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ORIGINAL ARTICLE

Trends in treatment and outcome of stroke patients in Finland from 1999 to 2007. PERFECT Stroke, a nationwide register study

ATTE MERETOJA[1], MARKKU KASTE[1], RISTO O ROINE[2], MERJA JUNTUNEN[3], MIIKA LINNA[3], MATTI HILLBOM[4], REIJO MARTTILA[2], TERTTU ERILÄ[5], AIMO RISSANEN[6], JUHANI SIVENIUS[7] & UNTO HÄKKINEN[3]

[1]*Department of Neurology, Helsinki University Central Hospital, Helsinki, Finland,* [2]*Department of Neurology, Turku University Hospital, Turku, Finland,* [3]*National Institute for Health and Welfare, Helsinki, Finland,* [4]*Department of Neurology, Oulu University Hospital, Oulu, Finland,* [5]*Department of Neurology, Tampere University Hospital, Tampere, Finland,* [6]*Department of Neurology, Jyväskylä Central Hospital, Jyväskylä, Finland, and* [7]*Brain Research and Rehabilitation Center Neuron; Department of Neurology, Kuopio University Hospital, Kuopio, Finland*

Abstract

Introduction: This article in this supplement issue on the Performance, Effectiveness, and Costs of Treatment episodes (PERFECT) project describes trends in Finnish stroke treatment and outcome.

Material and Methods: The PERFECT Stroke study uses multiple national registry linkages at individual patient level to produce a national stroke database with comprehensive follow-up of all hospital-treated stroke patients in Finland.

Results: There were 94,316 incident stroke patients treated in Finnish hospitals from 1999 to 2007. Lengths-of-stays decreased after ischemic stroke (IS), and increased after intracerebral (ICH) and subarachnoid (SAH) hemorrhage. Ten-year survival improved in IS (hazard ratio 0.75; 95% CI 0.71–0.79) and ICH patients (0.88; 0.79–0.97), increasing median survival by 2 and 1 life-years respectively. This has translated into more days spent home among IS patients, but not among ICH patients. Treatment by neurologists improved the survival of IS (odds ratio [OR] 1.77; 95% CI 1.70–1.84) and ICH patients (OR 1.55; 95% CI 1.40–1.69), and treatment by neurosurgeons of SAH patients (OR 2.66; 95% CI 2.25–3.16), the effects were further improved by care in specialized stroke centers.

Discussion: The survival of Finnish IS and ICH patients has improved. Specialized acute care was associated with improved outcome.

Key words: *Benchmarking, follow-up studies, mortality, outcome and process assessment (health care), regional differences, registries, specialization, stroke.*

Introduction

Stroke is the second leading cause of death worldwide after coronary heart disease, accounting for 10% of all deaths (1). In Finland, stroke mortality has been declining and is surpassed by cancer and recently also dementia as a cause of death. Despite this, stroke causes 8.9% of all deaths in Finland (2). Stroke incidence is strongly age-dependent (3) and Finland has one of the most rapidly ageing populations in Europe, with 17.2% of the population currently aged above 65 years, and the portion increasing to 25.1% by year 2030, that is a 50% increase (4). Estimates on the future numbers of stroke patients in Finland vary widely based on risk factor modification success (5). If primary prevention does not improve, Finland faces a rapidly growing number of stroke patients. Stroke care should be organized in an optimal way to satisfy future increases in demand.

In Finland, specialised care is provided by 21 hospital districts, each with one central hospital,

Correspondence: Atte Meretoja, Department of Neurology, Helsinki University Central Hospital, P.O. Box 340, FI-00029 HUS Helsinki, Finland. Tel: +358 400 536 752. Fax: +358 9 471 74089. E-mail: atte.meretoja@fimnet.fi

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Key messages

- Stroke outcome in Finland has improved.
- Acute treatment has become more specialized, which is associated with improved patient outcome.
- A significant portion of Finnish stroke patients still do not receive optimal care.

