis diabetes was recorded at a constant level of around 27% of treated patients throughout the years observed.

Codes for hemiparesis or hemiplegia were recorded as secondary diagnoses in 50.1% to 50.9% of all cases during the observation period. Codes for aphasia, anarthria, or dysarthria (36.9% in 2005 versus 45.0% in 2010) and for dysphagia (12.7% versus 14.3%) increased over the observation period.

Codes for pneumonia were recorded as secondary diagnoses in 6.2% of all patients treated for stroke in 2005. This percentage fell during the observation period to 5.1% in 2010 (Table 2).

Hospital characteristics

The number of hospitals charging at least one case of inpatient stroke care fell from 1462 in 2005 to 1334 in 2010. Percentiles of case numbers showed an increasing concentration in hospitals with high case numbers, while volumes in hospitals with lower case numbers fell.

The percentage of hospitals with stroke units according to the definition used here increased steadily. Since 2009, stroke unit treatment has been provided in more than a third of hospitals treating stroke patients. The percentage of hospitals performing systemic thrombolysis (27.0% in 2005 versus 43.4% in 2010) or

TABLE 1

Hospital admission rates for stroke treatment (age >19 years, excluding transferrals from other acute care hospitals)

	2005	2006	2007	2008	2009	2010	p ¹	Trend ² p <0.05
No. of hospital admissions	235 276	242 105	240 837	243 394	240 712	243 032	0.145	=
Rate per 100 000 inhabitants	357	366	363	367	362	365	0.375	=
Standardized rate (reference: 2005)	357	360	352	350	339	336	0.006	-
Age- and sex-specific rates per 100 000								
Men								
20–29	9	11	9	9	10	10	0.673	=
30 to 39	27	28	28	30	30	28	0.259	=
40 to 49	88	95	93	91	91	94	0.502	=
50 to 59	254	274	269	268	267	266	0.541	=
60 to 69	614	622	616	608	597	589	0.014	-
70 to 79	1268	1274	1222	1194	1134	1120	0.001	-
80to89	2116	2126	2075	2035	1990	2001	0.004	-
90+	2165	2168	2089	1966	1694	1719	0.005	-
Women								
20 to 29	10	12	11	12	11	12	0.168	=
30 to 39	26	28	28	27	27	26	0.690	=
40 to 49	68	70	69	68	68	69	0.435	=
50 to 59	131	139	135	138	136	133	0.967	=
60 to 69	329	329	322	332	318	315	0.118	=
70 to 79	951	927	894	871	828	808	<0.0001	-
80 to 89	2068	2077	2048	2059	2035	1978	0.032	-
90+	2656	2691	2669	2644	2339	2388	0.044	-

¹Two-sided p-value for linear trend; ²Direction of trend: -:Significant downward;+:Significant upward;=:No significant trend

selective thrombolysis in intracranial vessels (7.8% versus 12.1%) also increased (Table 3).

Patterns of care

Examination of the specialized departments admitting patients shows an increase in the percentage of stroke patients admitted to neurology units (40.8% in 2005 versus 54.1% in 2010). The mean length of stay in the hospital providing initial care fell from 12.5 days to 11 days.

Procedure codes for stroke unit treatment were recorded for 15.1% of patients in 2005. This percentage doubled in 2006 and then continued to grow, reaching 52.3% in 2010. The figures for patients receiving specified intensive care treatment also increased (7.6% in 2005 versus 11.3% in 2010). The percentage of cases receiving mechanical ventilation for more than 24 hours remained constant, at between 4.3% and 4.7%.

For cases with a principal diagnosis of cerebral infarction, an increase in the percentage with coded systemic thrombolysis was found during the observation

period, from 2.4% to 8.9%. Selective thrombolysis in intracranial vessels was recorded for 0.3% of cerebral infarction patients in 2005 and 0.6% in 2010 (Table 4).

