Regional Access to Acute Ischemic Stroke Intervention

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Background and Purpose—Benefit-risk ratios from recombinant tissue plasminogen activator (rtPA) therapy for acute ischemic stroke demonstrate lack of efficacy if intravenous administration is commenced beyond 3 hours of symptom onset. We undertook to enhance therapeutic effectiveness by ensuring equitable access to rtPA for patients affected by acute ischemic stroke within a 20,000 km² population referral base served by a tertiary facility.

Methods—Representatives of all provider groups involved in emergency medical services developed a Regional Acute Stroke Protocol (RASP), a coordinated regional system response by dispatch personnel, paramedics, physicians, community service providers, emergency and inpatient staff in community hospitals, and the tertiary facility acute stroke team.

Results—As of July 26, 1999, all ambulance services in Southeastern Ontario began bypassing the closest hospital to deliver patients meeting the criteria for the RASP to the Kingston General Hospital. At 12 months, approximately 403 ischemic strokes have occurred in the region, the RASP has been activated 191 times, and 42 patients have received rtPA.

Conclusions—We conclude that (1) acute stroke patients in Southeastern Ontario have improved access to interventions for stroke care; (2) geography of the region is not a barrier to access to interventions for patients with acute stroke; and (3) acute ischemic stroke patients treated with rtPA account for 5% of all acute strokes and 10% of all ischemic strokes in this region. (Stroke. 2001;32:652-655.)

Key Words health services accessibility ■ stroke, acute ■ stroke, ischemic

Analyses of the use of recombinant tissue plasminogen activator (rtPA) for acute ischemic stroke in clinical trials,1,2 and in routine practice (in Calgary,3 Detroit,4 and Houston2) indicate that this intervention benefits patients with thrombotic and embolic stroke, and that if National Institute of Neurological Disorders and Stroke (NINDS) guidelines are followed, particularly treatment initiation within 3 hours of onset, effectiveness is demonstrable and the risk of symptomatic hemorrhage is minimized.

The 3-hour window for intervention presents challenges to the effectiveness of acute stroke care, particularly access to appropriate human resources prepared to offer rtPA therapy and technology to substantiate certain inclusion criteria. Not surprisingly, the uptake and application of this new evidence to ischemic stroke care practice is being carried out predominantly in tertiary care settings. Because tertiary facilities are responsible for providing this level of care to the regions they serve, the application of best evidence of efficacy to stroke care practice demands systems changes to ensure equitable access throughout the region.

Southeastern Ontario is a 20,000 km² mixed urban-rural region with a population of slightly less than 500,000. Its demographics are similar to those of many regions of Canada. The Southeastern Ontario Health Sciences Center in Kingston provides tertiary care needs for this region. Under the “nearest hospital” emergency medical services policy applied to Southeastern Ontario, it was calculated that 75% of the population of this region would be ineligible for rtPA therapy for acute ischemic stroke. The vast majority of patients in Southeastern Ontario with acute ischemic stroke would not have access to rtPA therapy without modifications to the current practices. We undertook to develop a Regional Acute Stroke Protocol (RASP) to bring all patients with acute stroke who met the time criterion for intervention with rtPA to the tertiary facility. Using NINDS1 and Canadian Stroke Consortium guidelines as a framework, a multidisciplinary acute stroke planning committee developed the RASP that was implemented in Southeastern Ontario on July 26, 1999.

Subjects and Methods

Several important enabling factors for development of the RASP were in place in Southeastern Ontario when the Canadian Federal Health Protection Branch approved the use of rtPA for use in acute ischemic stroke in February 1999.

(1) An existing stroke collaborative care program (CCP) in Kingston General Hospital (KGH) provided an essential foundation for the emergence of provider leadership to develop the RASP. This leadership, with the input of a multidisciplinary stroke team, representative of the involved regional groups, was able to provide the context for the challenges to address system change related both to the emergency and acute care components of stroke care and the interface between them. Stroke multidisciplinary CCPs were introduced to KGH in 1997 and 1998 through the activities the Collaborative Care Coordinator and the Neurosciences Care Team. The CCPs operate under established evidence-based guidelines for orga-
nized stroke care that continues to demonstrate the reduction of stroke-related deaths and long-term disability. The stroke CCPs are overseen, and monitored against benchmarks, by a joint practice committee of health professionals. It was out of this framework that leadership to develop the RASP emerged.

