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In the Unlikely Event: Optimal Care Strategies for Stroke in the Cath Lab

By Mona Steinbeiser

As a result of advanced technology and science, stroke is now the fifth-leading cause of death in the United States, killing more than 130,000 Americans each year at a toll of $33 billion annually. It is also the leading cause of disability in the United States. The risk factors for stroke are very similar to those for coronary disease. Patients who are undergoing cardiac interventions for coronary disease have a periprocedural risk for stroke. Though the overall complication rates for cardiac catheterization and percutaneous coronary intervention (PCI) are low, periprocedural stroke affects thousands of patients each year. Stroke during and after diagnostic cardiac catheterization ranges from 0.11% to 0.4%; stroke during or after PCI ranges from 0.18-0.44%. Incidence of cerebral hemorrhage specifically after PCI is 0.2-0.3%.

Patients who experience a stroke during or after diagnostic cardiac catheterization or PCI will likely have an increased length of stay by approximately four days, and experience moderate to severe disability post-discharge. The in-hospital mortality rate ranges from 25-44%. If PCI is performed in case of an acute coronary syndrome (ACS), the overall risk of stroke and complications increase further.

The statistics show that, although rare, strokes *do* occur in the cardiac cath lab (CCL), making it necessary for the staff to be able to recognize the signs and symptoms of a stroke, along with knowing the immediate actions to take in order to prevent suboptimal outcomes.

Having the ability to recognize a stroke and being able to immediately intervene can significantly improve the long-term outcomes. Therefore, identifying patients at high risk, and understanding the symptoms and treatment possibilities for stroke is very important. We believe that raising the level of awareness of the CCL staff and having clear protocols in place to address recognition and intervention regarding stroke can facilitate staff comfort and efficiency in the unlikely event of a stroke in the CCL.

Invasive cardiac procedures carry additional ingrained risks, even though the risk factors for cardiovascular disease and cerebrovascular disease are very similar; which means the cath lab team must be aware of their hospital's protocol in the event that a PCI patient would suffer a stroke during or after their procedure.

Patients at higher periprocedural risk for stroke are those with:

- Advanced age
- Female gender
- History of stroke
- Renal failure
- Diabetes mellitus
- Arterial hypertension
- Peripheral vascular disease
- Dyslipidemia
- Tobacco use
- Atrial fibrillation
- Previous myocardial infarction
- Congestive heart failure
- Left-sided valvular disease
- Poor left ventricular systolic function
- Prior coronary artery bypass graft
- No or irregular use of needed antiplatelet medications
- Depressed ejection fraction
- PCI done under emergent conditions and the use of an intra-aortic balloon pump

Corazon encourages education for cath lab staff, ensuring that they are aware of these and other possible risk factors. Education can assist the staff and provide to them the tools needed to identify patients who are at high risk for experiencing a stroke and enable them to take the appropriate actions to help prevent/minimize the possibility of any adverse events.

The symptoms seen with a stroke is dependent on the location of the infarct or hemorrhage. In the general population, 80-90% of emboli result in a stroke that affects the anterior cerebral circulation. In the cardiac catheterization population, however, greater than 50% of the emboli affect the vertebrobasilar circulation. Approximately 20% of the cerebral blood flow travels through the posterior circulation and even very small emboli can cause significant neuro deficits. Symptoms of vertebrobasilar circulation disruption include facial paresthesias, dysphagia, dysarthria, hoarseness, hemisensory extremity symptoms, motor weakness, diplopia, and sudden sensorineural hearing loss.

Common neurological deficits seen during a stroke in the cath lab are motor weakness, aphasia, changes in mental status and visual disturbances, with the most common being motor or speech deficits. Stroke symptoms can be difficult to identify because they are camouflaged by or mimic the effects of sedation. In addition, other conditions such as seizures, hypoglycemia, and migraine can mimic stroke symptoms.

Offering education in various forms can enhance the staff's ability to retain the information. Periodic reviews, placement of a poster, and/or competency assessment can increase staff awareness and accurate diagnosis of the signs and symptoms of stroke. The goal should be to focus on the neuro exam in the CCL, targeting the assessment and identification of these particular signs and symptoms. Rapid discovery of a stroke and prompt intervention may minimize any long-term effects of the stroke or even save the life of the patient.