Hospital mortality

The absolute number of stroke patients who died in the first hospital in which they received treatment fell by 923 cases per year during the observation period, according to regression analysis (95% confidence interval [CI]: 711 to 1136). The national crude mortality rate fell from 11.9% to 9.5%. The SMR for 2010 was 0.79 in relation to the figure for 2005. Isolated examination of patients treated for cerebral infarction showed a similar decrease: The crude mortality rate fell from 8.5% to 7.2%, and the SMR fell to 0.81 (Table 5).

Discussion

Hospital admission rates showed decreasing trends for men and women in older age groups. With the exception of women aged 70 to 79 years, this trend began in 2006. Between 2005 and 2006 there were either no changes or counter-trend changes. This may

TABLE 2

Characteristics of patients admitted to the hospital with stroke as principal diagnosis (age >19 years, excluding transferrals from other acute care hospitals)

	2005	2006	2007	2008	2009	2010	p ¹	Trend ² p <0.05
No. of hospital admissions	235 276	242 105	240 837	243 394	240 712	243 032	0.145	=
Type of stroke (% of treated cases)								
Subarachnoid hemorrhage (I60)	3.83	3.61	3.45	3.34	3.35	3.17	0.002	-
Intracerebral hemorrhage (I61)	12.27	11.55	11.25	11.02	10.90	10.68	0.004	-
Cerebral infarction (I63)	71.21	74.66	77.57	79.99	81.22	82.17	0.001	+
Stroke, not specified as haemorrhage or infarction (I64)	12.69	10.18	7.73	5.66	4.54	3.98	0.001	-
Age distribution (% of treated cases)								
20 to 44	3.49	3.61	3.41	3.34	3.28	3.19	0.012	-
45 to 64	18.88	18.92	18.70	18.67	18.80	19.07	0.703	=
65 to 84	61.95	61.06	60.56	59.97	59.68	59.19	0.0002	-
≥85	15.68	16.41	17.34	18.03	18.25	18.56	0.001	+
Mean age	72.66	72.58	72.75	72.88	72.90	72.99	0.007	+
Women (%)	52.92	52.14	51.96	51.99	51.59	51.03	0.004	-
Coded secondary diagnoses (% of treated cases)								
Hypertension (I10 to I13, I15)	67.26	68.51	68.71	69.80	70.18	71.44	0.0003	+
Diabetes (E10 to E14)	27.45	27.26	27.33	26.94	26.97	27.08	0.055	=
Atrial fibrillation/flutter (I48)	23.85	23.54	24.07	24.72	25.36	26.13	0.004	+
Hemiparesis/hemiplegia (G81)	50.35	50.05	50.11	50.58	50.86	50.79	0.057	=
Aphasia/anarthria/dysarthria (R47)	36.95	37.82	38.68	40.87	42.53	45.03	0.001	+
Dysphagia (R13.0, R13.9)	12.70	12.58	13.12	13.22	13.67	14.28	0.004	+
Pneumonia (A48.1, J10.0, J11.0, J12 to J18)	6.23	5.69	5.39	5.18	5.12	5.13	0.012	-

¹Two-sided p-value for linear trend; ²Direction of trend: -: Significant downward; +: Significant upward; =: No significant trend
Type of stroke cases and secondary diagnoses: ICD10 codes are given in parentheses

be associated with the altered differentiation between stroke, transient ischemic attack (TIA), and prolonged reversible ischemic neurologic deficit (PRIND) in the German version of ICD-10. Classification of PRIND under ICD-10 code G45 (transient cerebral ischemic attacks and related syndromes) was removed from the 2006 version (10). This may have led to increased classification of milder strokes under the ICD codes included here.

Apart from that, the decrease in hospital admission rates in older age groups is in line with results from, for example, the USA, which are based on comparable data (11). The authors of this study assume that this development may be related to improvements in the management of high blood pressure and atrial fibrillation in older persons. The same may be also true in Germany. Besides, secondary prevention after a first stroke may also play a role in older age groups. The Rhineland-Palatinate stroke registry, for example, reports an increased prescription rate for antihypertensive medi-

cation, lipid-lowering agents, and anticoagulants for secondary prevention (2).

