Decreasing Door-to-Reperfusion Times

Steps taken at Foothills Medical Centre to improve stroke care.

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There is no doubt that "time is brain" when it comes to ischemic stroke treatment. Not only is this biologically and intuitively obvious, but it has also been illustrated in numerous studies on ischemic stroke.[1] Data from the ESCAPE trial have shown that every 30-minute increase in CT-to-reperfusion time is associated with an 8.3% reduction in the probability of achieving a functionally independent outcome (90-day modified Rankin Scale [mRS] 0–2; $P = .006$).[2] Similar data from the SWIFT PRIME trial showed that in patients undergoing endovascular therapy, a symptom onset-to-reperfusion time of 150 minutes led to a 91% estimated probability of functional independence; however, this estimate decreased by 10% over the next hour and by 20% with every subsequent hour of delay.[3]

Combined data from the five recent endovascular therapy trials showed that among patients with substantial reperfusion in the endovascular therapy group, delay in symptom onset-to-reperfusion time was associated with increased 3-month disability.[4] For every 9-minute delay in symptom onset-to-substantial endovascular reperfusion time, one out of 100 treated patients had a worse outcome (higher mRS score by at least one level). The probability of achieving functional independence (mRS 0–2) at 3 months decreased from 64.1% with a symptom onset-to-reperfusion time of 180 minutes to 46.1% with a symptom onset-to-reperfusion time of 480 minutes.

The relationship between time delay and poorer outcomes is magnified in the emergency department (ED) arrival-to-reperfusion time segment. Considering outcome distributions across all mRS health states, for every 4-minute delay in ED door-to-reperfusion time, one out of every 100 treated patients had a worse disability outcome.[4] The ESCAPE trial had a built-in quality improvement process to ensure that short door-to-reperfusion times were met, and in this article, we describe many of the strategies used.[5]

REDUCING DOOR-TO-REPERFUSION TIME

A comprehensive approach to reducing time from door to reperfusion is necessary at every institution. At our institution, we have been working on improving door-to-reperfusion time for over 10 years. We take an interdisciplinary approach, which includes emergency medical services (EMS), ED nurses, ED physicians, diagnostic imaging technicians, neurologists, neurointerventionists, interventional nurses, and interventional technicians. In the following sections, we summarize the major steps we have undertaken to reduce our door-to-reperfusion times.

Prenotification

We have implemented protocols in which EMS providers call ahead to the ED triage desk to notify the ED of an incoming patient with suspected stroke symptoms. Basic information about the patient, including age, time of onset, description of the deficit, and the expected time of arrival, is also provided.

Simultaneous Notification Page to All Relevant Staff

Once prenotification from EMS is received, the ED nurse or clerk sends a simultaneous notification page to the on-call stroke team along with information about the patient, which allows the stroke team to prepare accordingly. Members of the stroke team include stroke staff, ED staff, CT technologist(s), and the neurointerventional team.

Parallel Processing and Teamwork

Upon patient arrival, several things need to be done to properly diagnose the patient, determine eligibility for endovascular therapy, and subsequently prepare the patient for treatment. Rather than performing these tasks serially, we have created a system in which different team members are responsible for specific tasks, and tasks are then performed in parallel. Typical tasks include:

- Ensuring the patient is stable
- Establishing a large-bore intravenous line (if not already done by EMS)
- Sending relevant blood samples
- Obtaining a medical history, including current medications and understanding the patient's premorbid status
- Establishing a rapport with the patient's family and keeping them informed
- Involving an anesthesiologist, if needed
- Moving the patient to the imaging area as soon as possible

Registering the Patient as "Unknown"

Because registering the patient into the electronic ordering and charting system can be time consuming, we have created a system that allows for an "unknown" patient ID to be registered. Within the electronic system, there is always an unknown ID ready, which can be immediately associated with the patient to allow for patient registration and ordering of laboratory testing and imaging.