Infarcts during catheterization and intervention can occur from various embolic sources. The composition of the emboli also varies, from air to soft clot to calcified atheroma, or multiple compositions such as atheroma with a fibrin clot around it.

Emboli can be the result of various processes; large injections of air into the circulation down to gaseous microemboli that are due to microbubbles injected with contrast or saline can produce air emboli. Transcranial Doppler (TCD) studies have shown multiple cerebral microemboli released during cardiac catheterization. The exact incidence of air emboli is unknown and there are no specific neurological signs or symptoms related to air embolism.

Larger guide catheters are used in PCI, plus more and stiffer-caliber catheters than diagnostic catheterizations. This raises the risk of trauma to the aorta and the dislodgement of aortic atheroma during catheter manipulation. Emboli can also result from a thrombus which has formed within the catheter or catheter tip during the procedure. There is a question regarding the relevance of upper extremity versus lower extremity access sites and the risk of aortic atheroma. The transradial approach to catheterization is thought to lead to a higher number of solid emboli due to mechanical forces near the apertures of the right vertebral and common carotid arteries; plaques in those areas risk becoming dislodged and embolizing to the brain.

Asymptomatic infarcts (i.e., "silent" ischemic events) are not reflected in the statistics quoted for periprocedural stroke. Deficits may not exist or not be noticeable, such as some mild cognitive deficits. Since patients are not tested for these deficits, the impact on quality of life is uncertain, as are the long-term effects. It is estimated that asymptomatic cerebral infarction after cardiac catheterization has an incidence of approximately 15%.

Having the ability to recognize the cause and type of the infarct can assist in determining the treatment and interventions that are needed to produce the most beneficial outcomes for the patient, thus preventing the risk of secondary stroke occurrence.

The brain has a limited ability to reserve oxygen, making it unable to withstand an ischemic event for any length of time without permanent deficits. For this reason it is extremely important to provide immediate interventions as soon as possible when signs and symptoms of a stroke are detected. Patients who present to the Emergency Department (ED) with stroke symptoms should have treatment initiated within 60 minutes. The same time limit should be adhered to in the CCL as well with the discovery of symptoms.

Clear standards, based on best practice, must be in place and delineated to the staff that define the stroke protocol process in the CCL.

Corazon recommends that the CCL set up a stroke alert process (**Figure 1.**) that would ensure a rapid response to a necessary stroke intervention within the cath lab setting.

