EM Advances

Effect of online medical control on prehospital Code Stroke triage

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ABSTRACT

Objective: Prehospital Code Stroke triage has the potential to overwhelm stroke centres by falsely identifying patients as eligible for fibrinolysis. We sought to determine whether online medical control (whereby paramedics contact the medical control physician before a Code Stroke triage is assigned) reduced the proportion of false-positive Code Stroke patients.

Methods: Following the introduction of a protocol for prehospital Code Stroke triage in an urban centre, online medical control alternated with off-line medical control (whereby paramedics implement Code Stroke triage independently) over 4 discreet intervals. We reviewed data for patients triaged to 3 regional stroke centres to compare the proportion of false-positive Code Stroke patients during online versus off-line medical control. We predefined false positives as patients triaged as Code Stroke who had symptoms discovered on awakening, were last seen in their usual state of health greater than 2 hours before assessment or had a final diagnosis other than stroke.

Results: The proportion of false positives was lower during online medical control (31% v. 42%, $p = 0.003$). This was explained by a lower proportion of patients whose symptoms were discovered on awakening (8% v. 14%, $p < 0.001$) and who were last seen in their usual state of health greater than 2 hours before assessment (22% v. 32%, $p = 0.005$). A final diagnosis of stroke was similar in the 2 groups (77% v. 79%, $p = 0.39$), as was the proportion of patients receiving fibrinolysis (35% v. 33%, $p = 0.72$). Eighteen percent of patients were denied Code Stroke triage during online control, most commonly because of the time of symptom onset.

Conclusion: Online medical control is associated with a reduced proportion of false-positive Code Stroke triage.

Keywords: stroke, emergency medical services, triage, paramedic

RÉSUMÉ

Objectif : Le déclenchement préhospitalier d'un « code AVC » (code activé en cas d'accident vasculaire cérébral) pourrait submerger les centres de traitement des AVC si des patients sont identifiés à tort comme étant admissibles au traitement fibrinolytique. Nous avons cherché à déterminer si un contrôle médical en ligne (selon lequel les ambulanciers paramédicaux communiquent avec le médecin responsable du contrôle médical avant de déclencher un code AVC) réduirait le taux de codes AVC faussement positifs.

Méthodes : Après avoir mis en application, dans un centre urbain, un protocole de triage préhospitalier relatif au code AVC, le contrôle médical en ligne a alterné avec le contrôle médical hors ligne (selon lequel les ambulanciers paramédicaux déclenchent le code AVC indépendamment) au cours de 4 intervalles discrets. Nous avons analysé les données sur les patients ayant été acheminés à 3 centres régionaux de traitement des AVC pour comparer la proportion de cas de codes AVC faussement positifs pendant le contrôle en ligne par rapport au contrôle hors-ligne. Le terme *faux positif* a été préalablement défini comme étant les patients pour qui le code AVC avait été activé et qui avaient les caractéristiques suivantes : découverte de symptômes au réveil; vus pour la dernière fois dans leur état de santé habituel plus de 2 heures avant l'évaluation, réception d'un diagnostic final autre que celui d'AVC.

Résultats : Le taux de faux positifs était plus faible durant le contrôle médical en ligne (31 % contre 42 %, $p = 0{,}003$). Ceci s'explique par une plus faible proportion de patients dont les symptômes ont été découverts au réveil (8 % contre 14 %, $p < 0{,}001$) et qui avaient été vus pour la dernière fois dans leur état de santé habituel plus de 2 heures avant l'évaluation (22 % contre 32 %, $p = 0{,}005$). Le taux de diagnostic définitif d'AVC était similaire dans les deux groupes (77 % contre 79 %, $p = 0{,}39$), tout comme l'était la proportion de patients devant recevoir un traitement fibrinolytique (35 % contre 33 %, $p = 0{,}72$). On a refusé d'activer le code AVC pour 18 % des patients pendant le contrôle en ligne, le plus souvent en raison du temps écoulé depuis la survenue des symptômes.

Conclusion : Le contrôle médical en ligne est associé à une proportion réduite de codes AVC faussement positifs au triage.

