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Hospitalization Resource Use and Costs Before and After TIA and Stroke: Results from a Population-Based Cohort Study (OXVASC)

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ABSTRACT

Objectives: High hospitalization rates, prolonged length of stay, and increased risks of subsequent events mean a steep increase in health care usage after stroke. No study, however, has examined to what extent increased costs after transient ischemic attack (TIA) or stroke are due to hospitalizations for the initial event, recurrent events, and/or nonvascular hospitalizations, and how costs compare with the year prior to the event. **Methods:** We studied patients in a population-based cohort study (Oxford Vascular Study) in the United Kingdom from 2003 to 2007. Hospitalization and cost details were obtained from patients' individualized Hospital Episode Statistics records. **Results:** A total of 295 incident TIA and 439 incident stroke patients were included. For patients with stroke, average costs increased from £1437 in the year pre-event to £6629 in the year post-event ($P < 0.0001$). Sixty-four percent (£4224) of poststroke costs were due to hospitalizations linked to the index stroke, more than 30% of which were given nonvascular primary diagnoses on Hospital Episode Statistics, and £653 (10%) were due to hospitalizations linked to subsequent vascular events. For patients with TIA, costs increased from £876 1 year before the event to £2410 in the year post-event ($P < 0.0001$). Patients with TIA incurred nonsignificantly higher costs due to hospitalizations linked to subsequent vascular events (£774) than for hospitalizations linked to the index TIA (£720). **Conclusions:** Hospital costs increased after TIA or stroke, primarily because of increased initial cerebrovascular hospitalizations. The finding that costs due to nonvascular diagnoses also increased after TIA or stroke appears, in part, to be explained by the miscoding of TIA/stroke-related hospitalizations in electronic information systems.

Keywords: cost analysis, health care utilization, regression modeling, stroke.

Introduction

High hospitalization rates, prolonged length of stay and rehabilitation, and an increased risk of subsequent vascular events mean a steep increase in the use of health care resources and costs after stroke and to a lesser extent after transient ischemic attack (TIA) [1–4]. In addition, there is evidence that patients with stroke are at an increased risk of infection [5], falling [6], and experiencing bone fractures [7], with a further increased likelihood of higher hospital use and costs.

As TIA and stroke are associated with old age and generally occur in patients with other comorbidities [8], such patients are likely to consume substantial hospital resources even if they had not suffered a TIA or stroke, making the impact of disease on costs difficult to determine. Despite this, evidence from a literature review showed that only a minority of studies assessed the costs that could be directly attributed to TIA or stroke by either comparing costs of patients with controls or comparing costs incurred before the event to subsequent costs [9], with none including patients with TIA [9]. In addition, no study examined the reasons for the observed increase in costs after stroke, that is, whether observed increases in costs were due to hospitalizations for the initial event, recurrent events, and/or noncerebrovascular causes.

The objective of this study, therefore, was to compare differences in hospitalization resource use and costs during the 12 months before and after TIA or stroke onset and to investigate the reasons for any observed differences between the two time periods.

Methods

The Oxford Vascular Study

The Oxford Vascular Study (OXVASC) population comprises more than 91,000 patients registered in nine general practices across Oxfordshire, UK. The study methods have been described elsewhere [8]. Briefly, patient registration began on April 2002 and is ongoing. Only consenting patients recruited from April 1, 2003, to March 31, 2007, were included in this analysis. Patients recruited between April 1, 2002, and March 31, 2003, were excluded as electronic Hospital Episode Statistics (HES) records for the year before the event were not obtained. Patients in whom TIA or

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stroke was suspected were ascertained by using multiple overlapping methods of "hot" and "cold" pursuit and considered for inclusion [10], including the following:

1) A daily (weekdays only), urgent open-access "TIA clinic" to which participating general practitioners and the local accident and emergency department send all individuals with suspected TIA or stroke whom they would not normally admit to hospital, with alternative on-call review provision at weekends;
2) Daily searches of admissions to the medical, stroke, neurology, and other relevant wards;
3) Daily searches of the local accident and emergency department attendance register;
4) Monthly computerized searches of general practitioner diagnostic coding and hospital discharge codes;
5) Monthly searches of all cranial and carotid imaging studies performed in local hospitals; and
6) Monthly reviews of all death certificates and coroners reports.

Patients with suspected TIA/stroke were assessed urgently by a study clinician. Stroke was defined according to World Health Organization definitions and included all ischemic events, intracerebral hemorrhage, subarachnoid hemorrhage, and strokes of uncertain type. Informed consent was sought, and assessments of neurological impairment, history of presentation, medical and social history, and risk factors were performed. Impairment was measured by using the National Institutes of Health Stroke Scale (NIHSS), which was used to categorize event severity. Minor events were defined as NIHSS scores of less than or equal to 3, moderate as scores from 4 to 10, and severe as scores of more than 10.

