Improving People's Lives Through Innovations in Personalized Health Care

Common Complications from Acute Endovascular Stroke Therapy

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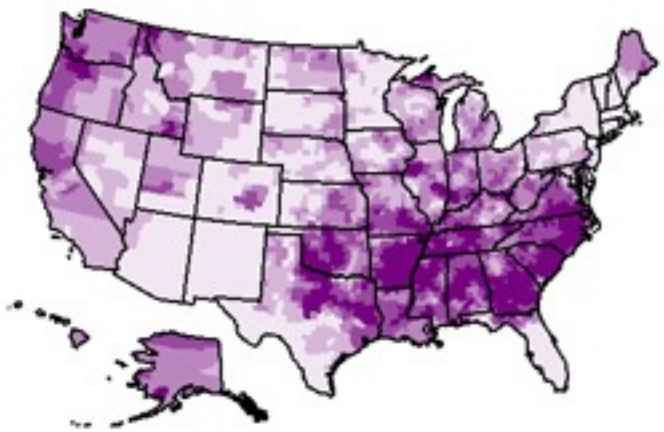
Disclosures

- 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

Jauch, E. C., Saver, J. L., Adams, H. P., Bruno, A., Connors, J., Demaerschalk, B. M., et al. (2013). Guidelines for the early Management of Patients With Acute Ischemic Stroke : A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke*, 1-87.

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.

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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

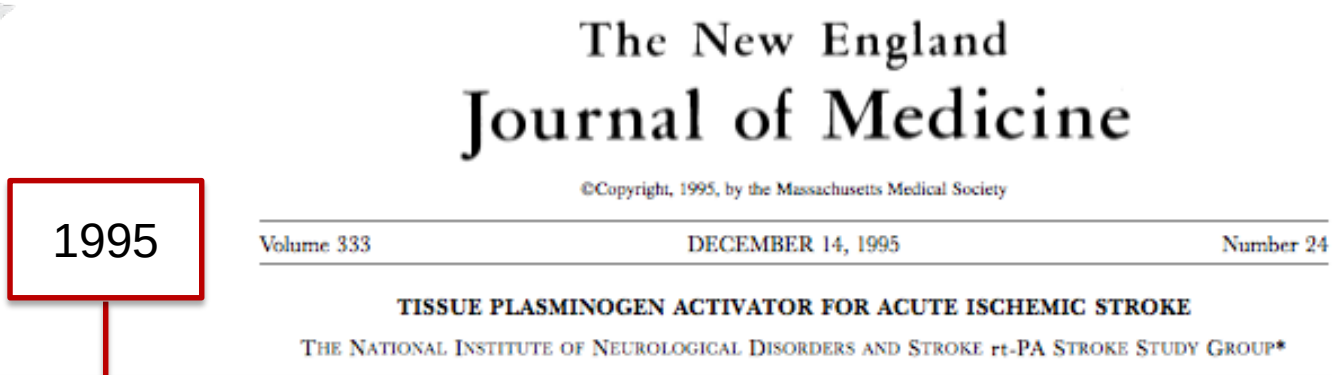
Pilot Randomized Trial of Tissue Plasminogen Activator in Acute Ischemic Stroke

E.C. Haley, Jr, MD; T.G. Brott, MD; G.L. Sheppard, MD; W. Barsan, MD; J. Broderick, MD; J.R. Marler, MD; G.L. Kongable, RN; J. Spilker, RN; S. Massey, RN; C.A. Hansen, MStat; J.C. Torner, PhD; for the TPA Bridging Study Group

1993

- 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.

History of Reperfusion in Acute Stroke



The New England
Journal of Medicine

Volume 333 DECEMBER 14, 1995 Number 24

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 out come 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

NINDS-rtPA Trial

Outcome	Thrombolysis	No Thrombolysis
Global Disability	40%	28%
Global Outcome	43%	32%
Activities of Daily Living	53%	38%
Neurological Deficits	34%	20%
Symptomatic ICH	6.4%	0.6%
Mortality at 3 months	17%	20%
Mortality at 1 year	24%	28%

History of Reperfusion in Acute Stroke

PROACT: A Phase II Randomized Trial of Recombinant Pro-Urokinase by Direct Arterial Delivery in Acute Middle Cerebral Artery Stroke

Gregory J. del Zoppo, MD; Randall T. Higashida, MD; Anthony J. Furlan, MD; Michael S. Pessin, MD†; Howard A. Rowley, MD; Michael Gent, DSc; and the PROACT Investigators

Combined Intraarterial/Intravenous Thrombolysis for Acute Ischemic Stroke

Valdis Keris, Svetlana Rudnicka, Vladimirs Vorona, Gertrude Enina, Biruta Tilgale, and Juris Fricbergs

1998

1998

1999

2000

2001

2002

Combined Intravenous and Intra-Arterial r-TPA Versus Intra-Arterial Therapy of Acute Ischemic Stroke

Emergency Management of Stroke (EMS) Bridging Trial

Christopher A. Lewandowski, MD; Michael Frankel, MD; Thomas A. Tomsick, MD; Joseph Broderick, MD; James Frey, MD; Wayne Clark, MD; Sidney Starkman, MD; James Grotta, MD; Judith Spilker, RN; Jane Khoury, MS; Thomas Brott, MD; and the EMS Bridging Trial Investigators

Intra-arterial Prourokinase for Acute Ischemic Stroke

The PROACT II Study: A Randomized Controlled Trial

Acute Intravenous–Intra-Arterial Revascularization Therapy for Severe Ischemic Stroke

Michael D. Hill, MD; Philip A. Barber, BM; Andrew M. Demchuk, MD; Nancy J. Newcommon, MN; Andrea Cole-Haskayne, RN; Karla Ryckborst, RN; Laurel Sopher, RN; Allison Button, RN; William Hu, MD; Mark E. Hudon, MD; William Morrish, MD; Richard Frayne, PhD; Robert J. Sevick, MD; Alastair M. Buchan, BM

Combined Intravenous and Intra-Arterial Recombinant Tissue Plasminogen Activator in Acute Ischemic Stroke

Robert Ernst, MD; Arthur Pancioli, MD; Thomas Tomsick, MD; Brett Kissela, MD; Daniel Woo, MD; Daniel Kanter, MD; Edward Jauch, MD; Janice Carrozzella, RN; Judith Spilker, RN; Joseph Broderick, MD

History of Reperfusion in Acute Stroke

2004

Combined Intravenous and Intra-Arterial Recanalization for Acute Ischemic Stroke: The Interventional Management of Stroke Study

The IMS Study Investigators

2004

MERCI FDA Approval 2004

2005

Safety and Efficacy of Mechanical Embolectomy in Acute Ischemic Stroke

Results of the MERCI Trial

Wade S. Smith, MD, PhD; Gene Sung, MD; Sidney Starkman, MD; Jeffrey L. Saver, MD; Chelsea S. Kidwell, MD; Y. Pierre Gobin, MD; Helmi L. Lutsep, MD; Gary M. Nesbit, MD; Thomas Grobelny, MD; Marilyn M. Rymer, MD; Isaac E. Silverman, MD; Randall T. Higashida, MD; Ronald F. Budzik, MD; Michael P. Marks, MD; for the MERCI Trial Investigators

Penumbra FDA Approval 2007

2008

TREVO & Solitaire FDA Approval 2012

The Interventional Management of Stroke (IMS) II Study

The IMS II Trial Investigators

Randomized Trial of Intraarterial Infusion of Urokinase Within 6 Hours of Middle Cerebral Artery Stroke

The Middle Cerebral Artery Embolism Local Fibrinolytic Intervention Trial (MELT) Japan

Akira Ogawa, MD; Etsuro Mori, MD; Kazuo Minematsu, MD; Waro Taki, MD; Akira Takahashi, MD Shigeru Nemoto, MD; Susumu Miyamoto, MD; Makoto Sasaki, MD; Takashi Inoue, MD; for The MELT Japan Study Group

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 SEPTEMBER 25, 2008 VOL. 359 NO. 13

