The Canadian Journal of Neurological Sciences (2024), **51**, 226–232
doi:10.1017/cjn.2023.36

Canadian Journal of Neurological Sciences
Journal Canadien des Sciences Neurologiques

Original Article

Direct to Angiosuite in Acute Stroke with Mobile Stroke Unit

Radhika Nair[1], Jeremy Rempel[2], Khurshid Khan[1], Thomas Jeerakathil[1], Rene Van Dijk[2], Brian H. Buck[1], Mahesh P. Kate[1], Sibi Thirunavukkarasu[1], Kimberly Gilbertson[3], Sathvika Thermalingem[3] and Ashfaq Shuaib[1]

[1]University of Alberta, Department of Medicine, Division of Neurology, Edmonton, Canada, [2]University of Alberta, Department of Radiology and Diagnostic imaging, Edmonton, Canada and [3]Alberta Health Services, Alberta, Canada

ABSTRACT: ***Background:*** Early reperfusion has the best likelihood for a favorable outcome in acute ischemic stroke (AIS) with large vessel occlusion (LVO). Our experience with mobile stroke unit (MSU) for direct to angiosuite (DTAS) transfer in AIS patients with suspected LVO is presented. ***Methods:*** Retrospective review of prospectively collected data from November 2019 to August 2022, of patients evaluated and transferred by the University of Alberta Hospital MSU and moved to angiosuite for endovascular thrombectomy (EVT). ***Result:*** A total of 41 cases were included. Nine were chosen for DTAS and 32 were shifted to angiosuite after stopping for computed tomography (CT) angiography of the head and neck (no-DTAS). Stroke severity measured by NIHSS (median with interquartile range (IQR)) was higher in patients of DTAS, 22 (14–24) vs 14.5 (5–25) in no-DTAS ($p = 0.001$). The non-contrast CT head in MSU showed hyperdense vessels in 8 (88.88%) DTAS vs 11 (34.35%) no-DTAS patients ($p = 0.003$). The EVT timelines (median with IQR, 90th percentile) including "door to artery puncture time" were 31 (23–50, 49.2) vs 79 (39–264, 112.8) minutes, and "door to recanalization time" was 69 (49–110, 93.2) vs 105.5 (52–178, 159.5) minutes in DTAS vs no-DTAS group, respectively. The workflow times were significantly shorter in the DTAS group ($p < 0.001$). Eight (88.88%) out of 9 DTAS patients had LVO and underwent thrombectomy. ***Conclusions:*** MSU for DTAS in patients with high NIHSS scores, cortical signs, and CT showing hyperdense vessel is an effective strategy to reduce the EVT workflow time.

RÉSUMÉ : Passage direct de patients ayant subi un accident vasculaire cérébral aigu, au bloc angiographique grâce à une unité mobile de prise en charge des AVC. ***Contexte :*** Ce sont dans les cas d'accident vasculaire cérébral ischémique (AVCI) aigu par occlusion de gros vaisseaux (OGV) que la reperfusion précoce a les meilleures chances de donner de bons résultats. Sera présentée ici l'expérience d'une unité mobile de prise en charge des AVC (UM d'AVC) en vue d'un passage direct au bloc angiographique (BA) de patients ayant subi un AVCI aigu avec une OGV présumée. ***Méthode :*** Il s'agit d'une étude rétrospective de données recueillies de façon prospective, de novembre 2019 à août 2022, chez des patients évalués et transférés par l'UM d'AVC de l'hôpital de l'Université de l'Alberta, puis dirigés au BA en vue d'une thrombectomie endovasculaire (TEV). ***Résultats :*** L'étude comptait au total 41 cas : 9 d'entre eux sont passés directement au BA, tandis que les 32 autres ont été transférés au BA après avoir subi une angiographie par tomodensitométrie (TDM) de la tête et du cou. Le degré de gravité des AVC, évalué sur l'échelle NIHSS (médiane : écart interquartile [EI]), était plus élevé chez les patients du groupe de passage direct au BA (PDBA) (22 : 14-24 contre [c.] 14,5 : 5-25) que dans le groupe de transfert au BA (TBA) (c'est-à-dire de « passage indirect ») ($p = 0,001$). La TDM de la tête sans produit de contraste, effectuée dans l'UM d'AVC montrait des vaisseaux hyperdenses chez 8 patients du groupe de PDBA (88,88 %) contre 11 patients du groupe de TBA (34,35 %) ($p = 0,003$). La ligne temporelle de la TEV (médiane : EI; 90^{e} centile), y compris le temps écoulé « entre l'arrivée sur les lieux et la ponction artérielle », était de 31 minutes (23-50; 49,2) contre 79 minutes (39-264; 112,8) et, « entre l'arrivée sur les lieux et la revascularisation », de 69 minutes (49-110; 93,2) contre 105,5 minutes (52-178; 159,5) dans le groupe de PDBA et dans le groupe de TBA, respectivement. Le temps du flux de travail était significativement plus court dans le groupe de PDBA que dans le groupe de TBA ($p < 0,001$). Dans le groupe de PDBA, 8 patients sur 9 (88,88 %) avaient une OGV et ont subi une thrombectomie. ***Conclusion :*** L'UM d'AVC en vue d'un passage direct au BA de patients qui ont un score élevé sur l'échelle NIHSS, qui présentent des signes d'atteinte du cortex cérébral et chez qui la TDM montre des vaisseaux hyperdenses permet de réduire efficacement le temps du flux de travail de la TEV.