and some with additional smaller local hospitals. The hospital districts plan and provide acute services for stroke patients, whereas rehabilitation and post-acute care is often provided by health centres owned by municipalities. Public universal health care is available for all, and is financed by the tax payers of the municipalities. There are large differences between the hospital districts in both acute and post-acute services for stroke patients. Organization of stroke care has specialized over recent decades with the introduction of the stroke units (6), and lately primary and comprehensive stroke centers (7,8), both of which have been shown to improve patient outcome (9,10). Acute thrombolytic therapy (11,12), and effective secondary prevention including antithrombotics (13–15), antihypertensive medications (16), and statins (17) have become available for ischemic stroke, and have been added to the European (18,19) and Finnish national guidelines (20). To further improve stroke care and implement existing treatments, clear goals have been defined in the Helsingborg declaration to be achieved by year 2015 (21).

This article in this supplement issue on the Performance, Effectiveness, and Costs of Treatment episodes (PERFECT) project demonstrates how the PERFECT Stroke database can be utilized in guiding health policy decision making. Specifically we describe trends in treatment of stroke patients (lengths-of-stay (LOS); treating specialty; treatment at stroke centers), and patient outcome after stroke in Finland. We also analyze differences between regions and providers.

Material and Methods

A comprehensive description of methodology in the PERFECT project is given in a separate article of this Supplement (22).

Patient selection

Patients in the PERFECT Stroke database are selected from the national hospital discharge registry (HDR) with the international classification of diseases 10th version (ICD-10) primary diagnosis stroke codes I60 (subarachnoid hemorrhage (SAH)), I61 (intracerebral hemorrhage (ICH)) and I63 (ischemic stroke (IS)). The database also includes transient ischemic attack ((TIA), G45), and other cerebrovascular disease (I62, I64–I68) patients, which are not included in this paper. Patients with a stroke syndrome diagnosis (G46) are classified according to etiological subcode (I60–I67).

Only incident, that is first-in-a-lifetime, strokes occurring between 1 January 1999 and 31 December 2007 are included in this report. Patients with a previous stroke diagnosis (I60–I69) are excluded. Previous diagnoses are checked for in the HDR back to 1987. Tourists, visitors, and foreigners without residence in Finland are not included in the database. All patients are currently followed up until 31 December 2008.

Abbreviations

HDR	Finnish national hospital discharge registry
HR	hazard ratio
ICD-10	International classification of diseases, 10th version
ICH	intracerebral hemorrhage
IQR	interquartile range
IS	ischemic stroke
LOS	length of stay
OR	odds ratio
PERFECT	Performance, Effectiveness, and Costs of Treatment episodes
SAH	subarachnoid hemorrhage
SII	Finnish national social insurance institution
TIA	transient ischemic attack

Episode definition

Treatment of stroke patients requires a multidisciplinary approach and a chain of recovery starting from acute care, through rehabilitation, up to discharge home or to long-term institutional care. Often several hospitals and providers are involved. In the PERFECT Stroke database, this chain is linked to form the total cycle of inpatient care, the first hospital episode, starting from initial acute hospital with incident stroke diagnosis, and ending with patient's death, discharge home, or discharge to a long-term care facility (e.g. nursing home).

Register linkage

In addition to in-patient care derived from the HDR, information on co-morbidities, concomitant medications before and after stroke, and mortality were gathered. For this purpose several national registries were linked with the HDR on individual patient level using social security codes, that is personal identification numbers. These unique numbers are uniformly used in all national registries, and all Finnish residents have one.

Prescription medication purchases one year prior and one year post incident stroke were derived from the registries of the national Social Insurance Institution (SII). Information on co-morbidities was gathered from several overlapping sources: previous HDR diagnoses, medication purchases, and SII database of reimbursement codes for long-standing diagnoses. Information on date of death was received from Statistic Finland Causes-of-Death registry (22). The registries have been reviewed (23).

Process and cost indicators

Stroke process of care indicators were LOS at various stages of the care, use of various medications before and after stroke, some procedures related to the stroke, and costs. Methodology for evaluating costs is described in detail elsewhere (24). Hospitals were designated as comprehensive or primary stroke centers, or not fulfilling these criteria, based on national audits described elsewhere (10).