Thrombolysis with Alteplase 3 to 4.5 Hours after Acute Ischemic Stroke

Werner Hacke, M.D., Markku Kaste, M.D., Erich Bluhmki, Ph.D., Miroslav Brozman, M.D., Antoni Dávalos, M.D., Donata Guidetti, M.D., Vincent Larrue, M.D., Kennedy R. Lees, M.D., Zakaria Medeghri, M.D., Thomas Machnig, M.D., Dietmar Schneider, M.D., Rüdiger von Kummer, M.D., Nils Wahlgren, M.D., and Danilo Toni, M.D., for the ECASS Investigators*

Mechanical Thrombectomy for Acute Ischemic Stroke

Final Results of the Multi MERCI Trial

Wade S. Smith, MD, PhD; Gene Sung, MD, MPH; Jeffrey Saver, MD; Ronald Budzik, MD; Gary Duckwiler, MD; David S. Liebeskind, MD; Helmi L. Lutsep, MD; Marilyn M. Rymer, MD Randall T. Higashida, MD; Sidney Starkman, MD; Y. Pierre Gobin, MD; for the Multi MERCI Investigators

The Penumbra System: A Mechanical Device fo the Treatment of Acute Stroke due to Thromboembolism

History of Reperfusion in Acute Stroke

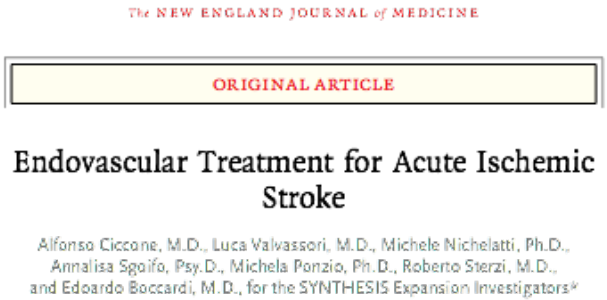
2013

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MARCH 7, 2013 VOL. 368 NO. 10

Endovascular Therapy after Intravenous t-PA versus t-PA Alone for Stroke

Joseph P. Broderick, M.D., Yuko Y. Palesch, Ph.D., Andrew M. Demchuk, M.D., Sharon D. Yeatts, Ph.D., Pooja Khatri, M.D., Michael D. Hill, M.D., Edward C. Jauch, M.D., Tudor G. Jovin, M.D., Bernard Yan, M.D., Frank L. Silver, M.D., Rüdiger von Kummer, M.D., Carlos A. Molina, M.D., Bart M. Demaerschalk, M.D., Ronald Budzik, M.D., Wayne M. Clark, M.D., Osama O. Zaidat, M.D., Tim W. Malisch, M.D., Mayank Goyal, M.D., Wouter J. Schonewille, M.D., Mikael Mazighi, M.D., Ph.D., Stefan T. Engelter, M.D., Craig Anderson, M.D., Ph.D., Judith Spilker, R.N., B.S.N., Janice Carrozzella, R.N., B.A., R.T.(R.), Karla J. Ryckborst, R.N., B.N., L. Scott Janis, Ph.D., Renée H. Martin, Ph.D., Lydia D. Foster, M.S., and Thomas A. Tomsick, M.D., for the Interventional Management of Stroke (IMS) III Investigators

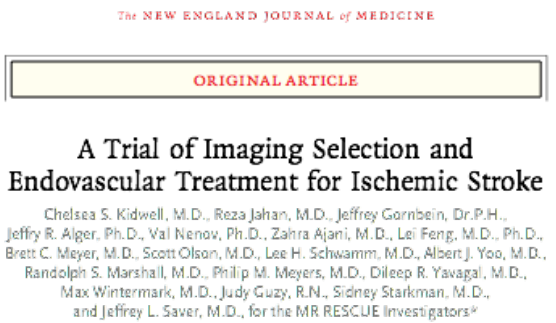


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Endovascular Treatment for Acute Ischemic Stroke

Alfonso Ciccone, M.D., Luca Valvassori, M.D., Michele Nichelatti, Ph.D., Annalisa Sgoifo, Psy.D., Michela Ponzio, Ph.D., Roberto Sterzi, M.D., and Edoardo Boccardi, M.D., for the SYNTHESIS Expansion Investigators*



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Trial of Imaging Selection and Endovascular Treatment for Ischemic Stroke

Chelsea S. Kidwell, M.D., Reza Jahan, M.D., Jeffrey Gornbein, Dr.P.H., Jeffry R. Alger, Ph.D., Val Nenov, Ph.D., Zahra Ajani, M.D., Lei Feng, M.D., Ph.D., Brett C. Meyer, M.D., Scott Olson, M.D., Lee H. Schwamm, M.D., Albert J. Yoo, M.D., Randolph S. Marshall, M.D., Philip M. Meyers, M.D., Dileep R. Yavagal, M.D., Max Wintermark, M.D., Judy Guzy, R.N., Sidney Starkman, M.D., and Jeffrey L. Saver, M.D., for the MR RESCUE Investigators*

History of Reperfusion in Acute Stroke

2015

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Randomized Assessment of Rapid Endovascular Treatment of Ischemic Stroke

M. Goyal, A.M. Demchuk, B.K. Menon, M. Eesa, J.L. Rempel, J. Thornton, D. Roy, T.G. Jovin, R.A. Willinsky, B.L. Sapkota, D. Dowlatshahi, D.F. Frei, N.R. Kamal, W.J. Montanera, A.Y. Poppe, K.J. Ryckborst, F.L. Silver, A. Shuaib, D. Tampieri, D. Williams, O.Y. Bang, B.W. Baxter, P.A. Burns, H. Choe, J.-H. Heo, C.A. Holmstedt, B. Jankowitz, M. Kelly, G. Linares, J.L. Mandzia, J. Shankar, S.-I. Sohn, R.H. Swartz, P.A. Barber, S.B. Coutts, E.E. Smith, W.F. Morrish, A. Weill, S. Subramaniam, A.P. Mitha, J.H. Wong, M.W. Lowerison, T.T. Sajobi, and M.D. Hill for the ESCAPE Trial Investigators*

The NEW ENGLAND JOURNAL of MEDICINE

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A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke

O.A. Berkhemer, P.S.S. Fransen, D. Beumer, L.A. van den Berg, H.F. Lingsma, A.J. Yoo, W.J. Schonewille, J.A. Vos, P.J. Nederkoorn, M.J.H. Wermer, M.A.A. van Walderveen, J. Staals, J. Hofmeijer, J.A. van Oostayen, G.J. Lycklama à Nijeholt, J. Boiten, P.A. Brouwer, B.J. Emmer, S.F. de Bruijn, L.C. van Dijk, L.J. Kappelle, R.H. Lo, E.J. van Dijk, J. de Vries, P.L.M. de Kort, W.J.J. van Rooij, J.S.P. van den Berg, B.A.A.M. van Hasselt, L.A.M. Aerden, R.J. Dallinga, M.C. Visser, J.C.J. Bot, P.C. Vroomen, O. Eshghi, T.H.C.M.L. Schreuder, R.J.J. Heijboer, K. Keizer, A.V. Tielbeek, H.M. den Hertog, D.G. Gerrits, R.M. van den Berg-Vos, G.B. Karas, E.W. Steyerberg, H.Z. Flach, H.A. Marquering, M.E.S. Sprengers, S.F.M. Jenniskens, L.F.M. Beenen, R. van den Berg, P.J. Koudstaal, W.H. van Zwam, Y.B.W.E.M. Roos, A. van der Lugt, R.J. van Oostenbrugge, C.B.L.M. Majoie, and D.W.J. Dippel, for the MR CLEAN Investigators*

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Endovascular Therapy for Ischemic Stroke with Perfusion-Imaging Selection

B.C.V. Campbell, P.J. Mitchell, T.J. Kleinig, H.M. Dewey, L. Churilov, N. Yassi, B. Yan, R.J. Dowling, M.W. Parsons, T.J. Oxley, T.Y. Wu, M. Brooks, M.A. Simpson, F. Miteff, C.R. Levi, M. Krause, T.J. Harrington, K.C. Faulder, B.S. Steinfort, M. Priglinger, T. Ang, R. Scroop, P.A. Barber, B. McGuinness, T. Wijeratne, T.G. Phan, W. Chong, R.V. Chandra, C.F. Bladin, M. Badve, H. Rice, L. de Villiers, H. Ma, P.M. Desmond, G.A. Donnan, and S.M. Davis, for the EXTEND-IA Investigators*

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Thrombectomy within 8 Hours after Symptom Onset in Ischemic Stroke

