



Operations Research for stroke care systems: An opportunity for *The Science of Better* to do much better

Leonid Churilov^{a,b,*}, Geoffrey A. Donnan^a

^a Florey Neuroscience Institutes (National Stroke Research Institute), Melbourne, Australia

^b Department of Mathematics and Statistics, The University of Melbourne, Australia

ARTICLE INFO

Article history:

Received 15 December 2011

Accepted 16 December 2011

Available online 25 January 2012

Keywords:

Review

Stroke care services

Systems modelling

Health policy

Operations improvement

Clinical applications

ABSTRACT

Stroke is one of the three most common causes of death around the world and the sixth most common cause of disability worldwide. Building effective and efficient stroke care systems is a critical step in improving patient outcomes in the prevention, treatment, and rehabilitation of stroke. Despite what seems like a great potential for Operations Research (often referred to as *The Science of Better*) to contribute to the design and operation of effective and efficient stroke care systems, OR contribution so far has been limited. The objectives of this paper are to review the field of stroke care systems for OR professionals, to illustrate existing OR contribution to stroke care systems and to propose an agenda for how *The Science of Better* could better contribute to the effort of designing and operating stroke care systems.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Stroke is one of the three most common causes of death around the world and the sixth most common cause of disability worldwide. Building effective and efficient stroke care systems is a critical step in improving patient outcomes in the prevention, treatment, and rehabilitation of stroke. Despite what seems like great potential for Operations Research (often referred to as *The Science of Better*) to contribute to the design and operation of effective and efficient stroke care systems, OR contribution so far has been limited.

This paper has been co-authored by an OR professional working in the area of stroke systems and a stroke clinician, with the three-fold objective:

- to provide a relatively self-contained “primer” of stroke and stroke care systems for OR professionals;
- to illustrate existing OR contributions related to stroke care systems;
- to propose an agenda for OR to contribute to the effort of designing and operating effective and efficient stroke care systems.

The paper is organized as follows. Section 2 provides a concise review of stroke, focusing on its epidemiology and burden, prognosis, risk factors, acute interventions and prevention strategies. In Section 3 we provide an overview of the issues involved in

design and operations of stroke care systems world-wide through the prism of several key public policy documents: American Heart Association Public Policy Agenda 2010–13 report [1]; NHS Department of Health: National Stroke Strategy for England [2]; Canadian Stroke Strategy Core Performance Indicators 2010 report [3]; and Australian National Stroke Foundation Clinical Guidelines for Stroke Management [4]. Section 4 is dedicated to an analysis of the existing published contributions of OR to stroke care. In Section 5 we present our vision for an agenda for Operations Research in stroke care by listing ten broad problem areas that, in our view, present the most pressing need from the stroke care services and systems perspective, as well as constituting interesting and productive targets for a concentrated OR effort. Concluding remarks are made in Section 6.

2. Stroke primer

This section presents an adapted version of the “Stroke seminar” co-authored by the second author for a clinical audience [5]. We do not include here references to original clinical papers and the interested reader is referred to the bibliography of this earlier work.

Types of stroke

Stroke occurs when the supply of blood to the brain is suddenly disrupted. Strokes are either ischaemic (when blood may stop moving through an artery because the artery is blocked by a blood clot or plaque), or haemorrhagic (when blood may stop moving through an artery because the artery breaks or bursts). Under both scenarios, the brain is deprived of the oxygen it needs, brain cells

* Corresponding author.

E-mail address: leonidc@unimelb.edu.au (L. Churilov).

in the area die and the brain can become permanently damaged. A term Transient Ischaemic Attack (TIA) is sometimes used when the signs of stroke are present but go away within 24 h. The distinction between symptomatic TIAs and events of longer duration (stroke) is entirely arbitrary. Permanent tissue damage can be seen with MRI in at least 25% of patients with TIAs. About 1 in 5 people who have a TIA will have a major stroke within the next three months and a large part of the risk occurs in the first few days.

About 80% of all strokes are ischaemic. Once vessel occlusion has occurred, a volume of functionally impaired but structurally intact tissue surrounds the ischaemic core. This tissue is the target for therapeutic interventions since its salvage is associated with neurological improvement and recovery. For patients experiencing acute ischaemic stroke, and for the physicians and allied health personnel treating them, every second counts. The results of the modelling by Saver [6] suggest that the typical patient loses 1.9 million neurons each minute in which stroke is untreated. Compared with the normal rate of neuron loss in brain ageing, the ischaemic brain ages 3.6 years each hour without treatment [6]. Due to dramatic differences in the management of different types of stroke, the clinical distinction between the subtypes is one of the most important and urgent steps in stroke management.

Prognosis and risk factors

About a quarter of stroke patients are dead within a month, about a third by 6 months, and a half by 1 year. Prognosis is even worse for identified subgroups of those suffering haemorrhagic strokes, where the one month mortality approaches 50%. The best predictors of stroke recovery at 3 months are the initial neurological deficit (the degree of neurological impairment attributable to the stroke) and age.