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INTRODUCTION

Every 10 minutes in Canada someone dies or is disabled from a stroke. Fibrinolytic therapy significantly improves neurologic outcomes in acute ischemic stroke,[1] but must be administered quickly.[1–4] Intravenous tissue plasminogen activator (tPA) is currently licensed for use only within the first 3 hours of the onset of stroke symptoms. The practice of transporting patients to a centre with immediate access to stroke expertise has been shown to increase use of tPA.[5] This has prompted the development of both prehospital stroke screening and Code Stroke protocols. Prehospital stroke screening increases stroke identification in the field, and Code Stroke protocols allow transport of qualifying patients directly to regional stroke centres and prehospital activation of the stroke team, as recommended by published guidelines.[6–9]

This critically important strategy places a significant resource burden on stroke centres, because Code Stroke patients require the immediate attention of emergency physicians, nurses, neurologists and radiologists, and compete with other critically ill patients for clinical resources. To use these limited resources efficiently, it is essential to minimize the number of false-positive Code Stroke patients.

Prospective studies have demonstrated that protocols for prehospital stroke screening are highly accurate in identifying patients with an acute stroke syndrome.[10–12] At the Sunnybrook Health Sciences Centre, the Ontario Prehospital Stroke Screening Protocol has a positive predictive value of 89%, with a false-positive rate of only 11% for a final diagnosis of acute stroke syndrome.[10] However, many Code Stroke patients correctly diagnosed with stroke syndrome do not meet criteria for tPA administration.[10] In the centre, we observed that Code Stroke patients are commonly ineligible for fibrinolysis owing to presentation after the recommended time for tPA administration. Because the primary purpose of prehospital stroke screening is to identify potential candidates for fibrinolysis, Code Stroke protocols can be limited in their effectiveness if they do not enforce time-sensitive criteria. Therefore a broader definition of "false positive" should include patients triaged as Code Stroke who are ultimately diagnosed with an acute stroke, but who are not candidates for tPA because time limits were exceeded, when this could have been identified in the prehospital setting.

One potential strategy to reduce the number of false-positive Code Stroke patients is the implementation of online medical control, whereby paramedics contact the medical control physician using a patch before the final decision is made to triage a patient directly to a stroke centre as a Code Stroke. This contrasts with off-line medical control, whereby paramedics implement the Code Stroke independently based solely on their interpretation of written protocols. The effect of online medical control on prehospital Code Stroke triage has not yet been evaluated. Accordingly, our primary objective was to determine whether online medical control reduced the proportion of patients falsely triaged as Code Stroke. We also sought to determine whether online medical control reduced the proportion of Code Stroke patients who were ultimately ineligible for tPA, especially owing to time-related factors. Finally, we wanted to calculate the proportion of patients who were denied Code Stroke triage by medical control physicians during online medical control and to identify the reasons for denial.

METHODS

Study setting and design

Our study took place in Toronto, Ont., a city of 2.5 million people, serviced by a single emergency medical service (EMS) system and 3 regional stroke centres: Sunnybrook Health Sciences Centre, St. Michael's Hospital and Toronto Western Hospital. The EMS system consists of a single "third" service, approximately 500 primary care paramedics and 350 advanced care paramedics under the medical direction of a single base hospital. All paramedics use the Ontario Prehospital Stroke Screening Protocol (Fig. 1).[10] This tool was designed to identify patients who, at the time of EMS assessment, meet criteria for fibrinolytic therapy for suspected acute stroke syndrome. Qualifying patients are triaged as Code Stroke and are expeditiously transported to the nearest regional stroke centre, bypassing closer hospitals. When this protocol was initiated in February 2005, online medical control was not in place. Changes in administrative decisions resulted in off-line medical control alternating with online medical control over 4 discreet time intervals, thus creating a natural experiment with an A-B-A-B design (Fig. 2). Accordingly, this allowed us to conduct a review comparing off-line medical control ("A" periods) with online medical control ("B" periods).

This study was approved by our institution's research ethics board.