Outcome measures

Outcome is measured as all-cause mortality within 28, 90, and 365 days after stroke. In addition, we report days spent at home within a year after stroke, which reflects both need for institutional care and survival. In this article we also analyze long-term mortality, up to 10 years of follow-up. Data on re-hospitalizations for new acute strokes is available, but not analyzed here due to lack of space.

Benchmarking and risk-adjustment

The PERFECT Stroke database is used for comparison of hospitals and health districts, that is, benchmarking, on performance and costs of stroke care. For benchmarking purposes, to make the patient material as comparable as possible, only ischemic stroke patients were compared, and patients in institutional care for 90 days prior to their incident stroke, aged below 18, or treated or living in the Archipelago of Åland (population 27,000) were excluded (Figure 1). Annual reports comparing all the health districts and those hospitals with more than 50 eligible patients treated annually have been produced. So far, no specific target values have been defined for performance measures.

Patient baseline characteristics were adjusted for using suitable multivariate models (22). In order to make justifiable comparisons between areas or in time,

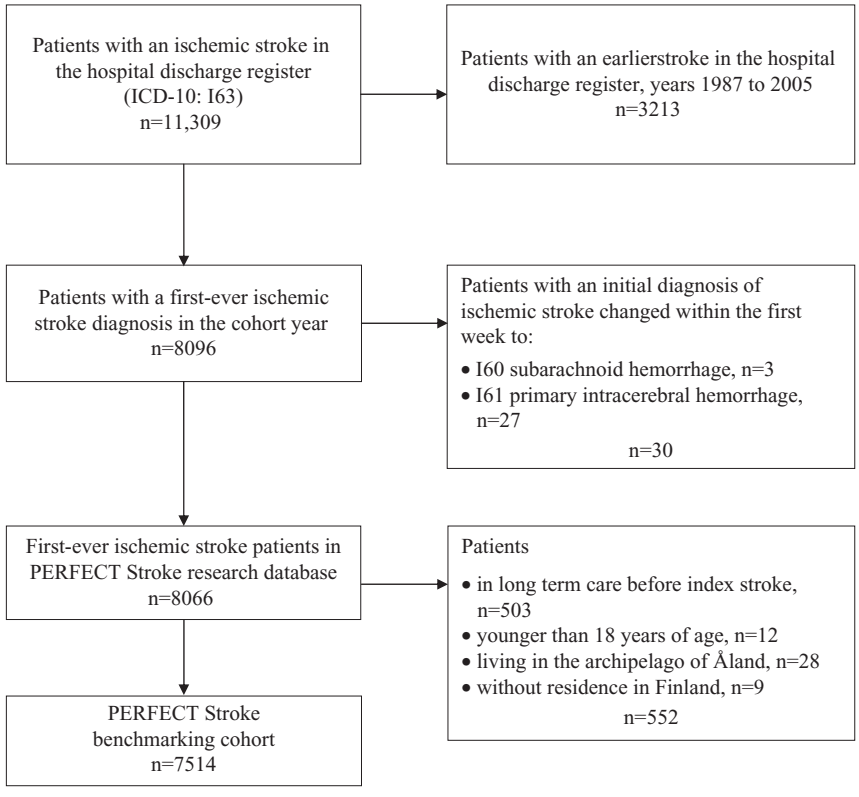

Figure 1. Flow chart for forming the benchmarking cohort of ischemic stroke patients reported in annual reports from the PERFECT stroke database, illustrated for 2005.

the indicators calculated for the subgroups of interest (hospitals, regions, years) are risk-adjusted using age and sex as well as the dichotomous variables derived from the previous use of hospital care (diagnosis codes) and the use of medications (prescription and special reimbursement data) describing the existence of hypertension, diabetes, coronary heart disease, congestive heart failure, atrial fibrillation, peripheral artery disease, chronic obstructive pulmonary disease or asthma, alcoholism or drug abuse, cancer, Parkinson's disease, dementia, depression, other mental illnesses, and prior statin or warfarin use.

Statistical methods

Annual trends were analyzed separately for IS, ICH, and SAH patients. Statistical significance was set at 95%. Median age is reported and compared between years 1999 and 2007 with the Mann-Whitney U-test. Mortality (28-day and 1-year) and days spent home by one year after stroke were first reported as crude mean annual values and mean annual change, with 95% confidence intervals.