Keywords: Acute ischemic stroke; Direct to angio transfer; Endovascular therapy; Large vessel occlusion; Mobile stroke unit; Reperfusion

(Received 19 November 2022; final revisions submitted 5 March 2023; date of acceptance 11 March 2023; First Published online 29 March 2023)

Corresponding author: Dr. Ashfaq Shuaib, Professor, Department of Medicine, Division of Neurology, University of Alberta, 7-112F Clinical Sciences Building, 8440 112 St NW, Edmonton, AB T6G 2B7, Canada. Email: shuaib@ualberta.ca

Cite this article: Nair R, Rempel J, Khan K, Jeerakathil T, Van Dijk R, Buck BH, Kate MP, Thirunavukkarasu S, Gilbertson K, Thermalingem S, and Shuaib A. (2024) Direct to Angiosuite in Acute Stroke with Mobile Stroke Unit. *The Canadian Journal of Neurological Sciences* **51**: 226–232, https://doi.org/10.1017/cjn.2023.36

Introduction

Early reperfusion has the best likelihood of excellent outcomes in patients with acute ischemic stroke (AIS) with large vessel occlusion (LVO).[1,2] The HERMES Investigators pooled data from seven randomized control trials, where they analyzed patients treated within 4 hours from onset to last known well. The exposure was measured with last seen well-to-door time, door-to-puncture time, and door-to-reperfusion time. Stroke-related quality of life at 3 months and years of healthy life lost were used to determine the outcome. The results showed every 1-second delay in endovascular thrombectomy (EVT) resulted in the loss of 2.2 hours of healthy life.[3] The chances of functional recovery without disability within the initial 6–8 hours of the onset of stroke reduce by 10 to 15% for every 30 minutes of delayed perfusion.[4] EVT is shown to be superior in restoring perfusion to medical treatment in patients of AIS with LVO as shown in a meta-analysis of five pivotal stroke trials.[5]

Mobile stroke units (MSUs) with computed tomography (CT) scans allow for quick assessment and thrombolysis of ischemic stroke patients, as early as within an hour of the onset of symptoms. Studies have shown very favorable results with MSU thrombolysis when compared to standard treatment.[6,7] Since most MSU scanners do not have CT angiography (CTA) capability, patients must first stop at the emergency room where CTA is performed before being shifted to the angiosuite if an LVO is detected. This “door-to-groin puncture” adds an additional hour or longer to the perfusion time.

The presence of cortical signs on examination, especially gaze preference, hemianopsia, and the presence of aphasia (left hemisphere) or neglect, increases the likelihood of the presence of an LVO. The presence of gaze deviation is the single best predictor of LVO.[8] Detection of a hyperdense artery further increases the likelihood of an LVO.[9,10] If such patients are taken directly to the angiosuite, the time to treatment can be greatly improved. The DTAS approach has recently been tried in two situations: DTAS from the ambulance and transfer from a primary care center (where imaging with CT/CTA is completed) to a comprehensive stroke center. While this allows for considerable saving of time, patients who are directly transferred from an ambulance may not have LVOs or have intracranial hemorrhage (ICH) when imaged in the angiosuite. Another option in centers with MSUs is to transfer the patient directly to the angiosuite provided there is a high likelihood of LVO.

We aimed to present our experience with stroke ambulance for DTAS transfer in patients with cortical signs, high NIHSS, and where MSU imaging showed hyperdense middle cerebral artery (MCA) on CT imaging.

Method

This was a retrospective chart review of prospectively collected data from the University of Alberta Hospital (UAH), Edmonton, Canada. We included all the consecutive patients who were evaluated in the University of Alberta Hospital MSU/stroke ambulance and transferred to the intervention radiology suite for consideration of EVT from November 2019 to August 2022. The stroke ambulance project is approved by the University of Alberta ethics board – Pro00037601.