Increasingly, the principal diagnosis of stroke is classified more precisely by type. This may be a sign of the increased use of diagnostic imaging, but more precise coding thanks to the DRG (diagnosis related groups) system is also possible (i.e. the precise type of stroke is not only recorded in writing in patients' medical records but also given the appropriate code in administrative data).

Overall, it can be assumed that the introduction of the DRG system for reimbursement of all hospital services in Germany, in 2003 and 2004, has led to an increased incentive to improve coding, which is becoming clear over time. This has little effect on principal diagnosis, as this always had to be stated, but a much greater effect on the completeness of coding of secondary diagnoses and procedures that used to be recorded more rarely. For instance, for stroke patients the secondary diagnoses hypertension and atrial

TABLE 3

Characteristics of hospitals providing stroke care

	2005	2006	2007	2008	2009	2010	p ¹	Trend ² p <0.05
No. of hospitals treating at least 1 case	1462	1429	1400	1384	1361	1334	<0.0001	-
Mean no. of cases per hospital	161	169	172	176	177	182	0.001	+
Distribution of cases (percentiles)								
5 th percentile	4	4	4	3	4	3	0.188	=
Bottom quartile	40	42	36	35	31	27	0.004	-
Median	91	92	88	82	76	71	0.002	-
Upper quartile	200	217	223	231	229	242	0.004	+
95 th percentile	546	587	615	630	671	685	0.0001	+
Interquartile range	160	175	187	196	198	215	0.001	+
Care services provided (% of hospitals)								
Stroke unit (at least 10 cases per year)	13.82	20.85	23.79	25.87	33.43	34.86	0.001	+
Systemic thrombolysis	27.02	32.68	36.86	39.38	42.32	43.40	0.001	+
Selective thrombolysis in intracranial vessels	7.80	8.47	10.07	10.91	12.12	12.14	0.001	+

¹Bilateral p-value for linear trend; ²Direction of trend: -: Significant downward; +: Significant upward; =: No significant trend

fibrillation, as well as speech, language, and swallowing disorders, were recorded increasingly frequently, and this may have been the result of more complete coding. In contrast, the percentage of cases in which a code for the cardinal symptom hemiplegia was recorded as a secondary diagnosis remained unchanged at the level of approximately half of stroke patients.

During the observation period, there was a drop in the percentage of stroke patients for whom a code for pneumonia as a secondary diagnosis was recorded. We consider this decrease as real because it went against the incentives for coding. It may indicate a decrease in this particular complication, e.g. due to improved dysphagia management, and thereby have contributed to the decrease in mortality rates (12).

The number of hospitals providing stroke care fell by 128 during the observation period, which is probably only partly because of the fall in the total number of acute care hospitals in Germany since the DRG system was introduced (13). Percentiles of case numbers show increasing concentration of stroke care. The upper quartile of case numbers increased from 200 to 242, which indicates increasing numbers of cases in high-volume hospitals. At the same time, the lowest quartile of case numbers fell from 40 to 27. This means that many smaller hospitals continued to treat stroke patients despite decreasing case numbers.

The number of hospitals with stroke units according to the definition used here rose from 202 to 465 during the observation period. On the one hand, it is possible that hospitals that already had stroke units before 2006 only began to code this procedure fully

when the OPS code became reimbursable. On the other hand, the fact that this form of care has financial implications for DRG reimbursement has also led to many hospitals opening new stroke units. Reimbursement of this treatment, if the minimum standards defined in the OPS are met, does not depend on whether the stroke unit is certified. In 2010 there were 163 certified stroke units in total (1), but DRG figures identified 465 hospitals that had billed at least 10 treatments in stroke units.

The number of hospitals providing systemic or selective thrombolysis rose from 395 to 579 and from 114 to 162 respectively during the observation period. This result may be due to more complete documentation (systemic thrombolysis has been subject to reimbursement since 2006), but it could also be due to actual provision of additional care services.

