Thrombectomy in special populations: report of the Society of NeuroInterventional Surgery Standards and Guidelines Committee

Fawaz Al-Mufti,1 Clemens M Schirmer,2 Robert M Starke,3 Neeraj Chaudhary,4 Reade De Leacy,5 Stavropoula I Tjoumakaris,6 Neil Haranhalli,7 Isaac Josh Abecassis,8,9 Krishna Amuluru,10 Ketan R Bulsara,11 Steven W Hetts,12 On behalf of the SNIS Standards and Guidelines Committee and SNIS Board of Directors

ABSTRACT

Background The purpose of this guideline is to summarize the data available for performing mechanical thrombectomy (MT) for emergent large vessel occlusion (ELVO) stroke in special populations not typically included in large randomized controlled clinical trials, including children, the elderly, pregnant women, patients who have recently undergone surgery, and patients with thrombocytopenia, collagen vascular disorders, and endocarditis. Methods We performed a literature review for studies examining the indications, efficacy, and outcomes for patients undergoing MT for ischemic stroke aged <18 years and >80 years, pregnant patients, patients who have recently undergone surgery, and those with thrombocytopenia, collagen vascular diseases, or endocarditis. We graded the quality of the evidence. Results MT can be effective for the treatment of ELVO in ischemic stroke for patients over age 80 years and under age 18 years, thrombocytopenic patients, pregnant patients, and patients with endocarditis. While outcomes are worse compared to younger patients and those with normal platelet counts (respectively), there is still a benefit in the elderly (in both mRS and mortality). Data are very limited for patients with collagen vascular diseases; although diagnostic cerebral angiography carries increased risks, MT may be appropriate in carefully selected patients in whom untreated ELVO would likely result in disabling or fatal outcome.

RECOMMENDATIONS

1. Mechanical thrombectomy (MT) should not be withheld from octogenarians and nonagenarians, but rather be evaluated on a case-by-case basis. (class IIa-b, level B-NR and C-LD) 2. MT should not be withheld from thrombocytopenic patients. (class IIb, level C-LD) 3. There is no absolute minimum platelet count that excludes patients from MT given the high morbidity of emergent large vessel occlusion (ELVO). The expert panel considers <20K very concerning for potential hemorrhagic conversion of infarction or procedural complication, and hematologic consultation to understand the underlying etiology of extreme thrombocytopenia is reasonable. Some experts also consider platelet transfusion to be reasonable in patients with very low platelet count. (class IIb, level C-E0) 4. MT should not be withheld from neonates, infants, children, and adolescents, but rather be evaluated on a case-by-case basis. (class IIa-b, level B-NR and C-LD) 5. Standard techniques for radiation dose minimization (ALARA—as low as reasonably achievable) should be applied in diagnostic and therapeutic applications for pediatric stroke. (class I, level B-NR) 6. Where possible, and determined by local availability, initial radiologic work up of stroke in neonates, infants and children below the age of 10 should involve non-ionizing radiation, specifically MRI. (class IIa, level B-R) 7. Potential benefits and risks of MT should be evaluated on a case-by-case basis in patients with collagen vascular diseases with reference to the specific underlying disease. (class IIb-III, level C-E0) 8. Diagnostic catheter angiography in patients with collagen vascular disease carries increased risks; non-invasive imaging should be used whenever possible. (class III:Harm, level C-E0) 9. MT should not be withheld from patients who have recently undergone surgery. (class IIa, level C-LD) 10. MT should not be withheld from patients with endocarditis. (class IIb, level C-LD) 11. Endovascular thrombectomy is a safe and feasible procedure for treating acute ischemic stroke due to ELVO in pregnancy, and should be considered for patients in a similar manner as would be indicated in a non-pregnant patient. (class IIa, level C-LD) 12. Fluoroscopic radiation safety features should be fully used as well as a low threshold for anesthesia and obstetrics consultation in pregnant patients. (class IIb, level C-LD)

INTRODUCTION

The pendulum for the usefulness of mechanical thrombectomy (MT) for ischemic stroke treatment has gone from one extreme to another in recent years. Decades from now, 2015 will be remembered...
as a pivotal year in establishing it as the standard of care for large vessel occlusions. A pooled patient analysis of these trials concluded that MT in patients who met inclusion criteria led to significantly reduced disability compared with controls. For every 100 patients treated, 58 will have improved functional status compared with controls, and approximately 20 will achieve independence. As promising as the results have been in a relatively homogeneous population, the question of generalized applicability of these findings to a more heterogeneous population has been a topic of debate. Stroke systems of care predicated on these trials, as well as protocols to consider during the COVID-19 pandemic, have been extensively reviewed and incorporated into other standards and guidelines documents from the Society of NeuroInterventional Surgery. The majority of patients treated with MT in real-life practice, would probably not have qualified for inclusion in the clinical trials, but probably do benefit from treatment.