Moving the Patient to CT on the EMS Stretcher

Once the patient is stable, he or she is moved directly to the CT scanner on the EMS stretcher, which shortens time to imaging. We have created a standardized protocol for CT and multiphase CTA, which can be completed in < 5 minutes (including postprocessing) and allows for easier decision making. This is a critical change that has saved a substantial amount of time. This imaging protocol was used in the ESCAPE trial and has been validated in several other publications.[6-9] Initial results from the PROVE-IT study showed that decision making based on multiphase CTA was superior to decision making based on CT perfusion.[6]

Decision Making at the CT Console

Decision making at the CT console is a work in progress at our institution, and we currently practice it during working hours. The key members of the team converge at the CT scanner, and a decision is made as images are processed. Intravenous alteplase is often administered in the CT scanner between the CT and multiphase CTA. If indicated, the patient is moved directly from the CT scanner to the angiography suite for endovascular therapy.

No Anesthesia Unless Absolutely Necessary

We have previously published about the potentially harmful effects of anesthesia in this population,[10,11] which has been further substantiated by a meta-analysis and most recently in an analysis from the MR CLEAN study.[12,13] As such, we perform the endovascular procedure without general anesthesia, whenever possible. In fact, most patients do not receive any form of sedation, as we believe that conscious sedation is often unnecessary and can have unpredictable results. Additionally, we think it is important to be able to examine the patient during the procedure.

Brisk Recanalization Ischemic Stroke Kit (BRISK)

Several years ago, we established a standardized stroke tray, which we have termed BRISK, wherein all the necessary equipment (over 50 items) for an endovascular procedure are laid out in a fixed pattern. The more expensive tools (eg, stent retrievers) are kept in the immediate vicinity of the stroke tray but within their individual sterile packing. This has led to substantial time savings.

Standardized Approach to the Procedure

All neurointerventionists at our institution reached a consensus regarding a standardized approach to endovascular procedures, which comprises a balloon-tipped guide catheter and use of a long stent retriever. Although there are significant possible variations on the approach and choice of catheters and devices used, by having a standardized approach, there are significant time savings. The typical steps consist of (1) groin arterial access and placement of an 8-F sheath, (2) access to the relevant carotid and placement of an 8-F balloon guide catheter in the internal carotid artery, (3) use a standard microcatheter over a microwire to access the clot and place the tip of the microcatheter in a sizeable vessel beyond the clot, (4) remove the microwire, (5) deploy a stent retriever across the clot, and finally (6) withdraw the stent retriever while applying suction to the balloon guide catheter (with the balloon inflated to prevent antegrade flow).

Use of Multiphase CTA for Procedure Planning

We use the coronal imaging of the arch to plan an access strategy in the common carotid artery. The