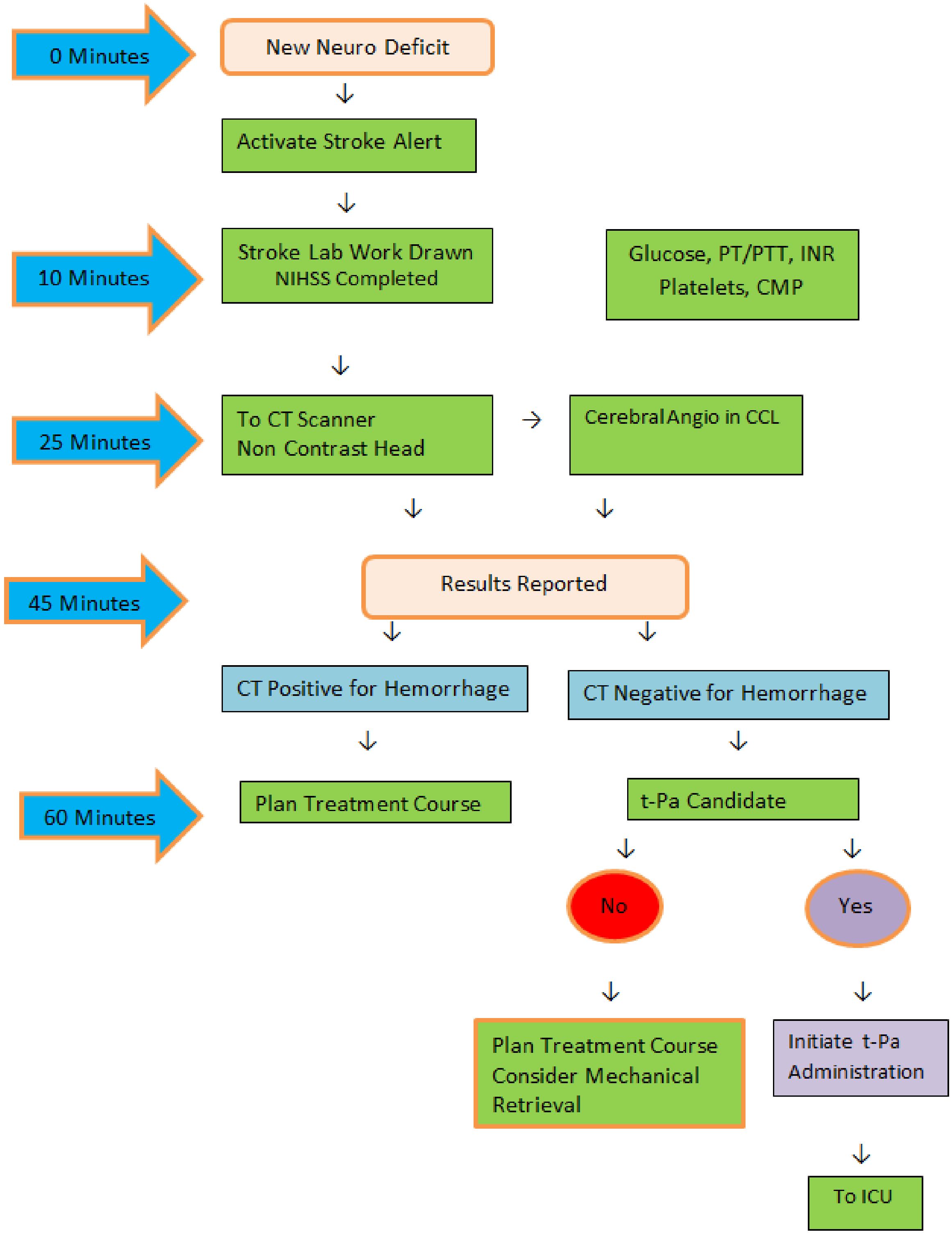
Issues that should be addressed include:

- Who should respond to the stroke code, (e.g., neurologist, neurological interventionalist, pharmacist [if t-PA is not readily available or the staff is not familiar with preparing and administering it], etc.)
- Who activates the alert process that notifies the responders
- The roles of the individual CCL team members
- Actions to be taken and in what sequence

Based on Corazon experience with diverse programs across the country, typically, the personnel to notify during a stroke alert activation are:

- **CT technician:** To ensure availability of the scanner. Protocol usually dictates that the technician will finish the current patient and then hold the scanner open for the incoming stroke patient.
- **Laboratory:** As soon as the blood specimen is brought to the lab, the specimen will be run through the next batch of blood work and the results reported back to the CCL as soon as possible.
- **Neurologist:** To verify the instance of stroke, and to help develop an optimal and timely treatment plan.
- **Pharmacy:** To verify dosage of weight-based t-PA, mix necessary drugs and deliver them to the CCL.
- **ICU:** Because the patient will require an ICU bed if t-PA is administered or a mechanical intervention is performed.

Figure 1. A Stroke Algorithm for the Cardiac Cath Lab



The stroke team responders should be notified when the symptoms are evident and the patient will require assessment for critical deficits. Assessment includes vital signs and basic neuro exam at least every 15 minutes, and performing the National Institutes of Health Stroke Scale (NIHSS) (**Figure 2**). The NIHSS is critical in determining baseline deficits and in assisting the staff to determine the patient's candidacy for thrombolytic intervention. The symptoms must be confirmed as the result of stroke, and other possible neurological events need to be ruled out, such as seizures or brain tumor. Either a CT or MRI can confirm a stroke, though CT is usually the diagnostic test most readily available. The procedure catheter can remain in place for the CT if there is a potential to use it for an intra-arterial lytic intervention. Also, if the sheath is still in place, a cerebral angiogram can be performed in lieu of the CT scan. An angiogram will better determine thrombus morphology, the location and degree of the occlusion, and the status of collateral circulation, when compared to CT. Also, the sheath can provide access for mechanical retrieval of the occluding material if necessary.