Structural changes correspond to care characteristics at the level of individual patients. In 2010 more than half of stroke patients received stroke unit treatment. Systemic thrombolysis was performed in 8.9% of all cerebral infarction patients. As a result of the recently extended time window for systemic thrombolysis, from 3 hours to 4.5 hours after the onset of a cerebral infarction (14), a further increase in the number of cerebral infarction patients receiving this treatment can be expected in the future.

Some of the care characteristics stated here differ from figures based on registry data. The percentage of patients treated in stroke units according to the Rhineland-Palatinate stroke registry is higher than our figure (2). The percentages of cerebral infarction

TABLE 4

Characteristics of stroke care (age >19 years, excluding transferrals from other acute care hospitals)

	2005	2006	2007	2008	2009	2010	p ¹	Trend ² p <0.05
No. of hospital admissions	235 276	242 105	240 837	243 394	240 712	243 032	0.145	=
Admitting department (% of treated cases)								
Internal medicine	43.55	41.35	38.81	36.26	34.20	32.34	<0.0001	-
Neurology	40.84	43.30	46.62	49.67	51.58	54.09	<0.0001	+
Neurosurgery	2.18	2.10	1.84	1.89	2.02	1.84	0.118	=
Intensive care	5.14	5.07	4.94	4.42	4.95	4.51	0.109	=
Other	8.29	8.17	7.79	7.77	7.26	7.22	0.001	-
Mean length of hospital stay (days)	12.52	12.03	11.79	11.61	11.27	10.98	0.0001	-
Specific types of treatment (% of treated cases)								
Complex treatment within neurology or internal medicine for acute stroke, lasting at least 24 hours (8-981 or 8-98b)	15.08	28.98	35.42	41.13	47.77	52.26	0.001	+
Complex treatment at intensive care unit (8-980)	7.56	8.94	9.32	10.16	10.91	11.34	0.0003	+
Ventilation for more than 24 hours	4.68	4.49	4.31	4.27	4.49	4.37	0.239	=
Specific treatment for cerebral infarction alone (% of treated cases)								
Systemic thrombolysis (8-020.8)	2.44	3.98	5.11	6.13	7.86	8.91	<0.0001	+
Selective thrombolysis in intracranial vessels (8-836.70)	0.26	0.25	0.27	0.36	0.47	0.61	0.007	+
Discharge disposition in survivors (% of treated cases)								
Regular end of treatment	61.31	62.14	62.33	62.51	61.76	60.91	0.630	=
Transferral to another acute care hospital	14.09	13.28	12.92	12.89	13.70	13.94	0.930	=
Discharge to rehabilitation facility	19.50	19.12	18.88	18.49	18.20	18.49	0.011	-
Discharge to nursing home	3.44	3.76	4.14	4.42	4.60	4.82	0.0001	+
Miscellaneous/other reasons	1.66	1.70	1.73	1.69	1.74	1.84	0.033	+

¹Two-sided p-value for linear trend; ²Direction of trend: -: Significant downward; +: Significant upward; =: No significant trend
Specific treatments: OPS codes are given in parentheses

patients undergoing systemic thrombolysis in each year are also higher according to the Rhineland-Palatinate stroke registry (2) and the north-western Germany stroke registry (1) than in the DRG figures. This may be because hospitals that provide corresponding care services account for a disproportionate fraction of registry data.

When controlled for demographic changes, the hospital mortality rate for stroke patients has fallen by approximately 20% since 2005. A frequent objection to the calculation of hospital mortality rates is that patients may be transferred before they die. Another mortality rate has therefore also been calculated, for patients who were not transferred to another hospital only. This means that patients who were actually “at risk” of death in the first hospital treating them were included in this subanalysis. This analysis showed an almost identical decrease in the SMR, to 0.80, in 2010. Overall, the fall in the mortality rate shown by DRG data is in line

with a parallel development in cause-of-death statistics (1) and trends reported in the USA (11, 15).

