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Cost of hospitalization for cerebrovascular disorders in Belgium

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Abstract

Background: There is only scarce information on the incidence and costs of stroke in Belgium. Knowledge of these figures permits targeted allocation of resources and aids cost efficacy estimates.

Methods: We analysed a nationwide administrative database used for reimbursement of hospitals in Belgium. This database allows analysis of the rate of all hospital admissions for TIA, acute ischemic stroke, intracranial hemorrhage and carotid surgery or angioplasty. We compared the costs of hospitalization for stroke and related disorders with the costs of hospitalization for coronary artery disease.

Results: There were 32970 admissions for stroke related disorders in 2007 at a cost of 191.6 million EUROS. There was a decline of 4.7% of the rate of hospitalization for stroke and associated disorders over the period 2002-2007. Despite this decline the total costs did not diminish substantially. In 2007 stroke and related disorders accounted for 2.0% of all Belgian hospitalizations, whereas coronary artery disease hospitalization accounted for 4.4%. The length of stay was longer for stroke and associated disorders. The average cost of hospitalizations in 2007 for stroke related disorders was 6188 EURO and the average cost of coronary artery related disorders was 5026 EURO.

Conclusion: The cost of hospitalization for stroke and related disorders is high. Although coronary artery disease is more frequent and has a larger impact on the health care expenditures, the average cost per hospitalization is higher for stroke and related diseases. This is mainly due to the longer hospitalization duration for stroke.

Key words: Health economics; carotid endarterectomy; stroke; cerebrovascular disorders; Transient ischemic attack.

Introduction

Stroke is the most important cause of disability in adults. The health care costs incurred by governments, insurance companies or patients (i.e., the direct medical costs) in the first year after stroke have been estimated to vary between 5435 EURO and 13409 EURO in European countries (1-5). Data on the costs of stroke have not been analyzed systematically in Belgium. One Belgian study estimated a cost of 5990 EURO for hospitalization and 11445 EURO for follow up costs up to two years after acute ischemic stroke (6). These estimates were based on data from a single hospital from the mid-nineties. Information on the current costs of stroke is of interest because an accurate cost estimate can be used for better allocation of resources and can be used for cost-effectiveness analyses.

There are only a limited number of studies in Belgium on the incidence and prevalence of stroke. One study, based on data from 178 general practitioner (GP) sentinel practices, estimated a yearly incidence of stroke of 185 per 100000 inhabitants in the period 1998-1999 (7). The INTEGO network, a second GP network limited to the Flanders region in Belgium estimates an incidence of 2.18 per thousand yearly patient contacts in 2008, but translation to an exact population based incidence rate is not straightforward (8, 9). In the Belgian Health Survey of 2008, the prevalence of stroke among respondents aged 65 or more was three percent (10). These studies have limitations however as the registration by GPs might be incomplete and self-reported stroke diagnoses are not always accurate. An accurate way of real time monitoring of stroke incidence would be valuable.

The All Patient Refined Diagnostic Related Groups (APR-DRG) is a system to classify patients admitted to hospital into groups expected to have similar resource use. In order to assign patients to the DRG, information on ICD-9 diagnoses, the use of procedures, age, sex and the presence of complications and comorbidities is provided to a software tool to create categories of patients. Note that this

system is not intended as a diagnostic system, but as a tool for reimbursement of homogenous groups of patients with equivalent use of hospital resources.

As there is a lack of formal cost of stroke studies in Belgium, we used data from an administrative database based on the APR-DRG system of hospitalizations to study the cost of stroke and related disorders in Belgium. We also probed whether this database could be used to monitor the incidence of hospitalized stroke in Belgium.

Methods

Data sources

We used data from the period 2002-2007 of the "National Database Medical Diagnosis/Care & Cost" (11). This registry collects the medical diagnoses anonymously from all patients that are admitted overnight to all acute Belgian hospitals and the costs charged to the healthcare insurances for each admission. Briefly, hospitals provide ICD9 diagnoses and procedures for each hospital admission and 3M grouper software generates the associated medical diagnostic categories (MDC) and All Patient Refined Diagnosis Related Groups (APR-DRG, version 15). The database links the MDC and DRG to the costs charged for each admission to the health insurance companies. Information on age, sex and length of stay is also collected. The ICD-9 codes are validated by audits of individual files by the Ministry of Health. The costs are controlled by the insurance companies and INAMI/RIZIV.

