Significant decrease in door-to-needle times for Acute Ischemic Stroke after implementation of Code Stroke protocol in Brisbane

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Abstract

Background: Thrombolysis with tissue plasminogen activator (tPA) and endovascular clot retrieval (ECR) are the current hyperacute treatments for acute ischaemic stroke. The effectiveness and functional outcomes of these treatments are strongly time dependent. The "Code Stroke" protocol was implemented during working hours (0800-1630 M-F) at the Princess Alexandra Hospital's comprehensive stroke centre in October 2016. The major changes in protocol included notifying the PAH stroke team prior to hospital arrival and transferring patients directly to the computer tomography (CT).

Aim: To determine the impact of the "Code Stroke" protocol on door to CT (DCT), door to needle (DNT) and thrombolysis rates.

Methods: This is a retrospective observational study utilising our stroke database which has been maintained since 2010. It also includes the period following implementation of "Code Stroke" protocol, from October 2016 to present day.

Results: Of the 54 patients treated after implementation of the protocol between October 2016 and June 2017, 13 patients (24.1%) had thrombolysis. This was significantly increased compared to pre-protocol rates of 11.6%. Median door-to-CT (DCT) and door-to-needle (DTN) timeframes also significantly improved from 30 and 91 to 8 ($p<0.0001$) and 25 minutes ($p<0.0001$) respectively. Approximately 92.3% of patients eligible for thrombolysis were able to have treatment within 60 minutes of presentation.

Conclusion: The Helsinki model inspired "Code Stroke" protocol has significantly improved DCT, DNT and thrombolysis rates at our comprehensive stroke centre. As a result, stroke assessment and treatment times are now above the national standards and are comparable to international benchmarks.

Introduction

- Early intervention with intravenous thrombolysis and endovascular clot retrieval is crucial in acute stroke management as this can reduce significant long-term functional impairment
- Earlier door-to-needle time (DNT) for thrombolysis has been associated with not only better outcomes but also with a mortality benefit and a reduction in symptomatic intracranial haemorrhage

- The American Heart Association/American Stroke Association (AHA/ASA) suggest an ideal DNT for thrombolysis within 60 minutes from hospital presentation
- The "Code Stroke" protocol (Helsinki model) has been associated with improved outcomes resulting in reduction in DNT by up to 40 minutes
- Code Stroke involves early pre-hospital activation of the stroke team by ambulance services, streamlined in-hospital processes with direct transport of ambulance stretchers into CT, use of advanced CT imaging and activation of the catheter lab. Emergency Department staff are also educated to activate a Code Stroke if appropriate.
- These interventions do not require significant funding as it is essentially a re-organisation of existing procedures.
- The primary aim of this study is to:
  1. profile the last 32 months of experience since implementation of the "Code Stroke" protocol
  2. to compare door-to-needle thrombolysis time and door-to-CT time with pre- and post-intervention.
- The secondary outcomes would include number of stroke calls and number of thrombolysis.

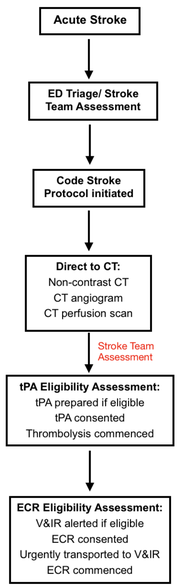

Figure 1. Code Stroke Protocol

Methodology

Settings and patients

- Princess Alexandra Hospital (PAH) is a 700-bed tertiary hospital in Brisbane (QLD, Australia). PAH is one of three tertiary hospitals in Queensland with neuro-interventional radiology capabilities.
- The Code Stroke protocol commenced in October 2016 and is triggered only by either the stroke team or the emergency department triage. The alert is based on early pre-arrival notification by the Queensland Ambulance Service (QAS) following an initial on-scene patient assessment.
- Activation of the code is restricted to the hours 0730-1700 on weekdays whilst stroke consultant supervision is present.
- Intravenous tPA is administered within 4.5 hours of symptom onset using a standardised protocol
- Endovascular clot retrieval eligibility criteria has been modified to reflect current evidence suggesting benefits in patients presenting <24hours with significant potentially reversible perfusion deficit

- There were a total of 64 patients who underwent stroke treatment under the Code Stroke protocol from October 2016 - June 2017.
- 54 patients were included in this study. The 10 patients that were excluded from the study were either due to lack of relevant data or because patients were treated during hours outside of 0730 to 1700.

Intervention	Pre code stroke	Post code stroke
Prenotification	Ambulance calls hospital ED over open-air radio. Stroke referral post ED assessment	ED triage nurse gathers patient information and ETA. Pages stroke and radiology team members
Medical History	ED assesses history on patient arrival through local paper records (before 2015) or ieMR (after 2015). GP sometimes called to obtain further history	Stroke team assesses background medical history through ieMR, calls GP and/or family before patient arrival
ED triage	Triage Category 2 Patients transferred to ED bed, assessed and CT requested	Triage Category 1 Stroke team waiting to assess patient at triage while on paramedic stretcher. Direct transfer to CT scanner on paramedic stretcher
Labs and IV line	IV access in ED bed. Routine bloods, INR only if clinically indicated.	IV access often available on arrival. If not, inserted in CT scanner. Urgent bloods, INR only if clinically indicated
Intravenous contrast	Delayed until renal functions available	IV contrast in all cases suitable for advance imaging, without waiting for renal functions
CT results	Often waiting for the Radiology report	Reviewed by Stroke team and Radiology registrar in the CT workstation
tPA preparation	tPA kept in "stroke-box" in resuscitation bay and drawn up after patient returned from ED CT	"Stroke-box" taken to ED CT scanner and drawn as soon as treatment decision made

ED= Emergency Department; ETA=estimated time of "patient" arrival; ieMR= integrated electronic medical records, GP= General Practitioner; CT= Computer Tomography; IV= intravenous; INR= International normalised ratio; tPA=tissue plasminogen activator

Figure 2. Interventions implemented in Code Stroke Protocol.