As trends could be due to changes in patient characteristics, risk-adjusted multivariate models were used as described also in the methodological article in this issue (22). To estimate risk-adjusted LOS, generalized linear models were used, and to estimate mortality, logistic regression models were used, all models adjusting for age, sex, above mentioned co-morbidities and medications, and living status (home or in institutional care) prior to stroke. Year of stroke was introduced as a continuous variable to test improvements in outcome over time. To analyze the independent effect of the treating specialty or stroke center treatment on 1-year survival, these were introduced into the same models. To evaluate long-term survival, a Cox proportional hazards regression model with the same covariates was estimated and plotted to compare year 1999 with 2007. A more detailed analysis was made using IS patients, where the number of patients is sufficient for regional and hospital level comparison

Results

Numbers of patients

There were 204,667 patients in Finland with a hospital-treated cerebrovascular event over the years 1999 to 2007. Of these, 67,992 (33%) were non-incident events, 28,879 TIAs, and 13,480 other non-stroke cerebrovascular events. The PERFECT Stroke database includes 94,316 incident stroke patients, whose baseline characteristics have been previously published (10,25). The mean annual number of incident stroke patients treated in Finnish hospitals over the study period was 10,480, with a slight decrease over the years (10,705 patients in 1999, 10,338 in 2007). Of these patients, 79% had IS, 14% ICH, and 7% SAH as their incident stroke. The median (interquartile range, IQR) age of stroke patients increased slightly but statistically significantly from 75 (67–82) in 1999 to 76 (66–83) in 2007 among IS patients, 72 (61–79) to 72 (61–81) among ICH patients, and 54 (44–67) to 58 (49–69) among SAH patients. A median patient was treated in a hospital with 369 annual stroke admissions (142–706).

Trends in treatment of patients

After risk-adjustment, there was an annual decrease (–0.8%; 95% confidence interval –1.1 to –0.4%) in IS patient in-patient days, and an annual increase in ICH (1.6%; 0.6 to 2.5%) and SAH (1.5%; 0.3 to 2.7%) in-patient days of the first year after stroke.

IS patients were treated more often in neurological wards towards the end of the study period (60% in 1999 to 76% in 2007). Likewise, ICH-patients were treated more often in neurological wards (58% to 68%), slightly less often in neurosurgery (13% to 11%), and less often by other specialties (30% to 21%). The proportion of SAH patients treated in neurosurgical (68% to 69%) or neurological (18% to 18%) departments remained stable. The proportion of IS (41% to 59%) and ICH (57% to 68%) patients treated in specialized stroke centers increased over the study period (Figure 2).

Trends in patient outcome

Figure 3. describes crude trends in mortality and days spent at home within a year after incident

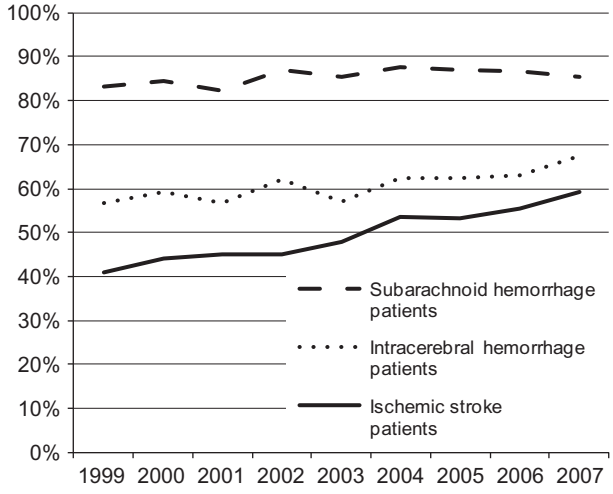

Figure 2. Proportion of Finnish stroke patients treated in specialized stroke centers, 1999–2007.