GUIDELINE SPECIFICs: CURRENT GUIDELINES FOR PATIENTS WITH EMERGENT LARGE VESSEL OCCLUSION ACUTE ISCHEMIC STROKE

Current US standards for the role of mechanical thrombectomy in emergent large vessel occlusion (ELVO) anterior circulation stroke are well summarized in the 2019 update to the 2018 guidelines for management of acute ischemic stroke published by the American Heart Association and American Stroke Association. Section 3.7 of that document includes guidelines on: (1) thrombectomy after intravenous thrombolysis, (2) thrombectomy 0 to 6 hours after last seen well, (3) thrombectomy 6 to 24 hours after last seen well, (4) anatomic targets, (5) thrombectomy techniques, (6) adjunctive antiplatelet and fibrinolytic medications, and (7) postprocedural blood pressure management. Table 1 below summarizes those recommendations as well as the class (strength) of recommendation and the level (quality) of evidence for each.

The American Heart Association (AHA)/American Stroke Association (ASA) guidelines are based on randomized controlled clinical trials such as DAWN, DEFUSE 3, ARISE 2, EXTEND-IA, REVASCAT, SWIFT-PRIME, ESCAPE, and MR CLEAN, all of which enrolled adult patients (18 years old or older) and some of which excluded very elderly patients (older than 80, 85, or 90 years in some trials, and also based on case series and expert opinion. In addition to extremes of age, other common criteria that have excluded patients from randomized trials are pregnancy, thrombocytopenia, active endocarditis, recent surgery, and collagen vascular disease. Patients who have one or more of these characteristics fall outside the mainstream of medical evidence to date and, thus, will be the focus of the remainder of this guideline document.

METHODS

We systematically reviewed the literature for manuscripts with the key word ‘stroke’ and any of the following: ‘mechanical thrombectomy’, ‘elderly’, ‘octogenarian’, ‘nonagenarian’, ‘pediatric’, ‘pregnant’, ‘pregnancy’, ‘thrombectomy’, ‘low platelets’, ‘collagen vascular disease’, ‘connective tissue disorder’, and ‘endocarditis’. These topics were chosen to reflect conditions not typically included in randomized controlled trials of stroke that were already published in 2020 or expected to be published in 2021. We graded evidence using the Oxford Centre for Evidence-Based Medicine guidelines and the American Heart Association guidelines, with the latter being applied to recommendations.

Octogenarians and nonagenarians

The proportion of elderly (≥65 years) individuals in the United States is expected to double by the year 2050, and people older than 80 years of age have the highest incidence of acute ischemic stroke. Thus, the proportion of patients aged ≥80 years who are eligible for endovascular therapy (EVT) for acute ischemic stroke (AIS) will continue to increase. This patient population was excluded from three of the six pivotal MT trials. Furthermore, this population was relatively under-represented in the trials that did include them, suggesting possible selection bias.

Several retrospective and prospective observational studies have reported MT for elderly patients. The generalizability of these studies is limited by small sample sizes, restriction to single centers, significant heterogeneity, and often without comparison with optimal medical management. Meta-analysis data from the Highly Effective Reperfusion evaluated in Multiple Endovascular Stroke trials (HERMES) trial showed better 90-day outcomes among patients aged >80 years treated with thrombectomy than for patients treated with intravenous thrombolysis alone (29.8% vs 13.9%; common OR=3.68, 95% CI 1.95 to 6.92). Additionally, elderly patients who underwent MT had a slightly reduced risk of death (28% vs 45%; adjusted ratio 0.60, 95% CI 0.36 to 0.99).

Hilditch et al performed a systematic review of 16 observational studies involving patients aged ≥80 years who underwent MT for AIS and combined this with data from the HERMES study. Among 860 patients, the authors showed a 27% rate of functional independence at 90 days (95% CI 21% to 32%), and a mortality of 34% (95% CI 23% to 44%), with significant heterogeneity between published reports (I²=70% and 91%, respectively). Although recanalization rates were excellent, 78% rate of Thrombolysis in Cerebral Infarction (TICI) 2b/3 recanalization (95% CI 72% to 85%), there was an 8% rate of symptomatic intracranial hemorrhage and a procedural complication rate of 11%.