The stroke ambulance project was implemented at the UAH in February 2017. The MSU is a custom-built ambulance with a portable CT scanner ([Ceretom, Neurologica], which is an 8-slice CT scanner that delivers high-quality non-contrast, angiography, and contrast perfusion studies. The X-ray detection system is a solid-state detector and the main detector has eight rows. For the axial head, the slice thickness used is 5 mm, 120 is the kV, the maximum scan range is 640 mm), tele-stroke equipment, and a point-of-care laboratory. The MSU team consists of a stroke neurologist or a stroke fellow, a CT technologist, a registered nurse, a primary care paramedic, and an advanced care paramedic. The MSU covers an area of approximately a 250 km radius surrounding the University of Alberta Hospital and the MSU is available during the weekdays only (Monday to Friday 8 am–4 pm). The usual workflow employed in MSU is as follows, the MSU is dispatched by the prehospital emergency medical services team when there is a suspicion of acute stroke in the window for intravenous thrombolysis (<4.5 hours from the onset or last seen well) or tele-stroke neurologist after a telephone consultation with the rural emergency department physician. After a brief neurological examination by a stroke neurologist/fellow and if the clinical examination is consistent with disabling stroke, the patient is transferred into the MSU for a brain CT scan, and the images are transmitted to the hospital tele-stroke neurologist for review in real time.[11,12,13] If the patients are eligible for intravenous tissue plasminogen activator (TPA) as per standard of care, they receive the treatment in the MSU and are transported in the MSU to the hospital for further imaging and management including EVT if necessary. CTA is not done in the MSU. Upon arrival at the hospital, the CT, CTA, and CT perfusion are completed in a scanner located in close proximity to the emergency department. If the CTA detects an LVO, the patient was transferred to the angiosuite after consultation with the interventional neuroradiologist.

There are no specific criteria for transferring the patients directly to the angiosuite. A clinical suspicion of a large cortical stroke and the presence of a “hyperdense artery” on the MSU CT were considered sufficient to initiate the process, and the on-call stroke neurologist consulted the on-call interventional neuroradiologist and activated the angiosuite team. The pre-hospital workflow was similar for patients chosen for DTAS; however, upon arrival at the hospital, they were directly shifted to the angiosuite without stopping in the emergency room or CT suite for CTA/CTP images. This was based on physicians' discretion and no specific protocol exists.

Data Collection

Connect Care was used to review the clinical characteristics, the severity of the stroke, onset time, EVT timelines including onset to the needle, door-to-artery puncture, onset to artery puncture, door-to-recanalization times, mRS (modified Rankin score) at discharge, and mRS at 3 months. Connect Care is a provincial electronic clinical information system from all acute care hospitals that are under the accountability of Alberta Health Services (AHS), hospital diagnostic facilities, hospital labs, hospital pharmacies, and other AHS clinics and facilities. Picture archiving and communication system was used to review imaging characters and thrombolysis in cerebral infarction (TICI) score.

Data Analysis

The patients were stratified into two groups based on whether they were transferred directly to the angiosuite from MSU (DTAS) vs had a stop at emergency for CTA head and neck imaging (no-DTAS) before shifting to the angiosuite. Normally distributed continuous data were expressed as mean and standard deviation. Non-normally distributed continuous data were expressed as

https://doi.org/10.1017/cjn.2023.36 Published online by Cambridge University Press

median with interquartile range (IQR). Categorical data were presented as an absolute number with the corresponding percentage. Differences in continuous variables were assessed by T-test for the means and Mann Whitney U test for the medians, and the chi-square test or Fisher's exact test was used for categorical variables. A probability value of <0.05 was considered significant for all tests.

Results

A total of 41 patients who were initially assessed and transferred in MSU underwent EVT during the study period. Of the 41 patients, 9 were transferred directly to the angiosuite (DTAS). The remaining 32 patients were re-evaluated at the emergency room, moved to the CT suite for CTA (no-DTAS), and then moved to the angiosuite for EVT upon identification of LVO.

Baseline Characters and Stroke Severity

The age, sex distribution, vascular risk factors, and presenting symptoms related to the vascular territory were similar in both groups. The stroke severity assessed by the EMS crew using the Los Angeles Motor Scale (LAMS) of 3–5 was higher in the patients chosen for DTAS. NIHSS as measured by the stroke neurology fellow or vascular neurologist in MSU showed a median (IQR) of 22 (14–24) in patients of DTAS vs 14.5 (5–25) in the no-DTAS, indicating that patients chosen for DTAS had a severe stroke at presentation ($P = 0.003$) (Table 1).