Limitations

Some limitations must be taken into account when interpreting the results of this study. Strokes that did not receive inpatient treatment are naturally not included in administrative hospital data. Strokes that occurred during inpatient hospital stays for other reasons (e.g. as postoperative complications) have also been intentionally excluded from calculation of numbers based on principal diagnoses. Although treated patients transferred from other hospitals were excluded from analysis, single cases may have been counted multiple times if stroke patients left the hospital and were admitted to another hospital for treatment of the same stroke more than 24 hours later. As DRG data are virtually complete for the clinical picture stroke and are not subject to any

TABLE 5

Hospital mortality rates for patients treated for stroke (age >19 years, excluding transferrals from other acute care hospitals)

	2005	2006	2007	2008	2009	2010	p ¹	Trend ² p <0.05
Stroke (I60, I61, I63, I64)								
No. of hospital admissions	235 276	242 105	240 837	243 394	240 712	243 032	0.145	=
No. of hospital deaths	27 872	26 540	25 250	24 811	23 706	23 197	0.0003	-
Crude mortality rate (%)	11.85	10.96	10.48	10.19	9.85	9.54	0.001	-
Expected mortality rate (%; reference: 2005)	11.85	11.86	11.92	11.96	11.97	12.06	0.001	+
SMR	1.00	0.92	0.88	0.85	0.82	0.79	0.001	-
Cerebral infarction (I63)								
No. of hospital admissions	167 541	180 764	186 827	194 680	195 506	199 700	0.003	+
No. of hospital deaths	14 289	14 397	14 605	14 844	14 603	14 293	0.683	=
Crude mortality rate (%)	8.53	7.96	7.82	7.62	7.47	7.16	0.001	-
Expected mortality rate (%; reference: 2005)	8.53	8.56	8.65	8.71	8.73	8.79	0.0003	+
SMR	1.00	0.93	0.90	0.88	0.86	0.81	0.001	-

¹Two-sided p-value for linear trend; ²Direction of trend: -; Significant downward; +; Significant upward; =; No significant trend
SMR: Standardized mortality ratio

selection bias, the information on hospital admissions for stroke they contain can be interpreted as a reliable representation of strokes requiring acute care in Germany, provided these limitations are taken into account.

Summary

Out of the more than 100 million cases receiving hospital treatment between 2005 and 2010 more than 1.4 million patients admitted for stroke were identified and analyzed for this research. This made it possible, for the first time, to provide a virtually complete picture of hospital treatment for stroke in Germany that was not distorted by selection effects, and of trends in the care of such cases.

We observed a decrease in hospital admission rates in older age groups. Although this study cannot demonstrate causal relationships, this decrease may be due to improved primary and/or secondary prevention.

The figures also point to increasingly specific care of stroke patients in hospital. There was a parallel decrease in hospital mortality rates. Whether this is connected with changes in care must be determined by further research.

DRG data cannot answer every question, as the observation period includes hospital stays only and individual record linkage (also with data from other care sectors such as outpatient medical care, rehabilitation, or nursing care) is as yet impossible (16). However, they may add to knowledge obtained from registry or health insurers' data, particularly regarding population-related conclusions, and contribute to the development of new questions.

Complete nationwide evaluations of trends in stroke care over time, which are urgently needed due to demographic changes, can only be obtained in this way, incurring justifiable costs. In our view, DRG data are currently the best available source of data for monitoring acute inpatient care, provided the relevant methodological features are taken into account when interpreting results.

Conflict of interest statement

The Department for Structural Advancement and Quality Management in Health Care at the Technische Universität Berlin, in which both authors are employed, is a foundation of the Helios hospital group.

Prof. Mansky has received a lecture fee from Astellas.

Manuscript received on 23 May 2012, revised version accepted on 5 October 2012.

Translated from the original German by Caroline Devitt, MA.

