The Canadian Journal of Neurological Sciences (2025), 1–12
doi:10.1017/cjn.2025.10386

Canadian Journal of Neurological Sciences
Journal Canadien des Sciences Neurologiques

Original Article

The Acute Stroke System of Treatment Across Canada: Findings from a National Stroke Centre Survey

Betty Adewusi[1], Andrew M. Demchuk[2], Grant Stotts[3], Renee Cashin[4], Marsha Eustace[5], Trish Helm-Neima[6], Heather Williams[7], Bridget Stack[8], Shahram Abootalebi[8], Julie Savoie[9], Alissa Decker[10], Melissa Buckler[11], Sherry Xueying Hu[10], Alexandre Yves Poppe[12,13], Marie-Christine Camden[14], Shelley Sharp[15], Aris Katsanos[16], Ravinder-Jeet Singh[17], Regan Spencer[18], Esseddeeg Ghrooda[19], Nishita Singh[20], Ruth Whelan[21], Regan Cooley[22], Mary-Lou Halabi[23], Balraj Mann[23], Brian H. Buck[24], Sacha Arsenault[25], Aleksander Tkach[26], Hannah Shoichet[27], Katherine Breen[28], Samantha Atwan[28] and Noreen Kamal[1,29,30]

[1]Department of Industrial Engineering, Dalhousie University, Halifax, NS, Canada, [2]Department of Clinical Neurosciences, Hotchkiss Brain Institute, Cumming School of Medicine, University of Calgary, Calgary, AB, Canada, [3]Division of Neurology, Department of Medicine, The Ottawa Hospital, Ottawa, ON, Canada, [4]Provincial Cardiovascular and Stroke Program, Newfoundland and Labrador Health Services, St. John's, NL, Canada, [5]Division of Neurology, Faculty of Medicine, Memorial University of Newfoundland, St. John's, NL, Canada, [6]Provincial Stroke Program, Health PEI, Charlottetown, PE, Canada, [7]Queen Elizabeth Hospital, Charlottetown, PE, Canada, [8]Horizon Health Network, Saint John, NB, Canada, [9]Vitalité Health Network, Moncton, NB, Canada, [10]QEII Health Sciences Centre, Nova Scotia Health, Halifax, NS, Canada, [11]Integrated Acute and Episodic Care Clinical Service Network, Nova Scotia Health, Halifax, NS, Canada, [12]Department of Neurosciences, Université de Montréal, Montréal, QC, Canada, [13]Centre Hospitalier de l'Université de Montréal, Montréal, QC, Canada, [14]Enfant-Jésus Hospital, Centre Hospitalier Universitaire de Québec, Laval University, Québec City, QC, Canada, [15]Stroke Clinical Program, Ontario Health, Toronto, ON, Canada, [16]Division of Neurology, McMaster University/Population Health Research Institute, Hamilton, ON, Canada, [17]Department of Medicine, Health Sciences North, Sudbury, ON, Canada, [18]Health Service Integration & Clinical Planning, Shared Health, Winnipeg, MB, Canada, [19]Neurology Division, Department of Medicine, University of Manitoba, Winnipeg, MB, Canada, [20]Health Sciences Center, Division of Neurology, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, MB, Canada, [21]Stroke Services, Saskatchewan Health Authority, Saskatoon, SK, Canada, [22]Division of Neurology, College of Medicine, University of Saskatchewan, Saskatoon, SK, Canada, [23]Neuroscience & Stroke Program Improvement and Integration Network, Alberta Health Services, Edmonton, AB, Canada, [24]Division of Neurology, Department of Medicine, University of Alberta, Edmonton, AB, Canada, [25]Stroke Services BC, Provincial Health Services Authority, Vancouver, BC, Canada, [26]Kelowna General Hospital, Kelowna, BC, Canada, [27]Department of Emergency Medicine, Stanton Territorial Hospital, Yellowknife, NT, Canada, [28]Yukon Hospital Corporation, Whitehorse, YT, Canada, [29]Department of Medicine, Division of Neurology, Dalhousie University, Halifax, NS, Canada and [30]Department of Community Health & Epidemiology, Dalhousie University, Halifax, NS, Canada

ABSTRACT: ***Background:*** Stroke is a devastating disease, but the disability due to stroke can be avoided or reduced through timely access to treatment and care. This study surveyed all designated stroke centres across Canada to better understand the national acute stroke treatment landscape. ***Methods:*** An online survey designed to obtain information on each stroke hospital's designation level, most responsible physician for acute reperfusion treatment decision-making, availability of stroke coordinators, stroke research activity and level of transition to tenecteplase for intravenous thrombolysis was distributed to stroke centres in Canada via a network of stroke administrators and physician leads from each province. The survey responses were collated and audited for completeness and accuracy, and final responses were analysed using descriptive statistics and graphical distributions as appropriate. ***Results:*** There are a total of 205 designated stroke centres in Canada; 13.2% ($n = 27$) are endovascular thrombectomy (EVT) capable ($n = 26$ provide 24/7 access), while the rest provide thrombolysis alone, comprising primary stroke centres ($n = 70$, 34.1%) and thrombolysis-ready centres ($n = 108$, 52.7%). The presence of neurologists in the thrombolysis-capable centres is minimal, although compensated for by a high use of telestroke in making thrombolysis decisions. Participation rate in stroke clinical trials was heavily restricted to the EVT-capable centres. There were variabilities among provinces in the availability of stroke coordinators. ***Conclusion:*** The acute ischaemic stroke landscape in Canada is variable between provinces, presenting unique opportunities for collaboration. There is a need for greater availability of stroke neurologists and stroke coordinators and for diversifying site participation in clinical trials.

Corresponding author: Noreen Kamal; Email: noreen.kamal@dal.ca

Cite this article: Adewusi B, Demchuk AM, Stotts G, Cashin R, Eustace M, Helm-Neima T, Williams H, Stack B, Abootalebi S, Savoie J, Decker A, Buckler M, Hu SX, Poppe AY, Camden M-C, Sharp S, Katsanos A, Singh R-J, Spencer R, Ghrooda E, Singh N, Whelan R, Cooley R, Halabi M-L, Mann B, Buck BH, Arsenault S, Tkach A, Shoichet H, Breen K, Atwan S, and Kamal N. The Acute Stroke System of Treatment Across Canada: Findings from a National Stroke Centre Survey. *The Canadian Journal of Neurological Sciences*, https://doi.org/10.1017/cjn.2025.10386

RÉSUMÉ: Le système de traitement des AVC aigus au Canada : résultats d'un sondage national mené auprès des centres de traitement des AVC. ***Contexte :*** L'AVC est une affection dévastatrice dont les invalidités qui en découlent peuvent être évitées ou réduites grâce à un accès rapide à des traitements et des soins. Cette étude a interrogé tous les centres de traitement des AVC désignés au Canada afin de mieux comprendre le paysage national qui concerne le traitement des AVC aigus. ***Méthodes :*** Un sondage en ligne conçu pour obtenir des renseignements sur le niveau de désignation de chaque hôpital spécialisé dans les AVC, le médecin responsable de la prise de décision en matière de traitement de reperfusion aiguë, la disponibilité de coordonnateurs spécialisés dans les AVC, les activités de recherche sur les AVC et le niveau de transition vers le ténectéplase pour la thrombolyse intraveineuse (TIV) a été distribué aux centres de traitement des AVC au Canada par l'intermédiaire d'un réseau d'administrateurs et de médecins responsables dans chaque province. Les réponses à ce sondage ont été compilées et vérifiées pour s'assurer de leur exhaustivité et de leur exactitude. Les réponses finales ont été ensuite analysées à l'aide de statistiques descriptives et, le cas échéant, de distributions graphiques. ***Résultats :*** Il existe 205 centres désignés pour le traitement des AVC au Canada. De ce total, 27 (13,2 %) sont équipés pour pratiquer la thrombectomie endovasculaire (TEV) ; sur ces 27 centres, 26 offrent un accès 24 heures sur 24, 7 jours sur 7. Notons que les autres centres ne pratiquent que la thrombolyse, ce qui comprend les centres de soins primaires pour les AVC (n = 70 ou 34,1 %) et les centres équipés pour la thrombolyse (n = 108 ou 52,7 %). La présence de neurologues dans les centres capables de pratiquer la thrombolyse est minime, mais elle est compensée par un recours important à des services de Télé-AVC pour prendre des décisions relatives à la thrombolyse. Le taux de participation aux essais cliniques portant sur les AVC était fortement limité aux centres capables de pratiquer la TEV. Enfin, il existe des variations entre les provinces en ce qui concerne la disponibilité des coordonnateurs en matière d'AVC. ***Conclusion :*** Le paysage de prise en charge des AVC ischémiques aigus au Canada varie d'une province à l'autre, ce qui offre des possibilités uniques de collaboration. À cet égard, il est nécessaire d'accroître la disponibilité des neurologues et des coordonnateurs spécialisés dans les AVC, et de diversifier la participation des centres de traitement aux essais cliniques.

Keywords: endovascular thrombectomy; ischaemic stroke; stroke centre designation; survey; thrombolysis

(Received 14 January 2025; final revisions submitted 24 June 2025; date of acceptance 25 July 2025)

Highlights

- There are 27 EVT-capable stroke centres and 178 thrombolysis-only centres in Canada.
- There is variation across the provinces in the availability of stroke coordinators and neurologists in the emergency department.
- The majority of provinces have limited or no availability of stroke specialist physicians on-site in the emergency department.

Introduction

Disability and death due to ischaemic stroke can be mitigated with timely acute reperfusion treatments using intravenous thrombolysis (IVT) and endovascular thrombectomy (EVT). IVT with alteplase[1,2] and now tenecteplase (TNK)[3,4] provides a first line of treatment for acute ischaemic stroke patients and is widely available across Canada at hospitals that are equipped with a CT scanner and have access to expertise to medically treat patients with thrombolysis. EVT is a relatively new and highly efficacious treatment[5,6] that requires highly specialized angiography infrastructure, devices and personnel, restricting its availability to specialized sites at larger urban and mostly tertiary care hospitals.

Both treatments are highly time dependent,[7,8] so it is critical that stroke systems are created to ensure that all citizens can have timely access to hyperacute ischaemic stroke treatment. Health systems across Canada have realized the need for structured acute stroke systems of care that ensure suspected stroke patients are directed by ambulance services to designated stroke centres to ensure timely access to treatment. Lack of well-designed systems of care is a critical factor associated with worse stroke outcomes.[9] Hence, appropriate stroke centre designation and selective triage of suspected acute stroke patients for bypass of non-designated hospitals can significantly improve the utilization of treatment and efficient time to treatment from onset, resulting in improved outcomes. Stroke centre designations are based on several criteria including the availability of neuroimaging, a dedicated stroke unit with treatment protocols, staffing with qualified personnel and the range of treatment capabilities.[10] There are heterogeneities in the conventions of designating stroke centres globally. For example, in the USA, stroke centre designations are mostly based on the recommendations of the Brain Attack Coalition, a non-profit professional group dedicated to reducing the burden of stroke.[11] Four levels of stroke centres are recognized: comprehensive stroke centre (CSC), thrombectomy-capable stroke centre, primary stroke centre (PSC) and acute stroke-ready hospital (thrombolysis-ready hospitals).[9,12] CSCs provide the highest level of stroke care including EVT treatment at all times and have neuro-intensive care and neurosurgery on-site; thrombectomy-ready centres have EVT treatment but not at all times or lack neuro-intensive care and neurosurgery on-site. PSCs do not have EVT on-site but provide thrombolysis at all times with an on-site stroke unit defined as a specialized, geographically defined hospital unit dedicated to the management of patients with stroke, while thrombolysis-ready centres provide thrombolysis at all times (this can be with or without telestroke capacity), but these centres do not have an on-site stroke unit.[9,12] Table 1 shows all four levels of stroke centre designation.

The purpose of this paper is to present the findings of a recent national stroke centre survey conducted in Canada. The primary objective of the survey was to scan the acute ischaemic stroke treatment landscape in Canada and gather preliminary information about each designated stroke centre, the level of stroke treatment provided and specialty of most responsible physician for acute reperfusion treatment decision-making, the use of telestroke, the availability of stroke clinical research professionals and the participation in clinical trials at each centre. The results from this study can help to identify opportunities for further optimization of stroke systems of care across all 10 provinces and 3 territories across Canada. This national stroke survey is part of an ongoing national stroke initiative called OPTIMISING ACCESS[13] that aims to ensure the highest level of quality in the treatment of acute

https://doi.org/10.1017/cjn.2025.10386

Table 1. Stroke centre designations

	Treatment	Infrastructure	Personnel
Comprehensive stroke centre	-EVT 24/7 -Thrombolysis 24/7 -Neurosurgery	-Dedicated stroke unit -Neuro-intensive unit -CT imaging -Advanced imaging 24/7	-Stroke team 24/7 -Neurologist 24/7
Thrombectomy-ready centre	-EVT-capable -Thrombolysis offered -Neurosurgery possible	-Dedicated stroke unit -CT imaging -Advanced imaging possible	-Stroke team 24/7 -Neurologist available but not 24/7
Primary stroke centre	-Thrombolysis offered	-Dedicated stroke unit -CT imaging	-Stroke team 24/7 -Neurologist available, often via telestroke
Thrombolysis-ready centre	-Thrombolysis capable	-CT imaging	-Stroke team 24/7 -Neurologist available, often via telestroke

EVT = endovascular thrombectomy.

Table 2. National stroke survey questions

Question	Domain	Purpose
• Name of hospital • Location of hospital: City • Location of hospital: Province or territory	Location	To obtain the name of the stroke centre and its location to help ascertain the distribution of stroke centres by province in Canada.
• Contact person: Full name • Contact email	Administrative	To obtain a contact person for the stroke centre, to help resolve queries and subsequent inquiries.
• Please complete information which type of designated stroke centre best describes your hospital	Stroke Centre Designation	To ascertain the stroke centre designation of the hospital.
• Do you have neurologists on-site seeing stroke patients in-person in the emergency department (ED)? • Do you have a fellowship-trained stroke neurologist or Canadian Stroke Consortium-certified physician on-site seeing stroke patients in ED? • Who makes the thrombolysis treatment decision at your site?	Acute stroke care: Physician	To ascertain the availability of neurologists in the ED at stroke centres across Canada and whether the available neurology experts have the requisite and specific training in provision of acute stroke care. To further determine whether other physician specialties (e.g. general internist, emergency physician) are making acute stroke care decisions and whether they are receiving specialized support from a stroke specialist (e.g. via telemedicine) to guide decisions.
• Has your site transitioned to intravenous tenecteplase (TNK)?	Acute stroke care: Treatment	To know if sites are up to date with the latest guidelines on stroke treatment.
• Do you have a local or regional coordinator for stroke care funded by your health system?	Stroke System Support	To ascertain the presence and level of funded and designated support for stroke care in the province and region.
• Are patients enrolled in stroke clinical trials at your site?	Research Participation	To discover site participation in clinical trials and identify potential patterns of inequities in clinical trial data across Canada.
• Do you have any additional comments?	Other	To obtain other pertinent information about the operations of the stroke centre.

ischaemic stroke patients with both thrombolysis and EVT across Canada, with the objective to reduce disparity between rural/remote and urban hospitals.

Methods

Survey design and distribution

The stroke centre survey was designed by the investigators (NK, AD, GS) with the purpose to obtain an overview of access to thrombolysis and EVT treatment for acute ischaemic stroke across Canada. The survey aimed to obtain information on each stroke hospital's designation level (Table 1), who makes the treatment decision, if they have a local/regional stroke coordinator, and their transition to TNK (Table 2). The survey included a combination of several question types including multiple choice and open-text questions.

The survey was designed and administered electronically using the online webform from Microsoft Office Forms (Microsoft Corp, Redmond, WA) and was distributed to a convenience sample consisting of the members of the OPTIMISING ACCESS national roundtable.[13] The OPTIMISING ACCESS national roundtable was assembled at the inception of the project and consists of stroke neurologist(s) and provincial-level stroke administrator(s) dyads from every province and territory in Canada. The members of the national roundtable then circulated the survey to their network of hospitals in their province, ensuring that each province was reached. The survey was distributed in January 2024 and remained open until the final response was received from all 205 stroke centres.

Survey response audit and quality checks

The survey responses were collated and audited by two members of the research team (BA, NK). Survey responses were checked for completeness and accuracy. The audit process was performed in two stages. In the first stage, questionable responses (from a logical

https://doi.org/10.1017/cjn.2025.10386

standpoint) were verified as each survey response was received. This included things like duplicate entries, defining the correct province for hospitals with close boundaries, etc. For this stage, the contact person on the national roundtable for the province or the person who filled the survey was contacted for verification. Prior to survey distribution, a master list of all possible stroke-treating hospitals in Canada was created in collaboration with the members of the national roundtable, which was used to track survey completion rates. For the final stage of the audit, after the responses was closed, the survey responses for each province were collated and sent to each provincial stroke coordinator and/or physician lead on the national roundtable to verify that each stroke-treating hospital in their province was accounted for and that the responses provided were accurate to the best of their knowledge. In this way, we were able to verify the accuracy and completeness of the designated stroke centres, which were included in this study.

Data analysis

The survey was exploratory in nature, and the survey variables were mostly categorical. Hence, analyses involved descriptive statistics (counts, percentages, mode) and graphical distributions performed as appropriate. Comparisons were made between provinces across Canada where possible. To calculate the crude and age-adjusted rate of stroke centres per 100,000 persons in each province, the most recent population data from the 2021 Canada census of population of each province were obtained from Statistics Canada.[14] The age-adjusted rates were calculated based on the population of adults aged 18 years and older, as paediatric stroke (stroke in infants and children < 18years) is rare and is often managed with different protocols.[15] All analyses were conducted using Microsoft Excel Version 2406.

Results

The first survey response was received on 30 January 2024, while the last response was received on 9 August 2024.

Distribution of designated stroke centres in Canada

There are a total of 205 stroke centres in Canada, and they were all represented in the final completed survey. In addition to these 205 stroke centres, there are 25 thrombolysis-ready, ambulance bypass centres in Canada, which are capable of providing thrombolysis to walk-in or in-hospital stroke patients only. These sites were not included in any of the further analyses as they are not considered stroke centres. The provinces of Quebec (QC), Ontario (ON) and British Columbia had the largest numbers of stroke centres, respectively, and comprised over 65% of all stroke centres in Canada. Table 3 lists the count of all the stroke treatment centres in Canada.

There are 27 EVT-capable stroke centres in Canada: 26 CSCs and 1 thrombectomy-ready centre. Ten (42%) of the CSCs in Canada are in the province of ON, which also has the only thrombectomy-ready centre in the country. There are no CSCs in the province of Prince Edward Island (PE) and in any of the three Canadian territories of Yukon (YT), Nunavut (NU) and Northwest Territory (NT). Stroke patients needing EVT in each of these provinces and territories are transferred inter-provincially; PE patients are transferred to the CSC located in NS, while the territories of YT and NT consult with and transfer eligible stroke patients to the CSCs located in Vancouver and Edmonton, respectively. The thrombolysis-ready stroke centre in Iqaluit, Nunavut, only serves a portion of the Nunavut population and consults with and transfers patients to Ottawa for EVT. The rest of Nunavut is split into regional health hubs that receive primary and advanced stroke care from Churchill, MB; Winnipeg, MB; Yellowknife, NT; and Edmonton, AB. The bulk of the stroke centres in Canada are thrombolysis-capable centres, comprising PSCs (n = 70, 34.1%) and thrombolysis-ready centres (n = 108, 52.7%) as shown in Table 3.

The distribution of thrombolysis and EVT-capable centres in Canada per 100,000 of the population in each of the provinces and territories is displayed in Table 4. The crude rate of

Table 3. Count of stroke treatment centres in Canada

Province	CSC	Thrombectomy-ready	PSC	Thrombolysis-ready
NL	1	–	2	8
PE	–	–	1	1
NS	1	–	6	3
NB	1	–	1	8
QC	5	–	18	36
ON	10	1	20	11
MB	1	–	1	6
SK	1	–	1	8
AB	2	–	12	2
BC	4	–	8	22
Territories	–	–	–	3
Canada	26	1	69	109

NL = Newfoundland and Labrador; PE = Prince Edward Island; NB = New Brunswick; NS = Nova Scotia; QC = Quebec; ON = Ontario; MB = Manitoba; SK = Saskatchewan; AB = Alberta; BC = British Columbia; Territories include Nunavut, Northwest Territory and Yukon; CSC = comprehensive stroke centre; PSC = primary stroke centre.

Table 4. Rate of thrombolysis-only and EVT-capable centres per 100,000

	Crude rate		Age-adjusted[+]	
	EVT-capable	Thrombolysis-only	EVT-capable	Thrombolysis-only
NL	0.20	1.96	0.23	2.34
PE	N/A	1.30	N/A	1.59
NB	0.13	1.16	0.16	1.40
NS	0.10	0.93	0.12	1.12
QC	0.06	0.64	0.07	0.79
ON	0.08	0.22	0.10	0.27
MB	0.07	0.52	0.10	0.67
SK	0.09	0.79	0.12	1.04
AB	0.05	0.33	0.06	0.42
BC	0.08	0.60	0.10	0.73
Territories	N/A	2.54	N/A	3.49
Canada	0.07	0.48	0.09	0.60

NL = Newfoundland and Labrador; PE = Prince Edward Island; NB = New Brunswick; NS = Nova Scotia; QC = Quebec; ON = Ontario; MB = Manitoba; SK = Saskatchewan; AB = Alberta; BC = British Columbia; Territories include Nunavut, Northwest Territory and Yukon; EVT = endovascular thrombectomy. EVT-capable sites include comprehensive stroke centres and thrombectomy-ready centres. Thrombolysis-only sites include primary stroke centres and thrombolysis-ready centres. [+]The age-adjusted rates were based on the population of adults aged 18 years and over from the 2021 Canada census of population.

https://doi.org/10.1017/cjn.2025.10386

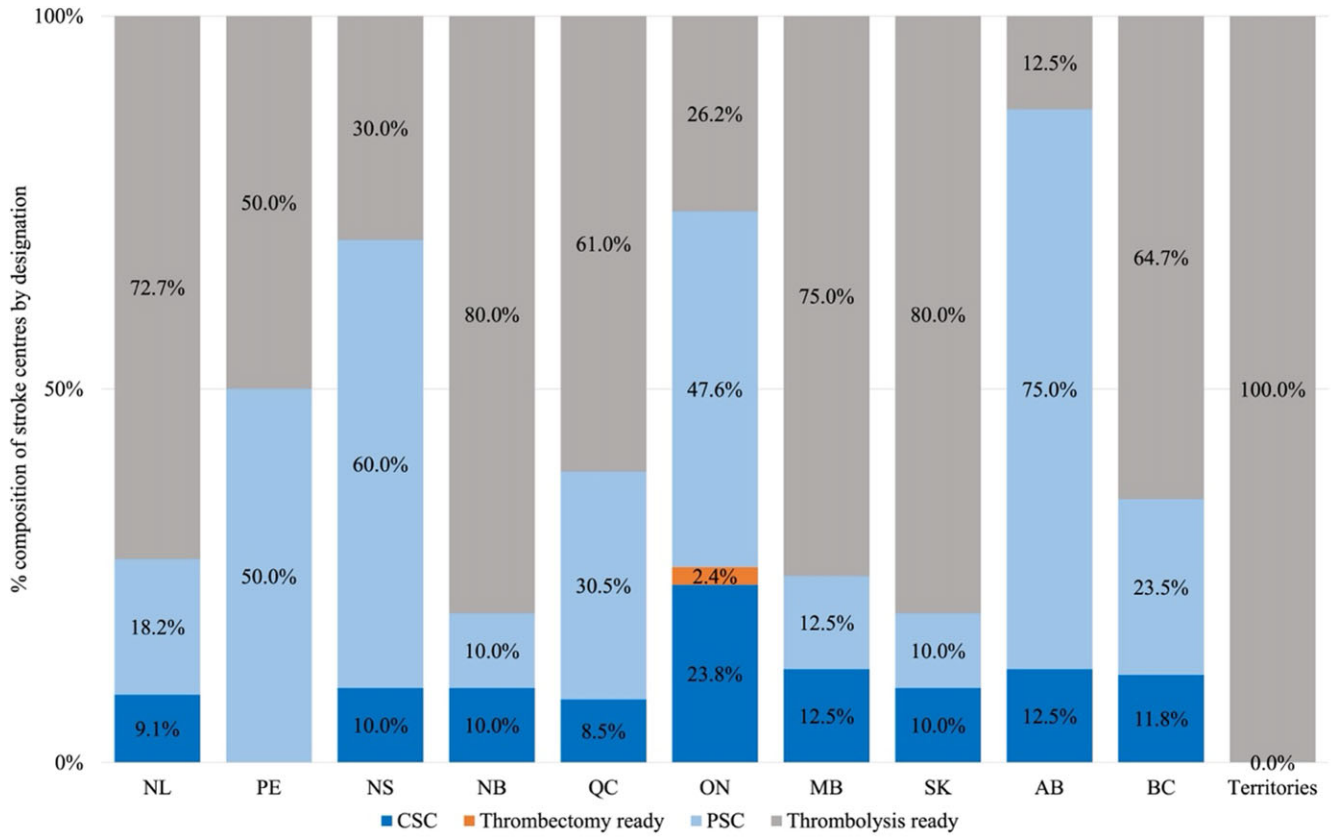

Figure 1. Percentage composition of stroke centres in Canada by province. Stroke centre types are expressed as a percentage of the total number of stroke centres in each province. NL = Newfoundland and Labrador; PE = Prince Edward Island; NB = New Brunswick; NS = Nova Scotia; QC = Quebec; ON = Ontario; MB = Manitoba; SK = Saskatchewan; AB = Alberta; BC = British Columbia; Territories include Nunavut, Northwest Territory and Yukon; CSC = comprehensive stroke centre; PSC = primary stroke centre.

thrombolysis-only centres per 100,000 of the population ranged from 0.22 in ON to 2.54 in the Territories, while EVT-capable centres ranged from 0.05 in Alberta to 0.20 in Newfoundland and Labrador. Age adjustment (to reflect the adult population 18 years and above) at most risk for stroke and eligible for treatment) increased the rate of thrombolysis and EVT-capable stroke centres per 100,000.

The percentage composition of stroke centres in each of the provinces and territories in Canada is displayed in Figure 1, and the distribution of stroke centres on a map is shown in Figure 2. Alberta has the largest percentage composition of PSCs (75%) and the fewest proportion (12.5%) of thrombolysis-ready hospitals. Apart from the territories that were just composed of thrombolysis-ready centres, 80% of the thrombolysis-capable hospitals in Saskatchewan are thrombolysis-ready, and 75% of the thrombolysis-capable hospitals in Manitoba are thrombolysis-ready.

Availability of local or regional stroke coordinator funded by the health system

In Canada, 67% of the stroke centres have a local or regional stroke coordinator that was funded by the health system, although there is considerable variation among provinces (Figure 3). For instance, the provinces of Prince Edward Island, Nova Scotia and Alberta have provincially funded stroke coordinators for all their stroke centres. In contrast, there is no stroke coordinator available in Manitoba, Horizon Health Network (NB) or the Territories.

Availability of neurologists in the ED

Only 70 (34%) stroke centres in Canada have neurologists physically present in the ED to attend to stroke patients, with some of the sites (8.3%) having the available neurologists on a part-time or on-call basis only (Figure 4). When comparing by type of stroke centres, most of the EVT-capable centres (96.3%) had availability of a neurologist in the ED all or most of the time as expected, whereas neurologists were available in the ED in only 53.6% of PSCs and 5.5% of thrombolysis-ready centres. QC and ON had the greatest availability of neurologists in the ED (40%–42% of their stroke centres). There was no neurologist present in any of the stroke centres in the Territories.

The neurology expertise in the ED was further stratified by the availability of specialists who have received stroke-specific training via fellowship or the Canadian Stroke Consortium certification. Only nine provinces had stroke neurologists, and only five provinces had stroke neurologists available at all times. Stroke neurologists were available in the ED most or all the time in 8.3% of all the sites and were available sometimes in 14.6% of stroke centres in Canada. The remaining 77.1% of stroke centres in Canada did not have stroke-trained neurologists available in the ED (Figure 5). When stratified by the type of stroke centres, stroke neurologists were centred in the EVT-capable centres. Apart from one hospital, all (96.3%) of the EVT- capable centres had stroke neurologists on-site in the ED on a regular or sporadic basis. In contrast, stroke neurologists were available in the ED in only 29% of PSCs and 1% of the thrombolysis-ready centres.

https://doi.org/10.1017/cjn.2025.10386

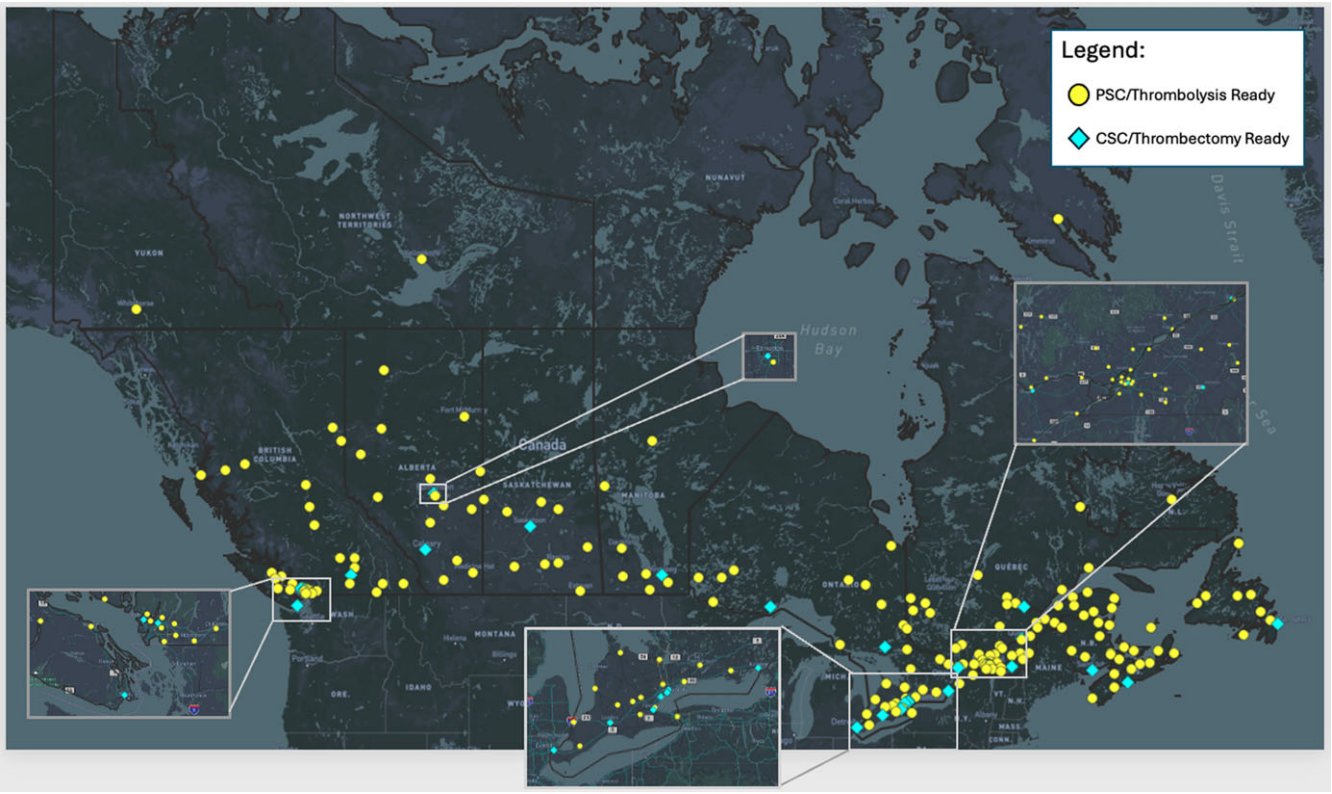

Figure 2. Distribution of all 205 stroke centres across Canada. CSC = comprehensive stroke centre; PSC = primary stroke centre.

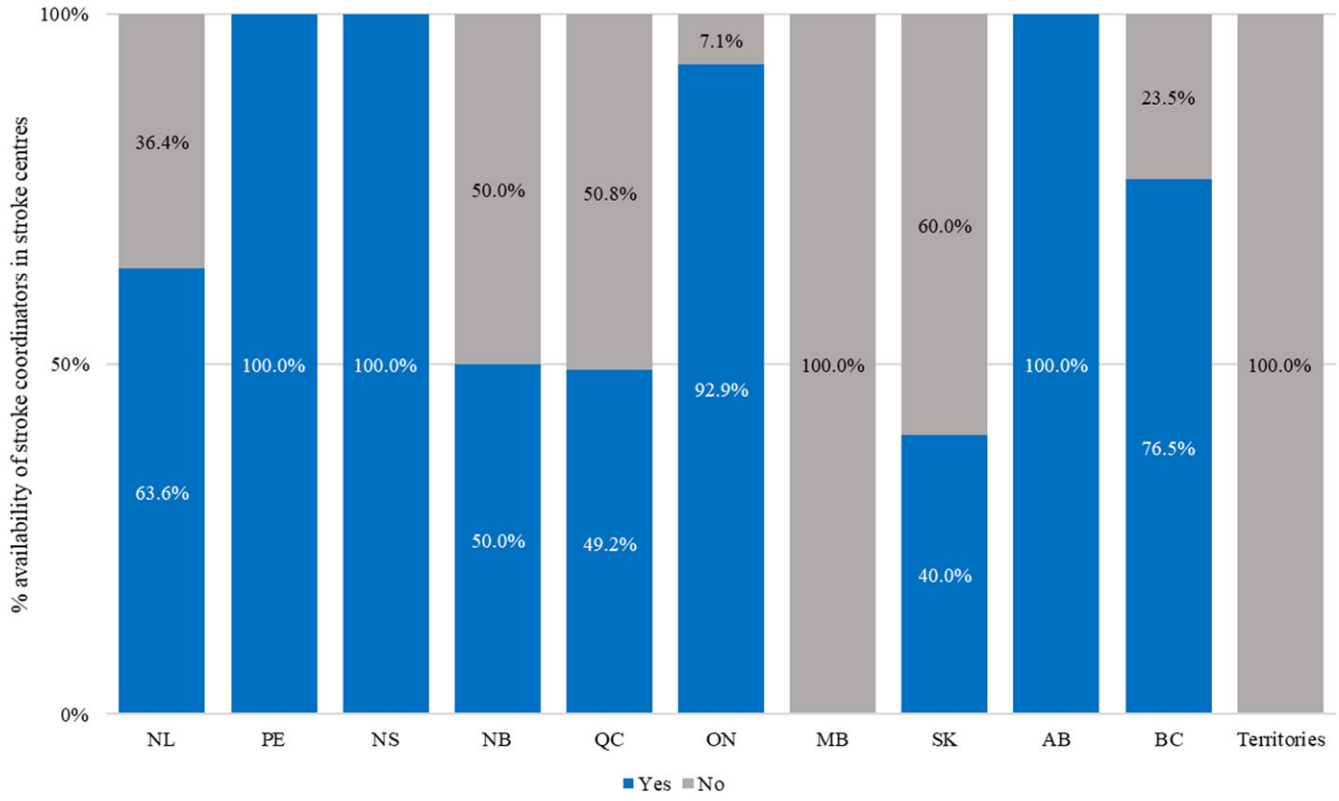

Figure 3. Availability of local or regional stroke coordinator funded by the health system. Bars show the percentage of stroke centres with provincially funded stroke coordinators in each province. NL = Newfoundland and Labrador; PE = Prince Edward Island; NB = New Brunswick; NS = Nova Scotia; QC = Quebec; ON = Ontario; MB = Manitoba; SK = Saskatchewan; AB = Alberta; BC = British Columbia; Territories include Nunavut, Northwest Territory and Yukon.

https://doi.org/10.1017/cjn.2025.10386

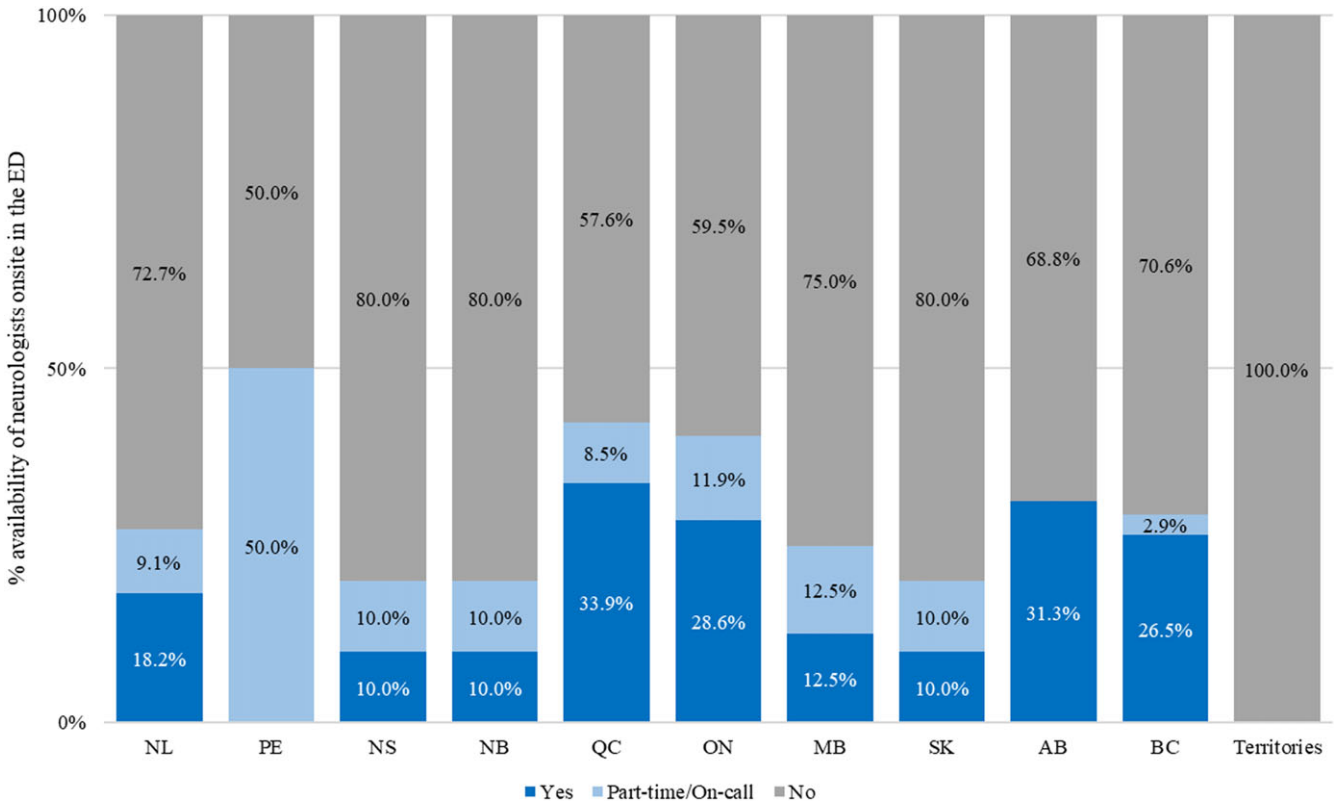

Figure 4. Availability of neurologists on-site in the ED of stroke centres. Bars show the percentage availability of neurologists on-site in the ED in the stroke centres in each province. NL = Newfoundland and Labrador; PE = Prince Edward Island; NB = New Brunswick; NS = Nova Scotia; QC = Quebec; ON = Ontario; MB = Manitoba; SK = Saskatchewan; AB = Alberta; BC = British Columbia; Territories include Nunavut, Northwest Territory and Yukon.

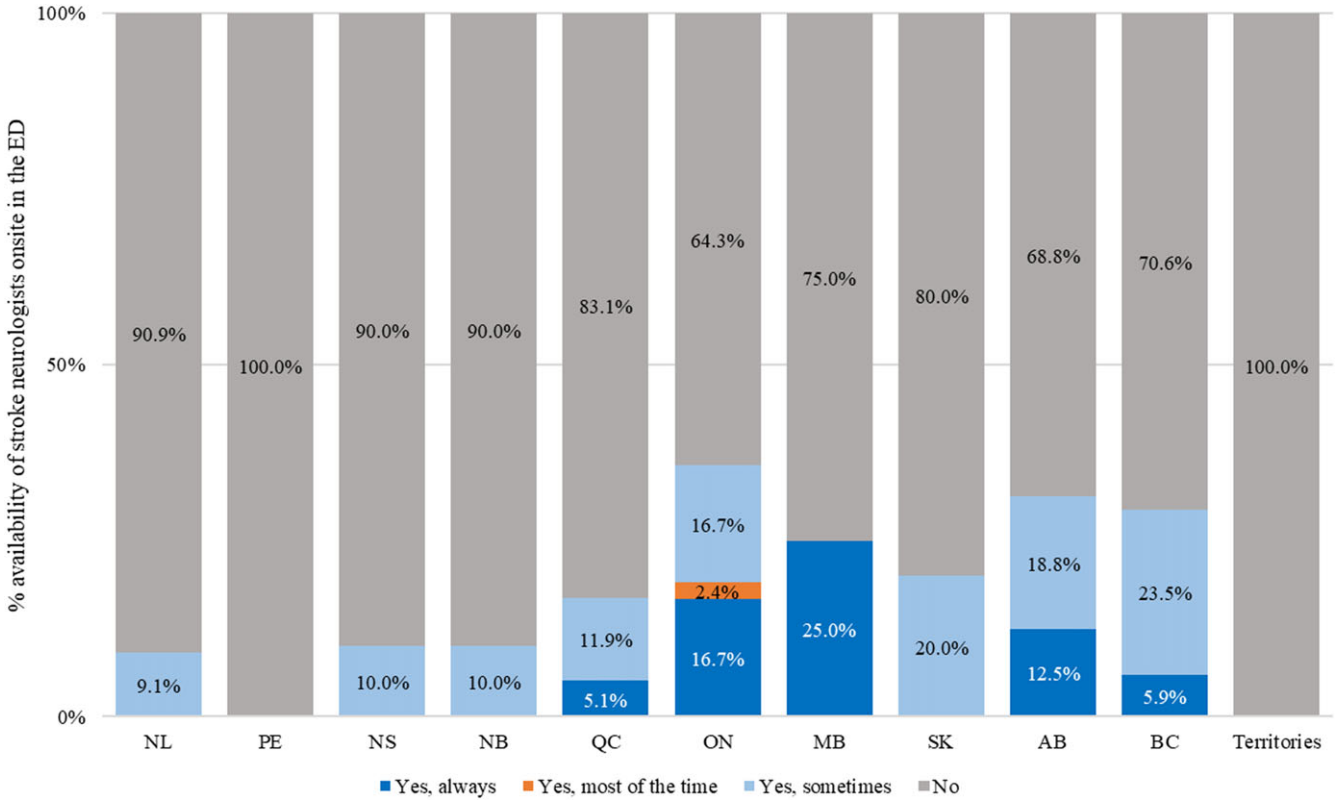

Figure 5. Availability of stroke specialists on-site in the ED of stroke centres. Bars show the percentage availability of stroke-trained neurologists on-site in the ED in the stroke centres in each province. NL = Newfoundland and Labrador; PE = Prince Edward Island; NB = New Brunswick; NS = Nova Scotia; QC = Quebec; ON = Ontario; MB = Manitoba; SK = Saskatchewan; AB = Alberta; BC = British Columbia; Territories include Nunavut, Northwest Territory and Yukon.

https://doi.org/10.1017/cjn.2025.10386

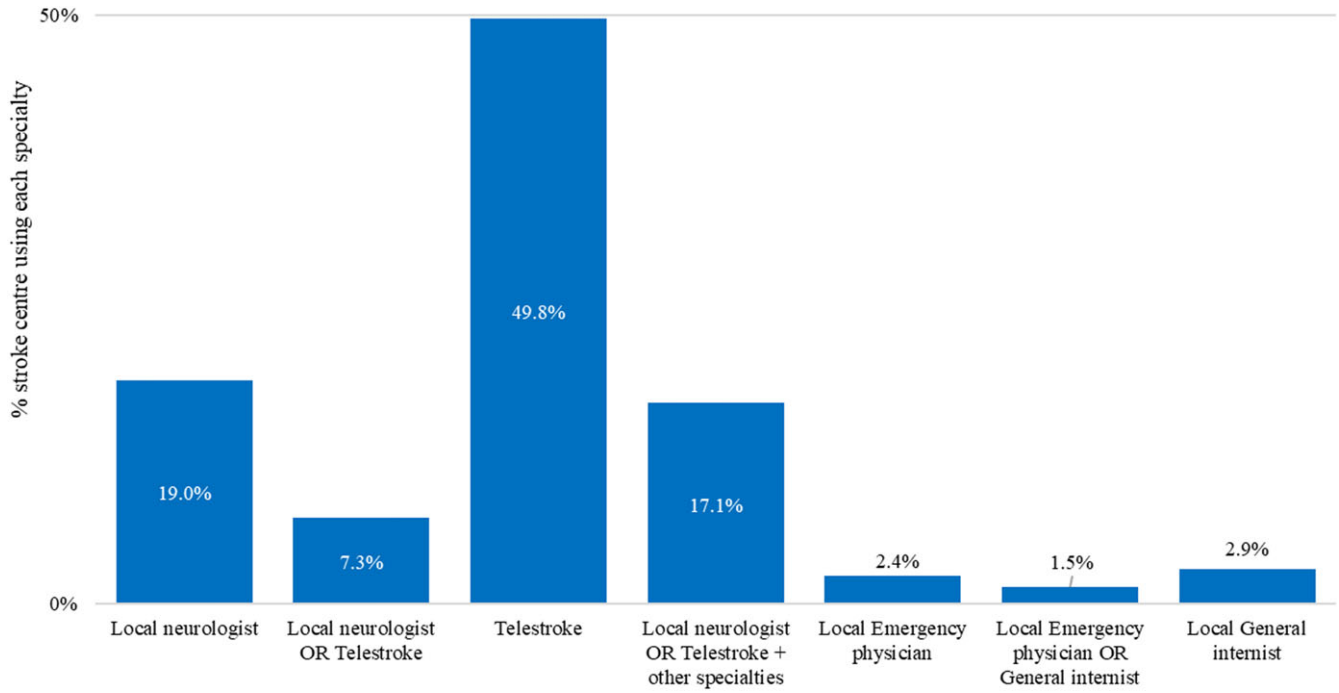

Figure 6. Physician specialty that makes the thrombolysis decision in the ED of stroke centres. Bars show the percentage of stroke centres across Canada that use each physician specialty in the thrombolysis decision-making.

Who makes the thrombolysis decision in the ED

There was involvement of neurology in the thrombolysis decision-making in most of the stroke centres, either physically in the ED or more commonly through telestroke consultation. For the purpose of this survey, telestroke was defined as consultation with a regional or provincial neurologist by telephone only or may include telehealth equipment. 156 (76%) stroke centres used neurology input alone for the thrombolysis decision-making. Another 17% of stroke centres used neurology input in combination with the expertise of other specialties such as general ED physicians and internists (Local Neurologist OR Telestroke +). Notably, there were 14 stroke centres (6.8%) that completely relied on non-neurologists for the thrombolysis decision-making in the ED. The thrombolysis decisions at these sites were made solely by the local emergency physician and/or general internist and were spread across the provinces of QC (6), NL (4), NS (2) and ON (2). The thrombolysis decision-making across stroke centres in Canada is displayed in Figure 6.

Transition to intravenous TNK

As of the time of survey completion in August 2024, 73% of stroke centres in Canada had completely transitioned to the use of IV (intravenous) TNK, with variability across provinces. There was 100% uptake of IV TNK in all stroke centres in the provinces of PE, NS, SK and AB. A small number of stroke centres (4.4%) thrombolysed patients with either TNK or Alteplase, depending on who was working, with this model centred mostly in NL. About 20% of sites were working on the transition. Notably, no stroke centre in Manitoba or in the Northwest and Yukon territories had transitioned to TNK at the time of the survey. The transition to IV TNK across stroke centres in each province in Canada is displayed in Figure 7.

Participation in stroke clinical trials

Site participation rate in stroke clinical trials was minimal, with only 34 out of the 205 stroke centres in Canada (16.6%) indicating that they enrol patients in stroke clinical trials (Figure 8). The clinical trial participation was heavily restricted to the EVT-capable centres, with an 85% participation rate across the CSCs and thrombectomy-ready stroke centres. In contrast, stroke clinical trials participation was only 6.2% in the thrombolysis-capable centres. ON, QC and Alberta had the highest number of site participation in clinical trials, accounting for 76% of all clinical trials participation, while New Brunswick and the Territories had no participation.

Discussion

This national stroke centre survey provides the first of its kind insight into the acute ischaemic stroke treatment landscape in Canada. Overall, there is provincial variability in the number of EVT-capable and thrombolysis-only stroke centres. For example, the provinces of Saskatchewan, Manitoba and Newfoundland and Labrador have a large proportion of thrombolysis-ready centres (80.0%, 75% and 72.7%, respectively), which shows a lack of availability of acute stroke units in these provinces. Alberta's stroke centres are mostly PSCs or CSCs with the lowest proportion of thrombolysis-ready centres. ON has one centre in Thunder Bay that is a thrombectomy-ready centre, providing EVT services at certain times, which means that access to EVT for its catchment varies and patients may be diverted to a different hospital, delaying the start of EVT.

Another area of variability is in the availability of neurology expertise in the ED for treatment decision-making at the stroke centres. Neurology expertise is mostly concentrated in the EVT-capable stroke centres, whereas only 24% of thrombolysis-capable centres in Canada have neurologists physically present in the ED to

https://doi.org/10.1017/cjn.2025.10386

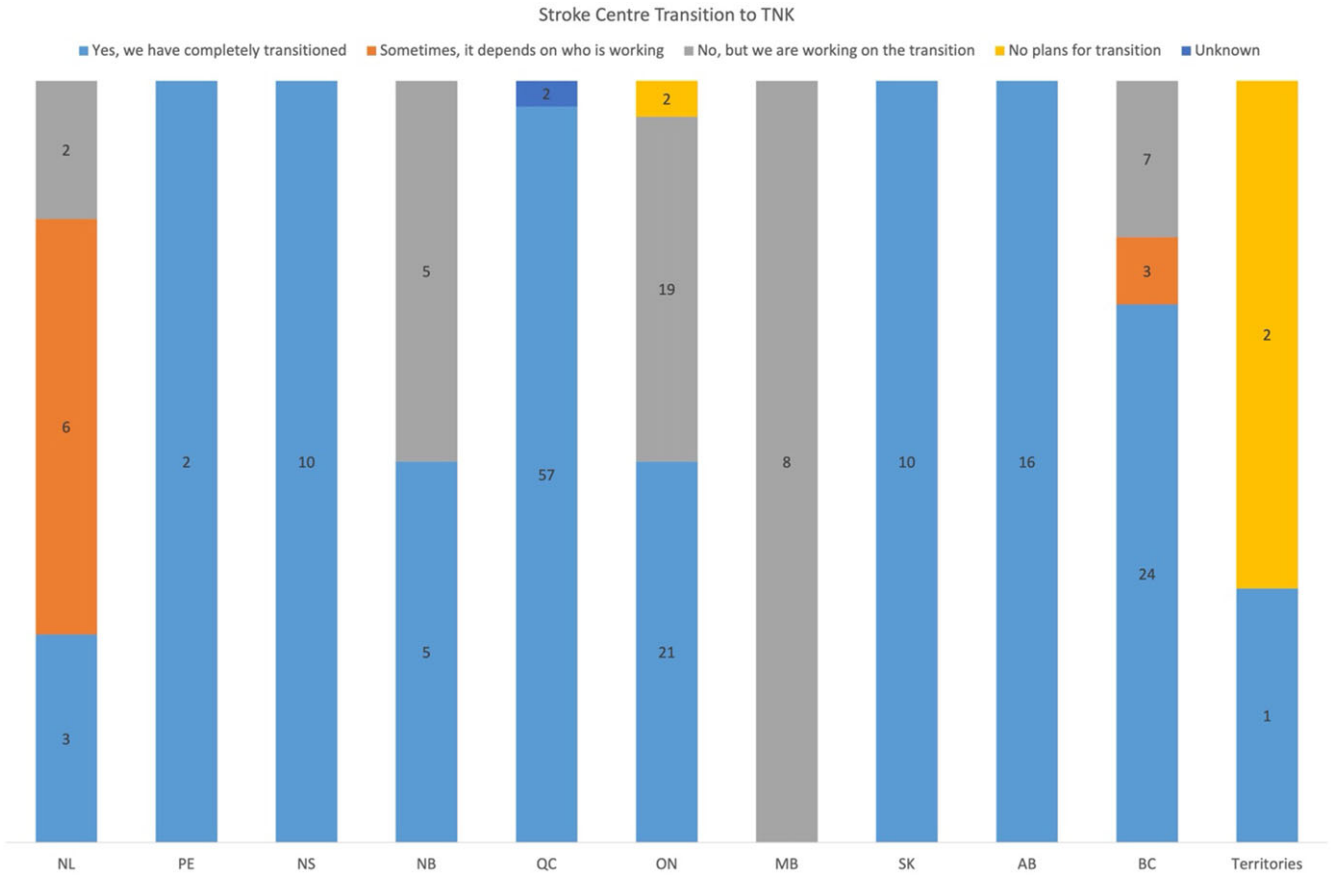

Figure 7. Stroke centre transition to intravenous TNK. NL = Newfoundland and Labrador; PE = Prince Edward Island; NB = New Brunswick; NS = Nova Scotia; QC = Quebec; ON = Ontario; MB = Manitoba; SK = Saskatchewan; AB = Alberta; BC = British Columbia; Territories include Nunavut, Northwest Territory and Yukon.

attend to stroke patients, and that number drops to 11.8% when considering stroke neurologists. Since a large proportion of suspected stroke patients in Canada[16] and globally[17,18] are directed first to hospitals with thrombolysis-only capability, there is a need to build more support with stroke specialty at these centres. The use of telemedicine in stroke care has assisted with neurology access in thrombolysis-capable centres and has been shown to increase the implementation of evidence-based therapy in areas where neurologists are not readily accessible.[19–22] There was good telestroke coverage in the thrombolysis-capable centres in Canada, although 17% of stroke centres used neurology input in combination with the expertise of other specialties such as general ED physicians and internists to make treatment decisions for thrombolysis, while another 6.8% of stroke centres completely relied on non-neurology specialties for the thrombolysis decision-making in the ED. While this survey did not collect information on the kind of acute stroke training that the non-neurology specialists have received, it provides some foundation for further engagement to ascertain the level of on-site support and stroke-specific training that would be required to enhance their delivery of acute stroke care.

Stroke coordinators are an important part of the stroke team, providing integral support that has been shown to improve the acute stroke treatment process and across the entire spectrum of stroke care.[23,24] We have defined stroke coordinators as health system-funded positions that can also act as navigators. The role is typically filled by experienced stroke nurses or allied health professionals, who perform duties ranging from data collection and performance evaluation, coordination of patient flow and discharge and patient and staff education.[25,26] Our survey revealed that in Canada, about 67% of the stroke centres had a local or regional stroke coordinator that was funded by the health system, although there was considerable variation among provinces, with Manitoba, the Horizon Health Network (NB) and the Territories lacking stroke coordinators in totality. Given the important role they play in ensuring quality of stroke care at their centres, there is need to identify the barriers preventing the provision of stroke coordinators and to identify sustainable models through which they can be funded.[27]

As at the time of survey completion, there was good uptake (67%) of TNK across stroke centres in Canada, with variability across provinces. While several trials,[28–30] including the Canadian-led AcT trial,[3] proved that TNK was not inferior to alteplase, the ease of use of TNK as a single bolus dose and its lower cost compared to alteplase provide evidence supporting that TNK provides efficiency.[31] The transition to TNK can also facilitate faster transfer times from thrombolysis-only centre to the EVT-capable centre, thus facilitating lower door-in-door-out times.[32] Most centres that have not yet transitioned are in the planning stages of transition, showing fast uptake of the latest evidence in Canada.

One of the differences observed in the survey was in the participation of stroke centres in clinical trials. Compared to an 85% participation rate in EVT-capable stroke centres, clinical trials participation was only 6.2% in thrombolysis-capable centres. In addition, larger provinces such as ON, QC and Alberta made up

https://doi.org/10.1017/cjn.2025.10386

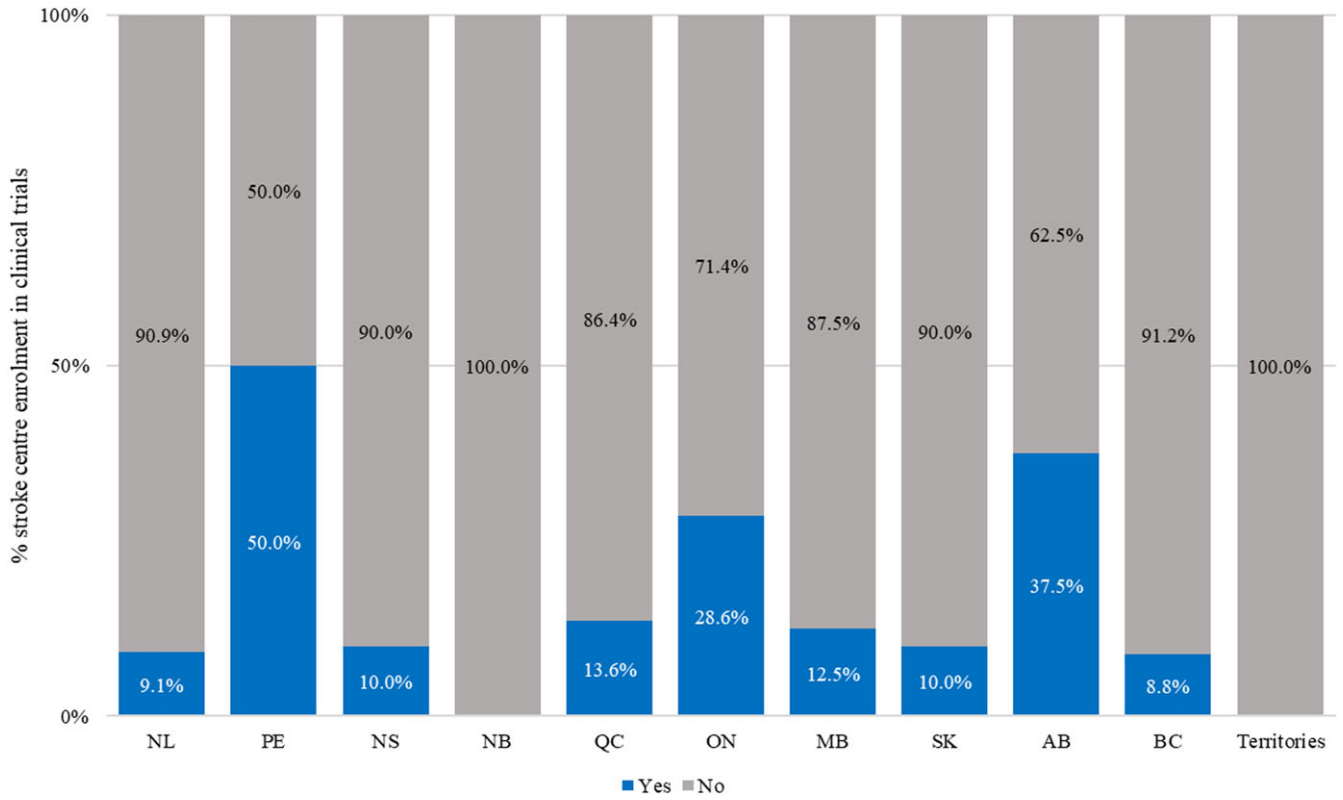

Figure 8. Enrolment of patients in stroke clinical trials at stroke centres. The bars show the percentage of stroke centres in each province that enrol patients in clinical trials. NL = Newfoundland and Labrador; PE = Prince Edward Island; NB = New Brunswick; NS = Nova Scotia; QC = Quebec; ON = Ontario; MB = Manitoba; SK = Saskatchewan; AB = Alberta; BC = British Columbia; Territories include Nunavut, Northwest Territory and Yukon.

the bulk of participation. This is largely because urban teaching hospitals have existing research infrastructure to participate in trials.[33,34] In addition to infrastructural constraints, rural hospitals often face more barriers in conducting clinical trials including insufficient research staffing, lower economic power, patients' attitude to research including the hesitancy to travel and miss work because of research, education and language barriers and lack of equal research opportunities and investments from sponsors.[33,35] As a result, current stroke clinical trials are only representative of urban populations, and there is a need to develop ways to include PSCs and thrombolysis-ready centres in stroke clinical trials so that the results are inclusive of this patient demographic. Additionally, the inclusion of these centres will allow us to answer research questions that are unique to this patient group.

There are several strengths of this survey. This is the first attempt, to the best of our knowledge, to obtain a scan of the acute stroke landscape within Canada, with representation from all provinces and territories. Insights from this survey can facilitate conversations concerning the acute stroke treatment landscape in Canada and encourage the sharing of best practices among provinces for a more national oversight of stroke care. A limitation of this study is its survey design; the accuracy of the stroke treatment information provided relied on the knowledge of the individual completing the survey. Nonetheless, the careful data audit and quality control performed for the survey responses increase the confidence in the data presented in these results. We were also careful in choosing the respondent for the province by making sure that they are involved in provincial stroke care and that they understand the treatment landscape for their province. In addition, we sought additional inputs and validation from stroke coordinators who are well versed with provincial stroke care.

This survey provides a preliminary scan of the acute stroke treatment process in Canada, and several opportunities for future work abound. Future research efforts will be directed to perform geographic modelling to identify specific areas with poor access including the size of the population that has poor access to thrombolysis and EVT. This is an important step to help further understand the Canadian stroke treatment landscape and distribution of services. There is also a large gap in the understanding of the treatment landscape of haemorrhagic stroke within Canada, which could be the target of future research efforts.

This stroke centre survey is a first step in a large long-term national project called OPTIMISING ACCESS,[13] which aims to ensure the highest level of quality in the treatment of acute ischaemic stroke patients with both thrombolysis and EVT across Canada, with the aim to reduce disparity between rural/remote and urban hospitals.

Conclusions

The acute ischaemic stroke landscape in Canada is established; however, there is variation between provinces, presenting unique opportunities for collaboration. There is a need for greater availability of stroke neurologists and stroke coordinators and for diversifying site participation in clinical trials.

Author contributions. BA, AMD and NK designed the study. BA conducted the data analysis. BA and NK wrote the initial draft. AMD, GJS, RC, ME, TH-N, HW, BS, SA, JS, AD, MB, SH, AP, M-CC, SS, AHK, R-JSS, RS, EG, NS, RW, RC,

https://doi.org/10.1017/cjn.2025.10386

M-LH, BM, BB, SA, AK, HS, KB and SA assisted with data collection, provided data validation and provided editorial input into the manuscript. NK holds the funds to conduct the study.

Funding statement. Funding for this work is provided by an NSERC Alliance grant (Title: Designing and Deploying a National Registry to Reduce Disparity in Access to Stroke Treatment and Optimise Time to Treatment, PI: Noreen Kamal).

Competing interests. NK is co-founder and part owner of DESTINE Health Inc. and holds leadership roles on the OPTIMISING ACCESS National Roundtable, Heart and Stroke's Stroke Quality Committee and Advocacy Committee. NK and AD have received grant funds from Medtronic, and the project manager for the study is funded through this grant. AD has received royalties or licences and is listed on a Patent from Circle CVI and consulting fees from Roche and honoraria from Boehringer Ingelhiem and Astra Zeneca, participated on data safety monitoring board or advisory board with Philips for the WE-TRUST trial and holds a leadership role on the Canadian Stroke Consortium as the Chair for the Board of Directors. SA holds a leadership role in the Heart and Stroke Foundation of New Brunswick. AK holds the New Investigator Award with Heart and Stroke Foundation of Canada and has received consulting fees with Diamedica Inc. and Bayer Inc. SH holds a leadership role on the Acute and Episodic Care Network: Provincial Stroke Advisory Committee for NS Health. AP has received contracts or grants from Canadian Institutes of Health Research, Heart and Stroke Canada and Brain Canada, payment or honoraria from Roche Canada, payment for expert testimony from Canadian medical Protective Agency, participation on data safety monitoring board or advisory board for the Act Trial's Safety Committee and a leadership role in the Canadian Stroke Consortium's National Stroke Fellowship programme. NS has received grants or contracts from Brain Canada and Research Manitoba. MH has received support from Acute Care Alberta. RW has received grants or contracts from the SHRF Mobilization Grant. BB has participated in the data safety monitoring board or advisory board for Modafinil and Exercise for Post Stroke Fatigue (MODEX). TH-N has received support from the HPEI Organized Stroke Care Program as Provincial Stroke Coordinator.

References

1. The National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group. Tissue plasminogen activator for acute ischemic stroke. *N Engl J Med*. 1995;333:1581–1587. doi: 10.1056/NEJM199512143332401.
2. Wardlaw JM, Murray V, Berge E, del Zoppo GJ. Thrombolysis for acute ischaemic stroke. *Cochrane Database Syst Rev*. 2014;2014:CD000213. doi: 10.1002/14651858.CD000213.pub3.
3. Menon BK, Buck BH, Singh N, et al. Intravenous tenecteplase compared with alteplase for acute ischaemic stroke in Canada (AcT): a pragmatic, multicentre, open-label, registry-linked, randomised, controlled, non-inferiority trial. *Lancet Lond Engl*. 2022;400:161–169. doi: 10.1016/S0140-6736(22)01054-6.
4. Warach SJ, Dula AN, Milling TJ. Tenecteplase thrombolysis for acute ischemic stroke. *Stroke*. 2020;51:3440–3451. doi: 10.1161/STROKEAHA.120.029749.
5. Goyal M, Demchuk AM, Menon BK, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. *N Engl J Med*. 2015;372:1019–1030. doi: 10.1056/NEJMoa1414905.
6. Goyal M, Menon BK, van Zwam WH, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. *Lancet Lond Engl*. 2016;387:1723–1731. doi: 10.1016/S0140-6736(16)00163-X.
7. Emberson J, Lees KR, Lyden P, et al. Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: a meta-analysis of individual patient data from randomised trials. *Lancet Lond Engl*. 2014;384:1929–1935. doi: 10.1016/S0140-6736(14)60584-5.
8. Saver JL, Goyal M, van der Lugt A, et al. Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: a meta-analysis. *JAMA*. 2016;316:1279–1288. doi: 10.1001/jama.2016.13647.
9. Adeoye O, Nyström KV, Yavagal DR, et al. Recommendations for the establishment of stroke systems of care: a 2019 Update. *Stroke*. 2019;50:e187–e210. doi: 10.1161/STR.0000000000000173.
10. Waldman A, Tadi P, Khan Suheb MZ, Rawal AR. Stroke Center Certification. In: *StatPearls*. StatPearls Publishing, 2024. Accessed August 26, 2024. http://www.ncbi.nlm.nih.gov/books/NBK535392/.
11. Brain Attack Coalition | National Institute of Neurological Disorders and Stroke. Accessed July 10, 2024. https://www.ninds.nih.gov/health-information/patient-caregiver-education/brain-attack-coalition.
12. Bulwa Z, Chen M. Stroke center designations, neurointerventionalist demand, and the finances of stroke thrombectomy in the United States. *Neurology*. 2021;97:S17–S24. doi: 10.1212/WNL.0000000000012780.
13. OPTIMISING ACCESS. Accessed July 22, 2024. https://www.optimisingaccess.ca.
14. Government of Canada Statistic Canada. Census of population. 2023. Accessed July 29, 2024. https://www12.statcan.gc.ca/census-recensement/index-eng.cfm.
15. Felling RJ, Sun LR, Maxwell EC, Goldenberg N, Bernard T. Pediatric arterial ischemic stroke: epidemiology, risk factors, and management. *Blood Cells Mol Dis*. 2017;67:23–33. doi: 10.1016/j.bcmd.2017.03.003.
16. Katsanos AH, Poppe A, Swartz RH, et al. Interhospital transfer for endovascular stroke treatment in Canada: results from the OPTIMISE registry. *Stroke*. 2024;55:2103–2112. doi: 10.1161/STROKEAHA.124.046690.
17. Rilianto B, Kurniawan RG, Rajab NM, Prasetyo BT. Endovascular thrombectomy for acute ischemic stroke in Indonesia: challenging and strategic planning. *Neuropsychiatr Dis Treat*. 2024;20:621–630. doi: 10.2147/NDT.S453629.
18. Owolabi MO, Thrift AG, Martins S, et al. The state of stroke services across the globe: report of world stroke organization-world health organization surveys. *Int J Stroke Off J Int Stroke Soc*. 2021;16:889–901. doi: 10.1177/17474930211019568.
19. Hess DC, Audebert HJ. The history and future of telestroke. *Nat Rev Neurol*. 2013;9:340–350. doi: 10.1038/nrneurol.2013.86.
20. Hubert GJ, Santo G, Vanhooren G, et al. Recommendations on telestroke in Europe. *Eur Stroke J*. 2019;4:101–109. doi: 10.1177/2396987318806718.
21. Lazarus G, Permana AP, Nugroho SW, Audrey J, Wijaya DN, Widyahening IS. Telestroke strategies to enhance acute stroke management in rural settings: a systematic review and meta-analysis. *Brain Behav*. 2020;10:e01787. doi: 10.1002/brb3.1787.
22. Nguyen-Huynh MN, Klingman JG, Avins AL, et al. Novel telestroke program improves thrombolysis for acute stroke Across 21 Hospitals of an integrated healthcare system. *Stroke*. 2018;49:133–139. doi: 10.1161/STROKEAHA.117.018413.
23. Purvis T, Kilkenny MF, Middleton S, Cadilhac DA. Influence of stroke coordinators on delivery of acute stroke care and hospital outcomes: an observational study. *Int J Stroke Off J Int Stroke Soc*. 2018;13:585–591. doi: 10.1177/1747493017741382.
24. Cadilhac DA, Purvis T, Kilkenny MF, et al. Evaluation of rural stroke services: does implementation of coordinators and pathways improve care in rural hospitals? *Stroke*. 2013;44:2848–2853. doi: 10.1161/STROKEAHA.113.001258.
25. Purvis T, Middleton S, Alexandrov AW, et al. Understanding coordinator roles in acute stroke care: a national survey. *J Stroke Cerebrovasc Dis Off J Natl Stroke Assoc*. 2021;30:106111. doi: 10.1016/j.jstrokecerebrovasdis.2021.106111.
26. Rattray NA, Damush TM, Luckhurst C, Bauer-Martinez CJ, Homoya BJ, Miech EJ. Prime movers: advanced practice professionals in the role of stroke coordinator. *J Am Assoc Nurse Pract*. 2017;29:392–402. doi: 10.1002/2327-6924.12462.
27. Purvis T, Middleton S, Alexandrov AW, et al. Exploring barriers to stroke coordinator roles in Australia: a national survey. *Collegian*. 2022;29:423–429. doi: 10.1016/j.colegn.2021.12.007.

28. Huang X, Cheripelli BK, Lloyd SM, et al. Alteplase versus tenecteplase for thrombolysis after ischaemic stroke (ATTEST): a phase 2, randomised, open-label, blinded endpoint study. *Lancet Neurol*. 2015;14:368–376. doi: 10.1016/S1474-4422(15)70017-7.
29. Kvistad CE, Næss H, Helleberg BH, et al. Tenecteplase versus alteplase for the management of acute ischaemic stroke in Norway (NOR-TEST 2, part A): a phase 3, randomised, open-label, blinded endpoint, non-inferiority trial. *Lancet Neurol*. 2022;21:511–519. doi: 10.1016/S1474-4422(22)00124-7.
30. Yogendrakumar V, Churilov L, Guha P, et al. Tenecteplase treatment and thrombus characteristics associated with early reperfusion: an EXTEND-IA TNK trials analysis. *Stroke*. 2023;54:706–714. doi: 10.1161/STROKEAHA.122.041061.
31. Bach KT, Lui F. Tenecteplase. In: *StatPearls*. StatPearls Publishing, 2024. Accessed August 29, 2024. http://www.ncbi.nlm.nih.gov/books/NBK592420/.
32. Warach SJ, Dula AN, Milling TJ, et al. Prospective observational cohort study of tenecteplase versus alteplase in routine clinical practice. *Stroke*. 2022;53:3583–3593. doi: 10.1161/STROKEAHA.122.038950.
33. Mudaranthakam DP, Gajewski B, Krebill H, et al. Barriers to clinical trial participation: comparative study between rural and urban participants. *JMIR Cancer*. 2022;8:e33240. doi: 10.2196/33240.
34. Sabesan S, Burgher B, Buettner P, et al. Attitudes, knowledge and barriers to participation in cancer clinical trials among rural and remote patients. *Asia Pac J Clin Oncol*. 2011;7:27–33. doi: 10.1111/j.1743-7563.2010.01342.x.
35. Farris P, Crist R, Miller S, Shannon J. Rural research capacity: a co-created model for research success. *Health Res Policy Syst*. 2023;21:76. doi: 10.1186/s12961-023-01030-5.