VALUE IN HEALTH ▮ (2016) ▮▮▮–▮▮▮

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Societal Costs of First-Incident Ischemic Stroke in Patients with Atrial Fibrillation—A Danish Nationwide Registry Study

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ABSTRACT

Background: Oral anticoagulation therapy reduces the risk of ischemic stroke in patients with atrial fibrillation (AF). However, more data on the costs of stroke in patients with AF are needed to assess how this therapy affects societal costs. **Objectives:** The aim of the study was to estimate the average 3-year societal costs of first-incident ischemic stroke in Danish patients with AF, including costs of health care, social care services, and productivity loss. **Methods:** The study was designed as an incidence-based cost-of-illness study covering the entire Danish population. All patients with a hospital diagnosis of AF were identified, and propensity score–matched analyses were used to estimate costs attributable to first-incident stroke among patients with AF in the period 2002 to 2012. All data were obtained from nationwide registries. **Results:** A total of 21,673 patients with AF were identified with a first-incident stroke. The average 3-year costs attributable to stroke were US $30,925 per patient (present value) corresponding to US $19,989 in the incidence year and US $7,683 and US $5,176 1 and 2 years after the stroke, respectively. Health care accounted for 66% of the 3-year costs, with hospitalizations in the incidence year as the main cost driver. After the incidence year, costs of social care services exceeded health care costs. Sensitivity analyses showed that the cost estimates were relatively robust. **Conclusions:** The societal costs of first-incident stroke in patients with AF are substantial. This new evidence can be valuable as an input for decision making regarding the treatment of AF and prevention of future strokes.

Keywords: atrial fibrillation, cost-of-illness, propensity score matching, stroke.

Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia affecting 1% to 2% of the population [1]. More than 6 million people in Europe and 5 million people in the United States currently suffer from AF [1,2], and projections suggest that the prevalence of AF will at least double by 2050 [1–3].

Cardioembolic strokes remain a major concern in relation to AF because AF is associated with a significantly elevated risk [4,5]. Strokes due to cardioembolism account for about one-fifth of all ischemic strokes and are generally more severe than noncardioembolic strokes [4,6,7]. Continuous oral anticoagulation therapy has been shown to reduce stroke incidence [1].

Because the prevalence of AF is rising and budgets are under pressure, it is becoming increasingly critical to take costs into account when choosing among different treatment options, including oral anticoagulation therapy. Numerous studies on the costs of stroke exist, but few studies have examined the costs of stroke in patients with AF. We found only two large studies on the costs of stroke in patients with AF, and these studies included only hospital costs [8,9]. Previous studies have shown that the costs of stroke are higher in patients with AF than in patients without AF [8–11]. Additional studies are needed to ensure that valid cost estimates can be used to strengthen the foundation for evidence-based decision making regarding the treatment of AF and prevention of future strokes.

Our aim was to estimate the 3-year societal costs attributable to first-incident ischemic stroke in patients with AF, including costs of health care, social care services, and productivity loss.

Methods

The study was designed as a nationwide registry-based cost-of-illness study from a societal perspective. We used an incidence-based approach and propensity score–matched analyses [12] to

Conflict of interest: KORA was a paid vendor to Pfizer and Bristol-Myers Squibb on the project. M. Jakobsen, C. Kolodziejczyk, and E. K. Fredslund—members of the project group—are employees of KORA. S. P. Johnsen was paid by Pfizer and Bristol-Myers Squibb for his work as clinical expert on the project and for being part of the project group. L. Dybro and P. B. Poulsen are employees of Pfizer Denmark and were also members of the project group.

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1098-3015$36.00 – see front matter

http://dx.doi.org/10.1016/j.jval.2016.01.009

estimate costs attributable to first-incident stroke among patients with AF in the period 2002 to 2012.

Registry Data Sources

The study was based on national Danish registries covering the entire population, which makes this a study at the population-level of a whole country. Every Danish resident has a permanent and personal registration number that enables linkage between registries at the individual level. Admissions and outpatient visits to hospitals are registered in the Danish National Patient Registry, with primary and secondary diagnoses coded according to the *International Classification of Diseases, 10th revision* (*ICD-10*) [13]. Contacts to private practice health care professionals covered by national health insurance are registered in the National Health Insurance Service Registry [14]. Both the Danish National Patient Registry and the National Health Insurance Service Registry are used for payment purposes and the quality of data is considered to be high. All prescriptions dispensed from Danish pharmacies are registered in the Danish Registry of Medical Products Statistics (Prescription Registry) using the international therapeutic chemical classification system (Anatomical Therapeutic Chemical) [15]. The Civil Registration System holds information on sex, age, residence, and vital status [16]. Furthermore, data on home help, education, labor market affiliation, and income are available from Statistics Denmark [17–19]. Data from different registries were linked together at the patient level using the personal registration number that all Danish residents have.

