Stroke services in New York City (NYC) face unique challenges related to coordination of care and timely treatment of patients with neurointervention. Since the publication of the MR CLEAN, REVASCAT, EXTEND IA, ESCAPE, and SWIFT PRIME trials in 2015, the volume of stroke neurointervention cases has rapidly expanded. Evidence for the efficacy of neurointervention has revolutionized stroke care for patients with emergent large vessel occlusion (ELVO), and hospitals and health systems have had to quickly adapt to new stroke protocols. Furthermore, recent results from the DAWN and DEFUSE 3 trials suggest that the window for neurointervention should be increased from 6 hours to 24 hours of last known well in select patients. This extended window of neurointervention expands the number of patients who qualify for treatment, but the maxim “time is brain” must continue to be emphasized. An analysis of SWIFT PRIME data found that patients with a last known well to reperfusion time of < 150 minutes had a 91% estimated probability of functional independence. Probability of a good outcome decreased by 10% over the next hour and 20% after each subsequent hour. A more recent analysis further suggests that each minute saved in door-to-treatment time is associated with an average gain of 4.2 days of healthy life.

A challenge to minimizing onset-to-treatment times in urban environments is that patient transfer is often subject to gridlock and therefore prone to delay. These obstacles are especially problematic in NYC, which has the largest population and highest population density of any major city in the United States. Onset-to-door time is a critical area for improvement in stroke care, as prehospital delays are the most common cause of patients missing the therapeutic window for intravenous tissue plasminogen activator (IV tPA), with only 20% to 25% of patients presenting to the emergency department within 3 hours of stroke onset.

STROKE TRANSFER MODELS
Drip and Ship and Mothership
The two most common models of stroke transfer are *drip and ship* and *mothership*, which have their roots in IV tPA protocols. Drip and ship is based on transporting patients to the nearest primary stroke center (PSC) to receive IV tPA, with subsequent transfer to an endovascular-capable comprehensive stroke center (CSC) if an ELVO is diagnosed and the patient qualifies for neurointervention.

In the mothership model, stroke patients suspected of having an ELVO are instead directly transported to a CSC, which minimizes delays associated with transfer between hospitals. A concern with the mothership model is that bypassing hospitals may delay time to IV tPA. Administering IV tPA before thrombectomy has not been found to improve patient outcomes compared with thrombectomy alone. However, minimizing time to IV tPA remains relevant for patients...
who ultimately do not qualify for neurointervention.\textsuperscript{14} Evidence in favor of the mothership model is nonetheless accumulating for select patients, especially in cases of efficient prehospital stratification of patients with high clinical suspicion for ELVO.\textsuperscript{15,16} Probability and prediction models suggest that the relative benefit of mothership over drip and ship is based on distance between PSC and CSC, as well as fast door-to-needle times at the CSC.\textsuperscript{17,18}

The RACECAT trial, which is based in Barcelona, is currently recruiting participants and will directly compare these two models. A potential disadvantage to the mothership model is the unnecessary transfer of patients away from PSCs, due to the lack of a highly specific pre-screening tool for ELVO, which could lead to overcrowding of the CSC and loss of patients to the PSC.

\textbf{Trip and Treat}

At Mount Sinai Health System, we have implemented an alternative model of stroke transfer called \textit{trip and treat}.\textsuperscript{19} Patients who present to a PSC with interventional capacity (PSCI) remain at the PSCI and are not transferred to a CSC. Instead, a mobile interventional stroke team (MIST) travels from the CSC to treat the patient at the PSCI. The MIST consists of an attending neurointerventional physician, a fellow, and a radiologic technologist. Use of a MIST allows patients to receive IV tPA and medical management while the MIST is mobilized and avoids risks and delays inherent in patient transfer.

The trip-and-treat model had an onset-to-treatment time that was 79 minutes faster than the drip-and-ship model and allows a neurointerventional team to expand coverage across multiple hospitals.\textsuperscript{19} The MIST approach may be especially effective in NYC relative to drip and ship because of inefficient transfers. This model may become increasingly relevant as more patients qualify for endovascular treatment for stroke and growing case volumes tax bed capacity at CSCs. A case report on the method known as \textit{helistroke} has also been described and involves transporting a neurointerventionalist to the patient via helicopter, which may further expand application of the trip-and-treat paradigm.\textsuperscript{20}

Coordination of care between the CSC, other hospitals in the Mount Sinai Health System, and referring health centers has further streamlined the process of stroke treatment. Stroke teams at each hospital communicate directly with neurointerventionists to discuss emergent treatment for stroke cases and whether to activate the MIST or have the patient transferred. Constant communication between stroke teams at each hospital and the neurointerventional team allows for effective use of the MIST and keeps each component of the stroke service up to date and prepared for incoming patients.

\textbf{Mobile Stroke Treatment Units}

Another approach to decreasing time to treatment is very accurate prehospital identification of strokes caused by ELVO. Some hospitals in NYC have adopted a method that has potential to do this, with New York-Presbyterian launching a mobile stroke treatment unit (MSTU) in 2016. The MSTU is a specialized ambulance equipped with a CT scanner, laboratory testing, and tPA. The ambulance is staffed by a technologist, paramedics, and has either a vascular neurologist on board or telestroke capacity. First pioneered in Germany and introduced in the United States at UTHHealth Medical School in Houston, Texas, the MSTU allows stroke patients to be diagnosed and treated with IV tPA en route to the hospital.\textsuperscript{21,22} An additional step of performing a CTA in the MSTU can accurately triage patients in the field for delivery to the CSC.

\textbf{CONCLUSION}

Health care systems in NYC have incorporated a broad range of models for stroke transfer, including the drip-and-ship, mothership, and more recently, the trip-and-treat models, as well as MSTUs. The high population density, relatively close proximity of hospitals, and inefficiencies in patient transfer associated with gridlock may make the MIST approach particularly effective in metropolitan environments such as NYC. Approaches to stroke treatment in NYC have rapidly evolved in the past few years, and interhospital models of stroke care will continue to adapt to improvements in neurointerventional procedures and expansion of its window for treatment.
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