Definition of stroke and related conditions

Online Table 1 shows the APR-DRG which were considered to be related to cerebrovascular disorders in this study. There are some limitations to these data. Non-traumatic subdural hematomas are included in the APR-DRG 44, although this is strictly not considered a stroke phenotype. Regarding APR-DRG 24, there is no information on the rate of carotid intervention for symptomatic versus asymptomatic carotid stenosis. Finally, intracerebral hematomas for which a craniotomy is performed are not coded as APR-DRG 44 as these are included into the broad APR-DRG category 21 (craniotomy except for trauma). For these analyses we will use the term stroke related conditions as admissions with APR-DRG 24 & 44-47. The APR-DRG 45 and 46 will be referred to as single category of ischemic stroke. In patients with APR-DRG 46 a definite diagnosis of ischemia versus intracerebral hemorrhage is impossible. Yet, as the proportion of ischemic stroke versus intracerebral hemorrhage is much larger we elect to classify these as ischemic stroke. APR-DRG 44 will be considered ICH and APR-DRG 47 as TIA. APR-DRG 24 were considered as carotid endarterectomies (CEA).

Online Table 1

Stroke and related conditions

APR DRG	24	Extracranial vascular procedures
	44	Intracranial hemorrhage
	45	CVA with brain infarction
	46	Nonspecific CVA and precerebral occlusion without brain infarction
	47	Transient ischemia

Definition of coronary artery disease

Online Table 2 shows the APR/DRG which were related to coronary artery disease. We tried not to be limitative for the definition of coronary artery disease.

Validation of APR-DRG data

First validation cohort

To validate the stroke and related conditions coding data we compared the discharge diagnosis of patients enrolled in the Stroke Registry of the Stroke

Online Table 2

Coronary artery disease and related conditions

APR DRG	165	Coronary bypass without malfunctioning coronary bypass with cardiac catheterisation
	166	Coronary bypass without malfunctioning coronary bypass without catheterization
	170	Permanent cardiac Pacemaker implant with acute myocardial infarction, shock or heart failure
	174	Percutaneous Coronary Intervention with myocardial infarction
	175	Percutaneous Coronary Intervention without myocardial infarction
	190	Circulatory disorders with acute myocardial infarction
	192	Cardiac catheterization for ischemic heart disease
	196	Cardiac arrest, unexplained
	202	Angina Pectoris

Unit of the Department of Neurology of the University Hospitals Leuven in the year 2006-2007 with the coding of cases provided by the government database for the same years. The Leuven database prospectively registers all admissions for suspected ischemic stroke and TIA to the Stroke Unit. Subarachnoid hemorrhages are not recorded in this database, nor are endarterectomy procedures for asymptomatic carotid stenosis. A final diagnosis is recorded by a neurologist specialized in cerebrovascular disorders based on clinical and imaging data. Patients are divided into a discharge diagnosis of ischemic stroke, any cerebral hemorrhage, transient ischemic attack and non-stroke. We also register whether carotid endarterectomy is performed during the admission. Patients with dissections without cerebral ischemia and patients with cerebral venous thrombosis are coded as non-stroke.

Second validation cohort

As the stroke registry is tailored towards ischemic problems, we retrospectively studied an additional sample of patients suffering from intracranial hemorrhage. The patients were recruited from the Stroke unit of the University Hospitals Leuven under supervision of the treating neurosurgeon with admission diagnoses of intracerebral hemorrhage, subarachnoid hemorrhage and subdural hematomas between September 1th 2006 and August 31th 2007. Intracerebral hemorrhages and subarachnoid hemorrhages were classified as intracranial hemorrhages by a stroke neurologist blinded to the results of the APR-DRG assignment. Subdural hematomas were not classified as intracranial hemorrhage.

Statistics

For the administrative data analyses only group level data and averages were used as no individual data were available. Spearman rank correlation analysis was used to correlate demographic data, length of stay and costs over time. For the validation study, we measured the sensitivity and specificity and 95% confidence intervals of the APR-DRG codes as compared to the discharge diagnosis. In the first validation cohort, we compared first all stroke related APR-DRGs with any discharge diagnosis of TIA, ischemic stroke, intracerebral hemorrhage or the performance of a carotid endarterectomy. Secondly, we compared the individual APR-DRGs with the discharge diagnosis or the performance of carotid endarterectomy. In the second validation cohort we compared the discharge APR-DRG with discharge diagnosis. Statistics were performed in SPSS 16.0. A two tailed p-value of smaller than 0.05 was considered significant.