T.G. Jovin, A. Chamorro, E. Cobo, M.A. de Miquel, C.A. Molina, A. Rovira, L. San Román, J. Serena, S. Abilleira, M. Ribó, M. Millán, X. Urra, P. Cardona, E. López-Cancio, A. Tomasello, C. Castaño, J. Blasco, L. Aja, L. Dorado, H. Quesada, M. Rubiera, M. Hernández-Pérez, M. Goyal, A.M. Demchuk, R. von Kummer, M. Gallofré, and A. Dávalos, for the REVASCAT Trial Investigators*

The NEW ENGLAND JOURNAL of MEDICINE

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

Jeffrey L. Saver, M.D., Mayank Goyal, M.D., Alain Bonafe, M.D., Hans-Christoph Diener, M.D., Ph.D., Elad I. Levy, M.D., Vitor M. Pereira, M.D., Gregory W. Albers, M.D., Christophe Cognard, M.D., David J. Cohen, M.D., Werner Hacke, M.D., Ph.D., Olav Jansen, M.D., Ph.D., Tudor G. Jovin, M.D., Heinrich P. Mattle, M.D., Raul G. Nogueira, M.D., Adnan H. Siddiqui, M.D., Ph.D., Dileep R. Yavagal, M.D., Blaise W. Baxter, M.D., Thomas G. Devlin, M.D., Ph.D., Demetrius K. Lopes, M.D., Vivek K. Reddy, M.D., Richard du Mesnil de Rochemont, M.D., Oliver C. Singer, M.D., and Reza Jahan, M.D., for the SWIFT PRIME Investigators*

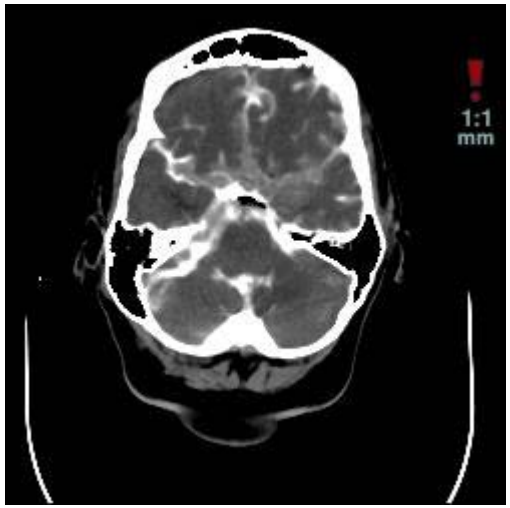
AHA/ASA Updated Guidelines

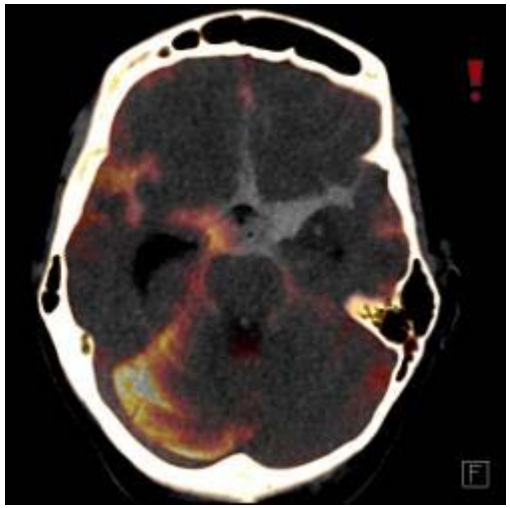
- Patients should receive endovascular therapy with a stent retriever if they meet all of the following criteria
  - Prestroke mRS score 0-1
  - Acute ischemic stroke receiving IV r-tPA within 4.5 hours of onset according to professional medical societies
  - Occlusion of the ICA or proximal MCA (M1)
  - 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

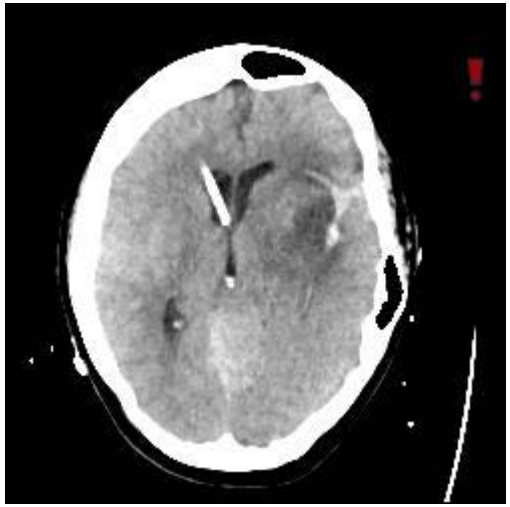
- 43 F mother of three, with PMH of HTN and HLD. Not a TPA candidate d/t low NIHSS. Transferred from OSH for fluctuation of symptoms. Initial NIHSS 1 by overnight coverage. LKW determined to be 0245. Worsened symptoms with NIHSS 8. CTA with LICA stenosis and Left M1 occlusion. Patient/Family consented.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

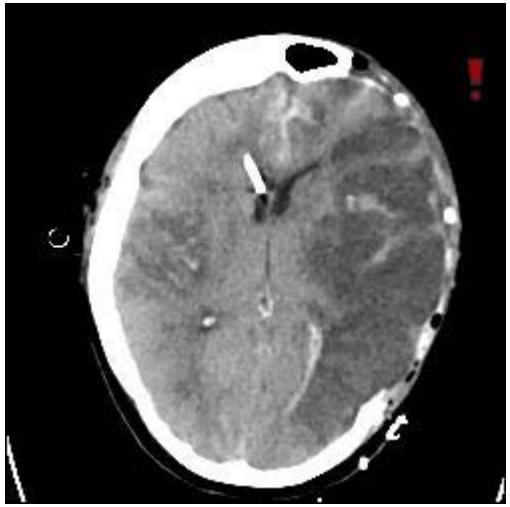




Case Study

- Hydrocephalus requiring EVD
- Refractory vasospasm with multiple spondioloysis
- 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

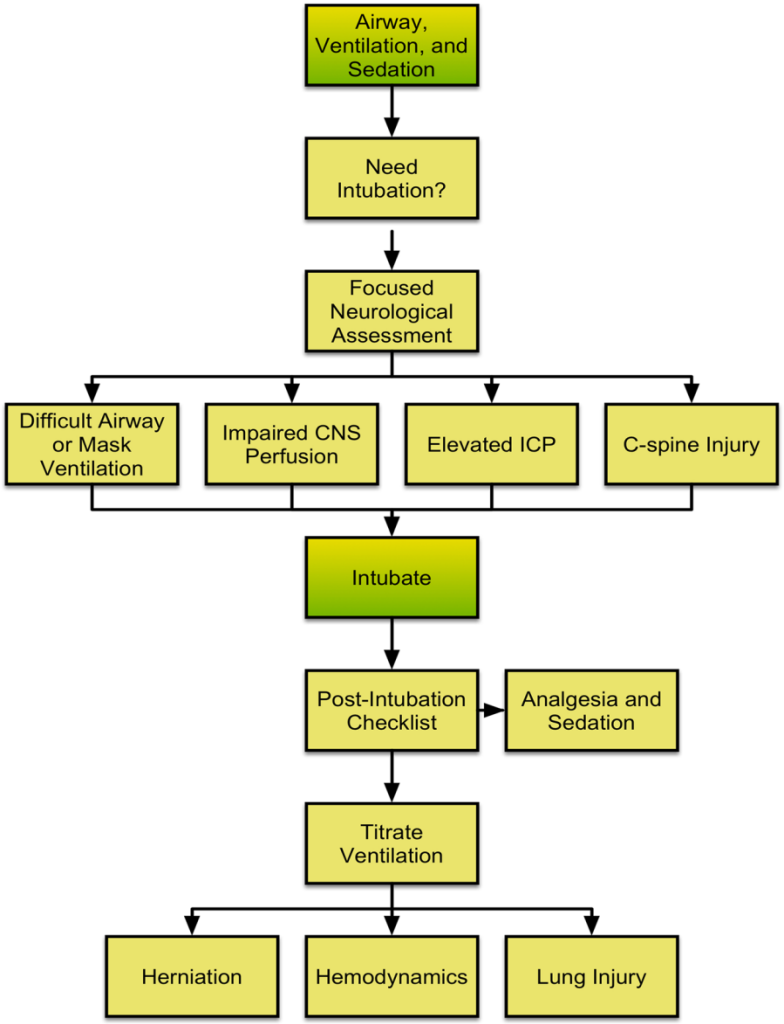
Acute Stroke Complications

- 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

Seder, D. B., Jagoda, A., & Riggs, B. (2015). Emergency Neurological Life Support: Airway, Ventilation, and Sedation. *Neurocritical Care Society*, S5-S22.