Even before the major stroke trials, controversy existed as to whether or not MT for anterior circulation ELVO was efficacious in patients aged 80 or older, largely due to poor outcomes in most cases (ie, 60–70%) despite good recanalization rates (~80%). This is problematic since about one-third of ischemic strokes occur in patients of this age and are associated with particularly poor clinical outcomes. In 2016, the trial investigators collectively pooled the data into a collaboration from the MR CLEAN, ESCAPE, REVASCAT, SWIFT PRIME, and EXTEND-IA trials into HERMES and performed a meta-analysis to evaluate whether the benefit of MT persisted when applied to specific populations of patients that were relatively under-represented in the major trials. One of these populations included the elderly, as some of the trials excluded elderly patients (SWIFT PRIME excluded patients >80 years and REVASCAT excluded those >85 years), and the median age of subject in the trials when pooled was only 68. The authors found that although older age correlated with worse functional outcomes via the modified Rankin Scale (mRS), there remained a significant and fixed difference between the outcomes of the intervention (MT) and the non-intervention groups. Since then, more studies have emerged that evaluate technical feasibility with MT in the elderly and clinical outcomes, with mixed results. In the DAWN (diffusion-weighted imaging (DWI) or CTP Assessment with Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurointervention with Trevo) trial, the elderly were included but only with specific core infarct sizes and/or National Institutes of Health Stroke Scale (NIHSS).
score, and there was no dedicated age analysis. In the DEFUSE-3 (The Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke) trial, patients aged >80 years were excluded.

Online supplemental table 1 displays the various studies published, in chronological order, examining the relationship between elderly age and outcomes in MT. We identified 22 studies in the advanced elderly (ie, ≥80 years) and very old (ie, ≥90 years), four of which were meta-analyses, and a majority of which were retrospective, single-center analyses (10), with some multicenter studies (six), including two with national registry data. Half of the studies (11/22) performed an analysis dedicated to nonagenarians. The majority of relevant endpoints included 90-day mRS score, 90-day mortality, TICI score, and rates of symptomatic intracranial hemorrhage (sICH). A subgroup analysis of patients enrolled in MR CLEAN showed significant improvements in functional outcome with MT regardless of age or initial Alberta Stroke Program Early CT Score (ASPECTS).25 The collective HERMES data also showed
significant improvements in outcomes with the addition of MT, despite the overall rate of good outcome being lower than for younger patients. Many single-center retrospective studies have shown the technical feasibility of MT in the elderly, good recanalization rates, but low rates of good clinical outcomes. Some studies (including one that combines octogenarians and nonagenarians), show comparable clinical outcomes to those of younger patients. A few meta-analyses have shown poor outcomes in comparison with those for younger patients. Important to note, there are limited data comparing octogenarians receiving MT with those who did not receive MT as the comparison group, with a clear benefit in functional outcomes for the former.

Some studies (also listed in online supplemental table 1) have performed a dedicated analysis on patients who are ‘very old’ (ie, aged ≥90 years). Multiple multicenter retrospective studies show that MT is feasible in this population, but with low rates of good outcomes. These data were revalidated with additional national registry data from Germany. Some data from single-center studies also show that MT in nonagenarians is feasible, but with low rates of good outcomes, and a particularly high rate of hemorrhagic complications. Some data from single centers show no difference between octogenarians and nonagenarians or younger patients, and no difference in discharge disposition between younger patients (≥69 years) and nonagenarians. There has been one meta-analysis for this topic showing high revascularization rates in nonagenarians with low rates of good clinical outcomes.

Summary of data

- MT in octogenarians and nonagenarians is technically feasible with acceptable recanalization rates.
- Clinical outcomes, including 90-day mRS score and 90-day mortality, are improved in the elderly who receive MT compared with those who do not. Clinical outcomes in this population are worse than in younger patients (ie, aged <80) undergoing MT. It is unclear whether clinical outcomes in the very old are comparable, worse, or better in comparison with either the elderly or younger patients.
- Symptomatic intracranial hemorrhage (sICH) rates may be higher in elderly patients undergoing MT.

Recommendation

- MT should not be withheld from octogenarians and nonagenarians, but rather evaluated on a case-by-case basis. (class IIa-b, level B-NR and C-LD)

Patients with thrombocytopenia

There is a paucity of data guiding decisions for MT in thrombocytopenic patients (SWIFT PRIME and EXTEND IA excluded patients with platelet counts <100 K/μL, and DAWN and DEFUSE-3 excluded those <50 K/μL). This latter population is particularly vulnerable, since the American Heart Association and Eurorpean Stroke Organization guidelines from 2018 both suggest a platelet count of <100 K/μL to be a contraindication to IV tissue plasminogen activator (tPA).

We identified three studies evaluating the impact of thrombocytopenia in MT, of which one was a retrospective review of prospectively collected trial data, and two were retrospective single-center analyses (online supplemental table 2). Nogueira et al analyzed data retrospectively from the prospectively conducted MERCi and Merti MERCi trials. The authors identified a total of 35 patients with abnormal bleeding profiles, including thrombocytopenia (though only six of these 35 patients constituted this category), who underwent MT and compared outcomes with results for a group of 270 patients with normal bleeding profiles who underwent MT. Rates of sICH were comparable between the two groups, though the latter group did have better clinical outcomes, probably due to worse pre-stroke functional status. Mönch et al performed a retrospective analysis specifically examining thrombocytopenia (defined here as <150 K/μL). The authors also included patients who presented with normal platelet count but experience a drop in platelet count. There was no statistical difference in rates of sICH in any of the groups, though patients with a drop in platelet count had worse mortality and functional outcomes, and thrombocytopenic patients had higher mortality. Finally, Desai et al retrospectively reviewed patients and found largely no major differences in rates of sICH (ie, the authors used three separate definitions of sICH, and one did have statistically significant difference between groups), but worse functional outcomes and higher mortality in the thrombocytopenic group.

Summary of data

- MT in thrombocytopenic patients does not result in higher rates of sICH than in patients with normal platelets, though mortality is higher and clinical outcomes after treatment are worse, probably due to pre-existing morbidity.

Recommendations

- MT should not be withheld from thrombocytopenic patients. (class IIb, level C-LD).
- There is no absolute minimum platelet count that excludes patients from MT given the high morbidity of ELVO. The expert panel considers <20K very concerning for potential hemorrhagic conversion of infarction or procedural complication, and hematologic consultation to understand the underlying etiology of extreme thrombocytopenia is reasonable. Some experts also consider platelet transfusion to be reasonable in patients with very low platelet count. (class IIIb, level C-E0).

Pediatric patients with ELVO

The incidence of AIS in children is low at approximately 2.3 per 100 000 children but can be devastating with a very high morbidity of 70% and a mortality rate of 3–6%. While the cause of pediatric stroke is poorly understood, it can be divided into childhood/adolescent (non-neonatal) and neonatal age groups. In the childhood/adolescent age group, common etiologies include congenital heart disease, arterial dissection, and sickle cell disease. For example, the Canadian Pediatric Stroke Registry revealed cardiac disease to be the cause in 25% of cases of pediatric AIS. On the other hand, among cryptogenic strokes, a patent foramen ovale was found to be the cause in 40–50% cases as opposed to 10–27% in the general population. Less common causes include inflammatory vasculopathies, head and neck trauma, and pro-thrombotic disorders.

However, in a large number of cases, the cause is often not be identified. This has led to the diagnosis of idiopathic etiology of stroke of childhood. In childhood, arteriopathy may be due to spontaneous or traumatic dissections, or infectious etiology like varicella or moyamoya syndrome. Childhood pro-thrombotic disorders are broad and include antiphospholipid antibody, anticoagulant factor deficiencies, and hyperhomocysteinemia. In the neonatal population, the etiology is often more elusive but, in general, congenital cardiac anomalies and thrombophilia


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Pediatric stroke intervention poses access, device, and technique related challenges. Femoral access for intervention is necessary, though appropriate sheath size is dictated by the age of the patient, which roughly correlates to femoral artery diameter. In general, the femoral artery of neonates and children up to 12 months will accommodate a 4 French sheath. In older children and adolescents, a 6Fr sheath may be the limit. This access consideration restricts the choice of guide catheter, and at the time of writing removes the availability of a balloon guide catheter for sheath sizes less than 6Fr. Alternative approaches include the use of an aspiration/intermediate catheter in place of a dedicated guide, through which routine microcatheters and micro-guide wires may be used for navigation of the aspiration catheter or the delivery and deployment of stent retrievers.