After TIA or minor stroke, the risk of further stroke is substantially higher than previously thought, reaching as high as 30% within the first month in some subgroups. Patients at very high risk (>30%) of further stroke within 7 days can be identified on the basis of their age, blood pressure, and the characteristics and duration of their symptoms; simple scores have been developed, on the basis of these factors, to predict those patients at greatest risk who might benefit most from early intervention to modify risk-factors. Additionally, imaging strategies can identify patients at increased risk of recurrence.

Risk factors for stroke can be broadly classified as modifiable or fixed. Some modifiable risk factors (such as hypertension, diabetes, and smoking) are common and affect health in several ways, providing opportunities and incentives to modify risk in large numbers of people. Other risk factors, such as atrial fibrillation and TIAs, are less prevalent. Risk factors that have been identified explain approximately 60% of the attributable risk.

Stroke epidemiology and burden

As stated, stroke is one of the three most common causes of death around the world, estimated to cause around 9% of all deaths. In Western countries, the proportion of deaths caused by stroke is 10%–12%, with 12% of these deaths in people younger than 65 years of age. The average age-adjusted stroke mortality for developed countries is around 50–100 per 100 000 people per year, with strong geographical variations potentially suggestive of differences in the prevalence of risk factors and genetic factors, as well as differences in the management of stroke. There has been a constant reduction in stroke mortality in developed countries during the past 50 years, possibly indicative of improved control of stroke risk factors (especially high blood pressure and cigarette smoking) combined with a parallel improvement in living standards. Trends in developing countries are less certain.

Community based studies report stroke incidence ranging from 240 per 100 000 people in Dijon, France (standardized to the European population aged 45–84 years), to about 600 per 100 000

people in Novosibirsk, Russia. While the overall trend is indicative of reduction of incidence (e.g. a 25% reduction in stroke incidence was seen in Perth, Australia between 1989 and 1995, and a 29% reduction was seen in Oxfordshire, UK between 1981 and 2002), some countries experience growth in stroke incidence (e.g. stroke incidence in people aged 35–69 years in Novosibirsk actually rose between 1987 and 1994).

Stroke prevalence (i.e. burden of patients living with the consequences of stroke) is usually more difficult to estimate. Typical estimates, largely drawn from knowledge of stroke incidence and mortality, are that about 500 people per 100 000 population live with the consequences of stroke. As stroke mortality is likely decreasing more rapidly than stroke incidence, the proportion of stroke survivors is likely to increase, which, in turn, will place increased demands on health-care and social-care systems.

Worldwide, stroke consumes about 2%–4% of total health-care costs, and in industrialized countries stroke accounts for more than 4% of direct health-care costs. The total annual costs to society have been variously estimated at £7.6 billion in the UK at 1995 prices, AUS\$ 2.14 billion in Australia [7], \$2.7 billion in Canada and US\$ 40.9 billion in the USA at 1997 prices, representing about US\$100 per head of population per year. Expressed in disability adjusted life years (DALYs—the sum of life-years lost as a result of premature death and years lived with disability adjusted for severity), stroke-related disability was judged to be the sixth most important cause of DALYs in 2002, but is estimated to become ranked the fourth in Western societies by 2030.

According to the [8], there are approximately 110,000 strokes in England each year, and 20%–30% of people who have a stroke die within a month. Stroke patients occupy over 2.6 million bed days per year. At any one time, 1 in 5 acute hospital beds and 1 in 4 long term beds are occupied by stroke patients. In USA, an estimated 795,000 residents have a new or recurrent stroke each year, and about 145,000 of these individuals die as a result. An estimated 6.5 million Americans are stroke survivors. Stroke is a leading cause of serious, long-term disability [9]. According to Heart and Stroke Foundation of Canada, about 50,000 strokes occur each year in Canada and over 15,000 Canadians die as a result. Three hundred thousand Canadians are living with its effects. In Australia, according to National Stroke Foundation, stroke is the second single greatest killer after coronary heart disease and a leading cause of disability. In 2011, Australians are estimated to suffer around 60,000 new and recurrent strokes—that's one stroke every 10 min. One in five Australians having a first-ever stroke is likely to die within one month and one in three within a year.

Acute interventions

There are four proven acute interventions supported by evidence from randomized controlled trials: *Stroke Care Units (SCUs); thrombolysis—treatment with recombinant tPA agent; aspirin; and decompressive surgery for ischaemic stroke.*

SCUs are effective and appropriate for all stroke subtypes, and provide a focus for professionals in stroke care. Management of patients within an SCU reduces mortality by about 20% and improves functional outcome by about the same amount. A physical space identified as an SCU is associated with better outcomes than seen with a dedicated stroke team visiting patients on general medical wards. Although the precise components of SCU management responsible for the effectiveness of SCUs are unclear, improved blood pressure control, early mobilization, and general adherence to best practice have been identified as some of the components.

Thrombolysis is the process of using thrombolytic therapy that restore cerebral blood flow in some patients with acute ischaemic stroke and may lead to improvement or resolution of neurologic deficits. Thrombolysis with recombinant tPA is one of the most biologically effective treatments for acute ischaemic stroke. Until

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات