ACTEAST: Atlantic Canada Together Enhancing Acute Stroke Treatment

Noreen Kamal, PEng PhD

November 20 2024

DALHOUSIE UNIVERSITY

ACTEAST

Land Acknowledgement

From coast to coast to coast, we acknowledge the ancestral and unceded territory of all the Inuit, Métis, and First Nations people that call this land home.

We also acknowledge the effect of residential schools and colonialism on Indigenous families and communities and consider how we are and can each, in our own way, try to move forward in a spirit of reconciliation and collaboration.

Dalhousie University operates in the unceded territories of the Mi’kmaw, Wolastoqey, and Peskotomuhkati Peoples. These sovereign nations hold inherent rights as the original peoples of these lands, and we each carry collective obligations under the Peace and Friendship Treaties. Section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights in Canada

Outline

- Background
- ACTEAST Objectives and Methods
- ACTEAST Engagement Results
- ACTEAST Results

https://www.dal.ca/sites/acteast.html

Impact of Stroke

- Leading cause of disability
  - Often a fate worse than death
- 3rd to 5th leading cause of death
- High cost to society
- 2nd leading cause of dementia

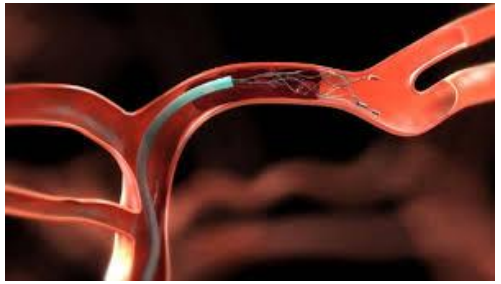
Revolutionary Advancements in Ischemic Stroke is a Treatable Disease

Thrombolysis with Alteplase (tPA, tissue Plasminogen Activator) or Tenecteplase (TNK)

- Proved in mid 1990's (tPA)
- Non-inferiority of TNK proven in Canadian ACT trial (2023)
- Must be given within 4.5 hours of treatment

Endovascular therapy

- A series of trials proved this in 2015
- Given to LVO patients



Both Treatments are Synergistic

Utilization of the treatments are less than optimal

Introduction

- Thrombolysis with alteplase (now tenecteplase) remains a proven effective treatment for acute ischemic stroke patients
- The effectiveness for alteplase is highly time dependent

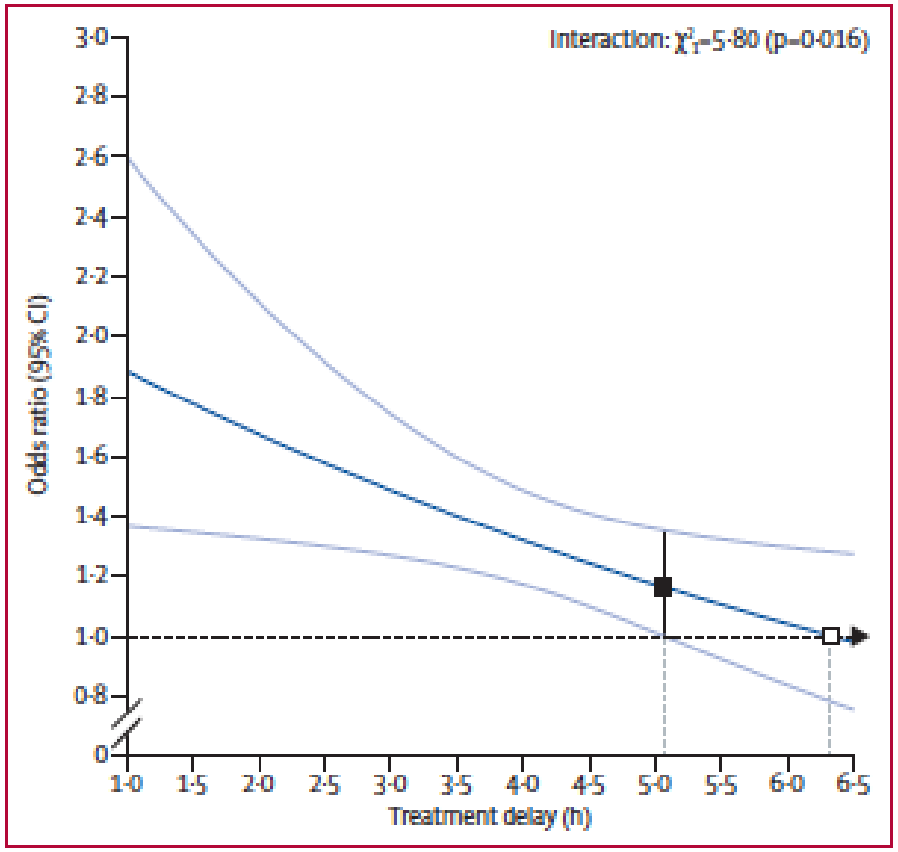
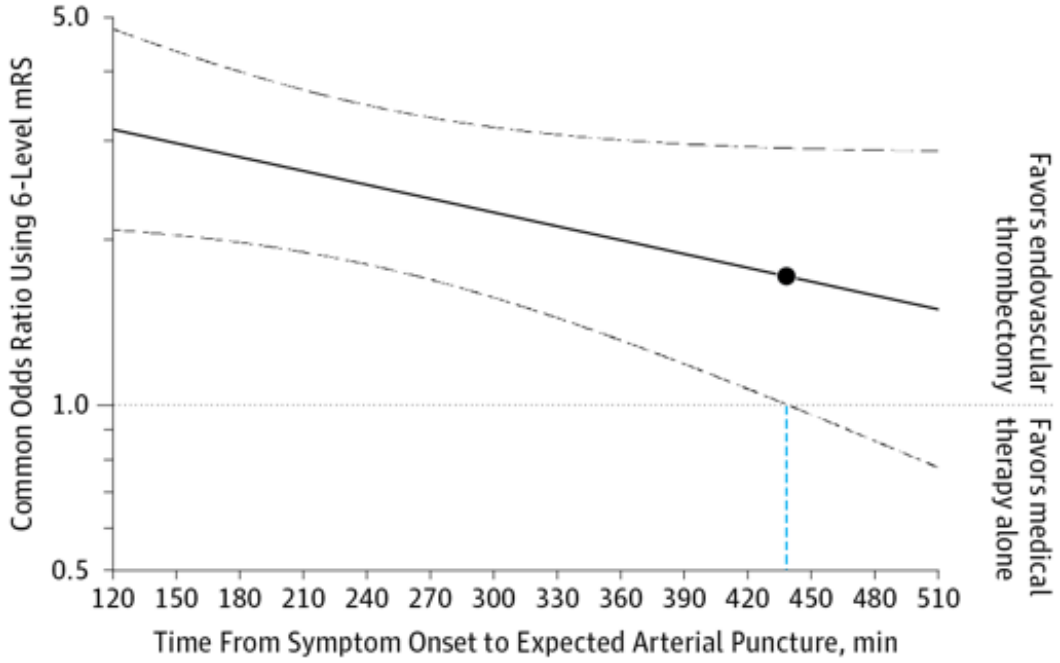


Figure 1: **Effect of timing of alteplase treatment on good stroke outcome (mRS 0–1)**

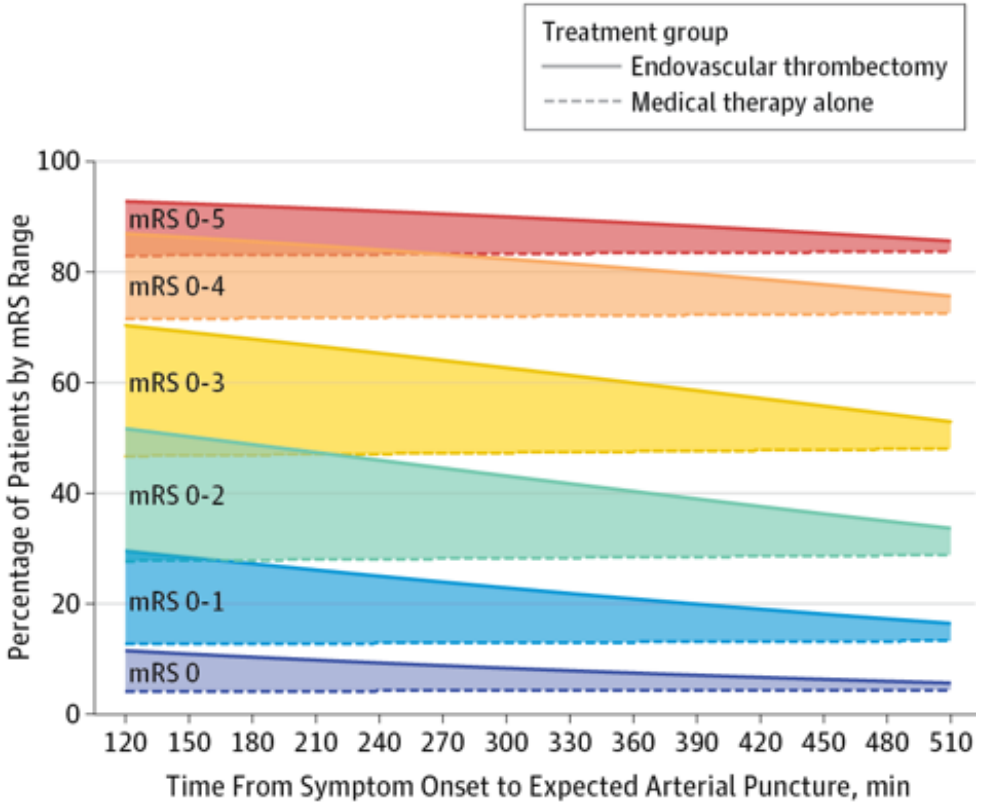
Emberson J, et al. Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: a meta-analysis of individual patient data from randomised trials. *Lancet*. 2014;384:1929-1935.