The intracerebral vessels in children may be more fragile than those in the adult population and may be damaged by minimal manipulation with intraluminal devices. The force applied to the pediatric endothelium must be titrated according to the size of the child on the operating table and the size of the cervical and intracranial blood vessels. Aspiration catheter and/or stentriever selection should be appropriately calibrated to the target vessel size diameter. The larger 6Fr stentriever should be reserved for larger and older children. While complete reperfusion (TICI >3) should remain the goal of any stroke intervention, a lower threshold for terminating the procedure should arguably be made when multiple passes or more distal catheter positions would be required to achieve such a target. Given the current device-related limitations, one strategy has been the use of intraarterial tPA at the site of the ELVO. Despite limited proof for this strategy in the adult literature, the technique has been used in the pediatric population. Although the efficacy of intra-arterial lytic remains unproved, it might represent a potential last resort technique.

Currently, MT employs fluoroscopy which involves the application of ionizing radiation. As with all medical imaging-guided interventions, care should be taken to ensure the lowest possible dose of radiation is used to achieve the intended purpose of the intervention, also known as the ALARA (As Low As Reasonably Achievable) principle. While this principle should be applied to patients of all age groups, children are thought to be at particular risk of dose-dependent and -independent radiation-related effects (deterministic and stochastic). The dose reduction strategies employed for other pediatric neurointerventions and body interventions should be applied equally in stroke treatment. Strategies applied equally to the adult and pediatric population include: limiting the use of magnification, routine use of collimation, low pulse rates for fluoroscopy, minimizing the patient to detector distance, minimizing non-essential oblique projections, shielding radiosensitive organs where possible, and eliminating unnecessary digital subtraction angiograms. These measures can all substantially reduce the radiation exposure to both the patient and operator during MT procedures.

Post-thrombectomy care is critical in maximizing the benefits of recanalized vessels to the patients for translation to improved neurological function. Postoperatively, patients should be admitted to a pediatric or neonatal intensive care unit (ICU), with close attention to blood pressure goals and to minimize possibilities of reperfusion hemorrhage following recanalization. After recovery in the ICU, attention should be on aggressive rehabilitation with dedicated goal-directed physical therapy. In recent times, advances have been made in the understanding of neuronal functional recovery and how that might be optimized further by use of artificial intelligence and novel applications of both virtual and augmented reality rehabilitation platforms.
Patients with CVD are considered very high risk for endovascular procedures given the presumed increased risk of iatrogenic vessel dissection or rupture. Standard screening for intracranial aneurysms with diagnostic cerebral angiography is not generally recommended in these patients for these reasons.67 68 Historically, some studies have even advocated that conventional angiography is absolutely contraindicated as a diagnostic tool in patients with vascular Ehlers-Danlos syndrome.67 Additionally, transvenous approaches for treatment of intracranial fistulas, when possible, have been recommended as there is less risk of arterial injury.63 In the setting of carotid and vertebral artery dissections, evaluations with non-invasive imaging and medical management are the recommended standards. Despite the high risk of arterial injury, some patients may be refractory to medical management, necessitating endovascular interventions. Given the rarity of these cases, there have been no technical guidelines published for these patients. However, numerous case studies describe transarterial approaches to the stenting of carotid artery dissections, treatment of carotid-cavernous fistulas, and treatment of intracranial aneurysms using a standard endovascular technique and guidelines.2–75

Acute ischemic stroke is rare in CVD, but most reports are associated with cervical carotid or vertebral artery dissection. Additionally, cases of cerebral infarction secondary to intracranial steno-occlusive disease, with a moyamoya pattern, have been reported in neurofibromatosis 1 and pseudoxanthoma elasticum as well.66 67 69 There have been no reports in the literature, however, of AIS secondary to thromboembolism and no studies evaluating the use of MT in this patient population. Given this lack of data, major guidelines cannot be made about the safety and efficacy of neuroendovascular procedures in this population. However, although there are some reports of successful treatment, and no absolute contraindication to endovascular intervention can be made at this time, careful clinical consideration must be made when dealing with these patients.

Summary of data
► MT in patients with CVD may carry increased procedural risks, but this varies by the specific underlying CVD.

Recommendations
► Potential benefits and risks of MT should be evaluated on a case-by-case basis in patients with collagen vascular diseases with reference to the specific underlying disease. (class IIIb-III, level C-EO)
► Diagnostic catheter angiography in patients with CVD carries increased risks; non-invasive imaging should be used whenever possible. (class III:Harm, level C-EO)

Large vessel occlusion in patients following surgery
Acute ischemic stroke following surgery is a major cause of perioperative patient morbidity and mortality. The overall incidence of stroke is variable depending the type of procedure, with cardiothoracic surgeries having the highest risk.