Results

Validation study

First validation study

We enrolled 676 patients during the years 2006 and 2007 in the stroke registry. The discharge diagnosis was ischemic stroke in 476 (70%), TIA in 168 (25%) and intracerebral hemorrhage in 4 (1%). A non-stroke diagnosis was made in 28 (4%) patients. Carotid endarterectomy was performed in 33 (5%) patients with cerebral ischemia. The sensitivity of all stroke related APR-DRG versus the discharge diagnosis of any of ischemic stroke, intracerebral hemorrhage or carotid endarterectomy was 0.89 (95% CI, 0.88-0.90) and the specificity was 1 (95% CI, 0.88-1.00). For the individual diagnoses, the sensitivity and specificity were as follows: for the APR DRG 45-46 versus discharge diagnosis ischemic stroke the sensitivity was 0.81 (95% CI 0.78-0.82) and the specificity 0.81 (95% CI 0.76-0.85), for the APR-DRG 47 versus TIA the sensitivity was 0.66 (95% CI 0.62-0.68) and the specificity 0.98 (95% CI 0.97-0.99), for the APR-DRG 24 versus carotid endarterectomy the sensitivity was 0.97 (95% CI 0.89-0.99) and the specificity 0.99 (95% CI 0.99-1.00). The main reason for differences in APR-DRG assignments and discharge diagnoses was the (rightful) use of surgical codes for patients with TIA or ischemic stroke because of performance of surgical procedures during admission.

Second validation study: Intracerebral hemorrhage

We enrolled 84 patients from the Department of Neurosurgery during the study period. The discharge diagnosis was intracerebral hemorrhage in 51 (61%) patients, subarachnoid hemorrhage in 26 (31%) and other diagnoses in 7 (8%) patients. The sensitivity of the APR-DRG 44 versus any ICH or SAH was 0.46 (95% CI 0.42-0.47) and the specificity was 0.71 (95% CI 0.37-0.92). Again, the main reason for the differences between discharge diagnosis and APR-DRG assignments was the rightful use of surgical codes in the APR-DRG system because of performance of surgical procedures during admission.

Analysis of administrative database

Demographics 2002-2007

There were 32970 admissions for APR-DRG stroke related conditions in 2007. This represents

2.0% of the total of 1569827 number of admissions in Belgium. There were 3055(9.3%) admissions for ICH related APR-DRG, 16239(49.3%) for ischemic stroke related APR-DRG and 7606(23.1%) for TIA related APR-DRG. Additionally, CEA related APR-DRG were coded during 4063 (12.3%) admissions.

In 2007 the average age for patients admitted with ICH was 73 years, for ischemic strokes and TIA 75 years. Patients with CEA were on average 71 years. The age of patients with ICH increased from 71 to 73 years between 2002 and 2007 ($\varrho = 0.926$, $p = 0.008$) and remained stable for TIA and stroke.

Table 1 shows the number of stroke related conditions during the years 2002-2007. In these 6 years there was a significant decline of the numbers of hospitalized patients by 4.6 percent ($\varrho = -0.943$, $p = 0.005$). There was an important reduction in the use of code DRG 46 and an increase in the use of code DRG 45. Combining these two, there was a net reduction of 5.4% ($\varrho = -1$, $p = 0.003$). There was a non-significant decrease of hospitalizations for TIA with 7.4% ($\varrho = -0.77$, $p = 0.072$). The frequency of admissions for carotid endarterectomy and ICH did not change over time.

Length of stay

In 2007 the average length of stay for ICH related APR-DRG was 17 days, for strokes with brain infarction 20 days, for ill defined strokes 12 days and for TIA 9 days. Patients who underwent extracranial vascular interventions stayed on average 8 days. The average length of stay for all patients with stroke and related disorders was 14 days. Except for a decline in the length of stay for APR-DRG 46 ($\varrho = -0.986$, $p = 0.001$) and a minor decline in the length of stay for TIA ($\varrho = -0.845$, $p = 0.03$) and CEA ($\varrho = -0.926$, $p = 0.008$), there is no clear reduction over time (data not shown).

