

Review Article

Streamlining Workflow for Endovascular Mechanical Thrombectomy: Lessons Learned from a Comprehensive Stroke Center

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Background: Recently, 5 randomized controlled trials confirmed the superiority of endovascular mechanical thrombectomy (EMT) to intravenous thrombolysis in acute ischemic stroke with large-vessel occlusion. The implication is that our health systems would witness an increasing number of patients treated with EMT. However, in-hospital delays, leading to increased time to reperfusion, are associated with poor clinical outcomes. This review outlines the in-hospital workflow of the treatment of acute ischemic stroke at a comprehensive stroke center and the lessons learned in reduction of in-hospital delays. *Methods:* The in-hospital workflow for acute ischemic stroke was described from prehospital notification to femoral arterial puncture in preparation for EMT. Systematic review of literature was also performed with PubMed. *Results:* The implementation of workflow streamlining could result in reduction of in-hospital time delays for patients who were eligible for EMT. In particular, time-critical measures, including prehospital notification, the transfer of patients from door to computed tomography (CT) room, initiation of intravenous thrombolysis in the CT room, and the mobilization of neurointervention team in parallel with thrombolysis, all contributed to reduction in time delays. *Conclusions:* We have identified issues resulting in in-hospital time delays and have reported possible solutions to improve workflow efficiencies. We believe that these measures may help stroke centers initiate an EMT service for eligible patients. **Key Words:** Acute ischemic stroke—workflow—time delay—endovascular mechanical thrombectomy.

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Introduction

Acute ischemic stroke is a major cause of morbidity and mortality globally.^{1,2} For nearly 2 decades, recombinant tissue plasminogen activator (rt-PA) has been the only effective intravenous therapy (IVT) approved for the treatment of patients with acute ischemic stroke.^{3,4} More recently, however, major trials have determined endovascular mechanical thrombectomy (EMT) to be a highly effective therapy for patients with large-artery occlusions.⁵⁻¹⁰ For treatment with IVT, EMT, or both, it has been established that the outcome of patients with ischemic strokes is largely dependent on the time to treatment.^{11,12} For patients undergoing EMT, a short time to reperfusion is strongly associated with good outcome post intervention.^{13,14} Furthermore, even a 15-minute delay in EMT reperfusion has been suggested to decrease the likelihood of good outcome by 10%.¹⁵

Given the importance of time to reperfusion, this review aims to detail the optimal workflow of treatment of patients with acute ischemic stroke at a single comprehensive stroke center. This represents a timeline from prehospital notification to femoral arterial puncture in the treatment of these patients with EMT. We aim to share our experiences of identifying the time barriers and implementing solutions to ameliorate them. All these developed procedures have contributed to a median reduction in door-to-needle time (DNT) of 25 minutes.¹⁶

Global Time Metrics of Time to Treatment

Currently, there is no international consensus regarding the time to treatment of both rt-PA and EMT. However, medical organizations in various countries have established regional time goals to improve clinical outcomes.¹⁷⁻²³ A summary of the goals for various time metrics can be seen in [Table 1](#).

Code Stroke System

What Is Code Stroke?

Code stroke is an integrated and efficient series of procedures carried out by a specialized team of emergency, radiology, and neurology staff. This includes patient assessment, imaging, investigations, and treatment spanning from the time of presentation in the emergency department (ED) to administration of rt-PA²⁴ and subsequent EMT. Code stroke is an effective means of reducing DNT, morbidity, and mortality, and increasing rates of thrombolysis.²⁵⁻²⁸

Stroke Team Members

A stroke team consists of a stroke consultant (a neurologist who has completed stroke specialist training), a stroke research fellow (junior neurologist or advanced trainee in neurology), a stroke registrar (advanced trainee in neurology), 2 junior medical officers (interns), a stroke nurse practitioner, and, if applicable, a stroke research nurse. The specific roles of each team member are summarized in [Figure 1](#).

Roster during Nonworking Hours

The stroke team operates differently during nonworking hours (between 5:00 PM and 8:00 AM). During these hours or on weekends, the neurology or stroke registrar is on call and off-site. However, there is a requirement that the doctor will return to hospital shortly after the activation of code stroke. The stroke consultant and research fellow are also on call and off-site, and are required to be available for consultation with the neurology or stroke registrar. There is no stroke nurse on-site during these hours. Before the arrival of the neurology or stroke registrar to the ED, a basic physician trainee or cover resident is on-site and is required to meet the patient in the ED

Table 1. Goals for time metrics in different organizations

Time metrics	CSA ¹⁹ CSN ²⁰	ASA ^{17,18}	SNIS ²¹	HSFC ²²	SAH ²³
Door to NCCT	N/A	25 min	N/A	N/A	30 min
Door-to-NCCT interpretation	N/A	45 min	15 min	N/A	N/A
Door-to-CTA interpretation	N/A	N/A	20 min	N/A	N/A
Door-to-therapeutic decision	60 min	N/A	N/A	N/A	N/A
Door to needle	N/A	60 min	30 min	30 min	45 min
Door-to-groin puncture	60-90 min	N/A	60 min	N/A	N/A
CT-to-groin puncture	N/A	N/A	N/A	60 min	N/A
Door to reperfusion	90-120 min	N/A	90 min	N/A	N/A
Onset to reperfusion	N/A	360 min	N/A	N/A	N/A
PSC picture to CSC puncture	N/A	N/A	90 min	N/A	N/A

Abbreviations: ASA, American Stroke Association; CSA, Chinese Stroke Association; CSC, comprehensive stroke center; CSN, Chinese Society of Neurology; CTA, computed tomography angiography; HSFC, Heart and Stroke Foundation of Canada; NCCT, non-contrast CT; PSC, primary stroke center; SAH, South Australia Health; SNIS, Society of NeuroInterventional Surgery.

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