(2) The Care Delivery Network (CDN) project is a time-limited research and development initiative funded through a partnership agreement between Queen’s University and GlaxoWellcome Canada. The project promotes and facilitates regional provider-driven innovations in the clinical and systems settings. It operates as a health services development unit and brings staff with dedicated time, effort, and expertise to the process of change by consulting with and engaging providers and organizations from throughout the region. Stroke was chosen as an ideal target for innovations by the CDN project team, principally because stroke services touch on all aspects of the continuum of care, and the stroke CCP was in place in KGH to provide the critical clinical leadership.

(3) The Coordinated Stroke Strategy for Ontario was initiated by the Heart and Stroke Foundation of Ontario (HSFO) in 1998. On the basis of a state of readiness, including provision by the CDN project of a dedicated regional coordinator, Southeastern Ontario was chosen by the HSFO as 1 of 4 initial sites in the province to lead in the development of innovative and coordinated approaches to stroke across the continuum of care. HSFO is providing leadership to the Coordinated Stroke Strategy by convening a provincial Steering Committee, and by sponsoring project process evaluation, managing a public awareness campaign, providing professional education and self-education opportunities, and holding collaborative forums.

KGH has a full complement of clinical neurosciences and neuroimaging expertise and technology available 24 hours per day, 7 days per week, including an inpatient CCP for acute stroke on internal medicine and clinical neurosciences service units supported by a neurocritical care unit. Key planning issues included regional medical advisory committee, and board support for hospital bypass; clinical leadership from neurologists and emergency physicians; common criteria and communication; specific training protocols; continuous improvement; focus on land ambulance transport; community repatriation policies; and public awareness through the HSFO.

Once the protocol was developed, over 250 dispatchers and paramedics received training and now use assessment guidelines and a region-wide by-pass protocol to ensure accurate and timely responses. In addition over 250 nurses and allied health professionals in the region received training on how to use the guidelines to respond to patients with acute stroke.

The protocol contains 3 elements summarized in Tables 1 to 3.

### TABLE 1. Prehospital RASP Activation

<table>
<thead>
<tr>
<th>Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community providers call 911 or local emergency number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prehospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambulance dispatched to scene “Code 4”</td>
</tr>
<tr>
<td>Rapid on-scene physical assessment</td>
</tr>
<tr>
<td>Paramedics bypass nearest hospital if predefined criteria met</td>
</tr>
</tbody>
</table>

**Prenotification**

- KGH ER is notified 30 minutes out
- Abnormal blood pressure is reported

**KGH ER**

- Start workup
- Notify and transport to KGH
- Fax blood work and relevant medical history

**Regional Community Hospitals**

- Rapidly triage and assess
- Notify and transport to KGH

### TABLE 2. Hospital Referral Process

### TABLE 3. Regional Stroke Center Activation

- Group page is sent out
- Stroke team is in place when patient arrives
- Stroke patient is “next on scan”
- Care pathway begins in emergency department
- Transfer to an appropriate bed
- Repatriation

The acute stroke team at KGH was designed to be led by the on-call neurologist to ensure timely assessment and treatment for both patients transported to the emergency room (ER), and inpatients. Over 34 organizations, hospitals, central ambulance communications centers, and the regional base hospital program became engaged in the development and implementation of the protocol. A detailed manuscript regarding the RASP development is currently in development (G. Jones, A. Reed, D.L. Groll, C. Bolton, R.J. Riopelle, D.C. House, unpublished data, 2001). Refinements to the development of the RASP prior to full implementation were enabled by a decision to implement use of rtPA for acute stroke at KGH following Health Canada approval for its use in ischemic stroke in February 1999. Between February and July 1999, a number of patients were treated with rtPA.

Data collection for the RASP was obtained through retrospective chart review of all patients brought in under the protocol. Information on demographics, ambulance call report, stroke type, patient comorbidities, hospital course, and discharge disposition were collected and entered into a computer database designed for this purpose. Univariate and bivariate statistical analyses were then performed on the data.

The development of the RASP enabled identification and tracking of a number of following implementation. These outcomes related both to the content and to the process of care. In addition, and in compliance with the Health Canada request for participation in the Canadian Avastive for Stroke Effectiveness Study (CASES), data on all patients treated with rtPA are submitted regularly using the standard CASES format.