Patient population

We identified consecutive acute stroke patients using

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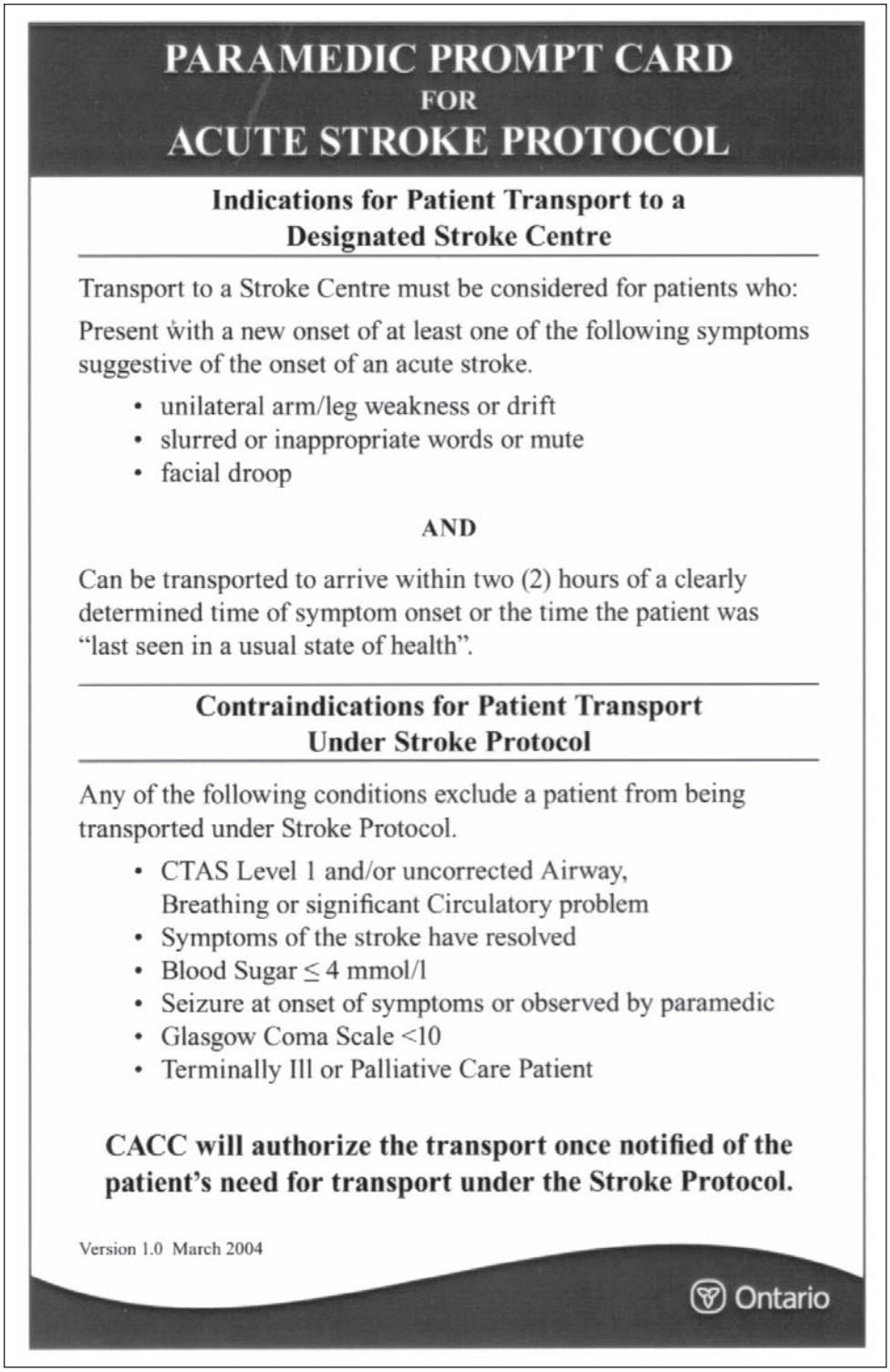
the Registry of the Canadian Stroke Network. This registry includes all patients who present at or are transferred to a designated stroke centre for a possible diagnosis of transient ischemic attack or stroke, both ischemic and hemorrhagic. The methodology of the registry has been described previously.[13] For this study,



PARAMEDIC PROMPT CARD
FOR
ACUTE STROKE PROTOCOL

Indications for Patient Transport to a Designated Stroke Centre

Transport to a Stroke Centre must be considered for patients who:

Present with a new onset of at least one of the following symptoms suggestive of the onset of an acute stroke.