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

Seder, D. B., Jagoda, A., & Riggs, B. (2015). Emergency Neurological Life Support: Airway, Ventilation, and Sedation. *Neurocritical Care Society*, S5-S22.

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-orolingual angioedema
- Has been linked to ACE-Inhibitor use and hereditary deficiency in C1-esterase
  - Initial CT with ischemia in insular and frontal cortex

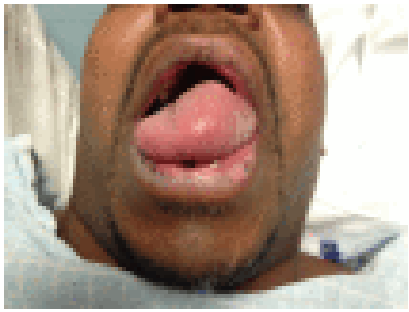
Monitoring for Angioedema

- 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

Summers, D., Leonard, A., Wentworth, D., Saver, J. L., Simpson, J., Spilker, J. A., . . . Mitchell, P. H. (2009). Comprehensive Overview of Nursing and Interdisciplinary Care of the Acute Ischemic Stroke Patient : A Scientific Statement From the American Heart Association. *Stroke*, 2911-2944.

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 Neurocritcial 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?

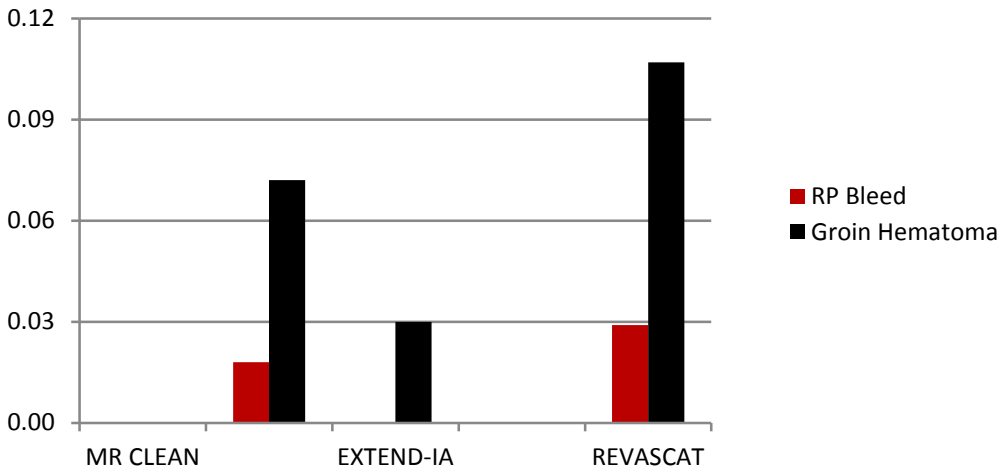
- Are these complications reasons to abort endovascular therapy?
  - No. Only Early Hemorrhagic Conversion should exclude a patient from endovascular therapy.

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



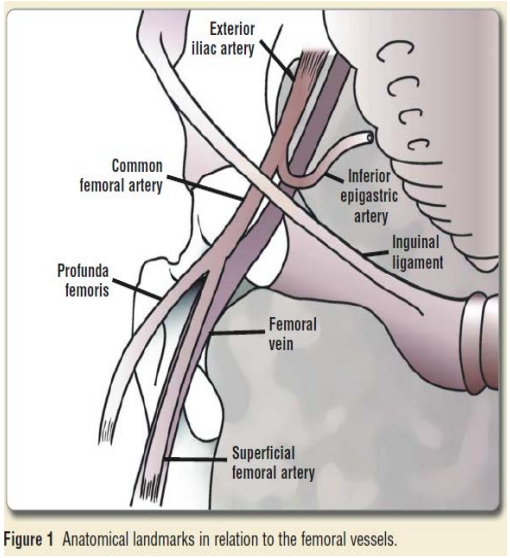


Figure 1 Anatomical landmarks in relation to the femoral vessels.

Merriweather, N., & Sulzbach-Hoke, L. M. (2012). Managing Risk of Complications at femoral Vascular Access Sites in Percutaneous Coronary Intervention. *Critical Care Nurse*, 16-29.

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

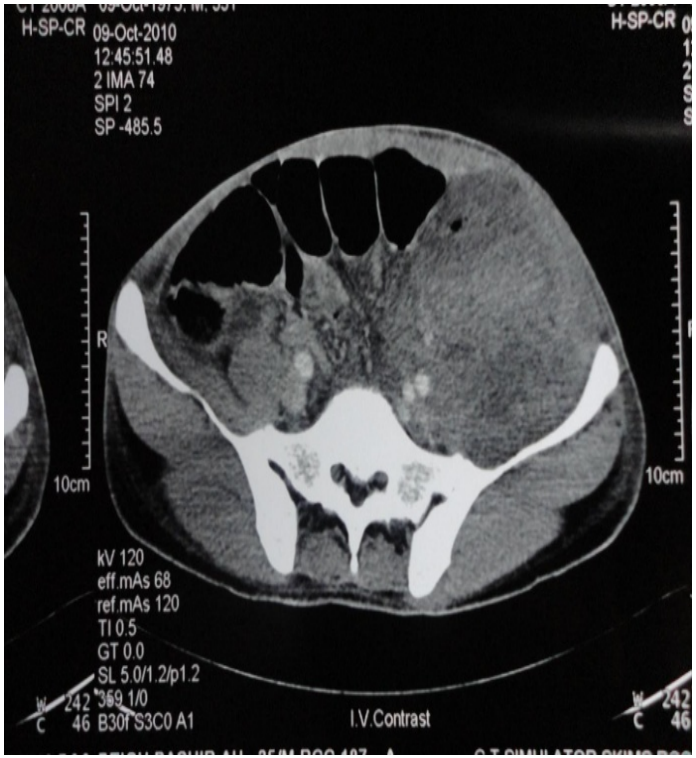
Merriweather, N., & Sulzbach-Hoke, L. M. (2012). Managing Risk of Complications at femoral Vascular Access Sites in Percutaneous Coronary Intervention. *Critical Care Nurse*, 16-29.

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



Merriweather, N., & Sulzbach-Hoke, L. M. (2012). Managing Risk of Complications at femoral Vascular Access Sites in Percutaneous Coronary Intervention. *Critical Care Nurse*, 16-29.