REFERENCES

1. Heuschmann PU, Busse O, Wagner M, et al. für das Kompetenznetz Schlaganfall, die Deutsche Schlaganfall Gesellschaft sowie die Stiftung Deutsche Schlaganfall-Hilfe: Schlaganfallhäufigkeit und Versorgung von Schlaganfallpatienten in Deutschland. *Aktuelle Neurologie* 2010; 37: 333–40.
2. Grau AJ, Eicke M, Biegler MK, Faldum A, et al.: Quality monitoring of acute stroke care in Rhineland-Palatinate, Germany, 2001–2006. *Stroke* 2010; 41: 1495–500.
3. Günster C: Schlaganfallversorgung in Deutschland – Inzidenz, Wiederaufnahmen, Mortalität und Pflegerisiko im Spiegel von Routinedaten. In: Günster C, Klose J, Schmacke N. *Versorgungsreport 2011*. Stuttgart: Schattauer 2011; 147–63.

KEY MESSAGES

- This original research investigated the care of stroke patients in German acute care hospitals between 2005 and 2010, on the basis of nationwide DRG administrative data.
- Hospital admission rates during this period showed a downward trend in men and women in older age groups. This decrease may indicate an improvement in primary and secondary prevention in Germany.
- The decrease in hospital admission rates in older age groups offsets the expected rise in cases due to demographic changes. As a result, the absolute number of cases did not change significantly during the observation period (e.g. in 2010 the actual number of patients treated for stroke was approximately 18 000 lower than would have been expected on the basis of 2005 rates).
- The percentage of patients treated in stroke units (complex stroke treatment according to the German procedure classification, the OPS) rose from 15% in 2005 to 52% in 2010; the percentage of cerebral infarction patients receiving systemic thrombolysis rose from 2.4% to 8.9%.
- The crude in-hospital mortality rate fell from 11.9% in 2005 to 9.5% in 2010; the relative decrease standardized according to age and sex was approximately 20%.

4. van den Bussche H, Berger K, Kemper C, Barzel A, Glaeske G, Koller D: Inzidenz, Rezidiv, Pflegebedürftigkeit und Mortalität von Schlaganfall. Eine Sekundärdatenanalyse von Krankenkassendaten. *Aktuelle Neurologie* 2010; 37: 131–5.
5. Forschungsdatenzentren der statistischen Ämter des Bundes und der Länder: DRG-Statistik 2005 bis 2010. Eigene Berechnungen.
6. Statistisches Bundesamt: Fallpauschalenbezogene Krankenhausstatistik (DRG-Statistik). Qualitätsbericht. Wiesbaden: Statistisches Bundesamt 2011.
7. Nimptsch U, Mansky T: Krankheitsspezifische Versorgungsmerkmale in Deutschland: Analyse anhand der Bundesauswertung der Ger-

man Inpatient Quality Indicators (G-IQI). *Deutsche Medizinische Wochenschrift* 2012; 137: 1449–57.

8. Deutsches Institut für Medizinische Dokumentation und Information: OPS Version 2010. Operationen- und Prozedurenschlüssel. Internationale Klassifikation der Prozeduren in der Medizin. Düsseldorf: Deutsche Krankenhaus Verlagsgesellschaft 2009.
9. Statistisches Bundesamt: Bevölkerung und Erwerbstätigkeit. Bevölkerungsforschung 2010. Fachserie 1 Reihe 1.3. Wiesbaden: Statistisches Bundesamt 2012.
10. Roeder N, Fiori W, Ringelstein E: Schlaganfallbehandlung im deutschen DRG-System 2006. *Der Nervenarzt* 2006; 77: 221–8.
11. Lee LK, Bateman BT, Wang S, Schumacher HC, Pile-Spellman J, Saposnik G: Trends in the hospitalization of ischemic stroke in the United States, 1998–2007. *International Journal of Stroke* 2012; 7: 195–201.
12. Heuschmann PU, Kolominsky-Rabas PL, Misselwitz B, et al. for the German Stroke Registers Study Group: Predictors of in-hospital mortality and attributable risks of death after ischemic stroke: the German Stroke Registers Study Group. *Archives of Internal Medicine* 2004; 164: 1761–8.
13. Statistisches Bundesamt: Grunddaten der Krankenhäuser 2010. Fachserie 12 Reihe 6.1.1. Wiesbaden: Statistisches Bundesamt 2011.
14. Nolte CH, Endres M: Akutversorgung des ischämischen Schlaganfalls. *Der Internist* 2012; 53: 585–94.
15. Roger VL, Go AS, Lloyd-Jones DM, et al. for the American Heart Association Statistics Committee and Stroke Statistics Subcommittee: Heart disease and stroke statistics—2012 update: a report from the American Heart Association. *Circulation*. 2012; 125: e2–e220.
16. Mansky T, Robra BP, Schubert I: Vorhandene Daten besser nutzen. *Dtsch Arztebl* 2012; 109(21): A 1082–5.