- unilateral arm/leg weakness or drift
- slurred or inappropriate words or mute
- facial droop

AND

Can be transported to arrive within two (2) hours of a clearly determined time of symptom onset or the time the patient was "last seen in a usual state of health".

Contraindications for Patient Transport Under Stroke Protocol

Any of the following conditions exclude a patient from being transported under Stroke Protocol.

- CTAS Level 1 and/or uncorrected Airway, Breathing or significant Circulatory problem
- Symptoms of the stroke have resolved
- Blood Sugar ≤ 4 mmol/l
- Seizure at onset of symptoms or observed by paramedic
- Glasgow Coma Scale <10
- Terminally Ill or Palliative Care Patient

CACC will authorize the transport once notified of the patient's need for transport under the Stroke Protocol.

Version 1.0 March 2004

Ontario

Fig. 1. The Paramedic Prompt Card for the Ontario Prehospital Stroke Screening Protocol. CACC = central ambulance communications centre; CTAS = Canadian Emergency Department Triage and Acuity Scale.

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we included all patients in the registry who were triaged by paramedics as Code Stroke to any of the 3 regional stroke centres in Toronto between Feb. 12, 2005, and Mar. 21, 2007. We excluded patients who were transferred from other hospitals.

Outcome measures

The primary outcome measure for this study was the proportion of false-positive Code Stroke patients during online versus off-line medical control. We expanded the definition of "false positive" to include patients triaged as Code Stroke who are ultimately diagnosed with an acute stroke, but are not candidates for tPA because time limits were exceeded. Accordingly, we predefined a false-positive case as a patient triaged as Code Stroke who met at least 1 of the following criteria: their symptoms were discovered on awakening (so the time of onset was not discernable), they were last seen in their usual state of health greater than 2 hours before paramedic assessment, or their final diagnosis was not consistent with acute stroke syndrome. These criteria were chosen based on the indications and contraindications for prehospital Code Stroke triage listed on the Paramedic Prompt Card for the Ontario Prehospital Stroke Screening Protocol (Fig. 1). Of note, our study took place entirely before recent evidence suggesting that future protocols may be modified to include patients presenting more than 3 hours after symptom onset.[14]

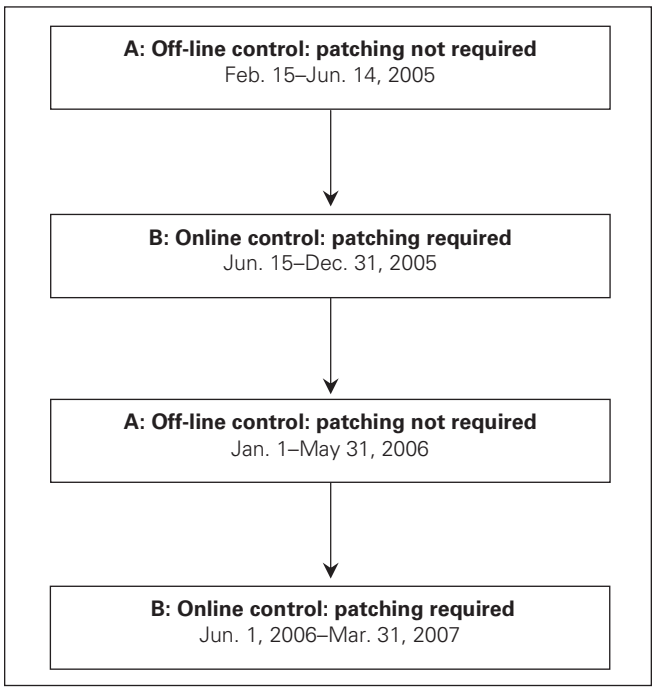

Fig. 2. Off-line medical control alternated with online medical control over 4 discreet time intervals, resulting in a natural experiment with an A-B-A-B design.