Stroke Imaging

CT head from MSU showed hyperdense vessel sign in 8 (88.88%) of 9 patients in the DTAS and 11 (34.37%) of 32 patients ($P = 0.003$) in the no-DTAS (Figure 1). All DTAS (100%) chosen patients received intravenous thrombolysis with TPA in MSU. In the no-DTAS patients, thrombolysis was offered to 25 (78.12%) patients in MSU. LVOs identified in patients of DTAS were internal carotid artery (ICA)+MCA in 4 (44.44%), MCA-M1 segment in 3 (33.33%), and MCA-M2 segment in 1 (11.11%) patient. In one (12.5%) patient, no LVO was identified, but the angiogram showed smaller distal occlusion. This likely represented breaking and distal movement of the clot with thrombolysis. In the no-DTAS patients, the intracranial vessel occlusions included ICA + MCA in 2 (6.25%) patients, MCA-M1 in 20 (62.5%) patients, and MCA-M2 in 9 (28.12) patients. In one (3.12%) patient, there was an occlusion of the posterior cerebral artery (PCA). Six of 9 patients in the DTAS underwent CTA with Dyna CT in the angiosuite prior to groin puncture (Table 1).

Stroke Timelines

Acute stroke workflow timings showed no significant differences in onset to needle time between patients of DTAS vs no-DTAS for IV thrombolysis with a median (IQR, 90th percentile) of 118 (47–270, 168.4) vs 79 (39–264, 112.8) minutes, respectively ($P = 0.32$). The EVT timelines median (IQR, 90th percentile) including "door to artery puncture time" was 31 (23–50,49.2) vs 69.5 (41–153,105.2) minutes, and "door to reperfusion time" was 69 (49–110,93.2) vs 105.5 (52–178,159.5) minutes among DTAS vs no-DTAS patients, respectively (Figure 2). The EVT workflow timings were significantly shorter in patients chosen for DTAS ($P < 0.001$). The "onset to artery puncture" was 179 (105–324,232) vs 181.5 (113–436,317.4) minutes in patients of DTAS vs no-DTAS ($P = 0.26$), and "onset to recanalization time" was 219 (140–341,302) vs 227 (148–442,335.5) minutes in DTAS vs CTAS showed no significant difference ($P = 0.8$) (Table 1).

EVT Outcomes

Successful EVT defined by final thrombolysis in cerebral infarction (TICI) score of 2b or more was achieved in 66.66% of the DTAS chosen patients compared to 71.87% in the no-DTAS with no significant difference between the group ($P = 0.86$). Complete or near complete recanalization (TICI 2c-3) was achieved in 4 (44.44%) vs 17 (53.12%) in DTAS vs no-DTAS, respectively. One (11.11%) patient in DTAS had no target on DSA imaging in the angiosuite, even though the patient had undergone Dyna CTA prior to groin puncture which showed suspicious distal M1 narrowing/occlusion. In the no-DTAS patients, two (6.25%) with an occlusion evident on the CTA showed no occlusion at the time of digital angiography. This was likely due to successful recanalization with intravenous thrombolysis. Safety outcome measured by symptomatic ICH was seen in one (11.11%) patient chosen for DTAS and none in the no-DTAS. Small parenchymal hemorrhage was seen in one (11.11%) in DTAS and two (6.25%) patients in no-DTAS on 24 hours repeat brain imaging (CT head/MRI). We also noted small volume subarachnoid hemorrhage in one (12.5%) patient in the patients chosen for DTAS and four (12.5%) patients in the no-DTAS (Table 1).

Functional Outcomes

At the time of discharge, 4 (44.44%) patients chosen for DTAS and 17 (53.12%) patients in the no-DTAS had achieved a good functional recovery with mRS of 0–2 ($p = 0.64$). At 3 months, 6 (66.6%) patients of DTAS and 24 (75%) in no-DTAS had made a good functional recovery with mRS of 0–2 ($p = 0.61$). In DTAS, two (22.22%) patients died during hospitalization and similarly, there were two (6.25%) deaths in the CTAS group during hospitalization.

Discussion

The false activation of the angiosuite is significantly less when MSU is used for DTAS. Eight (88.88%) of 9 in the DTAS chosen were identified with LVOs. It is possible that the 9th patient may also have had an LVO, which broke and migrated distally with the TPA treatment. Identifying patients with an LVO, as early as possible, is important and the time saved on a direct transfer to the angiosuite can significantly increase the likelihood of a better recovery. In our patients, the assessment was done by a stroke fellow or a vascular neurologist and identifying hyperdense artery signs on the CT was important for the high rate of LVOs when imaged at the angiosuite. Also, MSU non-contrast CT head ruled out intracerebral hemorrhage (ICH). In DTAS, one patient underwent conventional angiography with no target for thrombectomy. Two patients in the CTAS group had similarly recanalized when traditional angiography was performed, showing that no additional resources were used or the patients were exposed to an unnecessary conventional angiography with associated procedure-related complications.