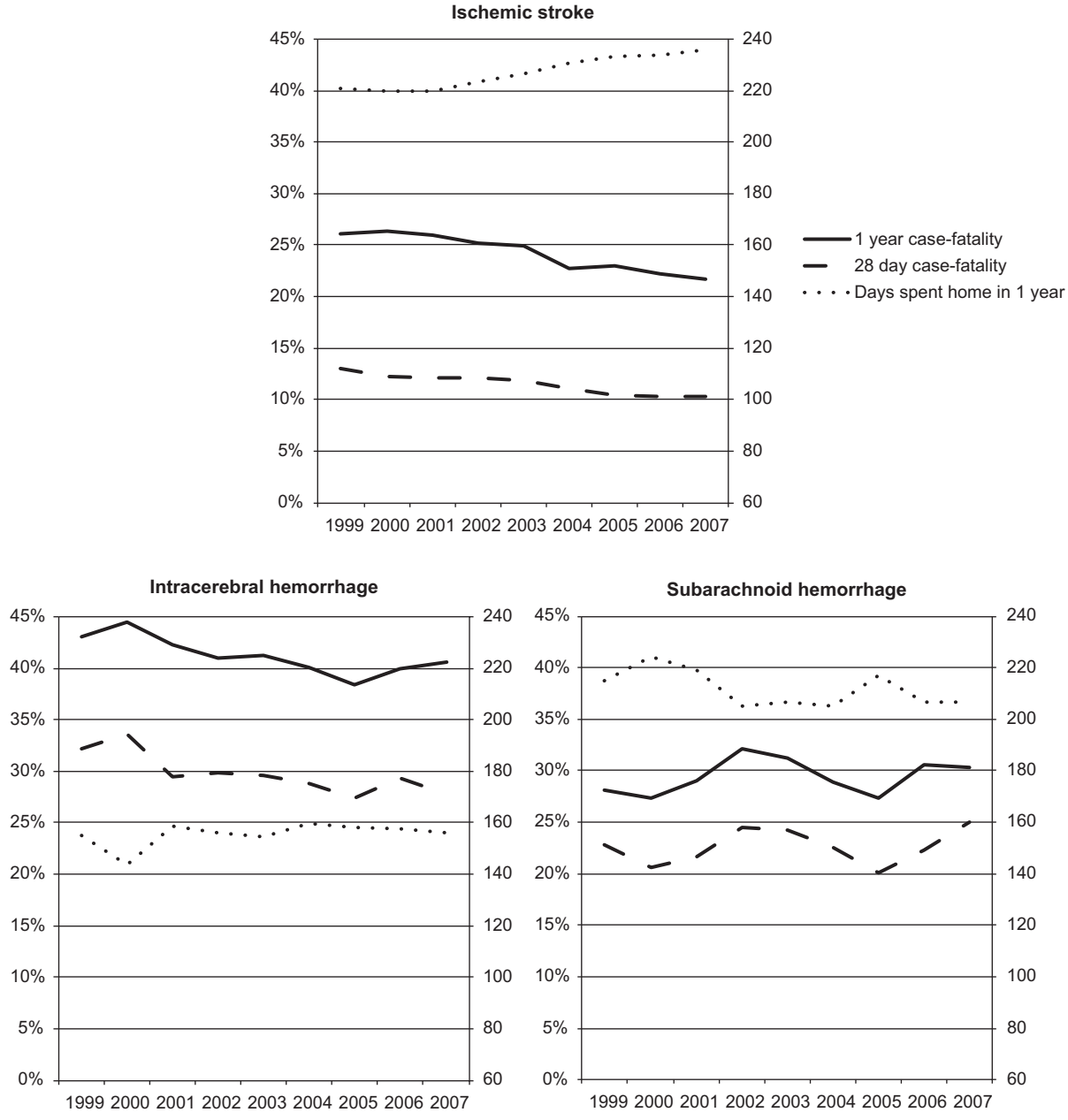

Figure 3. 28-day and 1-year all-cause mortality (left axis), and days spent home in 1 year after stroke (right axis) for stroke patients in Finland, 1999–2007.

stroke. In IS patients, both 28-day (annual absolute change –0.3%; 95% CI –0.3 to –0.4%) and 1-year (–0.6%; –0.5 to –0.8%) mortality decreased, and the patients were able to spend more days at home over the year (+2.3 days; +1.9 to +2.7 days). ICH patients showed a strong 28-day (–0.6%; –0.3 to –0.9%) and 1-year (–0.5%; –0.2 to –0.9%) mortality decrease, but this did not translate to more days spent home (+0.8 days; –0.3 to +1.8 days). No change was seen in SAH patient 28-day (+0.1%; –0.2 to +0.5%) or 1-year (+0.2%; –0.2 to +0.6%) mortality, and the patients were able to spend less time at home over the years (–1.5 days; –0.1 to –2.9 days).