The secondary outcome was the proportion of ischemic stroke patients ultimately deemed ineligible for tPA during online and off-line medical control. We also identified the subgroup of patients who were considered to be ineligible for tPA specifically for reasons listed as contraindications to Code Stroke triage on the Paramedic Prompt Card (i.e., symptoms for more than 2 hours, symptoms on awakening, seizure at onset of symptoms, terminally ill or palliative care patient, and the presence of hypoglycemia).

Our final outcome measure was the proportion of patients who were denied Code Stroke triage during online medical control following a patch to the medical control physician, and the reasons for denial. During paramedic patching, medical control physicians were required to complete a Stroke Triage Validation Form (Fig. 3) to determine whether the patient qualified for Code Stroke triage based on the same indications and contraindications listed on the Paramedic Prompt Card. We retrospectively reviewed the validation forms to determine the reason or reasons that physicians denied Code Stroke triage.

Data analysis

We used descriptive statistics to calculate outcome measures. We performed χ^2 and t tests for comparison between study periods, and considered $p < 0.05$ statistically significant. We used SAS software (version 9.1.3, SAS Institute Inc.) for all data analyses.

RESULTS

The Registry of the Canadian Stroke Network identified 4395 patients treated for acute stroke syndrome at the 3 study sites between Feb. 15, 2005, and Mar. 31, 2007 (Fig. 4). Of the patients, 67% (2966) presented to hospital by ambulance, and we were able to analyze ambulance data for 81% of these patients. Paramedics activated a Code Stroke protocol about one-third of the time, resulting in 856 potential study candidates. We excluded 130 patients because they were transferred from other hospitals, and we then evaluated the remaining 726 patients. Of these, 301 patients presented during off-line medical control, and 425 presented during online medical control. Demographic characteristics of included patients are shown in Table 1. Patients in the 2 groups were similar in age, sex and medical history.

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The percentages of false-positive Code Stroke patients during online and off-line medical control are shown in Figure 5. During online medical control, 31% of Code Stroke cases were false positives. The percentage of false-positive Code Stroke patients was significantly higher (42%, $p = 0.003$) during off-line control.

STROKE TRIAGE VALIDATION FORM

DATE:	**CONTACT TIME:**	**BHP:**
MEDIC NAME:		
VEHICLE #:		
RUN NUMBER:		
PATIENT INFORMATION:		
AGE:	**SEX:**	**WT:**
CHIEF COMPLAINT:		
ACUTE STROKE		
LAST SEEN IN USUAL STATE OF HEALTH < 2HRS AGO	**YES** ☐	**NO** ☐
INDICATIONS (new onset of at least one of the following):		
UNILATERAL ARM/LEG WEAKNESS OR DRIFT	**YES** ☐	**NO** ☐
SLURRED OR INAPPROPRIATE WORDS OR MUTE	**YES** ☐	**NO** ☐
FACIAL DROOP	**YES** ☐	**NO** ☐
CONTRAINDICATIONS:		
IS THE PATIENT A CTAS LEVEL 1 AND/OR HAVE AN UNCORRECTED AIRWAY, BREATHING OR SIGNIFICANT CIRCULATORY PROBLEM?	**YES** ☐	**NO** ☐
HAVE THE SYMPTOMS OF THE STROKE BEEN RESOLVED?	**YES** ☐	**NO** ☐
DOES THE PATIENT HAVE A BLOOD SUGAR <= 4 MMOL/L?	**YES** ☐	**NO** ☐
HAS THE PATIENT SEIZED SINCE THE ONSET OF SYMPTOMS?	**YES** ☐	**NO** ☐
DOES THE PATIENT HAVE A GLASGOW COMA SCALE < 10?	**YES** ☐	**NO** ☐
IS THIS A TERMINALLY ILL OR PALLIATIVE CARE PATIENT?	**YES** ☐	**NO** ☐
VITAL SIGNS:		
GLUCOMETRY:		**NOTES:**
P:		
BP:		
R:		
DOES PATIENT QUALIFY FOR TRIAGE TO STROKE CENTRE? **YES** ☐ **NO** ☐		

Fig. 3. The Stroke Triage Validation Form used by medical control physicians to determine qualification for Code Stroke triage.

