**Stroke: More than a ‘brain attack’**

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Stroke is a life-altering event that potentially affects stroke survivors, their families, healthcare resources, and society in general. Stroke has often been described as ‘brain attack’, denoting emergency emphasis on the vascular pathology. Consequently, many national and provincial stroke strategies have emphasized vascular care through primary prevention strategies and thrombolysis. Despite being important initiatives, this has resulted in a stroke system that emphasizes the frontloading of stroke care, focusing on the vascular pathology. The advent of thrombolysis therapy has benefited a small proportion of patients while a vast majority are still affected by stroke-related impairments. Management of the vascular elements of stroke is important; however, the impact of rehabilitation on stroke recovery has been relatively undervalued. Stroke care is in need of a revolution toward a more comprehensive and balanced approach. It is anticipated that the major focus of stroke care will include promoting recovery, in line with the growing evidence on stroke rehabilitation interventions. A paradigm shift is necessary to ensure that comprehensive and balanced stroke care which incorporates rehabilitation is taken into account, leading to a stroke care system where patient needs are managed both as a ‘brain attack’ and an ‘injured brain’.

Key words: acute stroke therapy, ‘brain attack’, rehabilitation, stroke, stroke care, thrombolysis

**Impact of stroke**

Stroke can be a life-altering event that often has a dramatic effect on stroke survivors, their families, healthcare resources, and society in general. In 2010 in the Canadian province of Ontario (population 13 million), 19,703 people presented to an emergency room with a stroke or transient ischemic attack (TIA), of which 15,524 were admitted to an acute care bed and 13,641 were discharged alive (1). Collectively, these patients occupied 187,840 acute bed days. Given this impact on the healthcare system, governments in Canada have been increasingly investing resources into stroke care. Regional, provincial, and national stroke systems have been developed, and organized stroke care is now the accepted ‘gold standard’ (2). This organized stroke care can be divided into two major components:

1. management of vascular pathology (i.e., arterial thrombosis, emboli) through primary and secondary prevention as well as thrombolysis, and
2. recovery from the consequences of brain damage (i.e., hemiplegia, visual perceptual and cognitive disorders, aphasia, dysphagia, etc.) largely through rehabilitation

Although both components are critical to optimizing patient outcomes, it is important that stroke care systems obtain a balance between the two.

‘Brain attack’ – Management of vascular pathology

Stroke is often described as a ‘brain attack’, a term first coined by Dr Vladimir Hachinski to convey that stroke is an emergency (3). The term implies the need for treatment similar to that of a myocardial infarction with the focus on ‘resuscitation’ efforts (4,5). A typical large-vessel acute ischemic stroke has been reported to cause the loss of 32,000 neurons every second and a staggering 1·2 billion neurons within the first 10 h (6). Given that the stakes are so high, it can be argued that it is more sensible to focus on the treatment of vascular pathology to prevent or limit brain damage than to have patients and the healthcare system deal with the long-term consequences that follow. Consequently, most national and provincial stroke strategies have emphasized vascular care first and foremost primarily through primary prevention strategies and thrombolysis. Although these are undeniably important initiatives, they have resulted in a stroke system that emphasizes the frontloading of stroke care, focusing on the vascular pathology.

Although the rational for this appears reasonable, what is often not appreciated in stroke system design efforts are some of the challenges in implementing a system focused on acute management. Once a stroke occurs, the narrow therapeutic window and restrictive inclusion criteria associated with thrombolysis mean that approximately 10% or less of stroke patients will be treated within the allotted time frame and, of these, approximately one in five will benefit (7). Moreover, the effective use of thrombolysis ultimately results in more stroke patients surviving their stroke. These challenges can be demonstrated using Ontario as an example.

In 2000, a province-wide Ontario Stroke System was established to promote coordinated, organized stroke care across Ontario, and data suggest that this initiative has been highly successful. Between 2003 and 2010, the number of age and gender risk-adjusted emergency department arrivals with stroke dropped from 2·0 to 1·7 per 1000 population. However, due to demographic changes in the province, the actual number of arrivals rose by 751. During the same time period, the risk-adjusted number of acute admissions per 1000 population dropped from 1·7 to 1·4, and the in-hospital mortality rate also decreased from 14·4% to 11·4%. This meant that in 2010, 465 more patients...
survived their stroke than would have been expected based on 2003 rates. The bottom line is that despite the tremendous success of these provincial initiatives, Ontario is faced with managing more stroke patients in 2010 than it did in 2003.

Thrombolysis data suggest a similar story. Between 2002 and 2010, the proportion of stroke or TIA patients who sought medical advice within the window of opportunity rose from 34% to 42%, and the proportion of ischemic stroke patients treated with tissue-type plasminogen activator (tPA) rose from 3.2% to 9.6%. Despite the undeniable success of tPA programs across the province (and the significant number of lives improved), Ontario was left to manage 9179 ischemic stroke patients in 2010 who did not receive tPA along with the majority of those who did receive tPA but were still left with significant impairments.