The results from studies of "direct to angio" where the assessment was not done by a neurologist and where CT was not available prior to shifting the patient to the angiosuite have shown lower rates of success. In a recent randomized trial from Barcelona, Spain, they randomized patients who had NIHSS scores of >10 with pre-morbid mRS of 0–2 and presentation

Table 1: Comparison of DTAS vs no-DTAS

	DTAS (*N* = 9)	No-DTAS (*N* = 32)	*P* Value
Age (Mean ± SD years)	66.55 ± 12.16	69.37 ± 14.50	0.59
Female sex *N* (%)	4 (44.44)	15 (46.87)	0.89
Pre-morbidity *N* (%)			
Hypertension	7 (77.77)	17 (53.12)	0.18
Diabetes mellitus	1 (11.11)	4 (12.5)	0.91
Atrial fibrillation	1 (11.11)	5 (15.62)	0.73
Dyslipidemia	2 (22.22)	16 (50)	0.13
Coronary artery disease	2 (22.22)	6 (18.75)	0.81
Smoking	2 (22.22)	11 (34.37)	0.48
Presenting symptoms *N* (%)			
Left MCA syndrome	6 (66.66)	18 (56.25)	0.77
Right MCA syndrome	3 (33.33)	14 (43.75)	
Los Angeles Motor Scale (LAMS) 3–5 *N* (%)	9 (100)	27 (84.37)	0.56
NIHSS median (IQR)	22 (14–24)	14.5 (5–25)	0.001
Hyperdense vessel sign *N* (%)	8 (88.88)	11 (34.37)	0.003
Intravenous TPA N (%)	9 (100)	25 (78.12)	0.34
Location of large vessel occlusion *N* (%)			
M1	3 (33.33)	20 (62.5)	0.01
M2	1 (11.11)	9 (28.12)	
ICA + MCA	4 (44.44)	2 (6.25)	
PCA	0 (0)	1 (3.12)	
Onset to IVT time Median (IQR, 90th percentile)	118 (47–270, 168.4)	79 (39–264, 112.8)	0.322
Door to artery puncture time Median (IQR, 90th percentile)	31 (23–50,49.2)	69.5 (41–153,105.2)	<0.001
Onset to artery puncture time Median (IQR, 90th percentile)	179 (105–324,232)	181.5 (113–436, 317.4)	0.26
Door to recanalization time Median (IQR, 90th percentile)	69 (49–110,93.2)	105.5 (52–178,159.5)	<0.001
Onset to recanalization time Median (IQR, 90th percentile)	219 (140–341,302)	227 (148–442,335.5)	0.80
EVT-recanalization *N* (%)			
TICI score (thrombolysis in cerebral infarction): 2b-3	6 (66.66)	23 (71.87)	0.86
TICI: 2c-3	4 (44.44)	17 (53.12))	0.64
No target for EVT *N* (%)	1 (12.5)	2 (6.25)	0.62
mRS at discharge (0–2) *N* (%)	4 (44.44)	17 (53.12)	0.64
mRS at 90 days (0–2) *N* (%)	6 (66.66)	24 (75)	0.61
Mortality *N* (%)	2 (22.22)	2 (6.25)	0.15

within 6 hours. In the intervention group, patients were transferred directly to the angiography suite without stopping for imaging and in the control group patients had to stop for CT imaging. The intervention group had a median NIHSS (IQR) of 18 (14–21). Out of 89 allocated to the intervention group, 8 had ICH and 15 had no LVO.[14] Recent meta-analysis published by Mohammaden et al. which included seven recent studies of “direct to angio” transfer showed that 28.2% of patients

https://doi.org/10.1017/cjn.2023.36 Published online by Cambridge University Press

