Common Complications from Acute Endovascular Stroke Therapy

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Disclosures

None
Objectives

- List the common complications reported in pivotal endovascular studies
- Defining complications for endovascular stroke intervention
- Understanding the definitions and recognition of symptomatic intracerebral hemorrhage after endovascular stroke intervention
- Describe treatment options for endovascular stroke complications
Stroke Statistics

- Approximately 795,000 individuals suffer a stroke a year.
  - Approximately 600,000 of these are first attacks, and 185,000 are recurrent strokes
- Nearly three-quarters of all strokes occur in people over the age of 65
- The risk of ischemic stroke in current smokers is about double that of nonsmokers after adjustment for other risk factors
- Atrial fibrillation (AF) is an independent risk factor for stroke, increasing risk about five-fold
- High blood pressure is the most important risk factor for stroke

Stroke Facts

- Fewer than half of 9-1-1 calls for stroke events are made within 1 hour of symptom onset.
- Four out of five families will be somehow affected by stroke over the course of a life time.
- Total cost in the United States is estimated at $65.5 billion per year.

Fun Facts about Large Vessel Occlusions

- Large Vessel Occlusion (LVO) is the new STEMI
- LVO accounts for approximately 10% – 30% of all strokes
- LVO was recently introduced as a type of stroke where the major cerebral artery is blocked, much like how a major coronary artery is blocked with STEMI.
- The typical LVO patient loses 1.9 million neurons each minute a patient is untreated
- LVO strokes have the highest mortality and poor outcomes
- Thrombolytic alone usually do not work with LVO, as demonstrated by recent publications.
- Experts estimate that up to 30% of all stroke patients will deteriorate in the first 24 hours
History of Reperfusion in Acute Stroke

Pre-1980

- No urgency - No treatment benefited therapy
- See patients the next day
- Therapy was driven by diagnosis and secondary prevention
- Treating patients within 90 minutes was seen as impossible.
History of Reperfusion in Acute Stroke

• First dose-escalation trial for stroke
• NO (0/58) patients where treated with IV rt-PA within 90 minutes at does of 0.85 mg/kg or less as compared to 3/16 (19%) of patients at doses greater than 0.95 mg/kg with sICH
• Small numbers of subjects in each dose-tier.
• NO outcome differences could be demonstrated among the different doses
• This Pilot demonstrated the feasibility of treating stroke patients within 90 minutes of onset and developed the logistics for the “trauma model” of stroke treatment.
The New England Journal of Medicine

Volume 333, December 14, 1995

Tissue Plasminogen Activator for Acute Ischemic Stroke
The National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group

1995

- Standardization of selection criteria
  - Inclusion / Exclusion criteria was defined within this study
- 30% greater likelihood of BETTER clinical outcome at 90 days
- Despite risk for symptomatic intracerebral hemorrhage (sICH)
  - 6% in treated group to 1% in placebo group
- Benefits sustained at one year mark
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Thrombolysis</th>
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<tbody>
<tr>
<td>Global Disability</td>
<td>40%</td>
<td>28%</td>
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<tr>
<td>Global Outcome</td>
<td>43%</td>
<td>32%</td>
</tr>
<tr>
<td>Activities of Daily Living</td>
<td>53%</td>
<td>38%</td>
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<tr>
<td>Neurological Deficits</td>
<td>34%</td>
<td>20%</td>
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<tr>
<td>Symptomatic ICH</td>
<td>6.4%</td>
<td>0.6%</td>
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<tr>
<td>Mortality at 3 months</td>
<td>17%</td>
<td>20%</td>
</tr>
<tr>
<td>Mortality at 1 year</td>
<td>24%</td>
<td>28%</td>
</tr>
</tbody>
</table>
History of Reperfusion in Acute Stroke

Endovascular Treatment for Acute Ischemic Stroke

Alfonso Ciccone, M.D., Luca Valvassori, M.D., Michele Nicolatoli, Ph.D., Annalisa Spacca, Psy.D., Michela Porcelli, Ph.D., Roberto Sierzi, M.D., and Edoardo Boccardi, M.D., for the SYNTHESIS Expansion investigators.