Figure 2. National Institutes of Health Stroke Scale

Category	Score
1.a. Level of Consciousness 0: Alert 1: Not alert, but arousable with minimal stimulation 2: Not alert, requires repeated stimulation to attend 3: Responds only with reflex motor or autonomic effects or totally unresponsive, flaccid, areflexic	
1.b. LOC questions (Ask patient the month and her/his age) 0: Answers both correctly 1: Answers one correctly 2: Answers neither question correctly	
1.c. LOC commands (Ask patient to open/close eyes & form/release fist) 0: Performs both correctly 1: Performs one correctly 2: Performs neither task correctly	
2. Best gaze (only horizontal eye movement) 0: Normal 1: Partial gaze palsy 2: Total gaze paresis or Forced deviation	
3. Visual Field testing 0: No visual field loss 1: Partial hemianopia 2: Complete hemianopia 3: Bilateral hemianopia (blind including cortical blindness)	
4. Facial Paresis (Ask patient to show teeth/ raise eyebrows & close eyes tightly) 0: Normal symmetrical movement 1: Minor paralysis (flattened nasolabial fold, asymmetry on smiling) 2: Partial paralysis (total or near total paralysis of lower face) 3: Complete paralysis of one or both sides (absence of facial movement in the upper and lower face)	
5a. Motor Function – Arm: Right 0: Normal (extends arms 90 degrees (or 45 degrees) for 10 seconds without drift) 1: Drift 2: Some effort against gravity 3: No effort against gravity 4: No movement NT: Untestable (Joint fused or limb amputated) (do not add score)	
6a. Motor Function – Leg: Right 0: Normal (hold leg in 30 degrees position for 5 sec without drift) 1: Drift 2: Some effort against gravity 3: No effort against gravity 4: No movement NT: Untestable (Joint fused or limb amputated) (do not add score)	
6b. Motor Function – Leg: Left 0: Normal (hold leg in 30 degrees position for 5 sec without drift) 1: Drift 2: Some effort against gravity 3: No effort against gravity 4: No movement NT: Untestable (Joint fused or limb amputated) (do not add score)	
7. Limb Ataxia 0: No ataxia 1: Present in one limb 2: Present in two limbs	
8. Sensory (Use pinprick to test arms, legs, trunk and face- compare side to side) 0: Normal 1: Mild to moderate decrease in sensation 2: Severe to total sensory loss	

9. Best Language (Ask patient to describe picture, name items, read sentences) 0: No aphasia 1: Mild to moderate aphasia 2: Severe aphasia 3: Mute	
10. Dysarthria (Ask patient to read several words) 0: Normal articulation 1: Mild to moderate slurring of words 2: Near unintelligible or unable to speak NT: Intubated or other physical barrier (do not add score)	
11. Extinction and inattention (Formerly Neglect) (Use visual or sensory double stimulation) 0: Normal 1: Inattention or extinction to bilateral simultaneous stimulation in one of the sensory modalities 2: Severe hemi-inattention or hemi-inattention to more than one modality	
TOTAL SCORE	

Selective intra-arterial treatment may be preferred if the patient has recently received antiplatelets and anticoagulants which would increase the risk of bleeding. Since there is a lesser dose of drug administered, the risk of bleeding should be decreased.

Once the stroke is determined via CT and an infarct differentiated from a hemorrhage, a consulting neurologist can assist in determining the benefits/risks ratio and develop a treatment plan. A neuro interventionalist can perform the angiogram or the intravascular interventions, if necessary. If the CT suggests an infarct, the t-PA inclusion/exclusion criteria list should be reviewed (**Figure 3**). If the patient meets the criteria for intravenous t-PA, the drug should be started immediately.

