The Burden of Stroke Mimics: Present and Future Projections

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Background and Purpose: An increasing proportion of patients presenting with suspected stroke prove to have other conditions, often referred to as stroke mimics. The aim of this study was to present a projection of the number of hospitalized strokes, transient ischemic attacks (TIAs), and stroke mimics in Norway up to the year 2050 based on expected demographic changes, to estimate the burden of stroke mimics in the coming decades. *Materials and Methods:* This prospective study included all admissions to the stroke unit of Akershus University Hospital from March 1, 2012, to February 28, 2013. Relevant resource use was recorded. Based on the age- and sex-specific absolute incidences for the study period, the expected numbers of strokes, TIAs, and stroke mimics in the entire Norwegian population were computed for every fifth year for the period 2020-2050. *Results:* We included 1881 admissions, of which 38.2% were stroke mimics. With constant age- and sex-dependent incidence rates, we estimated that the number of strokes and stroke mimics will respectively increase by 121.3% and 88.7% (men) and 97.6% and 71.7% (women). For hospital admission levels to stay constant at the 2013 level, an annual reduction of 2.1% and 1.7% (men) and 1.8% and 1.5% (women) must take place for strokes and mimics, respectively. *Conclusions:* A significant proportion of stroke unit admissions prove to have other conditions than stroke. With constant age- and sex-dependent incidence rates, the number of stroke mimics admissions will increase substantially over the next decades. **Key Words:** Demography—diagnosis—projections—stroke—stroke mimics.

Introduction

Stroke is one of the leading causes of death, and the main cause of long-term disability in Norway and other developed countries.[1,2] Treatment in specialized stroke units decreases mortality and morbidity.[3,4] In addition, administration of intravenous thrombolysis with tissue plasminogen activator (tPA) and endovascular treatment with thrombectomy are highly effective, but limited by narrow time windows, and their benefit decreases as the time from symptom onset to treatment initiation increases.[5-7]

The emergence of thrombolytic treatment has led to an increased focus on stroke as a condition of medical emergency in a similar manner as myocardial infarction, with a focus on minimizing both prehospital and in-hospital delay. Combined with the widespread knowledge about the severe disability after a stroke without timely and adequate reperfusion of the brain, health authorities have clearly signaled via national stroke treatment guidelines[8] that a very high sensitivity for stroke cases is desirable. Stroke symptom recognition campaigns such as the Face-Arm-Speech-Time (FAST) campaign have been

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targeted at the general population[9] and implemented in the training of paramedics. Concurrently, hospitals have established streamlined stroke fast tracks beginning in the emergency department (ED). The initial diagnosis of ischemic stroke is based on patient history, a brief neurological examination, and a head computed tomography to confirm or exclude intracerebral hemorrhage (ICH). Increased focus on shortening onset-to-treatment time and door-to-needle time leads to further challenges in the differentiation between acute stroke and other conditions, and patients often need further assessment in a stroke unit before a diagnosis of stroke can be confirmed or excluded. An inevitable side effect of this increase in the health-care system's sensitivity for acute stroke is a decrease in specificity. Hence, an increasing proportion of patients presenting with suspected acute stroke prove to have other conditions often referred to as *stroke mimics*.[10-13]

Demographic projections provide valuable information for the planning of the future organization of acute stroke treatment. In Norway and in other developed countries, it is expected that stroke events will increase[14] over the next decades, despite a reduction[15] in age- and sex-adjusted incidence rates. It is estimated that the number of stroke events will increase by 60%-80% up to the year 2050.[16-19] Less is known about the estimated number of patients with stroke mimics in the future, despite the importance of such projections because these patients utilize a substantial part of hospital resources. The aim of the present study was therefore to present a projection of the number of hospitalized strokes, transient ischemic attacks (TIAs), and stroke mimics in Norway up to the year 2050 based on expected demographic changes, to estimate the burden of stroke mimics in developed countries in the coming decades.

Materials and Methods

The present study was part of the Norwegian Stroke—Paths of Treatment (NOR-SPOT) project. NOR-SPOT is an established cohort consisting of all patients admitted to the stroke unit of Akershus University Hospital during the period from February 15, 2012, to March 15, 2013. Akershus University Hospital is situated in Lørenskog in the Oslo greater metropolitan area, and is the largest acute care hospital in Norway with a catchment area of about 500,000 inhabitants (approximately 10% of Norway's population). All patients aged 18 years or older admitted to the stroke unit during the study period were prospectively included in the NOR-SPOT registry. In total, 2052 admissions were recorded. For the present study, we included admissions in the 1-year period from March 1, 2012, to February 28, 2013. As the focus of the present study was ward occupancy and resource usage, the level of inclusion was admissions; hence, for patients with more than 1 admission during the study period, all admissions were included.

For each admission, the patient's age, sex, length of stay (LOS), use of computed tomography or MRI, intravenous thrombolytic therapy, primary and secondary diagnoses, 4 relevant procedures (carotid Doppler ultrasound, transcranial Doppler ultrasound, echocardiography, and Holter monitoring), and in-hospital mortality were recorded. We also recorded whether the patient was evaluated by an allied health professional (physiotherapist, occupational therapist, or speech therapist) during the hospital stay. Based on the final primary diagnosis, adhering to the International Classification of Diseases, Tenth Revision (ICD-10), we categorized patients into *stroke* (I61, I63, and I64), *TIA* (G45), or *stroke mimics* (other primary diagnoses). Information on the risk factors hypertension, diabetes mellitus, atrial fibrillation, and hyperlipidemia was gathered from the secondary diagnoses.

Based on the age- and sex-specific absolute incidences for the study period, we computed the expected numbers of strokes, TIAs, and stroke mimics in the entire Norwegian population for January 1, 2013. Age grouping was done in accordance with The Norwegian Stroke Registry[20] (18-44, 45-54, 55-64, 65-74, 75-84, and 85+). Statistics Norway's projected demographic composition of the Norwegian population[21] (using the recommended middle alternative for fertility, life expectancy, domestic migration, and immigration) was collected for every fifth year for the period 2020-2050. Using the age- and sex-specific incidence rates computed from our cohort, the number of strokes, TIAs, and stroke mimics were tabulated for those years. We used 3 scenarios: (1) *constant* incidence rates, (2) a 1% annual *decrease* in incidence rates, and (3) a 1% annual *increase* in incidence rates. We also calculated how much the incidence rates would have to decline annually until 2050 to counterbalance the effects of the demographic changes, that is, for the number of strokes, TIAs, and stroke mimics in 2050 to remain unchanged compared with the 2013 level.

Statistical Analysis

Statistical comparisons were performed between patients with stroke, TIA, and stroke mimics using the Kruskal–Wallis test. Additionally, comparisons were performed between stroke and stroke mimics, and between cerebrovascular disease (stroke + TIA) and stroke mimics, using the Pearson χ^2 test, the Fisher exact-test, unpaired *t* test, and the Mann–Whitney *U* test as indicated. IBM SPSS Statistics version 21 (Armonk, NY; IBM Corp.) was used for statistical analyses.

Ethical Considerations

NOR-SPOT is an in-hospital project investigating the paths of treatment without any deviation from standard practices and has been classified as a quality assurance project by the Regional Ethics Committee. Therefore, and in accordance with Regional Ethics Committee's recommendation, ethical approval was sought with the Privacy