After risk-adjustment, annual improvements in 1-year survival were highly significant in IS (Odds ratio [OR] 1.04; 95% CI 1.03–1.05) and ICH (OR 1.03; 1.01–1.05) patients, while the prognosis of SAH patients did not change (OR 1.01; 0.99–1.03).

Also the long-term survival of IS and ICH patients improved over time (Figure 4). Cox-model hazard ratios were 0.75 (0.71–0.79) for IS, 0.88 (0.79–0.97) for ICH, and 0.92 (0.78–1.10) for SAH patients with their incident stroke in the year 2007

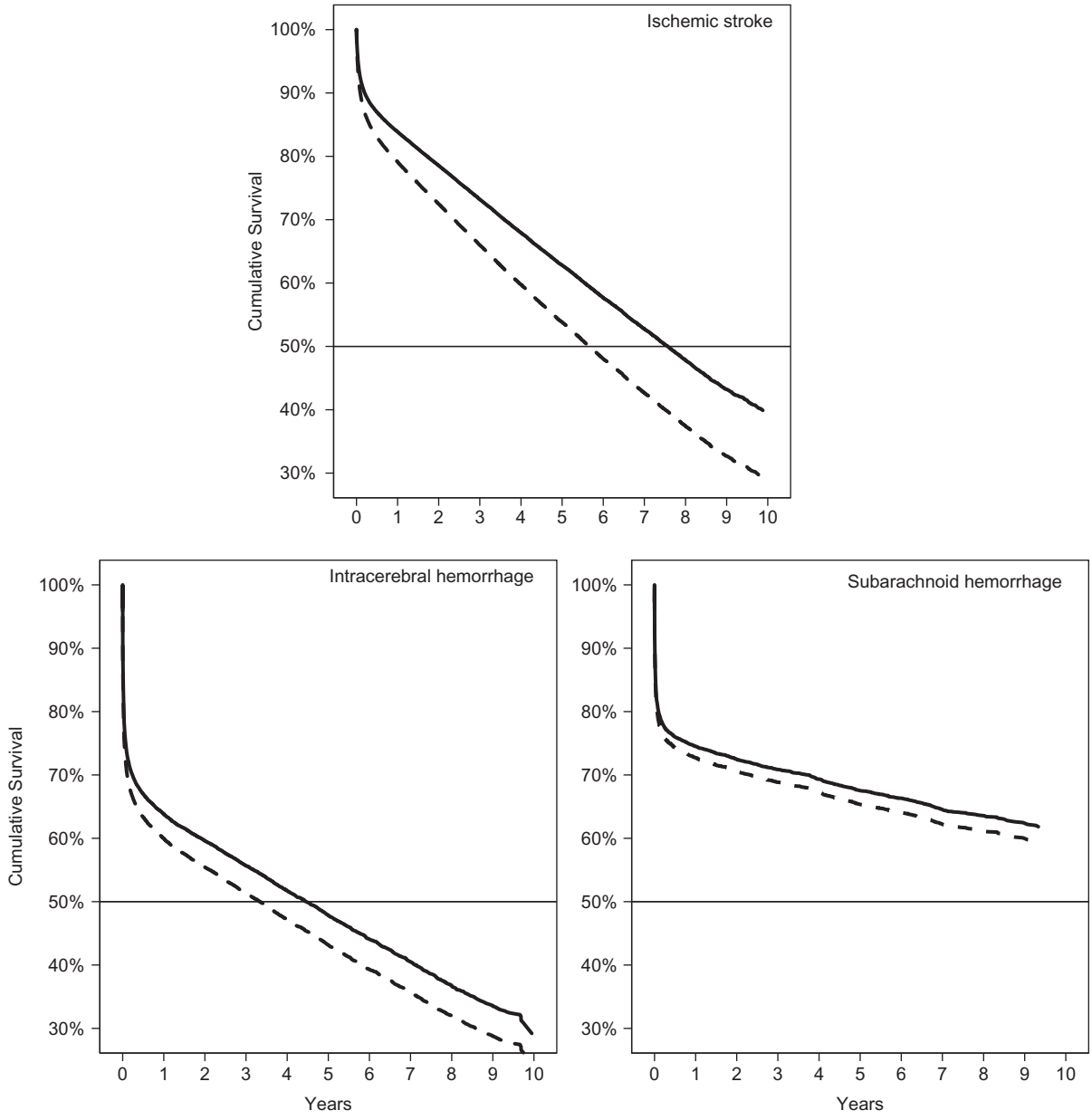

Figure 4. Long-term survival after stroke in Finland, 1999 (dotted line) and 2007 (solid line). Cox regression adjusting for age, sex, co-morbidities, medications and living status prior to stroke.

when compared with patients of year 1999. Median survival from 1999 to 2007 as plotted by the Cox model increased from 5 years 8 months to 7 years 7 months for IS, and from 3 years 4 months to 4 years 5 months for ICH patients. Less than half of SAH patients died over the 10-year observation period.

Differences among providers and regions

There are differences between the hospital districts in LOS, costs, and outcomes among the IS patients of the benchmarking cohort (Supplement Tables S13–S21). These regional differences decreased over time in some of the process and outcome indicators, and increased in others. The difference in risk-adjusted 1-year hospital LOS between hospital district with highest and lowed value has been reduced from 1999–2001 (88 versus 55 days; relative difference 33%) to 2005–2007 (74 versus 55; 25%), and the relative differences in costs have been reduced accordingly (from €10,756 versus €16,655; 35% to €14,097 versus €19,840; 29%). Access to stroke center care was highly unequally distributed. The regional differences in risk-adjusted survival remain large, having slightly reduced over the study period in 28-day mortality (from 7.4% versus 16.0%; absolute difference 8.6%; to 6.8% versus 11.8%; 5.0%), but increased in 1-year