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

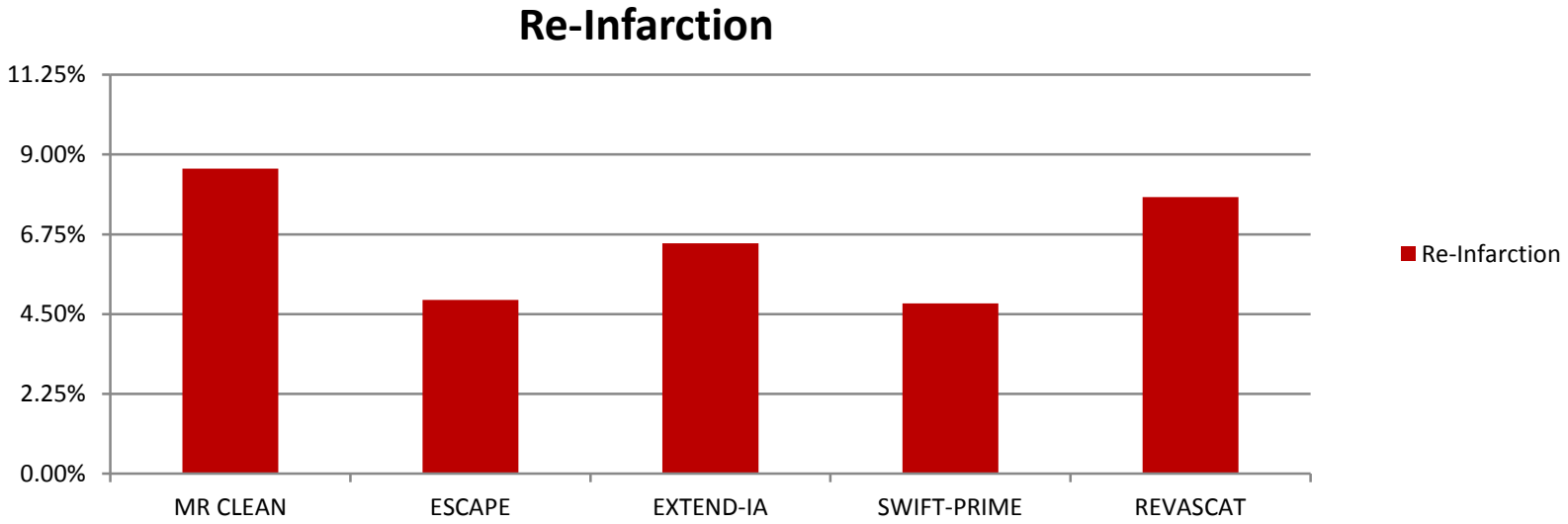
Loh, Y., McArthur, D., Vespa, P., Liebeskind, D., Jahan, R., Gonzalez, N., . . . Vinuela, F. (2010). The Risk of Acute Radiocontrast-Mediated Kidney Injury Following Endovascular Therapy for Acute Ischemic Stroke is Low. *American Journal of Neuroradiology*, 1584-1587.
low, T. R.-M. (2010). Loh, Y.; McArthur, D.L.; Vespa, P.;Shi, Z-S; Leibeskind, D.S.; Jahan, R.; Gonzalez, N.R.; Starkman, S.;Saver, J.L.; Tateshima, S.; Duckwiler, G.R.; Vinulea, F. *American Journal of Neuroradiology*, 1584-1587.

Treatment of RCM-AKI

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

low, T. R.-M. (2010). Loh, Y.; McArthur, D.L.; Vespa, P.;Shi, Z-S; Leibeskind, D.S.; Jahan, R.; Gonzalez, N.R.; Starkman, S.;Saver, J..; Tateshima, S.; Duckwiler, G.R.; Vinulea, F. *American Journal of Neuroradiology*, 1584-1587.

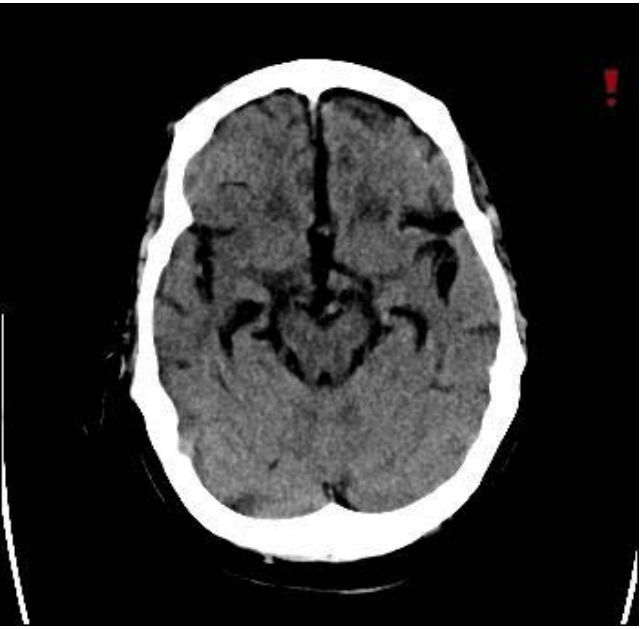
Re-Infarction

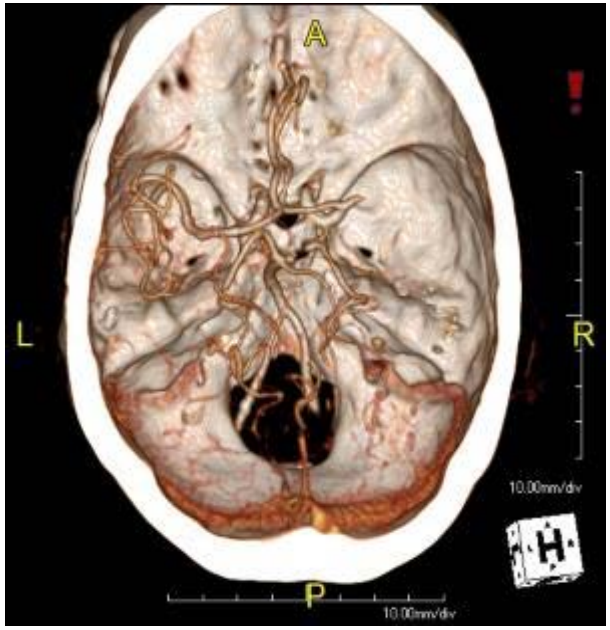


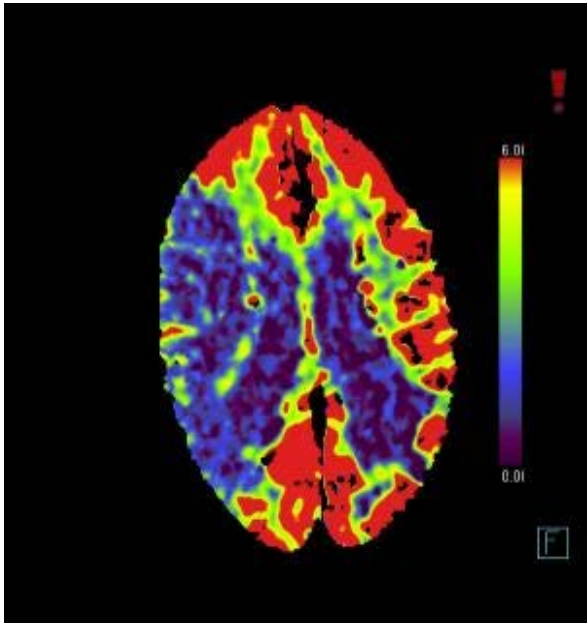
- Defined as embolization into a different vascular territory
  - Symptomatic and Asymptomatic
  - Up to 10-15% of patients with revascularization have re-occlusion
    - Some case reports of repeated endovascular therapy

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.



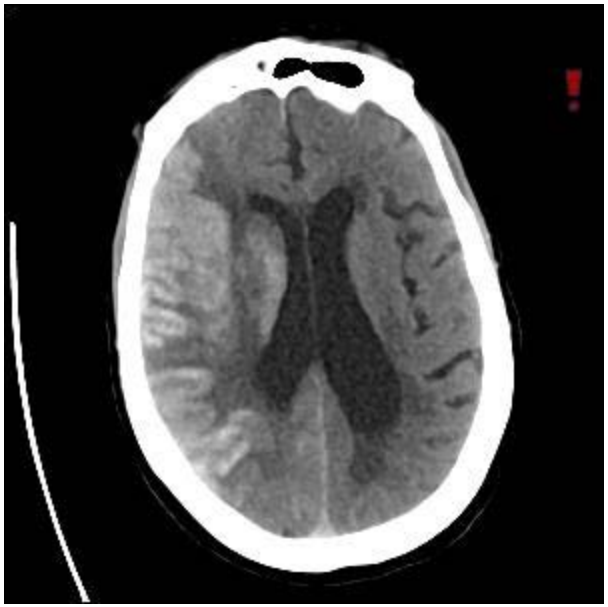




Case Study

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

Jung, S., Schindler, K., Findling, O., Mono, M.-L., Fischer, U., Gralla, J., . . . Galimanis, A. (2012). Adverse Effect of Early Epileptic Seizures in Patients Receiving Endovascular Therapy for Acute Stroke. *Stroke*, 1584-1590.

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.

Jung, S., Schindler, K., Findling, O., Mono, M.-L., Fischer, U., Gralla, J., . . . Galimanis, A. (2012). Adverse Effect of Early Epileptic Seizures in Patients Receiving Endovascular Therapy for Acute Stroke. *Stroke*, 1584-1590.