A Trial of Imaging Selection and Endovascular Treatment for Ischemic Stroke

Chelsea S. Kropel, M.D., Rosa Jahan, M.D., Jeffrey Gorrebee, Dr.P.H., Jeffy R. Alger, Ph.D., Vai Nefesia, Ph.D., Zaha Ajarri, M.D., Le Feng, M.D., Ph.D., Brett C. Meyer, M.D., Scott Olson, M.D., Lee H. Schwaerzm, M.D., Alber J. Yoo, M.D., Randolph S. Marchal, M.D., Philip M. Meyer, M.D., Dileep P. Papagil, M.D., Max Winterton, M.D., Judy Guay, R.N., Sidney Starkman, M.D., and Jeffrey L. Savitz, M.D., for the MIR RESCUE investigators.
History of Reperfusion in Acute Stroke

A Randomized Trial of Intravenous Treatment for Acute Ischemic Stroke

Original Article

Randomized Assessment of Rapid Endovascular Treatment of Ischemic Stroke


Endovascular Therapy for Ischemic Stroke with Perfusion-Imaging Selection

Original Article

Thrombectomy within 8 Hours after Symptom Onset in Ischemic Stroke

Original Article

Stent-Retriever Thrombectomy after Intravenous t-PA vs. t-PA Alone in Stroke


The Ohio State University
WEXNER MEDICAL CENTER
AHA/ASA Updated Guidelines

- Patients should receive endovascular therapy with a stent retriever if they meet all of the following criteria:
  - Prestroke mRS score 0-1
  - Acute ischemic stroke receiving IV r-tPA within 4.5 hours of onset according to professional medical societies
  - Occlusion of the ICA or proximal MCA (M1)
  - Age > 18 years
  - NIHSS score of >6
  - ASPECTS score of >6
  - Treatment can be initiated (groin puncture) within 6 hours of symptom onset.
Bring on the Doom!
Case Study

43 F mother of three, with PMH of HTN and HLD. Not a TPA candidate d/t low NIHSS. Transferred from OSH for fluctuation of symptoms. Initial NIHSS 1 by overnight coverage. LKW determined to be 0245. Worsened symptoms with NIHSS 8. CTA with LICA stenosis and Left M1 occlusion. Patient/Family consented. Taken for embolectomy at ~6hs.
Case Study

- Hydrocephalus requiring EVD
- Refractory vasospasm with multiple spondioleyosis
- Decompressive Hemicraniectomy
- Ultimately suffered Bilateral MCA infarctions and progressed to brain death 15 days later
Acute Stroke Complications

Where do these complications occur?

- Pre-Procedural
  - Pre-Hospital
  - On hospital to hospital transport
- Emergency Department
- Interventional Radiology Suite
- NeuroCritical Care Unit
Acute Stroke Complications

- Airway Compromise
- Angioedema from IV thrombosis
- Allergy to IVP Dye
- Early Hemorrhagic Conversion post IV thrombolysis
Airway

- One small study of hemiparetic patients, 63% developed hypoxia within 48 hours of onset
  - Hypoxia was defined as SPO2 <96% for >5 minutes
- Patient Position and Monitoring
  - In non-hypoxic patients able to tolerate lying flat, a supine position is recommended
  - Patients a risk for airway compromise or obstruction/aspiration should be elevated to 15-30 degrees
Treatment of Airway Compromise

- Intubation a patient with ischemia
- Avoid hypotension during induction and post-intubation
- Brain ischemia is worsened by hyperventilation upon vascular tone.
- Maintain normocapnia

Assessment

- Pre-intubation neurological examination
  - Level of arousal, interaction, and orientation, as well as assessment of simple cortical functions, such as vision, attention, and speech comprehension and fluency
  - Cranial nerve function
  - Motor function of each extremity
  - NIHSS