mortality (from 20.1% versus 26.9%; (6.8%); to 15.4% versus 24.4%; (9.0%)).

Among the largest providers of stroke care, the five Finnish university hospitals, there were some, but not large differences in patient 1-year mortality after risk-adjustment (Figure 5). Confidence intervals were wide due to smaller numbers of patients, annual range 341 to 1226 per hospital.

Factors explaining increased survival

After risk-adjustment, treatment by neurologists was independently associated with increased 1-year survival among IS (OR 1.77; 1.70–1.84) and ICH-patients (OR 1.54; 1.40–1.69) when compared with treatment by other specialties. Similarly, treatment by neurosurgeons was associated with increased 1-year survival of SAH patients (OR 2.66; 2.25–3.16).

Among IS patients treated by neurologists, treatment in a specialized stroke center additionally increased the patient's odds of surviving one year (OR 1.06; 95% CI 1.01–1.12) when compared with treatment by neurologists in non-designated centers. Among the ICH-patients treated by neurologists, a borderline significant effect was seen for benefit from treatment in highly specialized comprehensive stroke centers, such as university hospitals (OR 1.12; 1.00–1.24), but not for treatment in primary stroke centers.

Discussion

In Finland, there are approximately 10,500 incident hospital-treated stroke patients each year, and their outcome seems to be getting better, both overall, and after adjustment for baseline variables. The average IS patient has gained an extra two years of life over the study period, an increase of 34% in expected lifetime. Acute care has become more specialized, and this is associated with improved outcome. Despite these beneficial trends, one third of acute stroke patients are treated outside specialized stroke centers. Unfortunately, the improved survival of ICH patients seems to have translated into increased need for in-patient care, but not patients living at home.