Endovascular Treatment is Highly Time Dependent

A Odds ratio for less disability at 3 mo in endovascular thrombectomy vs medical therapy alone groups by time to treatment



B Difference in adjusted 3-mo disability rates between endovascular thrombectomy and medical therapy alone groups by time to treatment



Saver, Jeffrey L., et al. "Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: A meta-analysis." *Jama* 316.12 (2016): 1279-1288.

Evidence-to-Practice Gap

Both treatments are part of guideline care in Canada and around the world

Utilization rates are less than optimal especially for patients in rural areas

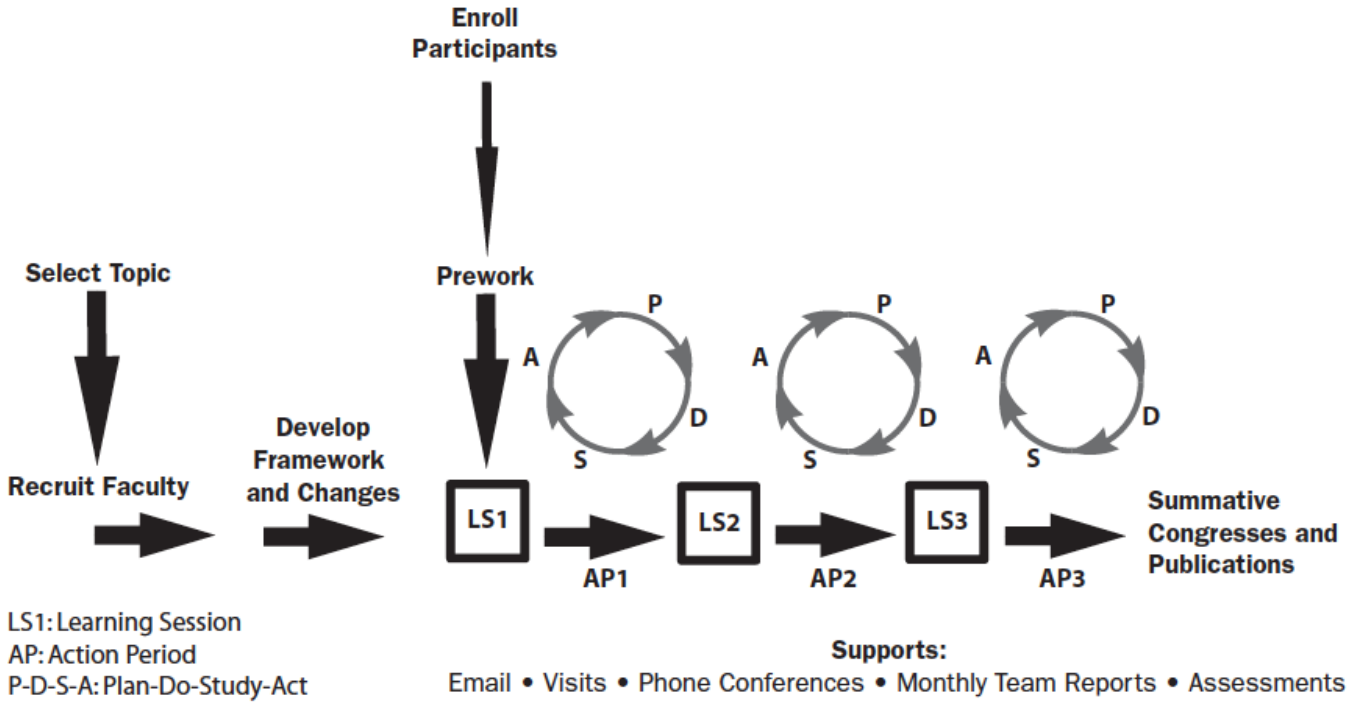
Context

% of Population that live in Rural Areas In Atlantic Canada	Rest of Canada
NS: 43% NB: 48% PEI: 53% NL: 41%	ON: 14% AB: 17% BC: 14% QC: 19%

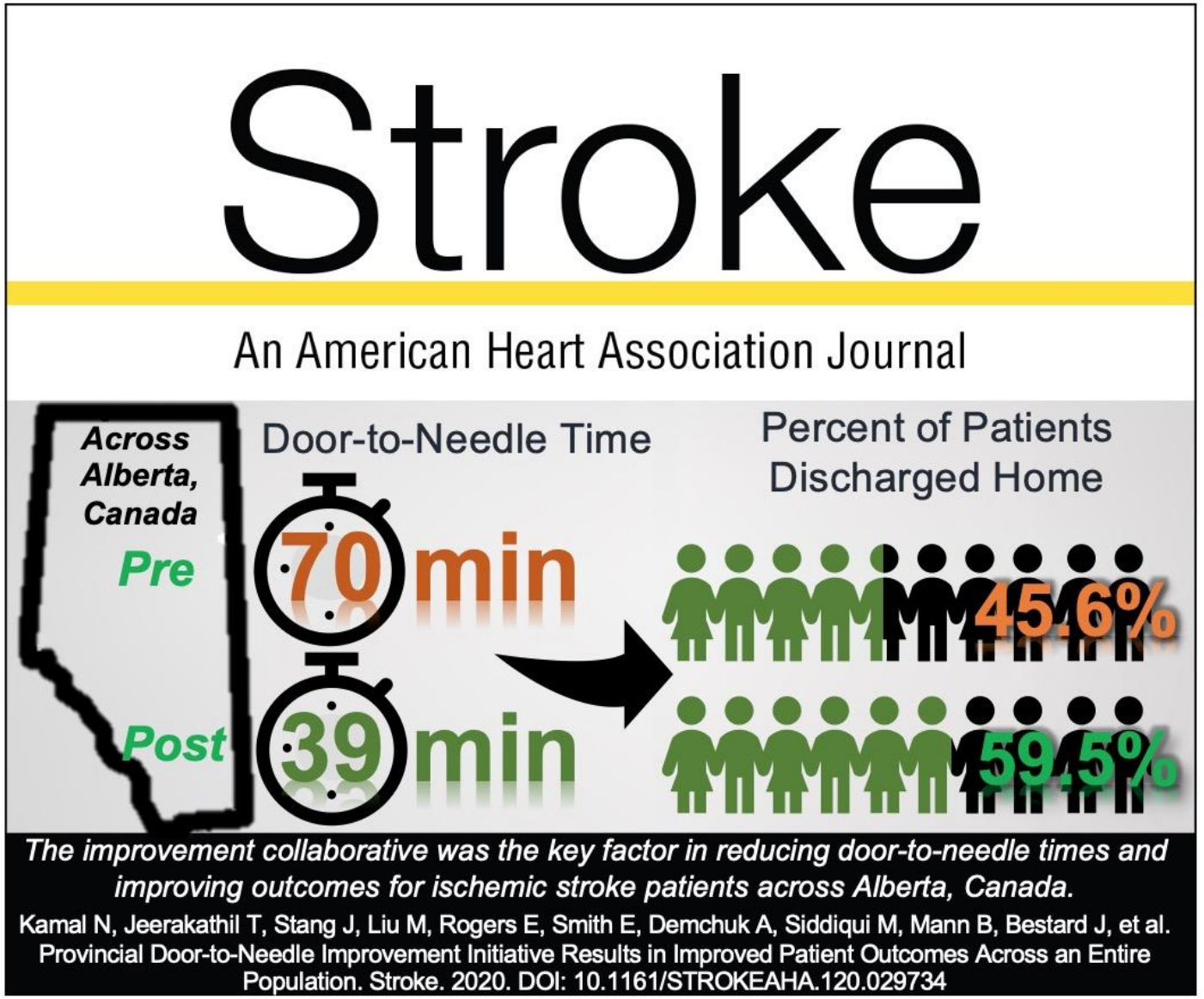
- Greater Stroke incidence in Atlantic Canada:
  - Up to 140/100,000 people compared to 113/100,000 people in ON
  - Age and risk standardized
- Older population than the rest of Canada
- Small populations in each province, but health is delivered provincially

IHI Improvement Collaborative Model has been used in improving Acute Stroke Treatment Processes

Institute for Healthcare Improvement



Alberta DTN Initiative: Summary



ACTEAST: TEAM

Research Team: Co-Investigators

Name	Role	Location
Dr. Stephen Phillips	Stroke Neurologist; Professor	Halifax (QEII)
Dr. Gordon Gubitz	Stroke Neurologist; Professor	Halifax (QEII)
Dr. David Volders	Interventional Neuroradiologist; Assistant Professor	Halifax (QEII)
Dr. Jens Heidenreich	Interventional Neuroradiologist; Associate Professor	Halifax (QEII)
Dr. Thien Huynh	Interventional Neuroradiologist; Assistant Professor	Halifax (QEII)
Dr. Michael Hill	Stroke Neurologist; Professor	Calgary (Foothills)
Dr. Bijoy Menon	Stroke Neurologist; Associate Professor	Calgary (Foothills)
Peter Vanberkel, PhD PEng	Engineer; Associate Professor	Halifax
John Blake, PhD PEng	Engineer; Associate Professor	Halifax
Dr. Alix Carter	Research Director, EMS; Associate Professor	NS
Judah Goldstein, PhD	EHS, Research Coordinator; Assistant Professor	NS
Dr. Patrick Fok	EHS, Lifeflight; Assistant Professor	NS
Dr. Etienne Van Der Linde	Emergency Physician; Clinical Assistant Professor	NL
Dr. Brian Metcalfe	EMS Medical Director; Assistant Professor	NL
Dr. Fraser Clift	Neurologist; Assistant Professor	NL
Dr. Greg Browne	Vascular Surgeon; Clinical Associate Professor	NL
Dr. Heather Williams	Neurologist; Assistant Professor	PEI
Dr. Dylan Blacquiere	Stroke Neurologist; Assistant Professor	Ottawa, ON