Costs of hospitalization

Table 2 provides cost data for the period 2002 and 2007. The total cost for stroke and related diseases admissions was 191.62 million EURO in 2007. This represents 2.9% of the total budget of hospital admissions in Belgium and 0.69% of the total health care expenditures by RIZIV/INAMI in Belgium for 2007 (12). The average cost per patient was 6189 EURO, varying between 3859 EURO for patients with TIA up to 7792 EURO for patients with stroke and brain infarction. There was no reduction of costs over time ($\varrho = 0.429$, $p = 0.4$). There was no correlation between the number of admissions and costs ($\varrho = -0.143$, $p = 0.79$). There also was no clear correlation between length of stay and costs (data not shown).

Comparison with hospitalization for coronary artery disease (CAD)

There were 68867 admissions for CAD related disorders in 2007. This represents 4.4% of all Belgian admissions for that year. The average cost per admission was 5026 €. The total cost was 351.98 million €. This represents 5.3% of the total budget for hospital admissions and 1.3% of the health care expenditures of RIZIV/INAMI (2007).

Discussion

There is a need for real time monitoring of the prevalence and incidence of common diseases, like stroke or ischemic heart disease in order to target

Table 1

Number of admissions per year

	Year	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**
DRG 44	Intracranial hemorrhage	3055	3106	3023	3116	2910	3047
DRG 45	Stroke with brain infarction	14159	13866	13035	10357	8977	7648
DRG 46	Ill-defined stroke	2080	2722	3652	6331	8177	9514
	All stroke	19294	19694	19710	19804	20064	20209
DRG 47	TIA	7606	7558	7545	7823	7982	8214
DRG 24	Interventions on extracranial vessels	4063	4223	4185	4287	3902	4045
	Total numbers of stroke related admissions, n	32970	33481	33445	33918	33951	34470
	Total numbers of admissions ,n	1569827	1594501	1557245	1526872	1532567	1525454
	Stroke related admission as % of total number of admissions	2.0	2.1	2.1	2.2	2.2	2.3

Table 2

Average and total costs for stroke in the years 2002 to 2007

Average cost (€)	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**
DRG 44-ICB	6964	6863	5835	6000	6521	6045
DRG 45-CVA w/ brain infarction	7792	7768	6625	6654	7197	7135
DRG 46-Ill-defined stroke	4828	4854	4452	5238	5733	5701
DRG 47-TIA	3859	3753	3593	3615	3872	3781
DRG 24-CEA	5075	5148	4890	4782	5065	5008
Average cost (€)	6189	6111	5338	5312	5670	5499
Total cost (million €)	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**
DRG 44-ICB	21.27	21,32	17,64	18,70	18,98	18,42
DRG 45-CVA w/ brain infarction	110.33	107,71	86,36	68,92	64,61	54,57
DRG 46-Ill-defined stroke	10.04	13,21	16,26	33,16	46,88	54,24
DRG 47-TIA	29,35	28,37	27,11	28,28	30,91	31,06
DRG 24-CEA	20,62	21,74	20,46	20,50	19,76	20,26
Total cost (million €)	191.62	192,34	167,82	169,55	181,13	178,54

health care resources appropriately and to assess the effect of health interventions on a population basis. Large scale, population based studies are the ideal source to study the epidemiology of these diseases but these studies are difficult to perform and are expensive. In order to provide the necessary numbers of endpoints to provide reliable estimates they require the follow up of a large population of subjects over a long period. Data from large government databases or insurance companies could provide a faster way to study trends in incidence over time provided they are accurate. In Belgium there is a dearth of epidemiologic studies. However, every year administrative data regarding hospitalizations are made publicly available. These administrative data provide nationwide information on the APR-DRG codes and on their associated costs. We sought first to correlate these administrative categorizations intended for reimbursement purposes with actual discharge diagnoses. We conclude from our study that the APR-DRG codes for ischemic stroke and TIA correlate quite well with the discharge diagnosis. In contrast, the APR-DRG code for intracerebral hemorrhage severely underestimates the number of admissions for ICH and, by definition, includes a non-stroke related condition (non-traumatic subdural hematoma). Using these administrative data, we moreover show a reduction in the number of stroke and related admissions over a period of 6 years. This reduction in admissions is not paralleled by a reduction in hospitalization costs. Finally, we demonstrate that the average cost per hospitalization for a stroke related condition is higher than the cost for coronary artery disease related diseases. Both stroke and coronary artery disease pose an important burden on the health care budget allocated to hospitalizations with both conditions accounting together for 6.8% of the entire hospitalization budget.