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

Jung, S., Schindler, K., Findling, O., Mono, M.-L., Fischer, U., Gralla, J., . . . Galimanis, A. (2012). Adverse Effect of Early Epileptic Seizures in Patients Recieving Endovascular Therapy for Acute Stroke. *Stroke*, 1584-1590.

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

Jung, S., Schindler, K., Findling, O., Mono, M.-L., Fischer, U., Gralla, J., . . . Galimanis, A. (2012). Adverse Effect of Early Epileptic Seizures in Patients Recieving Endovascular Therapy for Acute Stroke. *Stroke*, 1584-1590.

Hemorrhagic Conversion after Thrombolysis

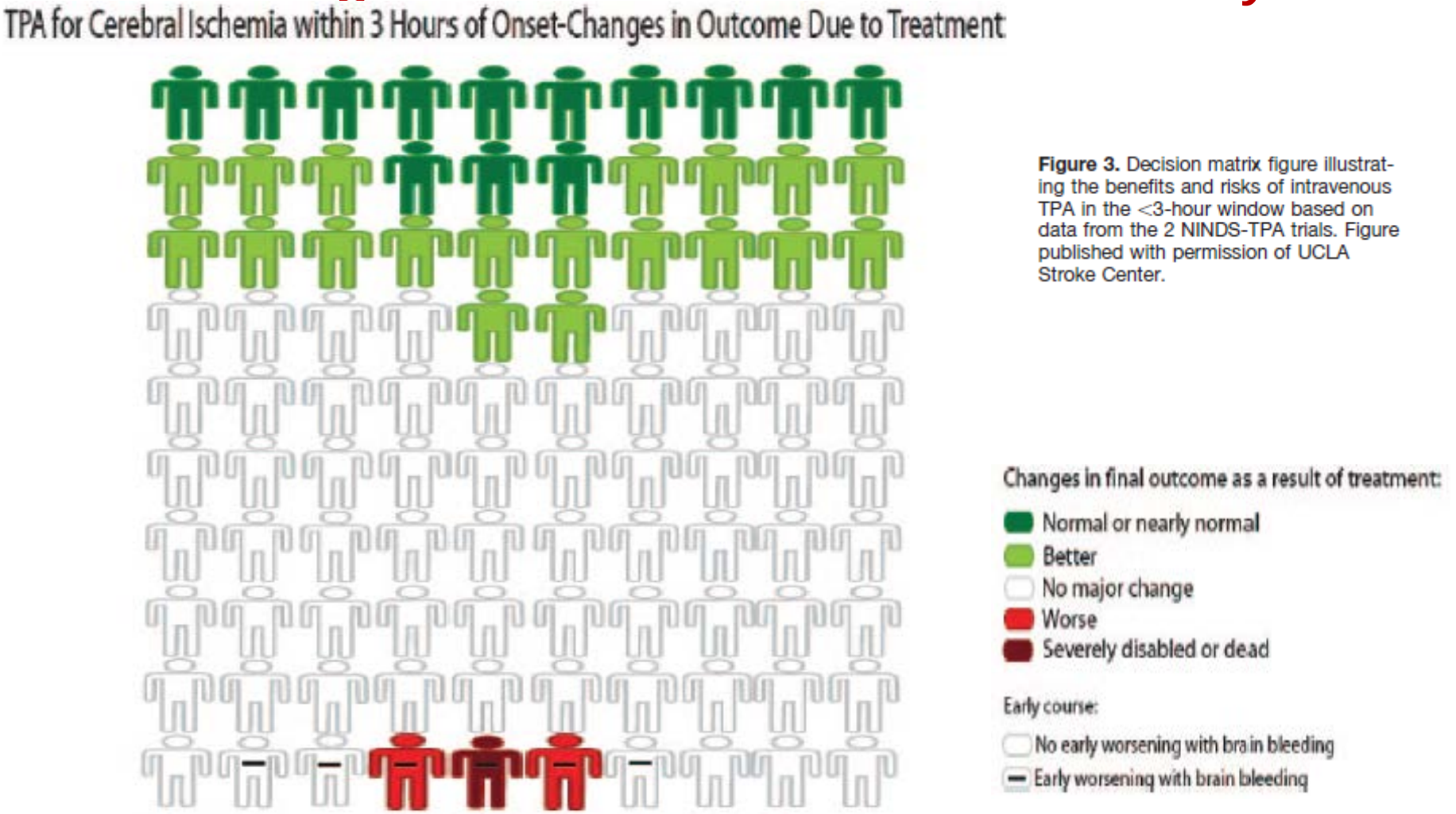


Figure 3. Decision matrix figure illustrating the benefits and risks of intravenous TPA in the <3-hour window based on data from the 2 NINDS-TPA trials. Figure published with permission of UCLA Stroke Center.

Lansberg, M. G., Schrooten, M., Bluhmki, E., Thijs, V. N., & Saver, J. L. (2009). Treatment Time-Specific Number Needed to Treat Estimates for Tissue Plasminogen Activator Therapy in Acute Stroke Based on Shifts Over the Entire Range of the Modified Rankin Scale. *Stroke*, 2079-2084.

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

Summers, D., Leonard, A., Wentworth, D., Saver, J. L., Simpson, J., Spilker, J. A., . . . Mitchell, P. H. (2009). Comprehensive Overview of Nursing and Interdisciplinary Care of the Acute Ischemic Stroke Patient : A Scientific Statement From the American Heart Association. *Stroke*, 2911-2944.

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

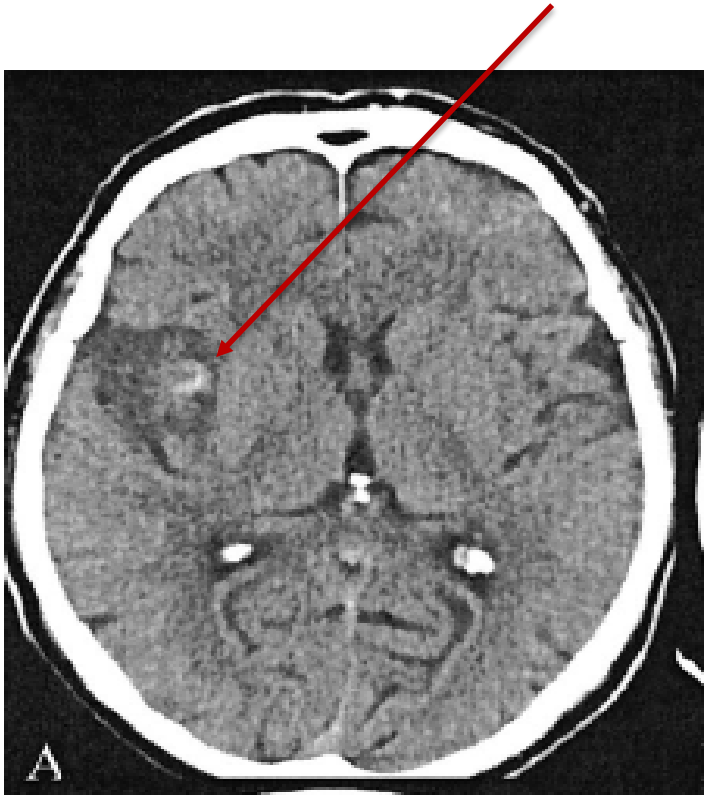
- Commonly used definition for Hemorrhagic Transformation (HT) is the ECASS-II radiological criteria
- HT after ischemic stroke can be divided into hemorrhagic infarction (HI) and parenchymatous hemorrhage (PH)
- Whether symptomatic or asymptomatic intracranial hemorrhages are a spectrum of severity 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

