



Code Stroke LVO: Multidisciplinary Quality Improvement Project to Decrease Door to Treatment Times for Stroke Patients

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Background: Treating patients with an acute ischemic stroke (AIS) caused by a large vessel occlusion (LVO) is time sensitive. Approximately 2 million neurons die every minute during cerebral ischemia (Saver, 2006). Recent research demonstrates eligible AIS patients with a LVO have more favorable outcomes when emergency mechanical thrombectomy (MT) is successful and reperfusion is achieved within 120 minutes (min) of arrival. Multiple specialties and departments are involved in the acute work-up, diagnosis, and treatment of AIS patients at Mayo Clinic Hospital in Phoenix, Arizona. The workflow was multifaceted, not streamlined, and required multiple phone calls to notify key stakeholders and arrange the necessary resources/staff resulting in delayed emergency intervention. Statistical analysis elucidated that neurosurgery notification (NN) to case start time (CST) was the highest variation and one of the largest root causes to overall time variations. Average NN to CST was 60.4 min resulting in average door to puncture (DTP) times of 124.8 min and door to reperfusion (DTRp) average of 180.9 min, 60 min longer than the national goal set forth by the American Stroke Association (ASA). This delay translates to an average of more than 120 million neurons lost. In 2019, a multidisciplinary plan was instituted to streamline the workflow for AIS patients requiring MT, improve communication to all responding staff with the ultimate goal of decreasing DTP times to 90 min or less to achieve early reperfusion.

Objective: To create a one-step, advance notification system called "Code Stroke LVO" to notify on call staff responding to MT cases using a collaborative, multidisciplinary team approach. Code Stroke LVOs would be activated via an existing group paging system designed to streamline communication. Standardized multidisciplinary roles would be instituted to improve workflow inefficiencies and align with the organization's strategic plan to transform its current practice. The established goals were to reduce NN to CST to ≤ 45 min resulting in DTP times of ≤ 90 min to achieve DTRp ≤ 120 min.

Planning and Research: A work group was assembled with broad representation from every stakeholder group including: Vascular Neurosurgery, Neurointerventional Radiology, Vascular Neurology, Anesthesiology, Emergency Department, House Supervisors (HS), Nursing Administration, Nursing, and Critical Care Department. A project timeline was organized and activities were developed in three categories: 1) planning, 2) education and training, and 3) implementation. Planning activities included research of current ASA clinical practice guidelines, surveying key stakeholders involved in the care of this patient population, multidisciplinary simulations to identify opportunities for improvement and HS group agreement to activate the system. Key stakeholders also provided input on who would receive the Code Stroke LVO page from their respective groups and what critical information would be included on the page. Staff education and training focused on each specialty's respective workflow and their role during a Code Stroke LVO. Educational materials were created for each specialty and included the following key information: who activates the system, what triggers system activation, information that will be communicated, and actions to take when a Code Stroke LVO page is received. System training materials were created specifically for the HS group which detailed how to update, validate, and activate the system, and how to send out cancellation notifications.

Implementation Method: Implementation required scheduled testing of the system to validate its functionality. Test pages were sent on specified days and times to on call staff with instructions to notify a designated person that the page was received. During test paging, hospital and surgical operations continued as normal to best simulate a real activation. On-call staff who received the page were required to respond promptly which meant brief diversion from daily activities (inpatient rounding, outpatient clinic, surgery, etc). Anesthesiology leadership instituted two "anesthesia stroke pagers," one for OR front desk and one for CRNA facilitator, to be used during normal business hours and ensure prompt anesthesia notification and coverage. Prompt electronic feedback would also be sent to staff involved in each case, department leaders, and department administrators to promote transparency, acknowledge achieved goals, and identify opportunities to improve the workflow. Feedback was also requested from on call staff involved in each case to determine staff perception of new workflow.

Results: Code Stroke LVO notification system went live September 3, 2019 with the first activation/case occurring on September 6, 2019. The first activation/case demonstrated a drastic reduction in NN to CST of 25 min (35.4 minute reduction) resulting in a DTP of 82 min (42.8 minute reduction) and DTRp of 105 min (75.9 minute reduction). There have been 14 activations since the system went live. The average NN to CST time is 26.7 min (33.3 minute reduction; $p < .0001$) resulting in an average DTP time of 83.4 min (41.4 minute reduction; ED cases only, $n=11$) and average DTRp of 135.2 min (45.7 min reduction). The group paging system was cost neutral because of existing licensing agreements.

These outcomes suggest instituting an early notification system, along with standardized multidisciplinary roles and workflows, can transform different specialty practices, improve system inefficiencies resulting in more timely treatment with the goal of early reperfusion for AIS patients requiring emergency MT.

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