### Results

The RASP was initiated on July 26, 1999. In the subsequent 12 months, the RASP was activated 191 times, and 42 patients (22%) received rtPA therapy. Of the 191 patient activations, 54% were diagnosed as having ischemic stroke, and 41% of these patients received rtPA.

Detailed analysis of the first 12 months of experience with the RASP indicates that of 191 patient activations, 40% came from the KGH catchment area, 40% bypassed the closest hospital, and 20% were transported from a community hospital. Patients have arrived at KGH within the 3-hour treatment window from locations >180 km away.

Males accounted for 62% of activations, and the mean age of patients was 69 (SD 14) years. For patients activating the RASP, premorbid history revealed that 45% were hypertensive and 38% had suffered previous transient ischemic attack or stroke. Atrial fibrillation and hyperlipidemia each were present in 10% of the patients.

Using Canadian Institute for Health Information (CIHI) data (ICD-9 codes 430, 431, 432 to 432.9, 433 to 434.9, and 435), we estimated the acute stroke diagnosis denominator for Southeastern Ontario corresponding to the period of implementation following RASP activation (July 26, 1999–July 26, 2000). During this 12-month period, it is estimated that...
there were 792 strokes in Southeastern Ontario. Using this
denominator, 5.3% of all strokes and 10.4% of all ischemic
strokes (ICD-9 433 to 434.9; n=403) in the region were
treated with rtPA during this period.

The Figure documents the communities of origin in South-
eastern Ontario of patients who have received rtPA. Forty
percent of patients (17/42) from outside Kingston had access
to rtPA, which suggests that the geography of Southeastern
Ontario is not a barrier to thrombolytic therapy for acute
stroke for patients who can access KGH within a 3-hour time
window. Table 4 shows the percent of ischemic strokes
treated with rtPA according to geographic location.

When process of care issues were examined, the mean time
of stroke onset to initiation of rtPA therapy was 150 (SD 28)
minutes. Within this patient population, the time from ambu-
lance dispatch to ER admission was 58 (SD 22) minutes, and
time from ER admission to CT scan was 26 (SD 15) minutes.

Discussion
This report summarizes activities of the RASP during the 12
months since its implementation and focuses on the changing
demographics of the Southeastern Ontario stroke population
since the implementation, as well as on the process issues
driving those changes.

Currently, clinical outcomes of patients treated with rtPA
at 3 months after acute stroke are being documented as part
of a national study (Canadian Activase for Stroke Effectiveness
Study). A preliminary assessment indicates that both benefi-
cial and deleterious outcomes for patients are similar to those
reported elsewhere.8

The principal observations emerging from this ongoing
study are that development and implementation of the RASP
has reduced geographical barriers and increased access of
patients in a large, nonurban geographical area to acute stroke
therapy with rtPA within the 3-hour time window. The
present experience, while addressing treatment effectiveness
by providing further support for the feasibility of translating
the results of clinical trials to routine practice, highlights at
the regional population level the critical influence of systems
factors on effectiveness of care.

Implementation of the RASP resulted in KGH intake of
60% of the patients diagnosed with acute stroke in a 12-
month period, who, before July 1999, would have received
care in their own communities. Our data reveal that patients
in communities outside of Kingston were no less likely to
receive rtPA than were patients in the Kingston area. How-
ever, there are patients across the region for which RASP
activation did not occur because they would have been
outside the time window. When identified as a group, 48% of
rtPA-treated acute stroke patients came from outside of
Kingston, while 52% were from inside the KGH catchment
area (Kingston and Gananoque).

A number of factors contributed to the development and
implementation of the RASP once Health Canada approval and

**TABLE 4. Regional Differences in tPA Treatment Rate by Area**
(July 1999–July 2000)

<table>
<thead>
<tr>
<th>Region</th>
<th>tPA-Treated Strokes, n</th>
<th>Ischemic Strokes, n</th>
<th>Treated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KGH catchment area (includes</td>
<td>28</td>
<td>312</td>
<td>8.9</td>
</tr>
<tr>
<td>Gananoque and Napanee)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belleville/Picton</td>
<td>5</td>
<td>65</td>
<td>7.6</td>
</tr>
<tr>
<td>Brockville/Prescott</td>
<td>2</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Trenton/Campbellford</td>
<td>3</td>
<td>19</td>
<td>15.8</td>
</tr>
<tr>
<td>Perth/Smiths Falls</td>
<td>4</td>
<td>5</td>
<td>80</td>
</tr>
</tbody>
</table>

Map of Southeastern Ontario, revealing the communities of origin of patients who have received rtPA (n=42).
Canadian Stroke Consortium guidelines were in place. These included a preexisting spirit of cooperation among provider groups and organizations in Southeastern Ontario, and more specifically, the existence of the stroke CCP, the CDN Project team, and the HSFO Coordinated Stroke Strategy program.