Angioedema

- Common complication after IV rt-PA
  - Occurs in 1-5% of patients treated with IV rtPA for AIS or acute MI
- Defined as an acute, transient, well-demarcated swelling that involves the deeper layers of skin. It usually affects the face, genitalia, as well as the upper respiratory airways and the intestinal epithelial lining.
- Typically hemi-orolinguinal angioedema
- Has been linked to ACE-Inhibitor use and hereditary deficiency in C1-esterase
  - Initial CT with ischemia in insular and frontal cortex
Monitoring for Angioedema

It is very important for nurses to evaluate post thrombolysis patients closely for throat or mouth edema and look for any difficulty breathing due to angioedema.
Treatment of Angioedema

- Initial goal of therapy is airway management with early intubation if necessary.
  - Due to extensive airway swelling that can occur the potential for airway complications are high.
  - Anesthesia should be notified.
- TPA infusion should be discontinued.
- Treat patient with
  - Histamine antagonists
  - Corticosteroids
- Admit to the Neurocritical Care Unit
IVP Dye Allergy

- Newer low-osmolarity nonionic agents has led to a marked decrease in the incidence of contrast reactions
  - Approximately 3% of patient will experience some type of reaction to these safer agents
  - Most are mild, self-limited and do not require treatment
- Severe reactions are (0.004%):
  - Dyspnea
  - Hypotension
  - Loss of consciousness
  - Cardiac Arrest
IVP Dye Allergy

- High risk patients can be prospectively identified
- Most commonly encountered risk groups include:
  - Previous reactions to iodinated contrast material
  - Patients with asthma
  - Patients who have any allergies
- IVP dye has been known to have risk of acute exacerbation of chronic diseases after ionic contrast injection
  - Cardiac arrhythmia's
  - Myasthenia graves (central type)
  - Sickle cell anemia
  - Pheochromocytoma
Treatment of IVP dye allergy

- Corticosteroid prophylaxis is the standard of care in the United States for the prevention of allergic contrast reactions
  - Controversial because there is no level 1 evidence supporting its use of the prevention of severe reactions to low osmolar contrast media
- Most severe reaction occurs within 20 minutes of injection
  - Oxygen
  - Epinephrine
  - H1 antihistamines (diphenhydramine)
  - H2-receptor blockers (cimetidine)
Abort Endovascular Therapy?

Are these complications reasons to abort endovascular therapy?

No. Only Early Hemorrhagic Conversion should exclude a patient from endovascular therapy.
Endovascular Procedural Complications

- Limited data in literature, and most recommendations are of exert opinion
- Major complications can occur during and following acute stroke interventions
  - RP Bleed
  - Radiocontrast-Mediated Acute Kidney Injury (RCM-AKI)
  - Re-Infarction
  - Hemorrhagic Conversion
    - Cerebral Re-Perfusion Syndrome
    - Seizures
    - Cerebrovascular Injury
RP Bleed

- Bleeding that occurs behind the serous membrane lining walls of the abdomen/pelvis
- Occurs more frequently if access is made above the inguinal ligament or penetration of the posterior wall.
- In PCI studies vascular complications occurred in 6% of all cases
  - More frequent with patients on antiplatelet medications
  - Women are at higher risk than men

RP Bleed Clinical Findings

- Moderate to severe back pain with ipsilateral flank pain
- Vague abdominal or back pain
- Ecchymosis and decrease in hemoglobin and hematocrit are late signs
- Abdominal distention
- Hypotension and tachycardia
- Diagnosed by CT scan of Abd/Pelvis

Monitoring

- Vascular Injury can occur anywhere post procedure
  - Monitor Pulses
    - Femoral
    - PT/DP
  - Monitor Urine Output
    - Possible renal artery injury
Treatment of RP Bleed

- Provide hydration
- Maintain prolonged bed rest
- Serial hemoglobin and hematocrit counts
- Interrupt lab values for potential reversal if medically necessary
  - Blood transfusion, if indicated
- If severe, may require surgical evacuation