To better understand the impact of stroke and TIA on hospital resource use and costs, we excluded from the analyses all those patients with a history of stroke and TIA. Surviving patients were then followed-up face to face by a research nurse at 1, 6, 12, 24, and 60 months after the event. Patients were also followed-up via their general practitioner records, recurrent vascular events were identified by ongoing ascertainment, and all patients had mortality follow-up.

Resource use

Resource use for each patient was obtained from the date of first TIA or stroke within the OXVASC period (i.e., index event) until 1-year follow-up or death within that period. In addition, the resources consumed within the 12 months prior to the index event were obtained. Details of hospital admissions were obtained from the patient's HES records [11]. HES contain details of all admissions to English hospitals funded by the National Health Service (NHS). For each hospital admission, HES provided information on the primary diagnosis and secondary diagnoses (coded using *The International Statistical Classification of Diseases and Related Health Problems, 10th Revision* [*ICD-10*]), date of admission and discharge, admission method, and details about the procedures and operations undertaken during each admission (coded by using the Tabular List of the Classification of Surgical Operations and Procedures).

For hospitalizations in which the patient was admitted and discharged on the same day, the number of days in hospital was 0 and the hospitalization was classified as a day case. When the index event occurred while in hospital, the hospital days before the event and those on or after the event were treated as pre- and postevent days, respectively. For those hospitalizations in which the patient was admitted during the 1-year study period after the index event, but discharged more than 1 year after event onset, we took into account only the days in hospital occurring during the 1-year period.

Reasons for hospitalization were determined by examining the primary diagnosis codes. For the purpose of our analysis, cerebrovascular hospitalizations were those with an *ICD-10* primary diagnosis code of G450 to G648, H340 to H342, H348, or I600 to I698; cardiovascular were those with *ICD-10* codes of I00 to I528, or I700 to I99; and those hospitalizations with any other *ICD-10* primary diagnosis code were recorded as nonvascular. As hospitalizations could have more than one primary diagnosis (e.g., an admission diagnosis and a discharge diagnosis), hospitalizations with multiple primary diagnoses in which at least one was for cerebrovascular disease were coded as cerebrovascular, irrespective of other primary diagnoses.

Hospitalizations occurring within 7 days of the index event (including those in which the index event occurred while in hospital), irrespective of primary diagnosis, were linked to that event. In addition, if the patient was subsequently discharged to another hospital, that hospitalization was also linked to the event (e.g., patient was transferred from the acute hospital to a community hospital). By using the same methodology, we also linked hospitalization information with subsequent vascular events, including stroke, TIA, and coronary and peripheral vascular disease events. Subsequent vascular events were identified by face-to-face follow-up and as part of the ongoing OXVASC ascertainment process. However, for those patients already hospitalized when a subsequent vascular event occurred, it was not possible to separately attribute resources to the multiple events and so all the days in hospital were combined together as part of the initial event.

Unit costs

In England, NHS hospitals are reimbursed for the services they provide through a national tariff of prices reflecting the national average cost of providing a hospital service. Each hospital service is assigned to a Health Resource Group (HRG) that groups together similar clinical procedures that cost an equivalent amount to deliver [12]. Prices in the national tariff have been set on the basis of the average cost of providing a particular HRG by using data gathered from NHS hospitals. In addition, hospitals receive additional funding for high-cost drugs, additional hospitalization days past a certain threshold, and provision of direct-access diagnostics and specialized rehabilitation.

Each hospitalization was valued by using the 2008/09 HRG English tariff. To determine the HRG for each hospitalization, and any additional payments received for the provision of additional services, each hospitalization in HES was coded by using the HRG grouper (version 4 2008/09) software (The Health and Social Care Information Centre, Leeds, UK). HRGs were then linked to a series of elective and emergency reference costs obtained from the 2008/09 schedule of NHS reference costs [13].

Statistical analyses

Hospitalizations were reported as rates (i.e., the total number of hospitalizations divided by the total time of observation). Rates before and after the event were reported with their standard error and compared by using rate ratios reported alongside 95% confidence intervals (CIs). Statistical differences were evaluated assuming a Poisson distribution. Days in hospital and costs were reported as means together with their SD, with mean differences between the two time periods reported alongside 95% CIs, and evaluated by using a Student's two-sided *t* test. Hospital days and costs for patients dying after the index event were analyzed in the same way as for survivors.

To assess the predictors of costs during the year after the index event, a two-part regression model was used. A logistic regression was first used to assess the predictors of having at least one hospital admission during the year following the index