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Research Team: Leads

Name	Position	Lead Area
Dr. Stephen Phillips	Stroke Neurologist (QEII – Halifax)	NS Lead
Dr. David Volders	Interventional Neuroradiologist (QEII – Halifax)	NS EVT Lead
Dr. Heather Williams	Neurologist (PEI)	PEI Lead
Dr. Tania Chandler	Neurologist (Saint John)	NB Lead
Dr. Brian Archer	Interventionalist (Saint John)	NB EVT Lead
Dr. Alier Marrero	Neurologist (Moncton, Vitalité)	NB Vitalité Lead
Dr. Fraser Clift	Neurologist (NL)	NL Lead
Dr. Etienne Van Der Linde	Emergency Physician (NL)	Emergency Physician Lead
Dr. Adela Cora	Interventional Neuroradiologist (QEII – Halifax)	Imaging Lead
Dr. Alix Carter	Research Director, EMS	EMS Lead
Kelly Mrklas	Knowledge Translation Expert, AHS	Qualitative Evaluation Lead

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* Also recognize Dr. Marsha Eustace (key physician)

Research Team: Collaborators

Name	Role	Location
Scott Theriault	Patient (received EVT in Halifax)	NS
Cassie Chisholm	(Former) Acting Director, Government of NL Director, Eastern Health	NL
Trish Helm-Neima	Provincial Stroke Coordinator	PEI
Carolyn MacPhail	Manager of Chronic Disease Prevention & Management	PEI
Noortje Kunnen	Director, Department of Health, Government of New Brunswick	NB
Nicole Tupper	Executive Director, Horizon Health Network NB	NB (Fredricton)
Julie Savoie	Stroke Coordinator Vitalite Health Network	NB (Moncton)
Edgar Goulette	VP Quality, Patient Safety and Education; Medavie Health Services New Brunswick (EMS)	NB
Kelly Mrklas	Knowledge Translation Expert	Calgary - AHS

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ACTEAST: OBJECTIVES and METHODS

Provincial DTN Improvement Paper

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https://www.dal.ca/sites/acteast.html

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Improving access and efficiency of ischemic stroke treatment across four Canadian provinces using a stepped wedge trial: Methodology

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Kamal N, Aljendi S, Carter A, Cora EA, Chandler T, Clift F, Fok PT, Goldstein J, Gubitz G, Hill MD, Menon BK. Improving access and efficiency of ischemic stroke treatment across four Canadian provinces using a stepped wedge trial: Methodology. *Frontiers in Stroke*. 2022 Oct 31;1:1014480.
https://www.frontiersin.org/articles/10.3389/fstro.2022.1014480/full

Background: Atlantic Canada

TABLE 1 Population and geographic size of each of the Canadian Atlantic provinces.

Province	Population (2022 estimate) (Statistic Canada, 2022)	Size (km^2)	Number of PSCs	Number of CSCs	Number of alteplase capable centers (bypass)
Nova Scotia	1,002,586	55,284	9	1	1
New Brunswick	797,102	72,907	9	1	0
Prince Edward Island	166,331	5,660	2	0	0
Newfoundland and Labrador	522,453	405,720	10	1*	1

PSC, Primary Stroke Center; CSC, Comprehensive Stroke Center; EVT, Endovascular Thrombectomy.
*The CSC in Newfoundland and Labrador began performing EVT treatment on June 20, 2022.

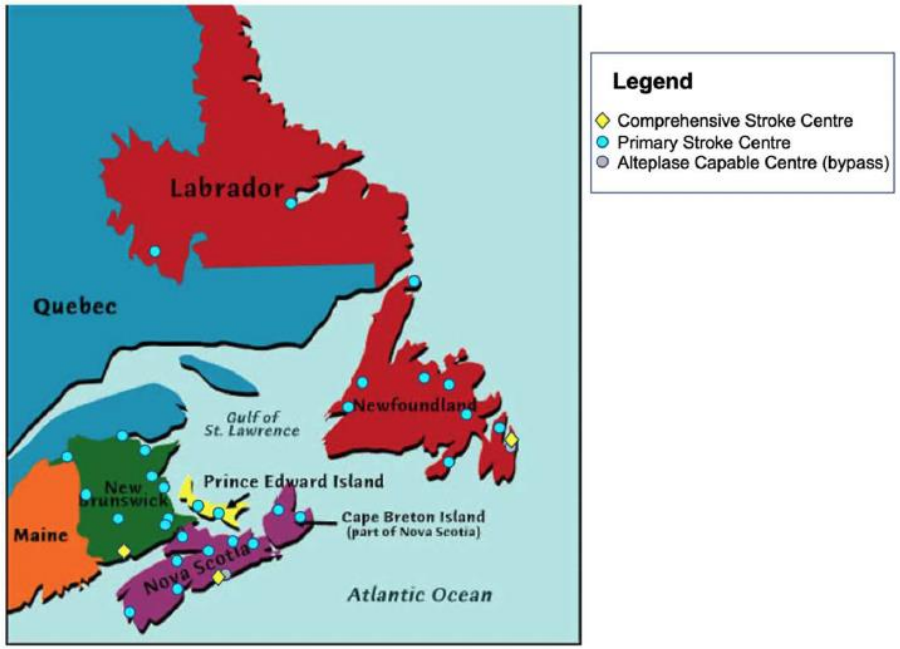


FIGURE 1
Location of all Primary Stroke Centers and Comprehensive Stroke Centers in Atlantic Canada. Also shown with a gray marker are two centers that are capable of alteplase treatment, but bypassed by ambulance due to proximity to another stroke center.

Methods: Improvement Collaborative

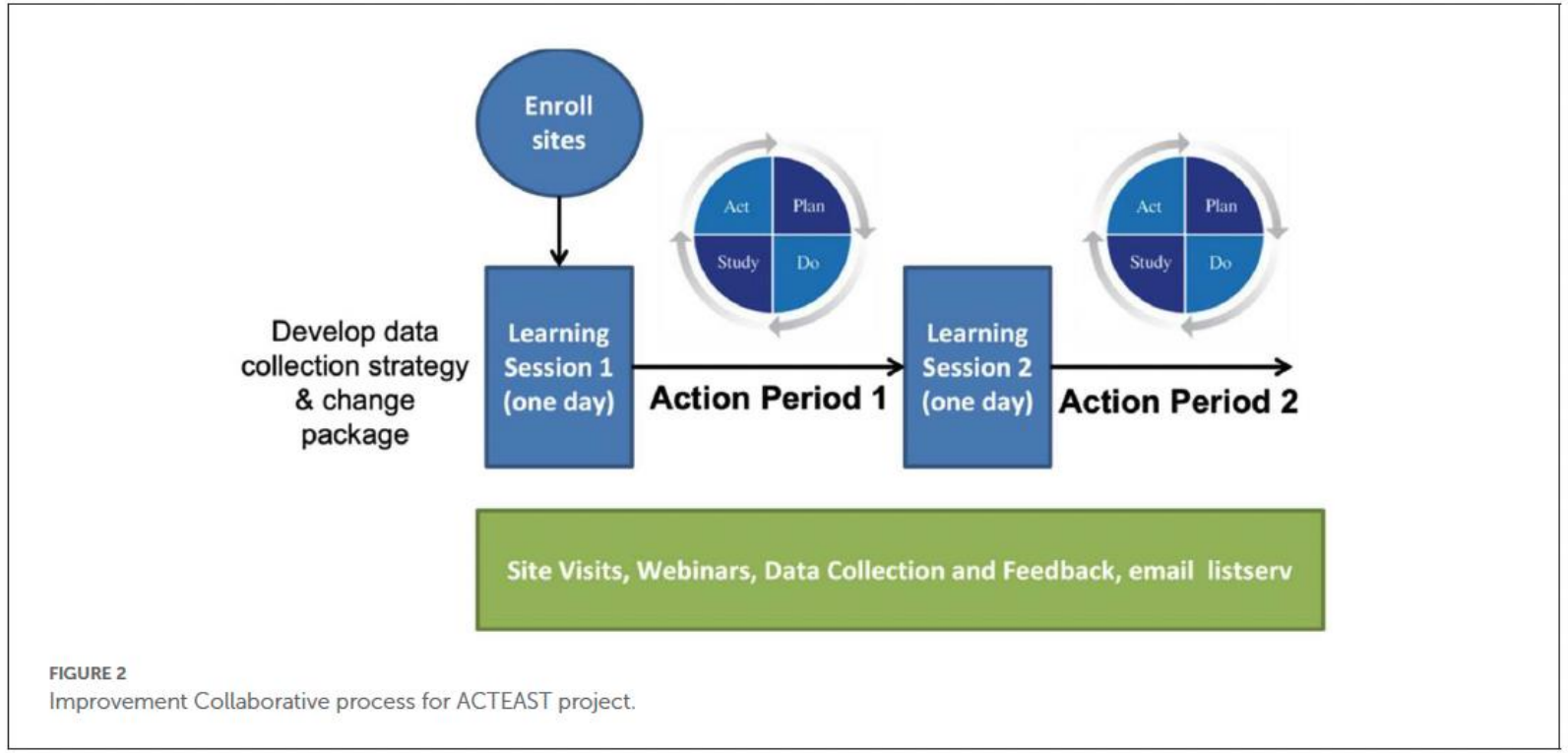
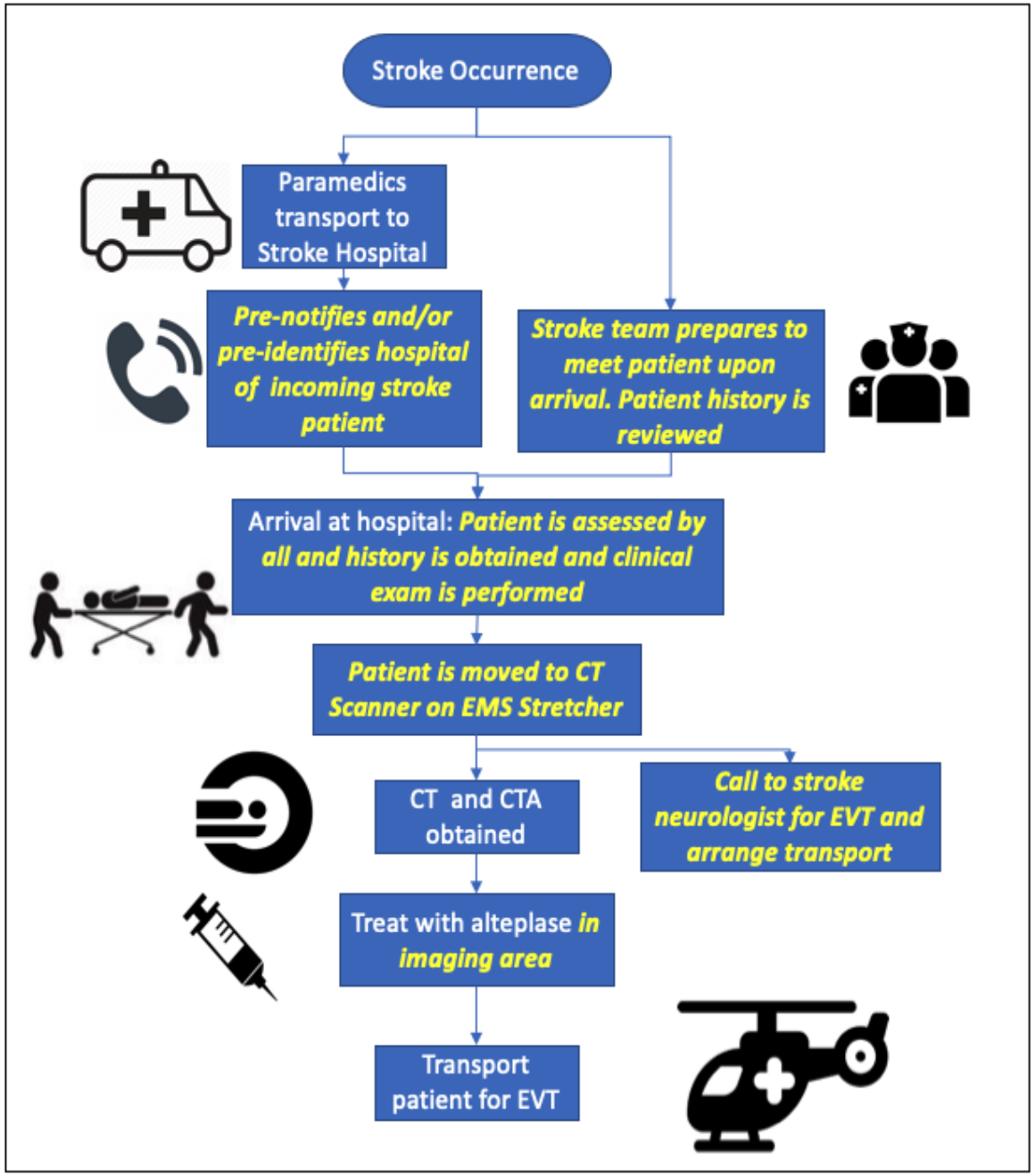


FIGURE 2
Improvement Collaborative process for ACTEAST project.

Suggested Changes for the Collaborative

- The provided change package provides additional details on this
- Changes for improvements have strong evidence associated with them
- Key changes that will be disseminated during the intervention are shown in Yellow in the diagram on right



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Change Package – List of Recommended Changes

1. ***Prenotification and stroke team activation***:
   - paramedics pre-notify the hospital of an incoming stroke patients
   - paramedics ensures that 2 IV lines are in place
   - the hospital create a single call activation of the stroke team.
2. ***Rapid registration process***:
   - the hospital adopts a "registration as *unknown*" (similar for trauma patients),
   - pre-registration process by using information from paramedics,
   - or a quick registration process where only minimal information is entered initially.

3. ***Patient moved to CT scanner on Emergency Medical Services (EMS) stretcher***:
   - having a thrombolysis kit ready
   - conducting a quick neurological exam on the way to the scanner
4. ***Not waiting for bloodwork when not indicated for the patient***
5. ***Thrombolysis administered in imaging area***
6. ***Rapid transfer process for EVT***:
   - adopting a heads-up call to the transport system when presented with a severe stroke.

Objectives

Aimed to improve access and time efficiency to both alteplase and EVT treatment for acute ischemic stroke patients across Atlantic Canada through the ACTEAST (Atlantic Canada Together Enhancing Acute Stroke Treatment) project

OVERALL: Increase the proportion of ischemic stroke patients that receive either alteplase or EVT by 5%

Process Objectives:

1. *To reduce the median door-to-needle time (DNT) of all patients treated with alteplase or Tenecteplase*
2. *To reduce the door-in-door-out times for all patients transferred for EVT*
3. *To reduce the door-to-groin-puncture times for all EVT treated patients*
4. *To reduce the time to treatment from first medical contact (911 call)*

Outcome Objectives:

1. *To increase the proportion of all ischemic stroke patients that are discharged home from acute care*
2. *To increase the proportion of all treated ischemic stroke patients that are discharged home from acute care*
3. *To reduce the hospital length of stay for all treated ischemic stroke patients*

Methods

Sites	Lead in Phase (May/20-Oct/20)	Phase 1 (Nov/20-Apr/21)	Phase 2 (May/21-Oct21)	Phase 3 (Nov/21-Apr/22)	Phase 4 (May/22-Oct/22)
Cluster 1 [NS]	Retrospective Data Collection	Intervention	Yes	Yes	Yes
Cluster 2 [NB,PEI]	Retrospective Data Collection	No	Intervention	Yes	Yes
Cluster 3 [NL]	Retrospective Data Collection	No	No	Intervention	Yes

FIGURE 3

Stepped-Wedge Trial for ACTEAST Project. The orange periods show the time periods prior to the intervention. The green periods show the time periods after the intervention. The yellow shows the 6-month period for the *Improvement Collaborative* intervention. NS, Nova Scotia; NB, New Brunswick; PEI, Prince Edward Island; NL, Newfoundland and Labrador.

ACTEAST: Summary of Engagement

Summary of Engagement

Component	NS	NB-PE	NL
Percent of Stroke Centres Participating*	91%	100%	100%**
Total number of participants	98	86	72
Total number of teams	11	12	9
Mean number of participants per team (SD)	8.6 (3.17)	7.7 (3.00)	7.9 (2.85)
Attendance at Learning Session 1	81	73	46
Attendance at Learning Session 2	60	43	50
Number of Webinars	6	5	5
Mean attendance at webinars (SD)	29.0 (6.8)	26.0 (6.3)	19.0 (8.5)
Mean attendance at site visits (SD)	8.8 (4.5)	7.0 (2.8)	8.3 (5.7)

*including tPA capable bypass centres

**one team withdrew halfway through the Improvement Collaborative

Summary of All Improvement Collaboratives

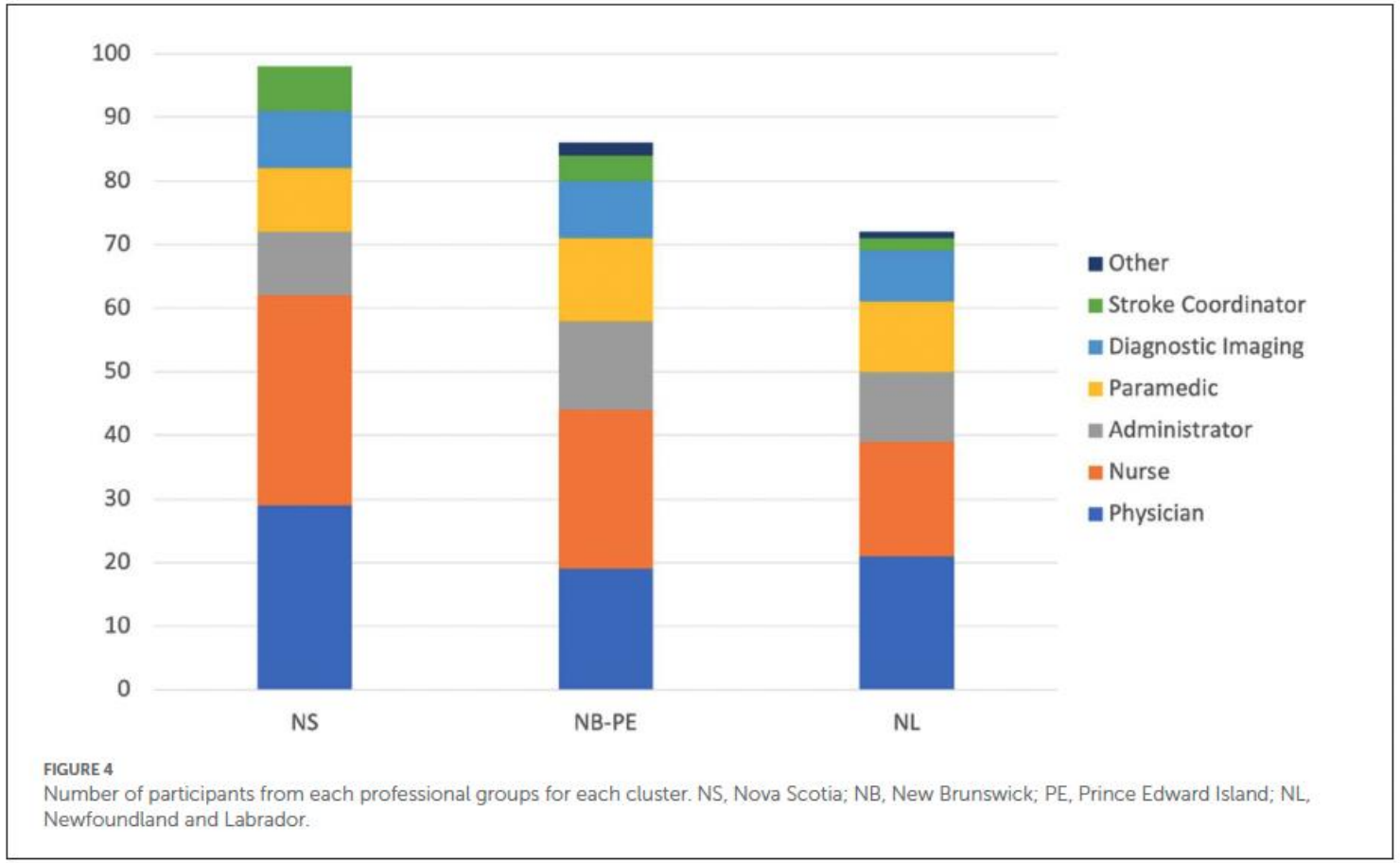


FIGURE 4
Number of participants from each professional groups for each cluster. NS, Nova Scotia; NB, New Brunswick; PE, Prince Edward Island; NL, Newfoundland and Labrador.

Webinars Conducted

Nova Scotia

Date	Topic of Webinar	Number of Attendees
Nov 24, 2020	Evidence and Best Practice Recommendations for Alteplase and EVT Treatment, and NIHSS	37
Dec 8, 2020	Case reviews of transfers for EVT	32
Jan 25, 2021	Skepticism around tPA and Emergency Consent	34
Mar 24, 2021	Changes at a NS Hospital (name supressed)	27
Apr 19, 2021	Changes at a NS Hospital (name supressed)	22
Apr 29, 2021	Endovascular thrombectomy	20

NB-PEI

Date	Topic of Webinar	Number of Attendees
Jun 9, 2021	Consent for tPA	35
Jun 21, 2021	Code Stroke Protocol at a NS Hospital	25
Sep 29, 2021	Changes at a NB Hospital (name supressed)	28
Oct 19, 2021	Changes at a PE Hospital (name supressed)	20
Oct 31, 2021	Continue with Improvement	20

NL

Date	Topic of Webinar	Number of Attendees
Feb 22, 2022	Tenecteplase and the Future of Stroke Thrombolysis	34
Mar 10, 2022	PEI Hospital (name supressed) changes to reduce DTN	16
Mar 31, 2022	Future of Stroke Treatment and Neuroprotectants	17
Apr 13, 2022	Improvements at a NS Hospital (name supressed)	12
Apr 14, 2022	Improvements at a NL Hospital (name supressed)	18

Engagement Discussion

High level of engagement in the 6-month Improvement Collaborative across all 3 clusters	
Engagement was highest in NS as it has the most established stroke program	
ACTEAST had a high level of physician engagement	CME credits was likely a factor
All (except LS 1 for NS) of the Improvement Collaboratives were delivered virtually due to COVID-19	
Site visit participation was lower than observed in the AB Collaborative	Less incentive, virtual

Quantitative Study

Publication is in review– Circulation: Cardiovascular Quality and Outcomes

Improving Access and Efficiency of Acute Ischemic Stroke Treatment Across Four Canadian Provinces: A Stepped-Wedge Trial

Noreen Kamal, PhD[1,2,3], Elena A. Cora, MD PhD[4,5], Simone Alim BSc (In Progress)[6], Judah Goldstien PhD[7,8], David Volders MD[4,5], Shadi Aljendi, PhD[10], Heather Williams MD[11], Patrick T. Fok MDCM PhD[4,7,9] Etienne van der Linde MD[12], Trish Helm-Neima BSc[11], Tania Chandler MD[13], Alix Carter MD[4,7,8], Renee Cashin BSc[14], Brian Metcalfe MD[15], Julie Savoie BSc[16], Wendy Simpkin BN[4], Fraser Clift MD[14,17], Cassie Chisholm MSc[14], Michael D Hill MD MSc[18], Bijoy Menon MD MSc[18], Stephen Phillips MD[3,4] and the ACTEAST Collaborators

Methods

Measures

Access to treatment – Denominator is *all ischemic stroke patients*

- Received thrombolysis with either alteplase or Tenecteplase
- Received endovascular thrombectomy
- Received thrombolysis and/or EVT

Time Efficiency – Denominator is *all community onset ischemic stroke patients that received treatment*

- Door-to-needle time
- 911-to-needle time
- Door-to-arterial-access time
- 911-to-arterial-access time
- Door-in-door-out time (transfer efficiency)

Outcome Measures

- Discharged home (all ischemic stroke patient)
- Discharged home (treated community onset stroke patients)
- Died in hospital (all ischemic stroke patient)
- Died in hospital (treated community onset stroke patients)

Methods: Statistical Analysis

The data for this trial includes all ischemic stroke patients in the entire province regardless of the number of sites that formally enrolled. Therefore, the trial is not a sample but **a population study**; no sample size was calculated.

All missing values for age, sex, and National Institutes of Health Stroke Scale (NIHSS) were imputed using the K-Nearest Neighbour algorithm (k-NN)

All Ischemic Stroke Patient Comparisons:

Proportion receiving treatment and discharge disposition

- Pre- and post- comparison using χ^2 (unadjusted)
- adjustments control for cluster using mixed effects logistic regression

Ischemic Stroke Patients Receiving Treatment:

Median Door-to-CT, Median Door-to-Needle, Median Door-in-door-out, Median door-to-groin-puncture, median 911-to-needle, median 911-to-groin-puncture, Median Length of Stay:

- Pre- and Post- comparison using Wilcoxon rank-rum test (unadjusted)
- Pre- and Post- comparison using mixed effects quantile test (adjusted for cluster, age, sex and NIHSS)

% Discharged Home, % in-hospital mortality.

- Pre- and post- comparison using χ^2 (unadjusted)
- Pre- and post- comparison using mixed effects logistic regression (adjusted for cluster, age, sex and NIHSS)

Ethical Approval and Trial Registration

Ethical approval for this study was obtained from:

1. NS Health Research Ethics Board (REB# 1025460),
2. Health PEI Ethics Board,
3. Horizon Health Network Research Ethics Board (ROMEO File #: 100906 and RS#: 2020-2893),
4. Vitalité Health Network Ethics Office (ROMEO file number: 101305), and
5. Newfoundland and Labrador Health Research Ethics Board (Researcher Portal File #: 20210255 and Reference #: 2020.074).

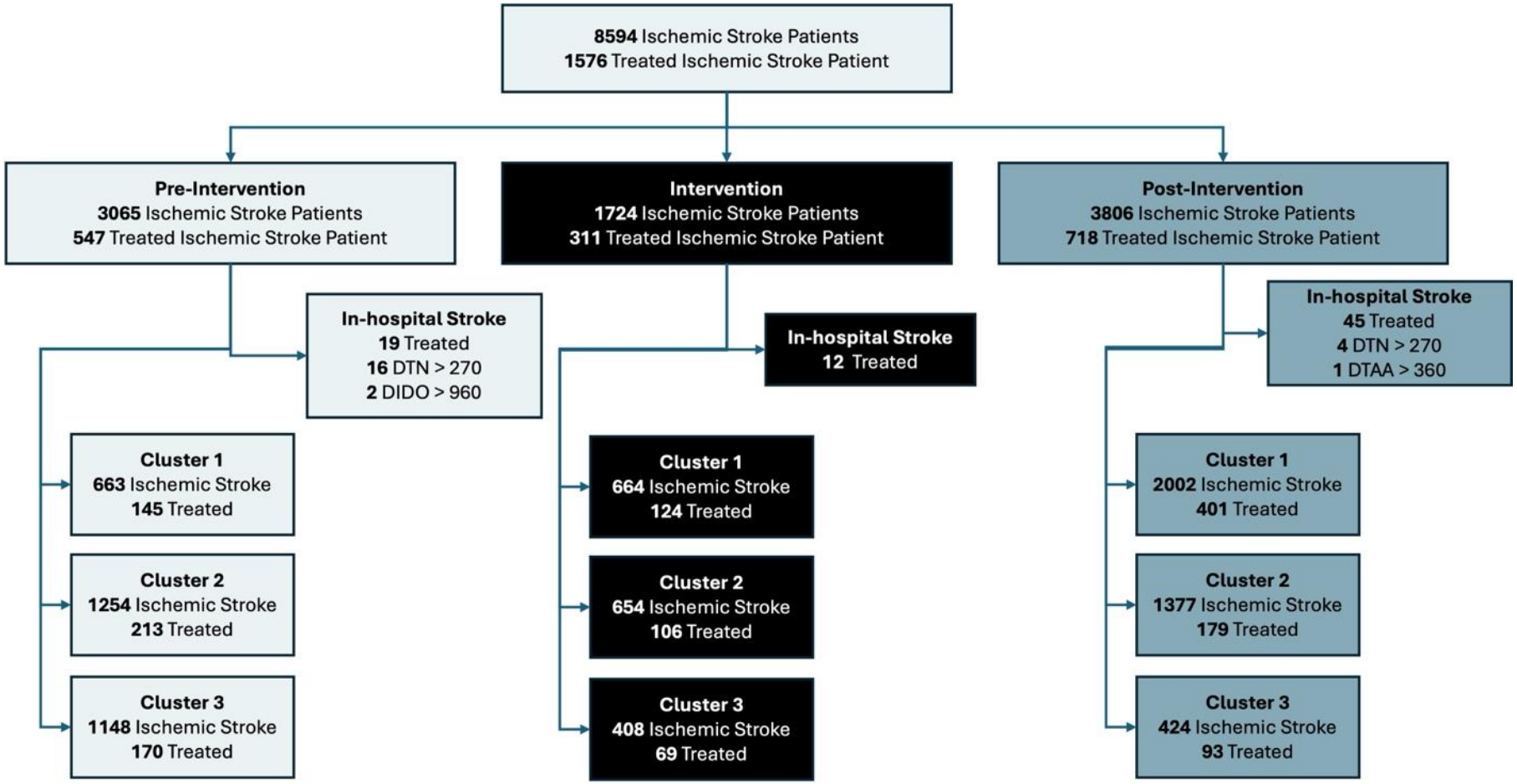
The trial is registered with the ISRCTN registry (ISRCTN11109800, https://www.isrctn.com/ISRCTN11109800).

Results (preprint available)

Stepped-wedge cluster trial design and timelines

Cluster	Lead in Phase (May/20-Oct/20)	Phase 1 (Nov/20-Apr/21)	Phase 2 (May/21-Oct21)	Phase 3 (Nov/21-Apr/22)	Phase 4 (May/22-Oct/22)	Total
Cluster 1 [NS; n=10]	N(IS)= 663 N(treated) = 145	N(IS) = 664 N(treated) = 124	N(IS) = 699 N(treated) = 129	N(IS) = 682 N(treated) = 137	N(IS) = 621 N(treated) = 135	N(IS)= 3329 N(treated)= 670
Cluster 2 [NB,PE; n=12]	N(IS) = 597 N(treated) = 114	N(IS) = 657 N(treated) = 99	N(IS) = 654 N(treated) = 106	N(IS) = 670 N(treated) = 89	N(IS) = 707 N(treated) = 90	N(IS) = 3285 N(treated) = 498
Cluster 3 [NL; n=12]	N(IS) = 354 N(treated) = 41	N(IS) = 403 N(treated) = 64	N(IS) = 391 N(treated) = 65	N(IS) = 408 N(treated) = 69	N(IS) = 424 N(treated) = 93	N(IS) = 1980 N(treated) = 332
Total	N(IS) = 1614 N(treated) = 300	N(IS) = 1724 N(treated) = 287	N(IS) = 1744 N(treated) = 300	N(IS) = 1760 N(treated) = 295	N(IS) = 1752 N(treated) = 318	N(IS) = 8594 N(treated)=1500

Flow diagram of patient allocation across each period and cluster



Baseline characteristics for all community onset ischemic stroke patients that received treatment (thrombolysis and/or EVT)

	Control		Intervention		Significance
All Clusters	n	value	n	Value	
Age mean (SD)	528	70.8 (13.2)	669	70.4 (13.6)	0.64
Sex, women (%)	528	236 (44.7%)	670	303 (45.2%)	0.90
NIHSS, median (IQR)	230	10 (6-14)	242	10 (5-15)	0.60
Onset to door, median (IQR)	493	85.0 (52.0-146.0)	629	85.0 (57.0-130.0)	0.70
Onset to 911, median (IQR)	364	22.0 (8.7-68.0)	434	17.0 (6.7-45.0)	0.001
Cluster 1					
Age, mean (SD)	145	73.0 (13.3)	402	71.01 (13.0)	0.13
Sex, women (%)	145	68 (46.8%)	402	188 (46.8%)	1
NIHSS, median (IQR)	73	9 (5-12)	147	8 (5-13)	0.84
Onset to door, median (IQR)	144	84.8 (54.5-134.2)	381	85.1 (60.0-127.0)	0.94
Onset to 911, median (IQR)	99	14.2 (7.6-35.7)	279	13.2 (6.0-35.1)	0.40
Cluster 2					
Age, mean (SD)	213	69.8 (13.7)	179	68.8 (14.2)	0.48
Sex, women (%)	213	95 (44.6%)	179	67 (37.4%)	0.18
NIHSS, median (IQR)	102	11 (7-15)	90	12 (7-17)	0.62
Onset to door, median (IQR)	192	82.5 (52.0-142.8)	159	88.0 (55.0-135.0)	0.71
Onset to 911, median (IQR)	167	25.0 (7.0-92.5)	116	20.0 (7.0-63.25)	0.36
Cluster 3					
Age, mean (SD)	170	70.5 (12.2)	89	70.8 (14.3)	0.64
Sex, women (%)	170	73 (42.94%)	90	48 (53.33%)	0.14
NIHSS, median (IQR)	55	10 (6-14)	6	5 (5-9.75)	0.20
Onset to door, median (IQR)	157	88.0 (51.0-150.0)	90	78.5 (45.0-134.0)	0.19
Onset to 911, median (IQR)	98	37.5 (13.0-85.0)	39	32.0 (19.0-74.0)	0.88

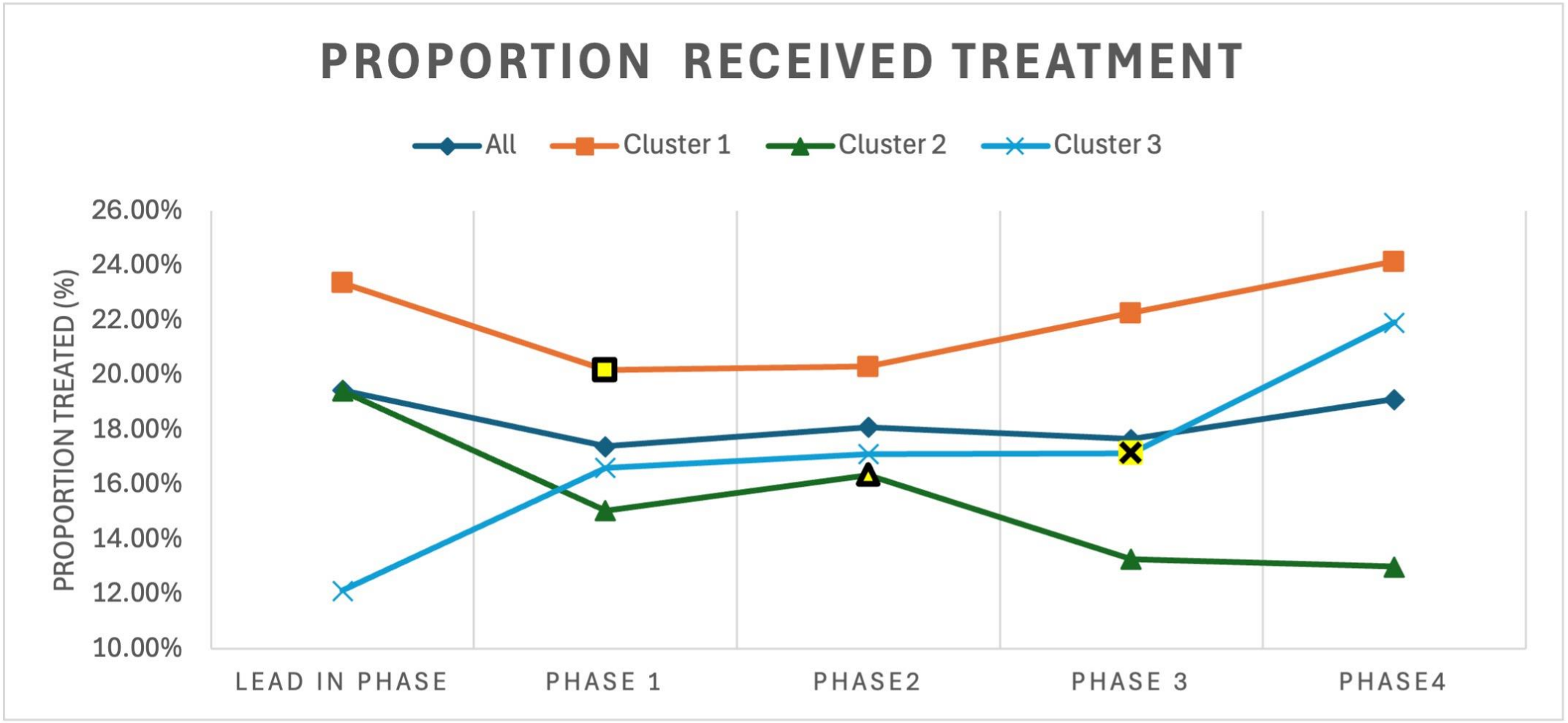
Proportion of ischemic stroke patients treated and discharge disposition (adjustments made for cluster)

Entire Cohort	Pre period (Control) n = 3065	Post period (Intervention) n = 3803	p (significance)
	N (%)	N (%)	
Received Thrombolysis	474 (15.46%)	620 (16.30%)	0.36
Received Thrombolysis (adjusted)	495 (16.15%)	647 (17.02%)	0.3
Received EVT	115 (3.75%)	196 (5.15%)	0.006
Received EVT (adjusted)	123 (4.00%)	151 (3.98%)	0.9
Received either thrombolysis and/or EVT	547 (17.85%)	718 (18.87%)	0.28
Received either thrombolysis and/or EVT (Adjusted)	570 (18.60%)	723 (19.00%)	0.68
Transferred for EVT	118 (3.84%)	193 (5.07%)	0.017
Transferred for EVT (Adjusted)	127 (4.15%)	145 (3.80%)	0.14
Discharged home	1015 (33.10%)	1569 (41.25%)	< 0.0001
Discharged home (Adjusted)	1016 (33.15%)	1768 (46.50%)	< 0.0001
Died	324 (10.57%)	570 (14.98%)	< 0.0001
Died (Adjusted)	349 (11.39%)	464 (12.20%)	0.3

Proportion of ischemic stroke patients treated and discharge disposition by cluster

	Pre-Period (control)	Post –Period (intervention)	p (significance)
Cluster 1	N=663	N=2002	
Received Thrombolysis	132 (19.90%)	383 (19.10%)	0.70
Received EVT	40 (6.03%)	122 (6.09%)	1
Received either thrombolysis and/or EVT	155 (23.37%)	444 (22.17%)	0.55
Transferred for EVT@	43 (6.40%)	114 (5.60%)	0.51
Discharged home	236 (35.59%)	699 (34.91%)	0.78
Died	117 (17.64%)	360 (17.98%)	0.89
Cluster 2	N=1254	N-1377	
Received Thrombolysis	165 (13.15%)	147 (10.67%)	0.056
Received EVT	75 (5.98%)	71 (5.15%)	0.40
Received either thrombolysis and/or EVT	215 (17.14%)	181 (13.14%)	0.004
Transferred for EVT@	75 (5.98%)	79 (5.73%)	0.85
Discharged home	543 (43.30%)	616 (44.73%)	0.48
Died	165 (13.15%)	189 (13.72%)	0.71
Cluster 3	N=1148	N=424	
Received Thrombolysis	*177 (15.41%)*	*90 (21.22%)*	*0.0081*
Received EVT	0	3 (0.70%)	0.02
Received either thrombolysis and/or EVT	*177 (15.41%)*	*93 (21.93%)*	*0.003*
Transferred for EVT	0	0	-
Discharged home	236 (20.55%)	254 (59.90%)	< 0.0001
Died	42 (3.65%)	21 (4.95%)	0.30

Trend of proportion of ischemic stroke patients treated



Treatment times and outcome measures for all community onset ischemic stroke patients treated with thrombolysis and EVT (adjustments made for cluster, age, sex, and NIHSS)

	Control		Intervention		Significance
	n	Values	n	Value	
Door to CT, median (IQR) (unadjusted)	464	17.0 (9.0-36.2)	580	17.0 (10.0-28.0)	0.80
Door to CT, median (IQR) (adjusted)	464	21.9 (8.2-40.0)	580	20.6 (11.6-29.3)	0.70
Door to Needle, median (IQR) (unadjusted)	*416*	*73.0 (49.0-109.0)*	*566*	*62.5 (40.0-93.0)*	*< 0.0001*
Door to Needle, median (IQR) (adjusted)	***416***	***71.2 (43.5-99.5)***	***566***	***62.0 (38.7-85.9)***	***0.01***
Door-in-door-out, median (IQR) (unadjusted)	55	148.0 (116.0-189.5)	91	155.5 (127.0-188.5)	0.62
Door-in-door-out, median (IQR) (adjusted)	55	151.0 (100.0-202.0)	91	160.0 (147.0-173.0)	0.80
Door-to-arterial-access, median (IQR) (unadjusted)	106	58 (11.2-101.7)	178	70.0 (30.0-100.0)	0.11
Door-to-arterial-access, median (IQR) (adjusted)	106	54.5(8.2-101.0)	178	50.0 (11.0-88.0)	0.50
911-to-needle, median (IQR) (unadjusted)	330	129.6 (97.0-164.6)	413	125.0 (93.0-157.0)	0.14
911-to-needle, median (IQR) (adjusted)	330	152.0 (44.2-259.8)	413	144.0 (75.4-212.6)	0.62
911-to-arterial-access, median (IQR) (unadjusted)	69	270.0 (147.0-356.0)	88	273.0 (160.0-349.0)	0.96
911-to-arterial-access, median (IQR) (adjusted)	69	256.0 (232.0-280.0)	88	239.0 (191.0-319.0)	0.97
Length of Stay[&] median (IQR)	423	6.0 (3.0-13.0)	520	6.0 (3.0-14.0)	0.30
Length of Stay[&] median (IQR) (adjusted)	423	5.75 (4.8-6.6)	520	6.9 (4.8-9.0)	0.16
Discharged home, n (%)	528	272 (51.5%)	673	282 (41.9%)	0.001
Discharged home, n (%) (adjusted)	528	274 (52.0%)	673	284 (42.1%)	0.002
Mortality at discharge, n (%)	528	84 (15.9%)	673	121 (17.9%)	0.40
Mortality at discharge, n (%) (adjusted)	528	84 (16.0%)	673	119 (17.7%)	0.46

CLUSTER 1: Treatment times and outcome measures for all community onset ischemic stroke patients treated with thrombolysis and EVT (adjustments made for cluster, age, sex, and NIHSS)

	Control		Intervention		Significance
	n	Values	n	Value	
Door to CT, median (IQR) (unadjusted)	125	13.0 (8.0-21.0)	341	15 .0 (8.0-22.0)	0.23
Door to CT, median (IQR) (adjusted)	125	13.0 (10.8-15.2)	341	14.8 (13.5-16.0)	0.18
Door to Needle, median (IQR) (unadjusted)	122	57.0 (41.5-83.5)	346	58.0 (37.0-83.0)	0.79
Door to Needle, median (IQR) (adjusted)	122	57.2 (50.7-63.8)	346	58.5 (54.5-62.5)	0.70
Door-in-door-out, median (IQR) (unadjusted)	19	137.0 (114.18-212)	49	153.0 (134.0-187.0)	0.62
Door-in-door-out, median (IQR) (adjusted)	19	136.8 (103.6-169.9)	49	155.0 (134.6-175.6)	0.36
Door-to-arterial-access, median (IQR) (unadjusted)	37	86.0 (56.0-123.0)	106	77.5 (63.0-101.8)	0.42
Door-to-arterial-access, median (IQR) (adjusted)	37	85.7 (69.6-101.7)	106	77.0 (67.7-86.5)	0.37
911-to-needle, median (IQR) (unadjusted)	102	113.9 (89.5-145.3)	279	119.2 (93.8-153.3)	0.30
911-to-needle, median (IQR) (adjusted)	102	113.4 (101.0-125.6)	279	118.5 (111.0-125.9)	0.40
911-to-arterial-access, median (IQR) (unadjusted)	15	213.0 (146.1-332.1)	43	180.0 (135.9-349.1)	0.67
911-to-arterial-access, median (IQR) (adjusted)	15	236.0 (131.0-341.0)	43	203.0 (165.0-241.0)	0.42
Length of Day, median (IQR)[&] (unadjusted)	114	6 (3-14)	300	6 (3-13)	0.67
Length of Day, median (IQR)[&] (adjusted)	114	6.7 (4.7-8.6)	300	6.6 (5.5-7.8)	0.90
Discharged home, n (%) (unadjusted)	145	65 (44.8%)	401	177 (44.1%)	0.80
Discharged home, n (%) (adjusted)	145	63 (43.7%)	401	179 (44.7%)	0.35
Mortality at discharge, n (%) (unadjusted)	145	27 (18.6%)	401	81(20.1%)	0.68
Mortality at discharge, n (%) (adjusted)	145	27 (18.9%)	401	80 (20.4%)	0.70

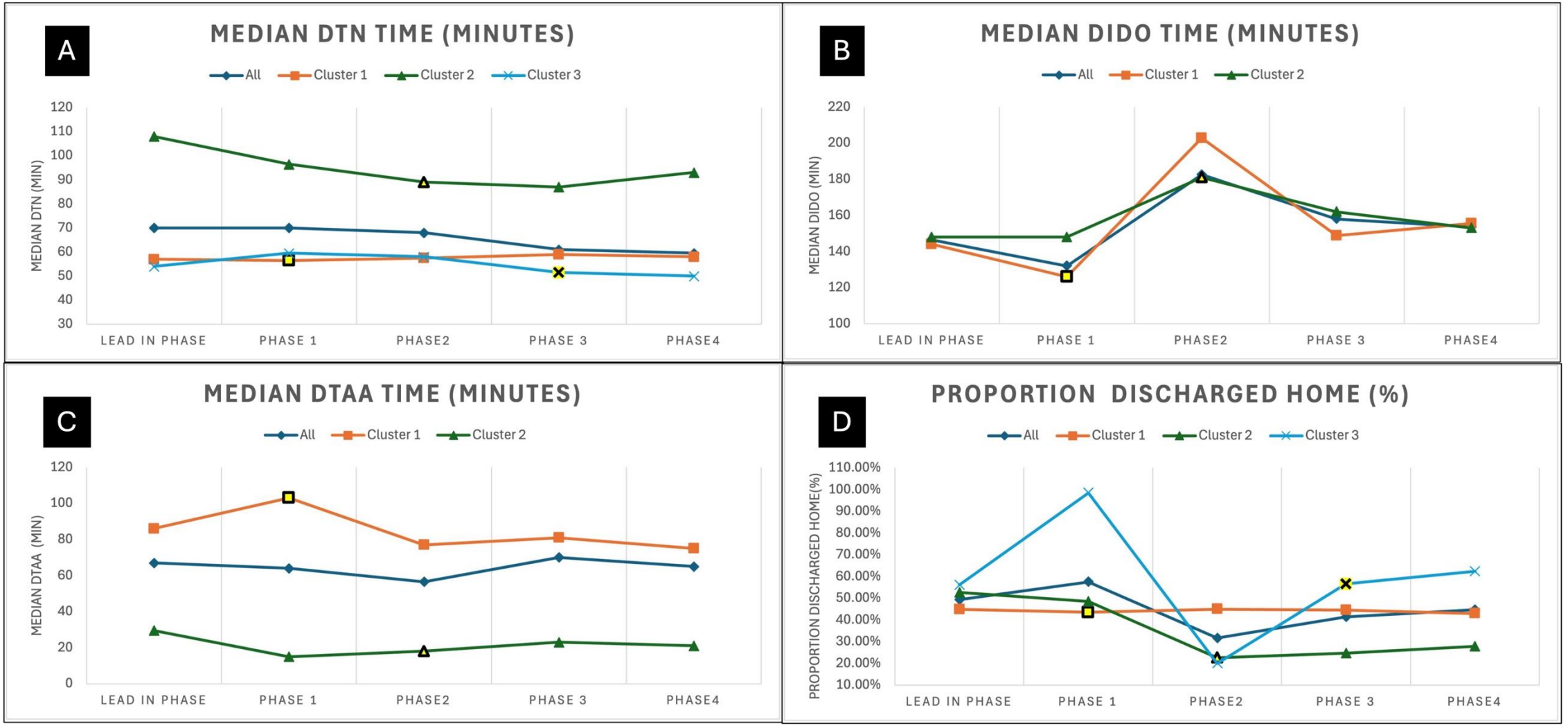
CLUSTER 2: Treatment times and outcome measures for all community onset ischemic stroke patients treated with thrombolysis and EVT (adjustments made for cluster, age, sex, and NIHSS)

	Control		Intervention		Significance
	n	Values	n	Value	
Door to CT, median (IQR) (unadjusted)	188	33.0 (22.8-50.2)	156	26.0 (15.0-42.0)	0.001
Door to CT, median (IQR) (adjusted)	***188***	***32.5 (28.6-36.2)***	***156***	***25.0 (22.4-29.6)***	***0.009***
Door to Needle, median (IQR) (unadjusted)	149	102.0 (82.0-123.0)	131	90.0 (67.0-113.0)	0.005
Door to Needle, median (IQR) (adjusted)	***149***	***102.2 (95.0-109.0)***	***131***	***89.6 (83.0-97.0)***	***0.01***
Door-in-door-out, median (IQR) (unadjusted)	36	148.0 (123.0-194.0)	42	157.0 (119.0-189.0)	0.55
Door-in-door-out, median (IQR) (adjusted)	36	146.8 (127.0-167.0)	42	162.6 (144.0-181.0)	0.26
Door-to-arterial-access, median (IQR) (unadjusted)	69	23.0 (9.0-53.0)	69	22.0 (10.0-79.0)	0.61
Door-to-arterial-access, median (IQR) (adjusted)	69	27.2 (10.0-44.0)	69	21.6 (4.0-38.0)	0.65
911-to-needle, median (IQR) (unadjusted)	129	154.0 (128.0-180.0)	94	151.0 (120.8-189.5)	0.37
911-to-needle, median (IQR) (adjusted)	129	151.6 (143.4-159.7)	94	146.0 (136.5-155.6)	0.38
911-to-arterial-access, median (IQR) (unadjusted)	54	281.0 (149.0-356.0)	45	309.0 (224.0-349.0)	0.36
911-to-arterial-access, median (IQR) (adjusted)	54	280.4 (240.7-320.1)	45	307.1 (263.6-350.6)	0.37
Length of Stay[&] median (IQR) (unadjusted)	171	6 (3-11)	145	6 (3-18)	0.55
Length of Stay[&] median (IQR) (adjusted)	171	6.9 (5.5-8.3)	145	7.6 (5.7-9.4)	0.60
Discharged home, n (%) (unadjusted)	213	108 (50.7%)	179	47 (26.2%)	< 0.0001
Discharged home, n (%) (adjusted)	213	110 (51.6%)	179	49 (27.3%)	0.01
Mortality at discharge, n (%) (unadjusted)	213	38 (17.8%)	179	32 (17.8%)	0.95
Mortality at discharge, n (%) (adjusted)	213	36 (16.9%)	179	32 (17.8%)	0.90

CLUSTER 3: Treatment times and outcome measures for all community onset ischemic stroke patients treated with thrombolysis and EVT (adjustments made for cluster, age, sex, and NIHSS)

	Control		Intervention		Significance
	n	Values	n	Value	
Door to CT, median (IQR) (unadjusted)	151	9.0 (4.0-17.0)	83	12.0 (6.0-21.0)	0.13
Door to CT, median (IQR) (adjusted)	151	9.6 (8.0-12.0)	78	11.8 (9.0-15.0)	0.24
Door to Needle, median (IQR) (unadjusted)	*145*	*54.0 (40.0-75.0)*	*89*	*50.0 (31.0-73.0)*	*0.05*
Door to Needle, median (IQR) (adjusted)	***145***	***54.5 (44.0-67.0)***	***89***	***49.0 (41.7-56.3)***	***0.05***
Door-in-door-out, median (IQR) (unadjusted)	0	-	0	-	
Door-in-door-out, median (IQR) (adjusted)	0	-	0	-	
Door-to-arterial-access, median (IQR) (unadjusted)	0	-	3	72.0 (69.5-91.0)	
Door-to-arterial-access, median (IQR) (adjusted)	0	-	3	72.0 (69.5-91.0)	
911-to-needle, median (IQR) (unadjusted)	*99*	*103.0 (70.0-146.0)*	*40*	*87.0 (66.0-121.0)*	*0.004*
911-to-needle, median (IQR) (adjusted)	***99***	***102.8 (90.9-114.7)***	***40***	***90.1 (70.9-109.3)***	***0.05***
911-to-arterial-access, median (IQR)	0	-	0	-	
Length of Stay[&] median (IQR) (unadjusted)	138	5 (3-12.50)	84	7 (3-22)	0.16
Length of Stay[&] median (IQR) (adjusted)	138	4.7 (3-6)	75	7.5 (5-9)	0.08
Discharged home, n (%) (unadjusted)	170	99 (58.2%)	93	58 (62.3%)	0.60
Discharged home, n (%) (adjusted)	170	100 (59.0%)	93	57 (61.2%)	0.79
Mortality at discharge, n (%) (unadjusted)	170	19 (11.17%)	93	9 (9.6%)	0.86
Mortality at discharge, n (%) (adjusted)	170	17 (10.2%)	93	11 (11.8%)	0.80

Trend of treatment times and outcomes for all treated ischemic stroke patients



Interpretation and Discussion

1. Improvements to door-to-needle time were evident (a reduction of 9.2 minutes, p=0.01)

- Smaller reduction than in previous studies that used the Improvement Collaborative intervention
  - 30-minute reduction in Alberta (Kamal et al. 2020)
  - 20-minute reduction in California (Nguyen-Huynh et al., 2018)
  - 15.5-minute reduction in Chicago (Prabhakaran et al., 2016)
- We have a larger rural population
  - 17% rural in Alberta
  - California study was done in San Francisco/Bay area (urban/suburban)
- *A longer intervention period is needed*
  - 6 months is too short, and 1 year as per other studies is needed
- COVID-19
  - Added steps in process – conducting COVID-19 tests on all patients
  - Distracted healthcare professional to focus on reducing spread of disease
  - Virtual Improvement Collaboratives are likely less effective – **need face-to-face Learning Sessions and Site Visits**

2. Each cluster responded differently to intervention

- NS showed no improvements (some trends), NB/PE showed some improvements, NL showed the most improvements
- Interventions should be tailored to each health system based on their readiness

3. Only door-to-needle improved

- Need evidence-based improvement strategies for door-to-arterial-access (EVT efficiency) and door-in-door-out (transfer efficiency)
- Implementation of recommendedchanges must be tracked and mandated for each hospital

What is Next?

OPTIMISING ACCESS – A National Acute Stroke Treatment Registry

Overall objective is to reduce disparity between rural and urban patients.

Improve the proportion of patients that receive EVT when presenting first to a peripheral stroke centre (capable of thrombolysis treatment only)

OPTIMISING ACCESS: Overall Work Plan

Years 1-3 Objective #1	Year 3 Objective #2	Years 4-7 Objective #3	Years 5->onwards
• Building the infrastructure • Engage sites to enter data	• Understand the current state	• Make improvements • Stepped-Wedge Trial	• Conduct RRCT

Questions & Discussion

"Start by doing what's necessary; then do what's possible; and suddenly you are doing the impossible."

Francis of Assisi