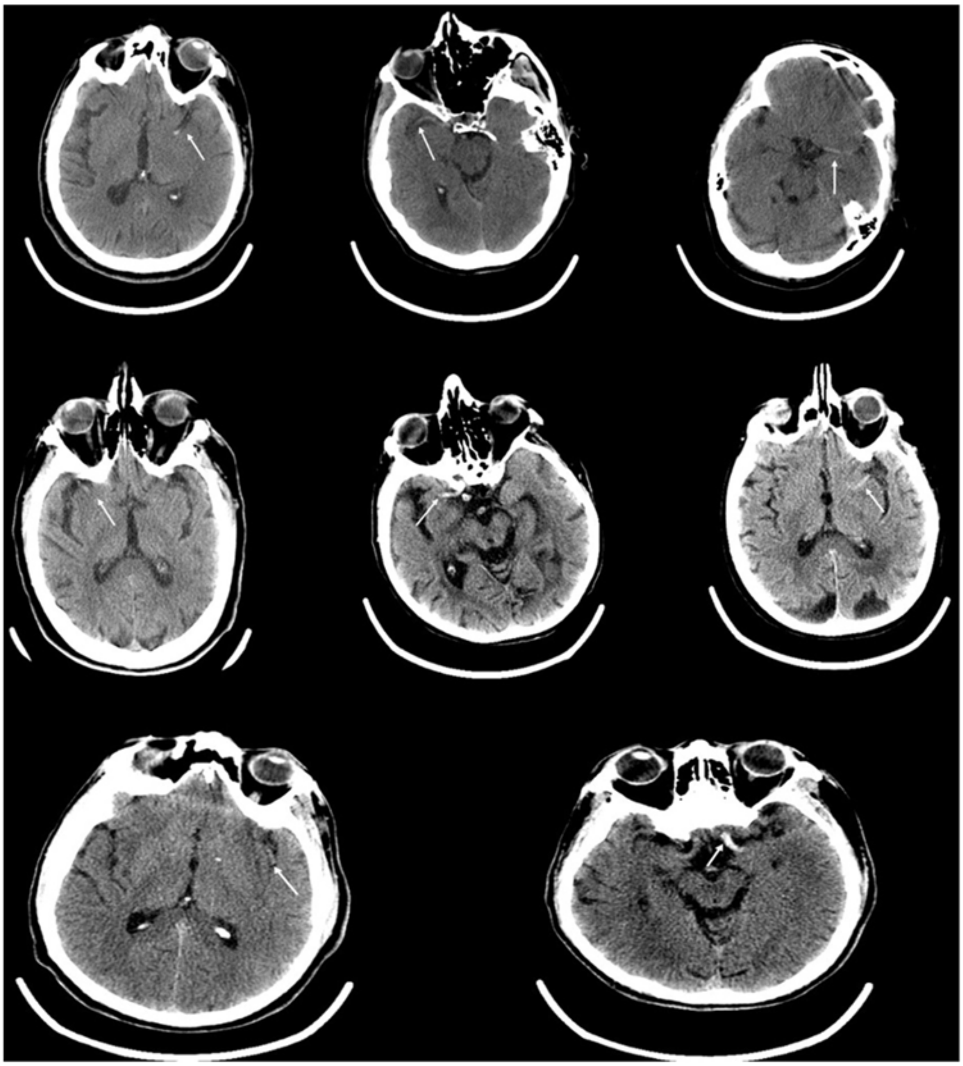

Figure 1: CT head images showing hyperdense vessel sign in DTAS patients.

were not eligible for EVT in the DTAS approach either because of ICH or no LVO.[15]

Using MSU for DTAS significantly reduced the hospital EVT workflow times including door-to-artery puncture (median 31 minutes DTAS vs 69.5 minutes in no-DTAS) and door-to-recanalization times (median 69 minutes DTAS vs 105.5 minutes in no-DTAS). Our door-to-artery puncture and recanalization time are comparable to the meta-analysis of seven studies, where the door-to-puncture mean difference was 30.76 minutes in direct to angio vs stopping for CT head.[13] One of the case–control studies showed a median door-to-artery puncture time of just 16 minutes in patients with the direct-to-angio transfer.[16]

Improved workflow time has been associated with improved clinical outcomes and higher rates of successful reperfusion.[17] Despite the hospital workflow timings being significantly more efficient in the DTAS patients, this did not translate into a reduction in overall onset to treatment times, due to faster arrival of the patient to the hospital after onset in the no-DTAS patients. The patients who were chosen for the DTAS also had severe strokes at presentation. These might be the cause of the nonsignificant clinical outcome differences between the groups at discharge and the 90-day mRS. Further, the total number of patients in DTAS was very low; hence, the study is underpowered to detect a meaningful difference in clinical outcomes. The most recent randomized study showed improved functional outcomes in the DTAS group, and a meta-analysis of recent seven studies also revealed improved functional independence in the direct-to-angio group as measured by mRS 0–2 at 90 days.[14,15]