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This difference was explained by a lower percentage of patients who were last seen in their usual state of health greater than 2 hours before EMS assessment (22% v. 32%, $p = 0.005$) and whose symptoms were discovered on awakening (8% v. 14%, $p < 0.001$) during online versus off-line control, respectively. The percentage of patients with a final diagnosis other than stroke was similar (8.7% v. 9%, $p = 0.39$) between groups.

The proportion of patients with confirmed ischemic strokes who received tPA was similar between groups. During online medical control, 263 patients were confirmed to have ischemic strokes, of whom 34% received tPA. In the off-line medical control group, 33% of the 179 ischemic stroke patients were treated with tPA ($p = 0.72$). The reasons for not treating patients with fibrinolysis are shown in Figure 6. During off-line control, the most common reason cited for not using tPA was the presence of symptoms for longer than 3 hours on assessment in the emergency department; conversely this reason was rarely cited during online medical control (27% v. 3%, $p < 0.001$). Seizure at onset of symptoms and hypoglycemia were never cited in either group.

For our third objective, to determine the proportion of patients who were denied Code Stroke triage, we identified 564 validation forms completed by medical control physicians during the online medical control periods. Eighteen percent (104 patients) were denied triage to a stroke centre. The most common reason cited was time of symptom onset (44%). A further 25% were denied Code Stroke triage because the patients had no signs of acute stroke as described by the screening tool, and 40% (42 patients) had the presence of a contraindication to tPA administration. Medical control physicians were permitted to cite more than 1 reason for denying Code Stroke triage, so patients may be counted in more than 1 category.

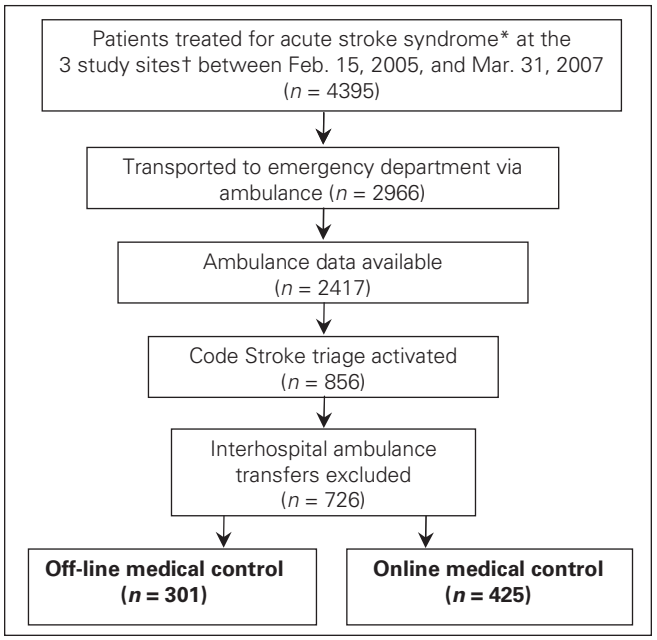

Fig. 4. Patient flow chart. *Identified by the Registry of the Canadian Stroke Network. †Study sites: Sunnybrook Health Sciences Centre, St. Michael's Hospital, Toronto Western Hospital.

DISCUSSION

This is the first study to evaluate the effect of online medical control on prehospital Code Stroke triage. We found that the proportion of false-positive Code Stroke patients was significantly lower during online medical control than during off-line medical control. This effect was driven by both of the time-related factors related to false-positive triage. Similarly, there was a lower proportion of patients who did not qualify for tPA for time-related reasons during online medical control. Finally, the most common reason physicians denied Code Stroke triage was time of symptom onset. This study suggests that online medical control reduces the proportion of Code Stroke triage patients who do not meet time criteria for fibrinolysis.