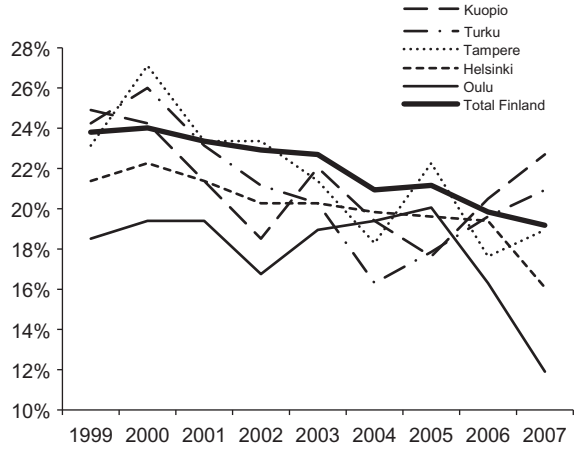

Figure 5. One-year all-cause mortality of ischemic stroke patients treated in the five Finnish university hospitals, 1999–2007. Benchmarking cohort adjusted for age, sex, co-morbidities, and previous medications. Annual 95% CIs are ± 1% for total Finland and range from ± 2.5% to ± 4% for individual hospitals.

The first proof that Finnish stroke patients benefit from specialist care by neurologists was gained from a randomized trial published in 1995 (26), and the finding has been repeated elsewhere (27). The shift from non-specialized care on general medical wards to departments of neurology, recommended nationally in 1989 (28), further on to specialized stroke units within the neurological departments, and further still to even more specialized stroke centers, is ongoing. Still almost a quarter of Finnish stroke patients are treated by non-neurospecialists; these patients have the worst prognosis. The PERFECT Stroke database has been used previously to show, for the first time, the effectiveness and validity of modern stroke centers (10).

A major goal of the PERFECT study was to benchmark providers and regions on clinical outcomes of patients. Timely information on clinical performance with meaningful benchmarking data should be valuable for both clinicians and administration. Stroke patient outcome would be best measured with a validated functional outcome score, such as the modified Rankin score (29). However, such scores are not available in national registries, so we used mortality and living status, which are easy to comprehend and communicate. Unfortunately, annual numbers of patients for even the largest hospitals and providers and the most common diseases are relatively small and subject to random variation, so that in benchmarking comparisons confidence intervals most often overlap. Therefore, data must be aggregated over several years to allow reliable comparisons, with the drawback of less timely analyses.

PERFECT data is used in Finland to evaluate trends in regional differences in the effectiveness of specialized care (30). Among IS patients, regional differences concerning LOS, costs, and acute mortality have diminished over the study period (See Supplementary Internet Tables). However, regional differences in 1-year mortality have rather increased, despite a national decrease in the mortality. This might reflect regional differences in rehabilitation, secondary prevention or follow-up of patients, and warrants further research.

There are weaknesses in our methodology. This is not an epidemiological study as patients who died before getting to a hospital (mainly SAH patients), or those treated solely as outpatients are not included. Baseline stroke severity is one of the strongest predictors of patient outcome, but we were unable to control for this, as stroke severity is not nationally registered. This forms a potential bias if strokes are getting less severe over time, as they did 40–20 years ago (31), and could also bias the analysis of the treating specialty should patients with more severe strokes be more often treated in non-specialized settings. Thrombolytic therapy for IS has been rapidly deployed in Finland over the study period, but unfortunately is poorly registered in national registers (25,32). We were unable to control for prescription-free medications, such as acetylsalicylic acid, as they are not registered.

There are also several strengths in this study. The large number of patients and the 100% follow-up for mortality for up to 10 years would have been difficult to obtain in any other setting. Finnish hospitalization rate for stroke is high at 95% –98% (25), stroke verification rates very high at >98% (33), and, based on previous studies evaluating the validity of the registries for stroke research, we estimate to have included 85% – 90% of all population-based stroke patients (25). No other national stroke registry covers such a large portion of patients, or has such a comprehensive follow-up (25). The results are thus representative of the Finnish stroke population and their outcome. While local trends in stroke patient outcome over time have been described before (3), to our knowledge, no nationwide data from registries with reasonable coverage (25) have been published (34).

To conclude, Finnish stroke care has improved with more patients treated by neurologists and neurosurgeons in specialized centers. In spite of these positive developments, there is still much room for further improvement. Register studies, such as ours, are vital in finding such associations, and in showing that quality should be monitored and improved, and that this does translate into better patient health.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Supplementary material available online

Supplementary Tables S13–S21