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eMETHODS

Trends in Acute Inpatient Stroke Care in Germany

An Observational Study Using Administrative Hospital Data From 2005–2010

Ulrike Nimptsch, Thomas Mansky

Methods

Data

The data used were the DRG statistics of Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder (federal states) for the years 2005 to 2010 (5). These contain discharge information on all in-hospital episodes in acute care hospitals that are reimbursed via DRG, independently from the type of patients insurance. Only a small percentage of acute inpatient cases are not covered by this database, primarily those treated in hospitals specializing in psychiatric and psychosomatic care (6).

The following information and other details are provided for each record:

- Patient age and sex
- Diagnosis and procedure codes
- Hours of mechanical ventilation
- Specialized departments providing treatment
- Source of admission and discharge status

The observation period for each patient begins on admission to the hospital and ends with discharge, transferral, or death. Patients can be assigned to the respective treating hospital via a pseudonymized hospital identifier.

Since the data do not contain a patient identifier, it is impossible to distinguish between first-time and recurrent strokes. The analyses therefore cover all first-time and recurrent strokes.

Inclusion and exclusion criteria

Patients included were those with the principal diagnoses cerebral infarction, intracerebral hemorrhage, subarachnoid hemorrhage, or stroke of un-specified type, identified using the codes of the German version of the International Classification of Diseases (ICD-10, codes I60, I61, I63, and I64). This means that only hospital treatment resulting from a stroke is included. Because the etiology of stroke in children and adolescents is different from that in adults, the study is restricted to patients aged over 19 years.

When a patient is transferred from one acute care hospital to another for continued stroke treatment, a single stroke may also lead to two or more cases of treatment. In order to prevent a single stroke being counted more than once (as far as possible) and to include primarily hospital stays in the first admitting

hospitals, cases transferred from another acute care hospital were excluded (*Figure*).

Specific treatments and care services provided

Specific treatments and interventions provided were identified via the procedure codes of the German procedure classification, the OPS.

Since 2005, complex treatment of an acute stroke at a specialized stroke unit for a duration of 24 hours minimum can be coded by a specific code of the German version of the OPS (8). Stroke unit care is reimbursable in the German DRG system since 2006.

Under the precondition of a principal diagnosis of stroke (I60, I61, I63, I64) or transient ischemic attack (TIA, G45) the number of episodes with documented stroke unit care per hospital and year was calculated. Existence of a stroke unit in a hospital is assumed when at least ten episodes with coded stroke unit care are present within a calendar year. This prevented isolated coding errors, which may occur, from being assessed as indicating the range of care services concerned. For systemic and selective thrombolysis, a single treated case per year in a hospital was taken to indicate availability of this service.

Statistical analysis

Annual hospitalization rates in relation to the residential population for the year in question (9) were calculated. The following information is given:

- Crude rates
- Rates directly standardized on the basis of distribution by sex and five-year age groups in 2005
- Age- and sex-specific rates for 10-year age groups

Figures on patient, hospital, and care characteristics are shown by year.

Annual in-hospital mortality rates were calculated as the number of patients dying in the hospital as a percentage of all included patients. The effect of demographic changes was controlled for using indirect standardization based on five-year age groups and sex. The mortality distribution in 2005 was used as the reference. The standardized mortality ratio (SMR) is shown. In order to assess trends over time, two-sided p-values were calculated for all parameters using linear regression. The significance level was set at $p < 0.05$. All analyses were performed using the analysis software SAS 9.1.