Given the limitations of vascular stroke management, there has also been a great deal of interest in trying to prevent the neurological sequelae of established vascular pathology. However, the search for neuroprotectants has been disappointing. Over 40 different medications have been tested and none have been able to prevent or attenuate brain damage poststroke in humans (8). Likewise, there has been a great deal of research on stem cells (designed to replace lost neurons following a stroke) despite challenges in the clinical translation of stem cell research and development of stem cell therapy for stroke (9–11). Progress has been slow and the benefits are still largely hypothetical. There is no question that stem cells represent an exciting potential treatment poststroke. However, should the time comes when stem cell therapy is a viable treatment option, it will only serve to increase the need for rehabilitation services as new neurons will need to be trained before they are able to help restore lost abilities.

‘Injured brain’ – Recovering from the consequences of brain damage

The vascular similarities between cerebrovascular and cardiovascular disease are highlighted by the fact that in Canada, the primary funding agency for stroke research is the Heart and Stroke Foundation. However, despite these vascular similarities, a stroke is as different from a myocardial infarction as the brain is different from the heart. While treating stroke as a brain attack emphasizes the importance of prompt acute care, this may be at the expense of assigning a lesser priority to the long-term deficits that commonly accompany a stroke; this is despite their importance to stroke survivors and the fact that they are highly amenable to rehabilitation.

The devastating neurological deficits that often follow a stroke are what make a stroke such a feared event. Rehabilitation, particularly organized interdisciplinary specialized care, has been shown to significantly improve important clinical outcomes for those stroke patients with disabling impairments. The concepts of neuroplasticity and brain reorganization have helped to erase the therapeutic nihilism which was prevalent decades ago, while the related concepts of early intensive task-specific therapy have revolutionized stroke rehabilitation (12–16). A large body of evidence now supports a wide variety of innovative interventions such as constraint-induced movement therapy (17–19) and mirror therapy (20), along with traditional gait training and activities of daily living retraining. Management of depression poststroke has also been shown to make a significant difference in outcomes (21), and evidence is building to support rehabilitation of more chronic stroke survivors, an area of care often neglected (22).

Given that stroke has such a dramatic impact on the brain and that the ‘brain attack’ strategy of treating vascular pathology is effective only in treating a small proportion of strokes, one would anticipate that the major focus of stroke care would be on promoting neurological recovery for the majority of stroke survivors who are left with residual neurological deficits. Yet much work remains to be done. Ontario data suggest that large numbers of patients are still not able to access the rehabilitation services they need. Ontario’s stroke evaluation report has set a benchmark of 42.3% of surviving stroke patients to be admitted to inpatient rehabilitation. In 2010, 30.7% (1) of surviving patients were admitted to inpatient rehabilitation and Ontario research suggests that the majority of the inpatient rehabilitation units where they received care were not stroke-specialized units (23). Only 5–9% of stroke patients discharged home from acute care received a referral to outpatient rehabilitation, and patients referred to in-home rehabilitation services receive only 3-9 total rehabilitation visits on average (1). While a great deal of effort has been spent on standardizing vascular care in the acute phase, rehabilitation of the subsequent brain damage is still managed in a more ad hoc fashion. Pervasive among stroke survivors is a sense of being abandoned by the healthcare system once the allotted (usually inadequate) period of outpatient therapy is complete.

Time for a shift

The limitations of vascular management, the failure of neuroprotectants, and the uncertain future of stem cells as a treatment, occur against a backdrop of patients continuing to have strokes, often with life-changing consequences. Although laudable and important, a stroke strategy focused on acute management will be limited in its impact. At some point the emphasis in stroke management needs to shift more toward recovery from the consequences of brain damage (i.e., hemiplegia, visual perceptual and cognitive disorders, aphasia, dysphagia), the very issues that characterize a stroke. This is where the greatest potential for improving stroke care exists. The evidence for stroke units and rehabilitation is impressive (24–26), and the impact of rehabilitation interventions well established. Furthermore, research has shown that in comparison to tPA, aspirin, and neuroprotection, organized stroke units provide the greatest potential absolute benefit to the community as a whole (27). When estimates of effect were extrapolated to the population, for every 1000 cases, 46 (95% CI 17–69) could have been saved from death or dependency with stroke unit management compared with only 6 (95% CI 1–11) by using aspirin and 11 (95% CI 5–17) or 10 (95% CI 3–16) by thrombolysis at three- and six-hours, respectively (27).

Given the clinical evidence, the likely impact on outcomes, and the fact that the brain is quite different from the heart, it is time to focus more on a comprehensive and balanced approach to stroke care. We believe that stroke care is in need of a revolution, one that
places greater emphasis on rehabilitation and neurological recovery. Management of the vascular elements of stroke is important; however, it is our contention that the impact of rehabilitation on stroke recovery has been relatively undervalued. A much-needed paradigm shift must take place to ensure that stroke care is balanced, taking into account the importance of investing in rehabilitation and that the unique features of stroke are appreciated.

Throughout the treatment of stroke patient needs are managed both as a ‘brain attack’ and an ‘injured brain’, with greater emphasis on the latter.

References

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