Our study shows that ischemic stroke not only is the most frequent neurovascular condition but also suggests that it is the most expensive of these disorders. We have to be cautious however to make this conclusion as brain hemorrhage might be much more expensive but this is not captured by the administrative data due to important coding limitations in ICH APR-DRGs as mentioned above. Using ICD9 codes might be a more accurate way of determining the incidence of hospitalized ICH (13).

The sensitivity and specificity we found using APR-DRG codes for ischemic stroke is similar to the accuracy of ICD9 coding (14, 15). One study found that when ICD-9 codes were used the top five discharge diagnoses had to be taken into account to accurately identify ischemic stroke (16).

The decrease in stroke hospitalization over time we found is puzzling. The only published study on the epidemiology of stroke in Belgium estimated an annual incidence of hospitalized ischemic stroke of 11700 per year in the years 1998-1999 (7). According to our study however, the rate of hospitalization in 2007 had risen to about 16000 ischemic strokes. Compared to the epidemiological study, this is an increase in hospitalization rate with 4300 patients or 37%. This does not of course necessarily mean an increase in the actual number of ischemic strokes, but probably indicates a higher admission rate given

the advent of new treatments and rising stroke awareness and information campaigns urging rapid admission for stroke (17). The hypothesis of easier admission of ischemic strokes to hospital is however at odds with the finding of a steady decrease in hospitalization rates from 2002 onwards according to our study. We suspect that different capture methods used in the different studies might explain the differences in stroke rates between the GP study and the hospital based administrative data. A decline of stroke incidence has been noted in several epidemiological studies in high income countries over the past decades with the increased adoption of cardiovascular prevention measures (18-21). This decline might have come to a standstill recently (22).

Despite the decline in hospitalization rate we could not demonstrate a proportionate reduction in the global costs of caring for hospitalized stroke patients. This might be due to the adoption of a less nihilistic attitude towards stroke over time with a more thorough approach to diagnosis, more extensive use of medical and paramedical resources and more aggressive use of medication. However, these more assertive attitudes would not be expected to lead to the haphazard increase and decrease of global costs we observed within a few years with variations in costs of up to 14% (eg between 2005 and 2006). These erratic cost fluctuations are difficult to interpret without more detailed access to the causes of the cost variations.

It is often thought that the hospitalization of patients with cardiac disorders is very expensive given the extensive use of advanced diagnostic technology and the access to costly therapeutic procedures like coronary artery stenting and coronary bypass grafting. Although it is true there are very costly APR-DRGs for some cardiac disorders, the average cost is 13% lower than the cost of stroke. One obvious difference explaining the high cost is the approximate threefold length of stay difference between stroke and MI. Correcting for length of stay leads to a higher per diem cost for coronary artery disease of about 1000 EURO compared to 400 EURO for stroke.

Our study has limitations. Data from administrative registries suffer from limitations (16, 23). The costs we calculated have not been validated by a bottom up approach and some costs might not have been taken into account. The big advantage of administrative data is their face validity especially from the viewpoint of the government and insurance companies. Our comparison between discharge diagnosis and APR-DRG assignment was performed in only one academic center. This should be extended to more academic and non-academic centers. The stroke registry we used does not capture stroke patients hospitalized outside of a stroke unit and may be therefore biased. Also, we did not correlate the codes from coronary artery diseases with discharge diagnoses. Also, in a minority of patients myocardial ischemia and stroke may have coexisted, yet in those cases a single APR-DRG is assigned. Our data are also already a few years old because of the publication delay of the administrative data on the website.

We conclude that the global cost of hospitalization for stroke and related disorders is high. Although coronary artery disease is more frequent and has a larger impact on the health care expenditures, the average cost per hospitalization is higher for stroke and related diseases. This finding is mainly due to the longer hospitalization duration for stroke. Hospitalization administrative data can be used to monitor the incidence of hospitalized ischemic stroke but not for intracranial hemorrhage.

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