One possible disadvantage of the portable CT scan in the MSU is the somewhat inferior quality of the imaging. This may affect the interpretation of early ischemia or measuring ASPECTS; hence, patients who already have a large ischemic core may end up going for EVT. Recent studies have however suggested that EVT may improve outcomes in patients with a large ischemic core.[18,19] Six patients of DTAS, including the one who did not have an EVT target on the conventional angiography, underwent Dyna CTA prior to groin puncture. In the patient with no target for EVT, Dyna CTA revealed unclear occlusion/narrowing of distal M1, demonstrating the low quality of Dyna CTA to definitively exclude the occlusion. Dyna CTA imaging also added 10–15 minutes to the time to groin puncture. Our study did not find Dyna CTA useful in our patients' treatment decisions. Hence, we suggest Dyna CTA should be avoided in "direct from MSU to angio" patients with high NIHSS scores, cortical signs including gaze deviation, and availability of a non-contrast CT head with a corresponding hyperdense vascular sign.

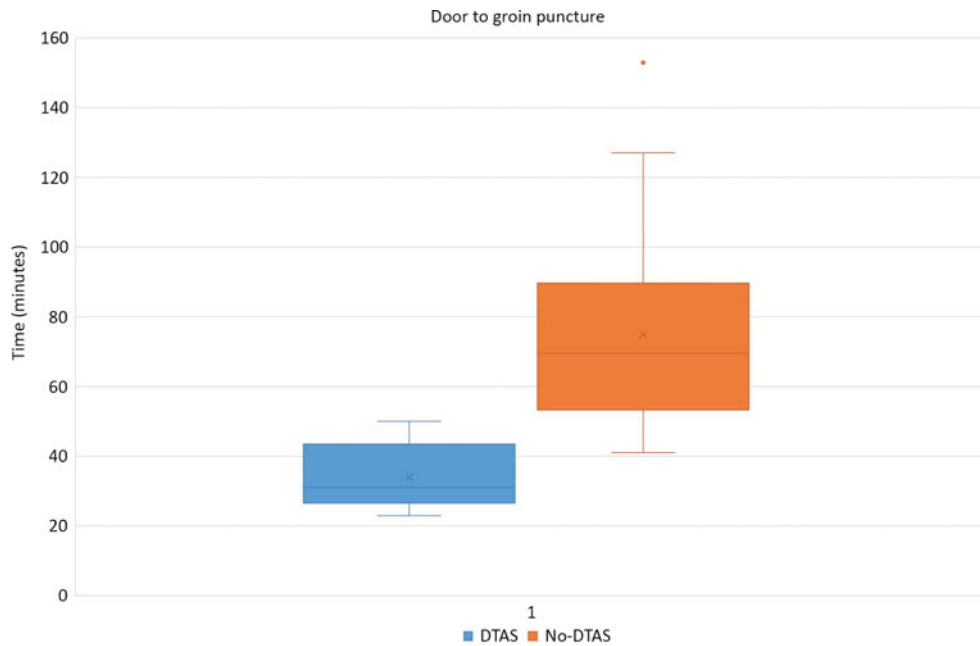

Figure 2: Comparison of door-to-artery puncture time between DTAS and no-DTAS.

Our study has limitations. The major drawbacks are very few patients in DTAS and the study's retrospective nature. Due to low sample size in DTAS-chosen patients, the study is underpowered to detect a meaningful difference in clinical outcomes. There were no specific criteria considered for shifting the patients to DTAS; this might have resulted in selection bias. The MSU works on weekdays from 8 am to 4 pm; only patients present during these hours can receive care from MSU. The angio-team is also onsite during these hours. The stroke ambulance typically evaluates patients who are in the window for IV thrombolysis (4.5 hours from onset). The patients who present beyond the 4.5 hours window are transferred to the hospital with a primary emergency medical crew; thus, the result cannot be extrapolated for late window patients.

Conclusion

MSU for DTAS transfer in AIS with suspected LVO is feasible. Using MSU with DTAS transfer in selected patients with high NIHSS scores, cortical signs, and hyper-dense vessel sign in the CT head may be an effective strategy to reduce the EVT workflow time and results in a significant reduction in door-to-artery puncture time.

Funding

- The University of Alberta mobile stroke unit is predominantly funded by the University Hospital Foundation, with additional funding from the Canadian Stroke Network, and Alberta Innovates.
- No funding was received to assist with the preparation of this manuscript.

JR: received a grant assessing reperfusion quality post-EVT for stroke, a grant from the University of Alberta Hospital Foundation, received a paid speaking arrangement for Penumbra, and was a member of the DSMB for the DUMAS trial.

TJ: received grants from the University of Alberta Hospital foundation which was made to the institution.

BHB is a board member of the Canadian Stroke Consortium.

MK received grants from the University Hospital Foundation, Edmonton.

Conflict of Interest. AS, RN, KK, RvD, ST, KG, and STh have no conflicts of interest to declare.