Study Population

Our basis population was identified from the National Patient Registry and consisted of all patients hospitalized in the period 1994 to 2012 with AF as the primary or secondary diagnosis (*ICD-10* code I48) (see Fig. 1). We excluded patients who had been hospitalized with ischemic stroke (*ICD-10* codes I63 and I64) in the period 1994 to 2001 to restrict the analysis to incident cases. For each of the following years (2002–2012), we identified the stroke group as patients who had been hospitalized with ischemic stroke as the primary or secondary diagnosis, conditional on them having been diagnosed with AF. For each year, we identified potential controls (the control reservoir) as the remaining patients with AF in the basis population. We censored patients at death. Furthermore, we excluded controls from the control group if they were hospitalized with ischemic stroke (*ICD-10* codes I63 and I64) after the incidence year. From this year on, they were part of the stroke group. This was done to avoid contamination of the control group.

Costs

The costs attributable to stroke were estimated using the matched control/regression approach, which is considered the criterion standard method of cost-of-illness studies [20]. We estimated costs for a 3-year period, counting from the year in which the stroke occurred (the incidence year). We calculated attributable costs as standardized costs incurred by patients in the stroke group minus standardized costs incurred by patients in the control group. Standardized costs were calculated as the costs incurred by patients in year t after the incidence year ($t = 0$, 1, 2) minus the costs incurred in the year before the stroke (the baseline year). Costs incurred in the baseline year were subtracted, because it was not possible to isolate diagnosis-specific costs when including costs outside the hospital. This was also the strategy used for the control group. A similar approach has been used in other cost-of-illness studies [21,22].

Costs of health care included costs of hospitalizations, outpatient and emergency visits to hospitals, contacts to private practice health care professionals covered by national health insurance, and prescription medicine dispensed from Danish pharmacies. Hospital resource use and contacts to private practice health care professionals were priced according to tariffs effective in the year of delivery. Data on hospital tariffs were available only until 2011. Therefore, costs were estimated for the stroke groups from 2002 to 2011. Prescription medicine was priced by the pharmacy, including both the share covered by the

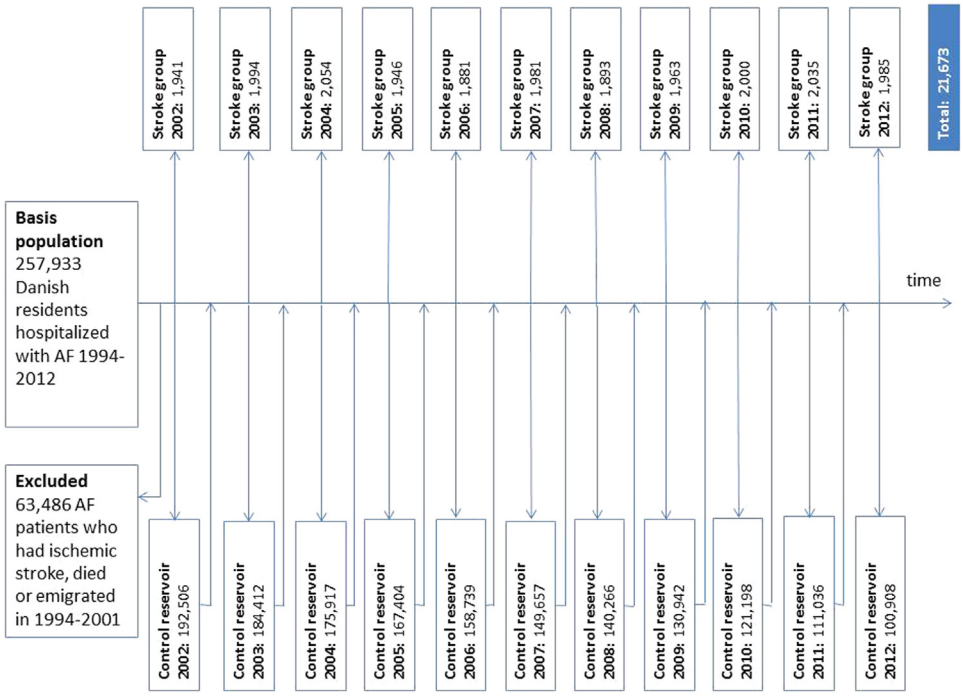

Fig. 1 – Flow chart. AF, atrial fibrillation.