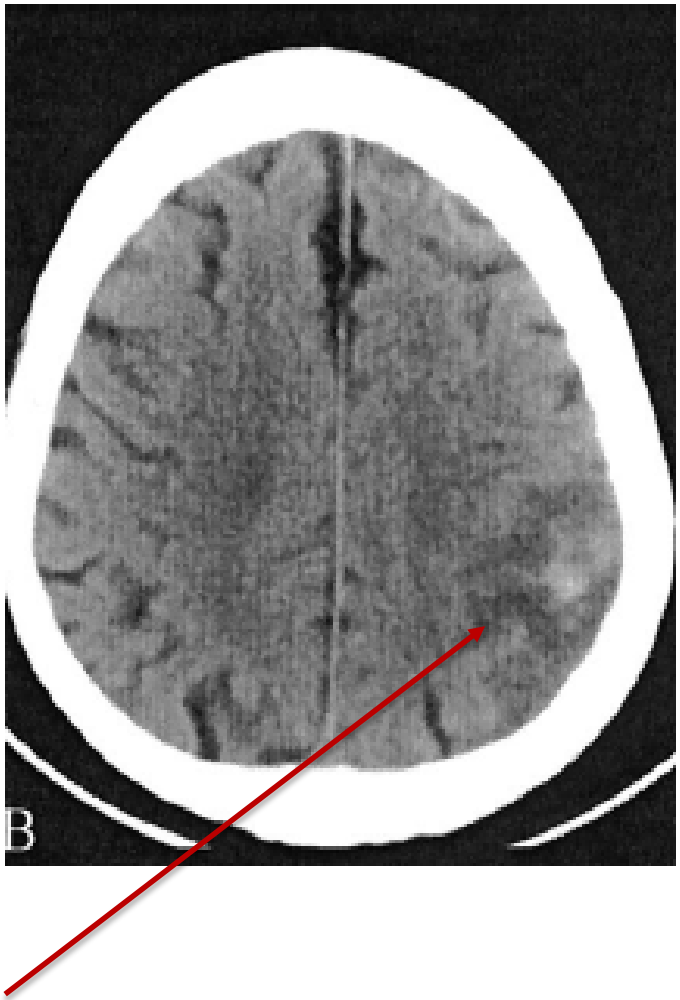
Classification of Hemorrhagic Conversion

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



Classification of Hemorrhagic Conversion

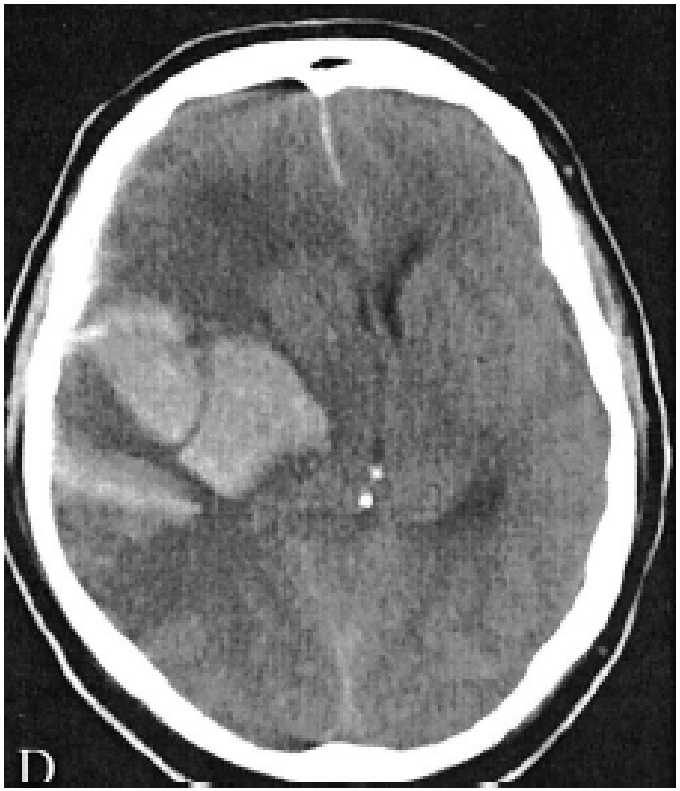
- Hemorrhage infarction type 2 (HI2)
  - More confluent hyperdensity throughout the infarct zone, without mass effect
- More confluent but still heterogeneous petechial within the infarcted area



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

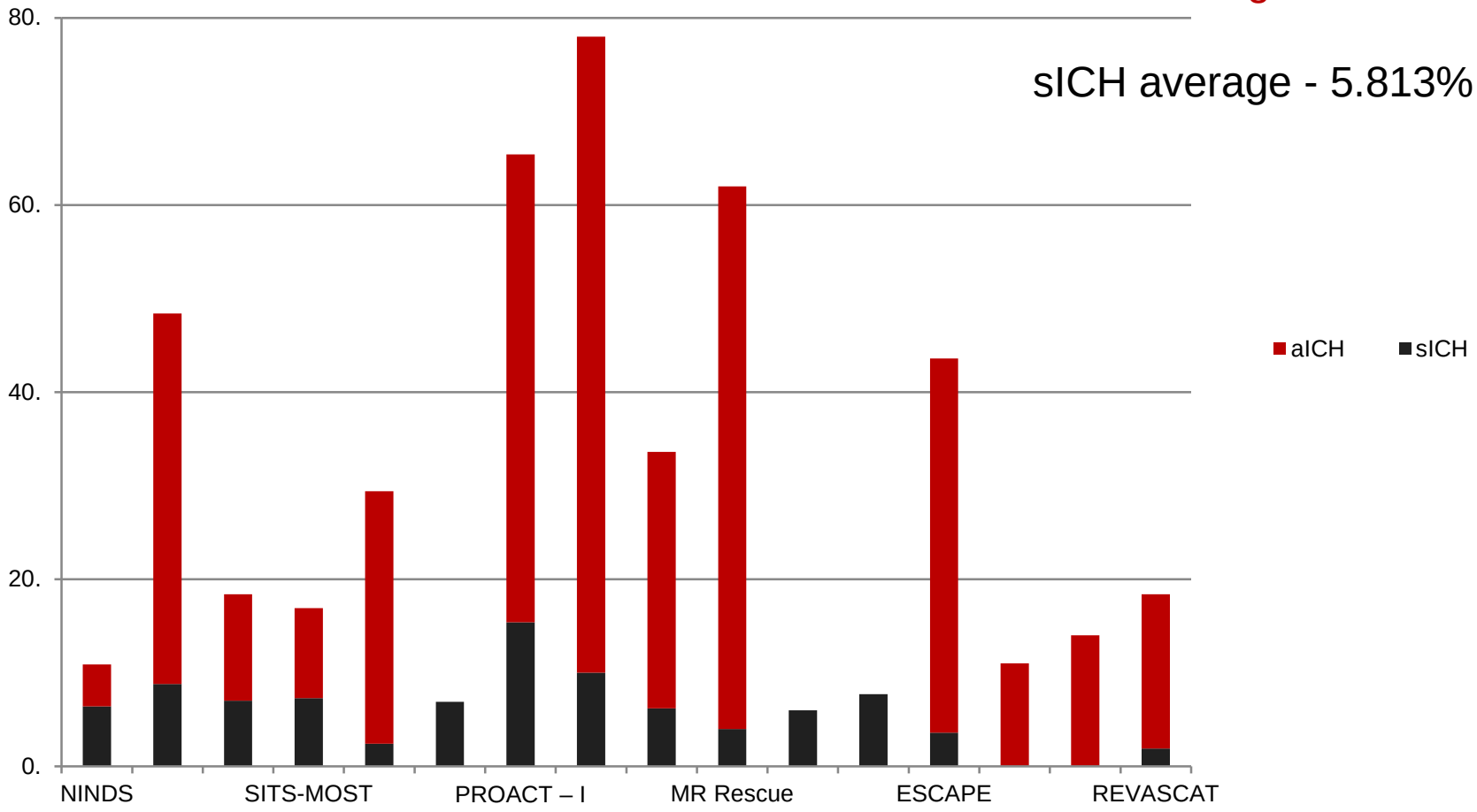


- Parenchymal hematoma type 2 (PH2)
  - Homogeneous hyperdensity occupying >30% of the infarct zone; significant mass effect.
  - Or any homogenous hyperdensity located beyond the boards of the infarct
- Dense hematoma >30% of the lesion volume with significant space-occupying effect