Radiocontrast-Medicated Acute Kidney Injury

- CTA in evaluation of AIS patients is safe
  - Single-Center study of 289 Acute Stroke Team activations
  - Renal function between groups were similar at 24 and 48 hours.
  - CTA acquisition was safe in regards to renal function
- Radiocontrast-Medicated Kidney Injury (RCM-AKI) after Endovascular Intervention
  - Small study of 99 patients
  - RCM-AKI following endovascular intervention is very low. 3% of patients had AKI but returned to baseline


Treatment of RCM-AKI

- Standard hydration after AIS is warranted
- Normal Saline 75-125 ml/hr

Re-Infarction

- Defined as embolization into a different vascular territory
- Symptomatic and Asymptomatic
- Up to 10-15% of patients with revascularization have re-occlusion
- Some case reports of repeated endovascular therapy
Case Study

86y old right handed female with PMH of Stroke, HTN, HLD, CAD, AF not on AC presented from OSH with Left hemiplegia, severe dysarthria and neglect. Received IV TPA prior to transfer (1h55min from onset). NIHSS on arrival 19. Classic Right MCA syndrome.
Case Study

Post IAT assessment, slightly lethargic NIH remains 19. Next morning, somnolent, no gag on assessment, gaze preference forced to left.

Repeat HCT with 1.8cm, with reperfusion edema. Patient made DNRCC and withdraw of care when family arrived.
Cerebral Re-perfusion Syndrome

- This is a rare, but very serious complication
- Defined as, a rapid increase in ipsilateral cerebral blood flow (CBF) that is well above the metabolic demands of the brain tissue.
  - Quantitatively: 100% or greater increase in CBF compared to baseline
- Frequently reported in post carotid procedures
  - Reported in < 1% of Carotid Artery Stenting
Cerebral Re-Perfusion Syndrome Symptoms

- Triad of symptoms
  - Ipsilateral headache
  - Contralateral neurological deficits
  - Seizures

- Symptoms can occur immediately after restoration of blood flow to up to 1 month after revascularization
  - Most are symptomatic within first week
Causes of Cerebral Reperfusion Injury

- Post-operative Hypertension
- High-grade stenosis with poor collateral flow
- Decreased cerebral vasoreactivity
- Contralateral carotid occlusion
- Recent CEA (<3 months)
Treatment of Reperfusion Injury

- Hypertension
  - Most common factor in symptomatic patients
  - Blood pressure control is the most important factor in preventing reperfusion syndrome
  - Early identification and control of hypertension
- Multiple studies have looked at this post CEA, very limited data or experience with Acute Ischemic Stroke
Treatment of Cerebral Reperfusion Syndrome

Blood pressures can be reduced gently with antihypertensives that do not increase CBF or cause excessive vasodilatation

- Labetalol
- Nicardipine

No specific parameters or guidelines have yet been established for optimal blood pressure after endovascular stroke intervention

- Post - IV tPA standards
- Standard post-operative Neurosurgery standards
Early Epileptic Seizure

- Reported incidence of seizures after ischemic infarction varies greatly, with most reports indicating incidence 2.2% - 10.5%
  - High incidence of seizures after ischemic infarction with hemorrhagic conversion
- Development of Epilepsy
  - Early seizures: 17% - 35% risk of later epilepsy
  - Late seizures: 65% - 90% risk of later epilepsy
- Seizures reported within first 24 hours of stroke onset after endovascular therapy has been reported to have worse long-term outcomes

Early Epileptic Seizures

- No studies to date have demonstrated a benefit of prophylactic anticonvulsant use after ischemic stroke.
- Very little information exists on indications for long-term use of anticonvulsants after seizure.
- Recurrent seizures after stroke should be treated in a manner similar to other acute neurological conditions.