Compliance with Ethical Standards. This is a retrospective chart review of patients who are evaluated in the Mobile Stroke Unit/Stroke ambulance. The stroke ambulance project is approved by the University of Alberta ethics board- Pro00037601.

Statement of Authorship. Research project conception: AS, KK, TJ, BB, MK, JR, RV, ST

Research project organization and statistical analysis design: AS, RN, TJ, JR, RV, BB, MK, ST, KG, STh.

Data collection: RN, KG, STh.

Statistical analysis: RN.

Writing of the draft: RN, AS

Review and critique: AS, JR, KK, TJ, RV, BB, MK, ST.

References

1. Jahan R, Saver JL, Schwamm LH, et al. Association between time to treatment with endovascular reperfusion therapy and outcomes in patients with acute ischemic stroke treated in clinical practice. JAMA. 2019;322:252–63.
2. 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;316:1279–88.
3. Almekhlafi MA, Goyal M, Dippel DW, et al. Time-benefit association is magnified in door-to-puncture window: lose 1 second, lose 2.2 hours of healthy life. Stroke. 2021;52:A17.
4. Mazighi M, Chaudhry SA, Ribo M, et al. Impact of onset-to-reperfusion time on stroke mortality: a collaborative pooled analysis. Circulation. 2013;127:1980–5.
5. 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. 2016;387:1723–173.
6. Walter S, Kostopoulos P, Haass A, et al. Diagnosis and treatment of patients with stroke in a mobile stroke unit versus in hospital: a randomised controlled trial. Lancet Neurol. 2012;11:397–404.
7. Ebinger M, Kunz A, Wendt M, et al. Effects of golden hour thrombolysis: a Prehospital Acute Neurological Treatment and Optimization of Medical Care in Stroke (PHANTOM-S) sub study. JAMA Neurol. 2015;72:25–30.

8. Taqi MA, Sodhi A, Suriya SS, et al. Design, application and infield validation of a pre-hospital emergent large vessel occlusion screening tool: ventura emergent large vessel occlusion score. J Stroke Cerebrovasc Dis. 2019;28: 728–34.
9. Mair G, Boyd EV, Chappel FM, et al. Sensitivity and specificity of the hyperdense artery sign for arterial obstruction in acute ischemic stroke. Stroke. 2015;46:102–7.
10. Lim J, Magarik JA, Froehler MT. The CT-defined hyperdense arterial sign as a marker for acute intracerebral large vessel occlusion. J Neuroimaging. 2018;28:212–6.
11. Shuaib A, Jeerakathil T, Alberta Mobile Stroke Unit Investigators. The mobile stroke unit and management of acute stroke in rural settings. CMAJ. 2018;190:E855–E858.
12. Shuaib A, Amlani S, Kalashyan H, et al. Mobile stroke unit triage of patients with a suspected stroke: a novel solution to reducing suspected stroke admissions in busy emergency departments. BMJ Innovations. 2018; 4:54–9.
13. Kate MP, Jeerakathil T, Buck BH, et al. Pre-hospital triage of suspected acute stroke patients in a mobile stroke unit in the rural Alberta. Sci Rep. 2021;11:4988.
14. Requena M, Olivé-Gadea M, Muchada M, et al. Direct to angiography suite without stopping for computed tomography imaging for patients with acute stroke: a randomized clinical trial. JAMA Neurol. 2021;78:1099–107.
15. Mohammaden MH, Doheim MF, Elfil M, et al. Direct to angiosuite versus conventional imaging in suspected large vessel occlusion: a systemic review and meta-analysis. Stroke. 2022;53:2478–87.
16. Mendez B, Requena M, Aires A, et al. Direct transfer to angio-suite to reduce workflow times and increase favorable clinical outcome. Stroke. 2018;49: 2723–7.
17. Kaesmacher J, Maamari B, Meinel TR, et al. Effect of pre- and in-hospital delay on reperfusion in acute ischemic stroke mechanical thrombectomy. Stroke. 2020;51:2934–42.
18. Desilles JP, Consoli A, Redjem H, et al. Successful reperfusion with mechanical thrombectomy is associated with reduced disability and mortality in patients with pretreatment diffusion-weighted imaging-Alberta Stroke Program Early Computed Tomography Score ≤6. Stroke. 2017;48:963–9.
19. Kaesmacher J, Chaloulos-Iakovidis P, Panos L, et al. Mechanical thrombectomy in ischemic stroke patients with Alberta Stroke Program Early Computed Tomography Score 0-5. Stroke. 2019;50:880–8.

https://doi.org/10.1017/cjn.2023.36 Published online by Cambridge University Press