A possible explanation for the effect of online medical control on Code Stroke triage is differing perspectives

Table 1. Characteristics of 726 patients treated for acute stroke syndrome who were included in the study

Characteristic	No. (%) of patients* Off-line control, n = 301	Online control, n = 425	p value
Mean (SD) age, yr	75 (12)	74 (14)	0.51
Female sex	163 (54)	217 (51)	0.41
Previous stroke	69 (23)	76 (18)	0.09
Previous transient ischemic attack	34 (11)	56 (13)	0.45
Diabetes	66 (22)	89 (21)	0.75
Hypertension	201 (67)	281 (66)	0.85
Myocardial infarction	33 (11)	40 (9)	0.49
Atrial fibrillation	67 (22)	83 (20)	0.37
Angina	47 (16)	85 (20)	0.13
Hyperlipidemia	106 (35)	145 (34)	0.76
Smoking	28 (9)	53 (13)	0.18
Preadmission antiplatelet use	98 (33)	145 (34)	0.66

SD = standard deviation.
*Unless otherwise indicated.

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of paramedics and physicians. Paramedics appropriately and necessarily aim to avoid any false negatives, and so likely err on the side of transporting patients to a designated stroke centre for physician assessment. The greatest harm would be done by not affording an eligible stroke patient the opportunity to receive treatment. Physicians, however, also aim to prevent any false positives. When the time of symptom onset is not clear, patients are not eligible for tPA, so physicians are more likely to deny a potential Code Stroke triage. For physicians, the greatest harm would be to provide fibrinolytic therapy to a patient with contraindications, with potentially disastrous consequences.

The proportion of patients diagnosed with ischemic stroke who received tPA treatment was similar between groups, suggesting that the benefit of online medical control was not large enough to change the overall frequency of tPA use. This is because prehospital Code Stroke screening cannot identify all contraindications to fibrinolysis. Online medical control was implemented to limit Code Stroke patients who are not eligible for fibrinolytic therapy for reasons that are identifiable in the field, including symptoms discovered on awakening, and time of symptom onset. Conversely, online medical control does not have an effect on Code Stroke patients who are ineligible for fibrinolysis for reasons that are only discovered during hospital workup, such as stroke severity, neuroimaging findings, coagulation abnormalities in blood work and patient/family wishes. We do not consider such cases to be false positives, because the contraindication to fibrinolysis could only be discovered after the Code Stroke was initiated. Still, these contraindications may have affected a sufficiently large proportion of Code Stroke patients to mitigate the benefit of online medical control on overall fibrinolysis. Further studies with larger sample sizes are needed to assess this.

Online medical control may significantly reduce the burden of care on regional stroke centres by minimizing the number of patients falsely triaged as Code Stroke. Importantly, emergency department resources might then be more available to other critically ill patients. In our study, there was an absolute reduction of false-positive Code Stroke patients of 11%. In the 9 months of off-line medical control, that translates to more than 30 patients, or almost 4 per month, who would not have been transported to a designated stroke centre to compete with other high-acuity patients such as a trauma patient requiring urgent computed tomography, an acute myocardial infarction patient requiring prompt percutaneous coronary intervention or a septic patient requiring goal-oriented therapy.

Our findings about online medical control are timely and even more relevant in light of newly published Canadian guidelines recommending tPA administration up to 4.5 hours after onset of stroke symptoms,[15] based on evidence from a recent multicentre randomized controlled trial.[14] Stroke screening protocols modified to reflect this evidence would likely lead to a greater number of patients meeting criteria for Code Stroke triage, increasing the importance of minimizing the number of false-positive Code Stroke patients.

Our study is limited by the retrospective analysis and nonrandomized design, although all patients were prospectively identified. Nineteen percent of our registry-based cases in which patients were transported by ambulance had missing information and could not be analyzed for clinical outcome parameters. Although causal conclusions cannot be drawn from correlation

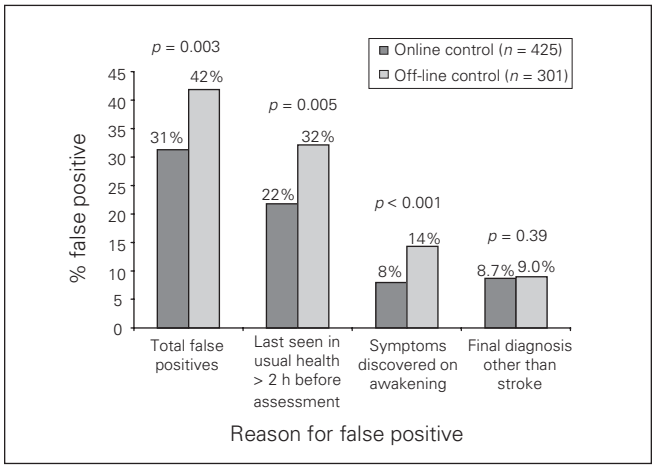

Fig. 5. Percentages of false-positive Code Stroke patients during online and off-line medical control.