Risk Factors for Development of Seizures

- Seizures occur with most stroke subtypes
  - Large stroke’s with high NIHSS
  - Ischemic stroke involving the cortex
  - Watershed infarcts
  - Anterior circulation
  - Hemorrhagic transformation

Treatment of Early Epileptic Seizures

- Acute Re-imaging of patient for hemorrhagic transformation
- AED’s initiation is debated in the literature.
  - Some suggest risk of epilepsy in patients with a single post-stroke seizure is high enough to justify initiation of AED’s before the second seizure.
  - Others suggest AED’s for 1-3 months during the highest risk of recurrence
  - Conservative approach is discontinue at 1 year
- No single AED has been show superior to another in early seizures after stroke

Hemorrhagic Conversion after Thrombolysis

Hemorrhagic Conversion - Facts

- The incidence of spontaneous hemorrhagic transformation (HT) ranges from 38-71% in autopsy studies.
- s(ICH) from 0.6% - 20%
- Factors include: age, blood glucose, thrombolytic agent, route of administration, time to therapy
- In the NINDS trials, 6.4% of treated patients had sICH, which was defined as “any CT-documented hemorrhage that was temporally released to deterioration in the patient’s clinical condition in the judgement of the clinical investigator” within 36 hours of treatment.
- 3% of patients with an NIHSS <10 had sICH
- 17% of patients with an NIHSS >20 had sICH

Definition of Symptomatic ICH

**Symptomatic ICH (sICH)** is defined as an intracranial hemorrhage temporally related to a decline in neurological status as well as a new or worsening neurologic symptoms.

A four (4) or more point increase in the NIHSS score from baseline to subsequent CT scan at the time of exam worsening.

**Asymptomatic ICH (aICH)** is petechial hemorrhage on HCT that does not relate to decline in neurological status.
Get With The Guidelines Definitions

Complications of Thrombolytic therapy:
- Symptomatic intracranial hemorrhage <36 hrs
- Life threatening serious systemic hemorrhage <36hrs
- Other serious complications
- No serious complications

GWTG abstraction guidelines
Pathophysiology of Hemorrhagic Transformation

- Complex and multifactorial phenomenon
  - Ischemia causes a robust inflammatory response
  - Variety of cellular and metabolic derangements which leads to a disruption in the blood-brain barrier (BBB)
- Disruption of the BBB along with impairment of auto regulation capacity of the cerebral vasculature predisposes to blood extravasation when ischemic tissue is reperfused.
- The degree of anatomical and physiological disruption is highly dependent on the duration of ischemia.
Classification of Hemorrhagic Complications

- Commonly used definition for Hemorrhagic Transformation (HT) is the ECASS-II radiological criteria
- HT after ischemic stroke can be divided into hemorrhagic infarction (HI) and parenchymatous hemorrhage (PH)
- Whether symptomatic or asymptomatic intracranial hemorrhages are a spectrum of severity with the same pathophysiology or are attributable to different mechanisms is still a matter of debate.
Predictors of Hemorrhagic Transformation

- Areas of infarction
- Atrial Fibrillation and cerebral embolism
- Higher National Institute of Health Stroke Scale
- Hyperglycemia
- Lower total cholesterol (TC) and low-density lipoprotein (LDL) level
- Lower platelet count
- Poor collateral vessels
Classification of Hemorrhagic Conversion

- Hemorrhage infarction type 1 (HI1)
  - Small hyperdense petechial
  - Scattered, heterogeneous petechial along the margins of the infarct
Classification of Hemorrhagic Conversion

- Hemorrhage infarction type 2 (HI2)
  - More confluent hyperdensity throughout the infarct zone, without mass effect
  - More confluent but still heterogeneous petechial within the infarcted area
Classification of Hemorrhagic Conversion

- Parenchymal hematoma type 1 (PH1)
  - Homogenous hyperdensity occupying <30% of the infarct zone; some mass effect
  - Mild space occupying hematoma.
Classification of Hemorrhagic Conversion

- Parenchymal hematoma type 2 (PH2)
  - Homogeneous hyperdensity occupying >30% of the infarct zone; significant mass effect.
  - Or any homogenous hyperdensity located beyond the boards of the infarct
  - Dense hematoma >30% of the lesion volume with significant space-occupying effect
Prevalence of Hemorrhagic Conversion