Data collection

- This is a retrospective observational quality improvement study utilising the PAH stroke database to analyse stroke patients treated at PAH between the implementation of the Code Stroke Protocol in October 2016 and June 2017.
- The data included demographics (age, gender) and several time points such as stroke onset time, presentation to ED, stroke referral time (recorded via paging service), stroke team assessment time, CT access time, and thrombolysis initiation time.

Statistical Analysis

- Statistical analyses were performed using SPSS version 22 (IBM, Armonk, NY, USA).
- Time data are presented as median values with interquartile range (IQR) because they were not normally distributed.
- Normally distributed data were analysed by Student's t-test and/or ANOVA.
- Continuous data that was not non-normally distributed were analysed using the Mann-Whitney test.
- Categorical variables were analysed using Chi-squared test. Two-tailed $P<0.05$ was considered significant.

Results

- 13 out of 54 patients (24.1%) were treated with thrombolysis. Of the patients who received thrombolysis, 92.3% had DTN times <60 minutes.
  - Prior to Code Stroke, 92 patients underwent thrombolysis and only 9.8% of patients had a DTN time <60 min
- Post Code Stroke, median door-to-CT (DCT) was 8 minutes (IQR 5 – 15 minutes) (see Figure 2) and door-to-needle time (DNT) was 25 minutes (IQR 21 – 28 minutes) (see Figure 3).
  - Prior to Code Stroke, the median DCT was 30 minutes (IQR 21 – 44 minutes) and DNT was 91 minutes (IQR 70 – 120 minutes).
- Implementation of Code Stroke significantly improves DCT and DNT times. The results of this study are consistent with the similar Helsinki model adaptation at the Royal Melbourne Hospital which reduced in-hours DNT to 25 minutes.
- Implementation of this protocol would help meet ASA/AHA guidelines
- National Stroke Audit 2015 revealed that only 20% and 30% of eligible patients in Queensland and Australia respectively were able to meet the target thrombolysis time of within 60 minutes; USA and UK report rates of 59% and 62% respectively.
- Code Stroke has allowed PAH to match international benchmarks with a 1-hour thrombolysis rate of 92.3%. With effective use of resources this rate can be further hypothetically increased to 94% patients while reducing DTN to less than 20 minutes.
- Common barriers to initiate treatment include a delay in diagnosis and inability to determine eligibility for thrombolysis.This is often due to unknown onset time and unknown INR in anticoagulated patients. Suggested solutions include the initiation of INR point-of-care testing.

Limitations

- retrospective nature
- small sample size
- missing data for some variables
- No investigation on whether Code Stroke had an impact upon short or long-term mortality. However, DTN is unlikely to be the sole cause for both morbidity and mortality, and rather these outcomes may reflect factors such as type of stroke as determined by TOAST criteria, stroke volume on neuro-imaging and whether ECR was required or successful
- This study does not provide reasons for ongoing in-hospital delays in treatment and treatment inertia. Future research should provide a qualitative aspect to determine these causes and potential interventions to help reduce such barriers.
- Unlike thrombolysis, ECR is not well integrated into the earlier designed Helsinki pathway despite it being a crucial stroke management intervention. This is potentially an area for further research and quality improvement on the current Code Stroke Protocol design.

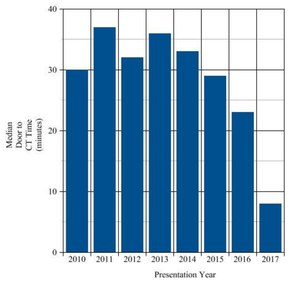

Figure 2. Comparison of Door to CT Time since database record

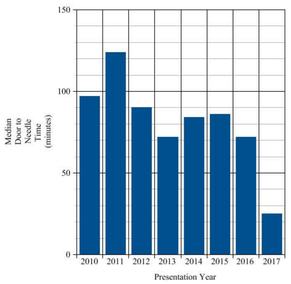

Figure 3. Comparison of Door to Needle Time since database record

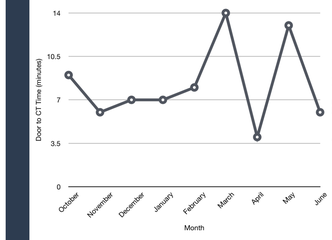

Figure 4. Trend over time of Door to CT Time since implementation of the Code Stroke Protocol

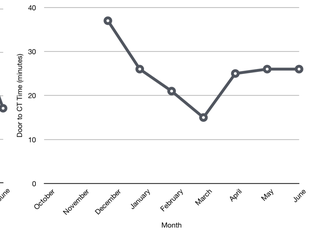

Figure 5. Trend over time of Door to Needle Time since implementation of the Code Stroke Protocol

Conclusion

The Code Stroke Protocol has helped to significantly reduce in-hospital delays thereby improving DCT and DNT. As a result, treatment time frames are now above Australian national standards and are comparable to international benchmarks. This study has helped add weight for the need to adhere to these guidelines to help improve patient outcomes across Queensland and Australia. The significant delay in pre-hospital time is concerning and suggests large-scale public education is warranted to ensure timely help is sought. Further research is required to identify reasons for persistent delays to help achieve ideal targets and optimal methods to integrate with ECR therapies.

Acknowledgements

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