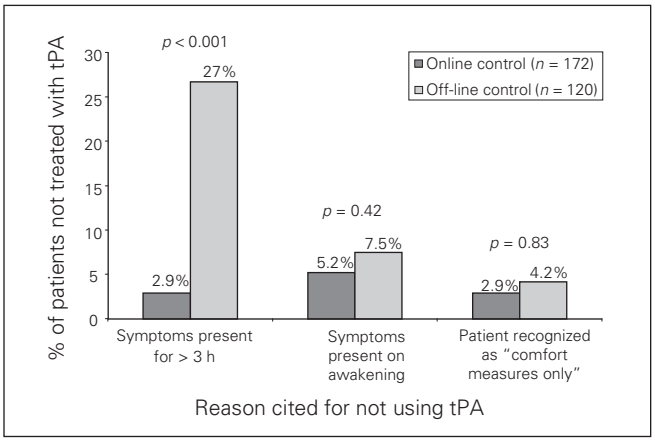

Fig. 6. Reasons cited for not using tissue plasminogen activator (tPA) to treat ischemic stroke patients during online and off-line medical control.

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data, we had the advantage of having alternating periods of online and off-line medical control. It would be highly unlikely for an external variable to affect both "A" periods but not "B" periods, or vice versa. Also, we do not have the data required to calculate the proportion of false negatives (unrecognized acute stroke patients triaged to a centre without immediate access to stroke expertise) in either group. Further studies are needed to evaluate the proportion of false negatives using the Ontario Prehospital Stroke Screening Protocol, for both online and off-line medical control. Reproducibility of our results at other centres, and with other stroke screening tools, needs to be evaluated.

This study is the first we are aware of to assess a protocol for prehospital stroke screening using a broader definition of false positives including time-related factors and contraindications to tPA use. This pragmatic approach to stroke screening provides insight into potentially resource-saving strategies.

We conclude that online medical control is associated with a reduced proportion of false-positive Code Stroke triage pertaining primarily to time-related criteria. Our study supports the implementation of online medical control as an effective means to limit Code Stroke triage of patients who ultimately do not meet the time criteria for administration of tPA.

Competing interests: The Registry of the Canadian Stroke Network is funded by an operating grant from the Canadian Stroke Network. The Institute for Clinical Evaluative Sciences is supported by an operating grant from the Ontario Ministry of Health and Long-Term Care. During the past 5 years Dr. Black has had financial relationships in the following forms: contract research funds (Novartis Pharmaceuticals, Myriad Pharmaceuticals, Eisai–Pfizer, Sanofi-aventis, Boehringer Ingelheim, Novo Nordisk, AstraZeneca), speaker's honoraria for CME (Janssen-Ortho, Novartis Pharmaceutical, Lundbeck, Pfizer and Myriad Pharmaceuticals) and honoraria for ad hoc consulting (Pfizer, Janssen-Ortho, Novartis Pharmaceuticals, Lundbeck, Myriad Pharmaceuticals, Epix Pharmaceuticals, GlaxoSmithKline). Dr. Gladstone received the Clinician–Scientist Award from the Heart and Stroke Foundation of Ontario, and is supported by the Heart and Stroke Foundation Centre for Stroke Recovery and the Department of Medicine (Sunnybrook Health Sciences Centre and University of Toronto). None of the other authors have any conflicts of interest to declare. The results and conclusions of this study are those of the authors, and should not be attributed to any of the sponsoring or funding agencies. The funding agencies had no role in the design or conduct of the study or the collection, management, analysis or interpretation of the data. The manuscript was reviewed and approved by the Publications Committee of the Registry of the Canadian Stroke Network.

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