Figure 3. Inclusion/Exclusion Criteria: Ischemic Stroke Patients Who could be Treated with IV t-PA within 3 Hours of Symptom Onset

Inclusion Criteria:

- Ischemic stroke diagnosis causing measureable neurological deficit
- Symptom onset < 3 hours before treatment begins (some up to 4.5 hours)
- Age ≥ 18 Years

Exclusion Criteria:

- Stroke or significant head trauma in previous 3 months
- Clinical presentation and symptoms suggestive of subarachnoid hemorrhage
- Arterial puncture in past 7 days at non-compressible site
- History of previous intracranial hemorrhage
- Intracranial neoplasm, AVM, or aneurysm
- Recent intracranial or intraspinal surgery
- Elevated blood pressure (systolic > 185 mm Hg or diastolic > 110 mm Hg)
- Active internal bleeding
- Acute bleeding conditions, including but not limited to:
    - Platelet count < 100,000 mm3
    - Heparin received within 48 hours resulting in abnormally elevated aPTT
    - Current use of anticoagulant with INR > 1.7 or PT > 15 seconds
    - Current use of direct thrombin inhibitors or direct factor Xa inhibitors with elevated aPTT, INR, platelet count, ECT, TT, or appropriate factor Xa activity assays
- Blood glucose concentration < 50 mg/dL (2.7 mmol/L)
- Multi-lobar infarction on CT (hypodensity > 1/3 cerebral hemisphere)

Relative Exclusion Criteria:

- Pregnancy
- Seizure at onset with postictal residual neurological impairments
- Major surgery or serious trauma within past 14 days
- Recent GI or GU hemorrhage within previous 21 days
- Recent acute myocardial infarction within prior 3 months
- Only minor or rapidly improving stroke symptoms (clearing spontaneously)

http://stroke.ahajournals.org

t-PA dosage is weight-based at 0.9 mg/kg to a maximum of 90 mg. The drug is mixed in sterile water and should not be shaken or sent through a pneumatic, which would destroy some of the product. It is given in two stages: 10% of the total dose is given through a dedicated IV line over one minute, with the remaining 90% of the dose given over 60 minutes via IV infusion pump. t-Pa preparation should be started as soon as possible, since it takes several minutes to mix.

Vital signs and neuro exams are performed every 15 minutes for two hours, every half hour for six hours, followed by every hour for the next 16 hours. The patient should be admitted to an intensive care unit to monitor for neurological changes and complications due to the t-PA.

The interventionalist will determine the dosage of Intra-arterial t-PA, which will be administered at a lesser dose. If the patient is not a candidate for either intravenous or intra-arterial t-PA, mechanical extravasation of the embolus or multimodal endovascular therapy may be considered.

Complications with t-PA administration can occur. The critical complications that can occur with t-PA are intracranial bleeding, systemic bleeding, and angioedema, all of which require immediate intervention. The incidences of complication are 6%, 2% and 5% respectively. During or shortly after cardiac catheterization, retroperitoneal bleeding and groin hematoma can also occur. If the sheath is in place during lysis, leaving it there for several hours after t-PA infusion helps to minimize the risk of bleeding. The risk of retroperitoneal blood loss from compressible access site is lower with intra-arterial than with intravenous t-PA.

If the stroke is due to an intracranial hemorrhage, anticoagulation should be reversed and a neurosurgeon consulted to determine if any surgical intervention is indicated. If the cerebral embolism is due to air, 100% oxygen should be administered by face mask and the patient considered for hyperbaric oxygen therapy.

In conclusion, stroke is an uncommon but potentially devastating complication of cardiac catheterization. There are measures that can be instituted that can assist in the prevention of the patient experiencing an ischemic stroke. Those would include identification of the high-risk patient before the procedure, having the patient well hydrated prior to the procedure, using catheter techniques to minimize trauma, and judicious use of ventriculography.

Just as with a cardiac emergency, having processes in place to address a stroke event can facilitate positive patient outcomes and save lives. Indeed, Corazon strongly believes in clear, well thought-out policies, procedures, and processes that activate a stroke code when needed. Initiating immediate patient assessment and intervention could minimize cerebral damage and facilitate positive long-term outcomes in the rare case of a CCL stroke event.

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