- **aICH average**: 31.041%
- **sICH average**: 5.813%

**Graph:**
- NINDS
- SITS-MOST
- PROACT – I
- MR Rescue
- ESCAPE
- REVASCAT

**Legend:**
- **aICH**
- **sICH**
Standards for Nursing Care of Acute Stroke

Comprehensive Overview of Nursing and Interdisciplinary Care of the Acute Ischemic Stroke Patient
A Scientific Statement From the American Heart Association

Debbie Summers, MSN, RN, FAHA, Chair; Anne Leonard, MPH, RN, FAHA, Co-Chair;
Deidre Wentworth, MSN, RN; Jeffrey L. Saver, MD, FAHA; Jo Simpson, BSN, RN;
Judith A. Spilker, BSN, RN; Nanette Hock, MSN, RN, FAHA; Elaine Miller, DNS, RN, FAHA;
Pamela H. Mitchell, PhD, RN, FAHA; on behalf of the American Heart Association Council on Cardiovascular Nursing and the Stroke Council

- No mention of:
  - Pre or Post - Endovascular Care
  - Complications after endovascular
  - Monitoring of endovascular patient
# Treatment for Hemorrhagic Conversion

<table>
<thead>
<tr>
<th>Care Element</th>
<th>Suspect ICH or systemic bleed</th>
<th>2-24 hours after ICH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nursing Assessments</strong></td>
<td>Vital signs every 15 min Neurological examination, signs of ICP every 15 minutes Look for other bleeding sites</td>
<td>Vital signs every 1 h and as necessary. Signs of ICP, neurological examination. GCS/Pupil check every 1 h as necessary Monitor SVO2, ICP</td>
</tr>
<tr>
<td><strong>STAT diagnostics</strong></td>
<td>CT Head, MRI with SWI sequence Labs: PT/PTT/INR, Fibrinogen, CBC with platelets, type and cross Consider hemodynamic monitoring</td>
<td>Labs Sodium, osmolality (if on mannitol and HTS) Glucose as needed ABGs Consider ICP monitor</td>
</tr>
<tr>
<td><strong>Treatments</strong></td>
<td>Received thrombolysis, STOP INFUSION Aggressive BP management Consider Mannitol Consider Reversal (Cryoprecipitate, FFP, Platelets, PRBCS, and Factor VIIa)</td>
<td>Keep PO2 &gt; 94%</td>
</tr>
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</table>

Treatment of Hemorrhagic Conversion

- Blood pressure management is crucial
  - Lack of definitive data
    - SBP 120-160 is reasonable
- If Subarachnoid hemorrhage is present treatment of vasospasm should be considered.
- Prophylactic AED’s should be considered
- Ventriculostomy placement may be indicated if hydrocephalus is present
- Early decompressive hemicraniectomy
Case Study

71 M with PMH of pAF (not on AC) d/t history of SAH and HTN. Presented to OSH with Right Hemiparesis and aphasia. NIHSS 29. No IV TPA administered d/t history. On arrival to OSU NIHSS 17. CTA with Left M1 occlusion, with large mismatch.
Case Study

TICI 3 revascularization
Patient up walking PSD #1
Discharged Home on Hospital day 2 with NIHSS 3 (facial weakness, mild aphasia and dysarthria)
30 and 90 day mRS = 0
Conclusion

- Patients eligible for IV tPA should receive IV tPA even if Intra-Arterial therapies are being considered.

- IA Therapies are safe and have demonstrated proven benefit in functional outcomes for patients with documented Large Vessel Occlusions.

- As with IV fibrinolytic therapy, reduced time from symptom onset to reperfusion with IA therapies is highly correlated with better clinical outcomes, and all efforts must be undertaken to minimize delays to definitive therapy.

- Complications do occur! We as providers and nurses need to anticipate these complications and be knowledgeable of signs and symptoms as well as treatments of these complications.
Thank You!
References

References