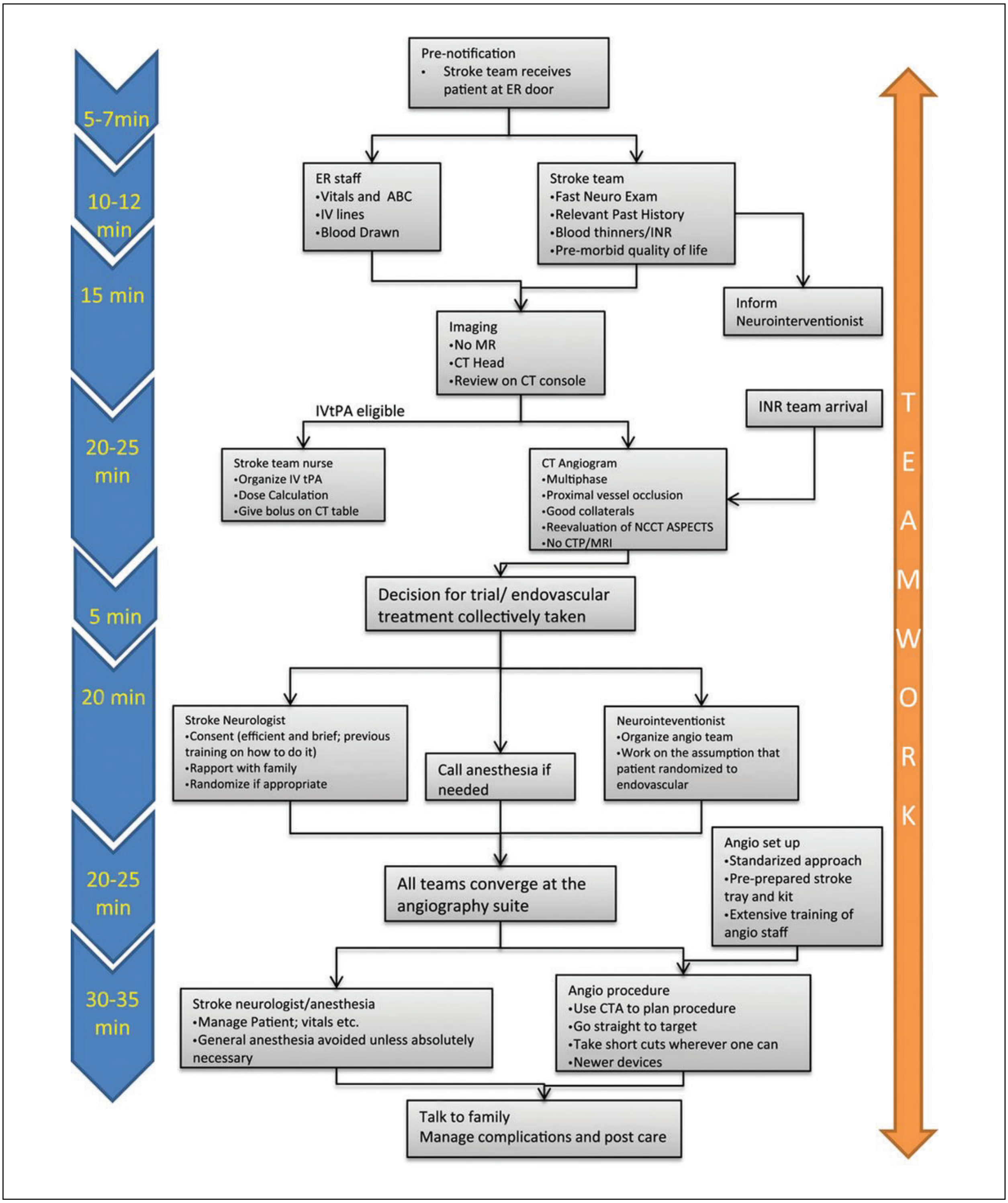

Figure 1. Patient workflow from ED arrival to endovascular procedure. ABC, airway, breathing, circulation; ASPECTS, Alberta Stroke Program Early CT score; CTP, CT perfusion; ER, emergency room; INR, international normalized ratio; IV, intravenous; NCCT, noncontrast CT; tPA, tissue plasminogen activator. Reprinted from Goyal M, Menon BK, Hill MD, Demchuk AM. Consistently achieving computed tomography to endovascular recanalization < 90 minutes: solutions and innovations. Stroke. 2014;45:e252–e256.

shape of the access catheter can be chosen based on the arch anatomy. We do not use an exchange wire. Similarly, the sagittals or oblique sagittals through the neck are utilized to understand the carotid bifurcation, degree of tortuosity, and where to safely position the balloon-tipped guide catheter. Images of the intracranial circulation are used to understand the anatomy and rule out anatomic variants (eg, fetal posterior cerebral artery) and danger points (eg, an incidental aneurysm).

Using Multiphase CTA to Determine Clot Length

The different phases of multiphase CTA can be utilized to determine the exact location and length of the clot. Typically, the proximal end of the clot (except in T and L occlusions) can be well visualized in the first phase, whereas the distal end of the clot can be well visualized in the second or third phase.

Presence of the Stroke Neurologist in the Angio Suite

Because we perform most of our procedures without anesthesia, the presence of the stroke neurologist is extremely useful not only for monitoring the patient but also for decision making after achieving partial reperfusion.

SUMMARY

Our overall workflow is summarized in Figure 1.[14] Most of these steps were implemented across all sites participating in the ESCAPE trial. The results of the ESCAPE trial reflect the impact of this workflow. The median CT-to-groin puncture time was 51 minutes, and the start of CT-to-first reperfusion time was 84 minutes.[2] These times were substantially faster than in previous endovascular trials. Each change results in important minutes saved for the patient, and when combined, ensures all patients can be treated as quickly, safely, and effectively as possible. ■

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