As expected, implementation of the RASP has perturbed resource utilization within KGH. On average, 4 acute strokes per week are transported to KGH; and 40% of these are from outside the KGH catchment area. Current development of protocols for repatriation of patients to their community hospitals, whether or not they receive rtPA therapy, will be led by community providers with the assistance of the CDN project team. One protocol will not fit all sites, because factors to be considered are availability of diagnostics (vascular and cardiac ultrasound) and human and operational resource capacity across the continuum of care (speech/language pathology, physiotherapy, occupational therapy, rehabilitation settings, and long-term facilities). At this time, therefore, and for the near future, because of the RASP, KGH resources are directed toward a disproportionate number of strokes in Southeastern Ontario.

The activities of the stroke CCP in KGH have facilitated implementation of the RASP in a setting in which the KGH Emergency Department is the only tertiary facility in the region operating around the clock, and in which the vast majority of acute care in Kingston has been relocated at KGH as a result of health services restructuring.

The interfaces between emergency services, including the ER, and the stroke CCP is the purview of the acute stroke team. Attention to this interface has prevented excessive space and human resource utilization pressures in the KGH ER. In particular, the disposition of patients receiving rtPA therapy initiated in the ER is very efficient; in the majority of cases, the time from ER admission to transfer to the KGH Neurocritical Care Unit for monitoring requires <90 minutes.

Twenty-two percent of acute stroke patients activating the RASP were treated with rtPA. This percentage is comparable to the North American experience (20% to 25%) and attests to the robustness of the dispatch and paramedic training protocol (A. Reed et al, unpublished data, 2001). However, accurate determination of symptom onset has been found to be an area for continuous improvement. Prenotification has been an important component of the protocol; it has established a state of readiness for interventions such as hypertension treatment (>185 mm Hg systolic; >110 mm Hg diastolic) to improve chances of patients receiving rtPA, and it has facilitated rapid adjustment of priorities and schedules by stroke team members.

Training was a critical preimplementation task. The time required to facilitate and undertake the training component of the RASP was underestimated despite the fact that paramedic and nurse/allied health professional sessions ran concurrently under different coordinators. During the training process, the draft RASP guidelines were continually updated in response to feedback from participants between February and July 1999.

The engagement of all provider stakeholders in developing and implementing the RASP has prompted widespread ownership of and enthusiasm for the protocol. Priorities for ongoing improvements to and maintenance of the RASP include modifications to paramedic diagnostic criteria based on early experience; review of ambulance call reports to understand reasons for RASP exclusion; and improved documentation to support ongoing evaluation and outcomes research.

Patients with acute stroke in Southeastern Ontario are up to 5 times more likely than those seen in other tertiary referral bases to receive rtPA therapy. On average, <1% to 2% of the affected population within the referral base of a tertiary facility currently has access to rtPA. The reasons for this difference have not been elucidated; however, it is possible that a significant proportion of patients and/or their families are sufficiently aware of the emergency nature of this condition through public-awareness campaigns, and therefore rapidly access emergency services in a region where an acute response protocol is available, for account for the high treatment rate. Nevertheless, there is room for improved reaction by patients/families when signs of stroke are apparent; our data demonstrate that the mean time from stroke onset to 911 call was 47 (SD 80) minutes.

The successful implementation of the RASP in Southeastern Ontario has become a catalyst for other initiatives across the continuum of care for stroke. As a result of the accomplishments to date, priority initiatives in Southeastern Ontario now include coordinated secondary prevention and implementation of stroke CCPs in community hospitals throughout the region and improved regional access to evidence-based interventions for ischemic stroke.

Acknowledgments

The authors acknowledge the Queen’s University/GlaxoWellcome Canada partnership in support of the Queen’s University Care Delivery Network project. Project evaluation activities of the MacKenzie Health Services Research Group are also acknowledged.

References

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Stroke. 2001;32:652-655
doi: 10.1161/01.STR.32.3.652
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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