Prevalence of Hemorrhagic Conversion

aICH average - 31.041%

sICH average - 5.813%



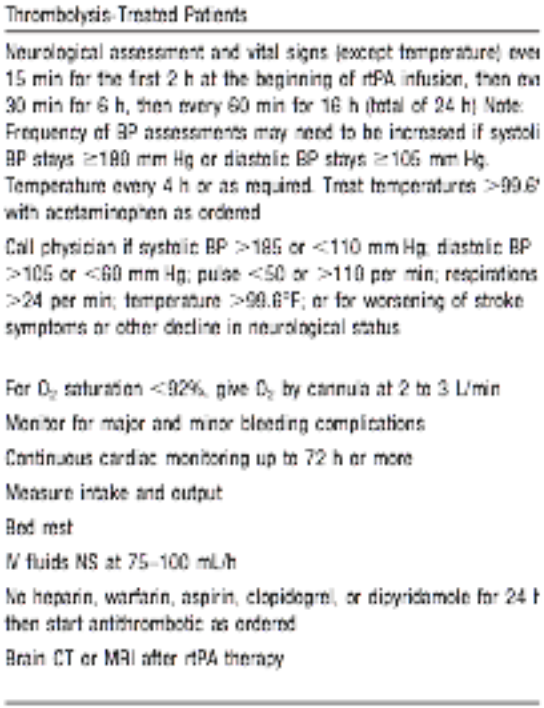
Standards for Nursing Care of Acute Stroke

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



Thrombolysis-Treated Patients

Neurological assessment and vital signs (except temperature) eve 15 min for the first 2 h at the beginning of rtPA infusion, then ev 30 min for 6 h, then every 60 min for 16 h (total of 24 h) Note: Frequency of BP assessments may need to be increased if systoli BP stays ≥180 mm Hg or diastolic BP stays ≥105 mm Hg. Temperature every 4 h or as required. Treat temperatures >99.6° with acetaminophen as ordered

Call physician if systolic BP >185 or <110 mm Hg; diastolic BP >105 or <60 mm Hg; pulse <50 or >110 per min; respirations >24 per min; temperature >99.6°F; or for worsening of stroke symptoms or other decline in neurological status

For O_2 saturation <92%, give O_2 by cannula at 2 to 3 L/min

Monitor for major and minor bleeding complications

Continuous cardiac monitoring up to 72 h or more

Measure intake and output

Bed rest

IV fluids NS at 75–100 mL/h

No heparin, warfarin, aspirin, clopidogrel, or dipyridamole for 24 h then start antithrombotic as ordered

Brain CT or MRI after rtPA therapy

Treatment for Hemorrhagic Conversion

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

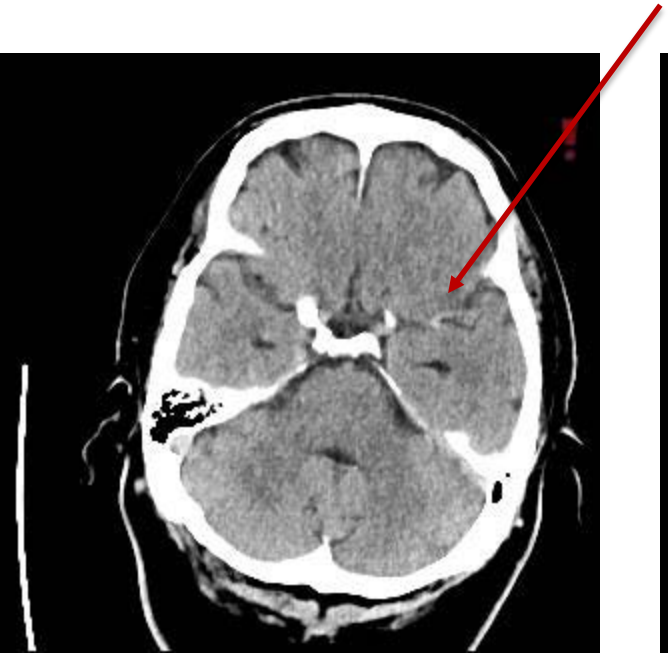
Summers, D., Leonard, A., Wentworth, D., Saver, J. L., Simpson, J., Spilker, J. A., . . . Mitchell, P. H. (2009). Comprehensive Overview of Nursing and Interdisciplinary Care of the Acute Ischemic Stroke Patient : A Scientific Statement From the American Heart Association. *Stroke*, 2911-2944.

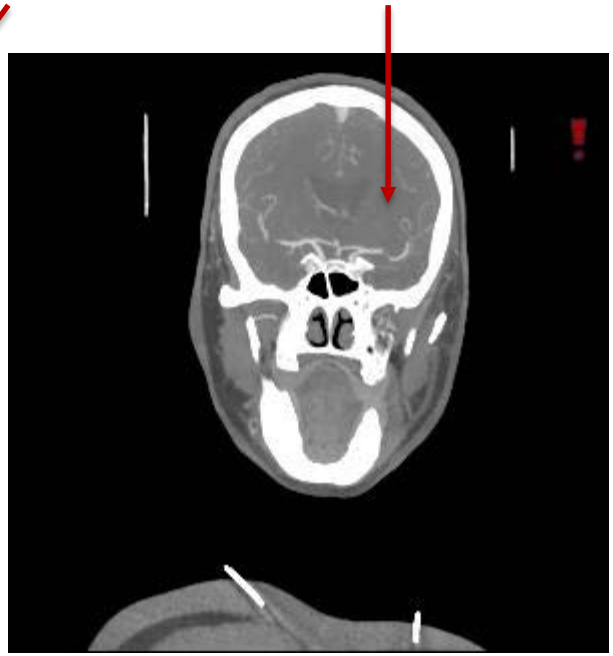
Treatment of Hemorrhagic Conversion

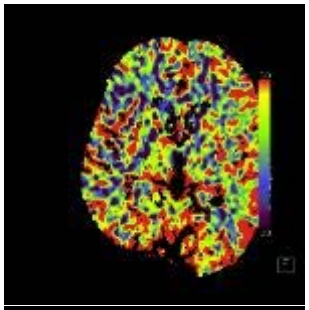
- Blood pressure management is crucial
  - Lack of definitive data
    - SBP 120-160 is reasonable
- If Subarachnoid hemorrhage is present treatment of vasospasm should be considered.
- Prophylactic AED's should be considered
- Ventriculostomy placement may be indicated if hydrocephalus is present
-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

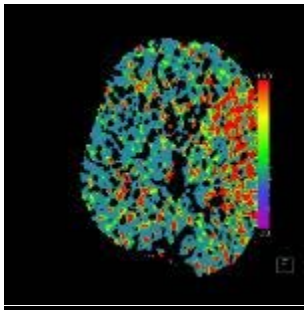
Case Study

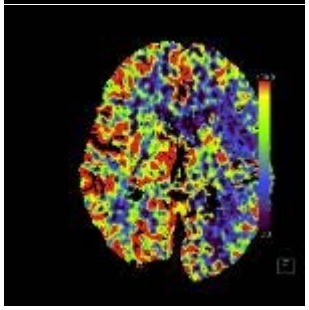
- 71 M with PMH of pAF (not on AC) d/t history of SAH and HTN. Presented to OSH with Right Hemiparesis and aphasia. NIHSS 29. No IV TPA administered d/t history. On arrival to OSU NIHSS 17. CTA with Left M1 occlusion, with large mismatch.

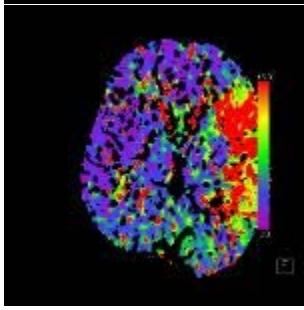






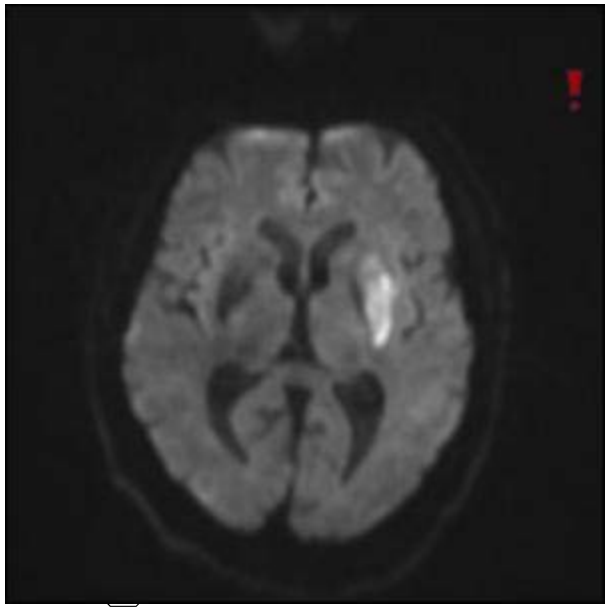






Case Study

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!

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