One of the largest prospective institutional databases of nearly 6000 patients concluded that the average incidence of cerebrovascular ischemia was 2.48%; ELVO occurred in 10.9% of those patients.67 Prolonged aortic cross-clamp and cardiac bypass times were both associated with higher risk of AIS and specifically, ELVO. This suggests a synergistic effect of cerebral hypoperfusion and cardioembolic events as the mechanism of ischemia. Other suggested mechanisms of stroke in these patients are aortic atherosclerosis, cerebral hyperthermia, hyperglycemia, anemia,
atrial fibrillation, and genetic predisposition. In addition, the type of cardiac procedure was closely related to the incidence of AIS, which increased along with the complexity of the case. Bocken et al showed that the incidence of AIS in coronary artery bypass grafting (CABG) was 1.7%, CABG and valve replacement 3.3%, and multiple valve replacements 6.7%. In a Denmark cohort study of 2435 patients who underwent a transcatheter aortic valve replacement (TAVR) procedure, the overall risk of AIS was highest in the early postoperative phase (0–90 days) but not in the later phase (90 days–5 years). Patients who received anticoagulation during the early phase had nearly half the incidence of cerebral ischemic events as non-anticoagulated patients (1.2% vs 2.4%). Despite these data, the recommendation for prophylactic use of anticoagulants in these patients has yet to be determined.

The presentation of patients with ELVO is variable, based on the timing of the ischemic event. A JAMA article of a large prospective study of CABG over three decades showed that the timing of the event was intraoperative in 40% of patients and postoperative, with a peak at 40 hours after surgery, in 60%. Patients who have an intraoperative incidence of AIS, are less likely to be diagnosed promptly because of the duration of the surgery and long emergence from anesthesia, which does not allow for accurate neurological evaluation. Therefore, urgent CT angiography and perfusion imaging is indicated, especially in the first group of patients. If the deficit is detected promptly in the postoperative phase, then a non-contrast CT head and CT angiography are adequate for evaluation, based on the latest AHA/ASA guidelines. A thorough neurological examination protocol in the recovery unit should be strongly considered in cardiothoracic patients, in order to prevent delays in diagnosis and subsequent treatment.

Although data are limited on patient outcomes following mechanical thrombectomy for ELVO in perioperative AIS, most studies suggest that acute stroke intervention has a trend for improved functional outcomes and lower mRS scores in 3 months. Therefore, these patients should be strongly considered for the expanded window of MT based on individualized perfusion imaging data.

Following the detection of ELVO and AIS, the patient should be promptly transferred to the angiography suite. An implementation of a AIS protocol in the hospital is of paramount importance for fast detection and patient transportation. As these patients may present with cardiovascular instability, the presence of the cardiothoracic team and cardiopulmonary equipment allows for safe transportation. In the angiography suite, a thorough patient examination and communication with the primary team are required prior to choosing the arterial puncture site. If the patient still has arterial access from the original surgery, then using that site may expedite revascularization time. If bilateral femoral cutdowns were performed, such as in TAVR procedures, then a transradial approach should be considered instead. Conversely, if a radial artery harvest was used, then a transfemoral approach may provide faster access times.

Intraoperative considerations in these critical patients include the ability to administer anticoagulation or thrombolytic agents. A thorough communication with the original surgical team is essential to make this decision. In general, patients who undergo an open thoracic approach are not good candidates for intravenous tPA, but they may safely receive intravenous anticoagulants or local intra-arterial thrombolytic agents. However, endovascular procedures, such as TAVR, generally do not have contraindications for either thrombolytic or anticoagulation therapies. Furthermore, the consistency of the thrombus may be variable as non-traditional types, such as lipids from pericardial suction aspirate, muscle, and fat emboli, may be involved. These may have a harder consistency and require aspiration thrombectomy with large-bore aspiration catheters, as opposed to stent retrievers.

The postoperative care of cardiac patients following MT requires a comprehensive approach involving both cardiothoracic and neurological teams. In general, a cardiac care unit with neurological protocol should be strongly considered. There are limited data, and therefore no recommendation, for postoperative medical management with antiplatelet or anticoagulation agents, therefore physician discretion is strongly advised.

**Summary of data**
- MT in patients who have recently undergone surgery can be successful and is especially important to consider given that surgery is a contraindication to intravenous thrombolysis.

**Recommendations**
- MT should not be withheld from patients who have recently undergone surgery (class IIa, level C-LD)

**Endocarditis**
Predicated on the high risk of hemorrhagic transformation, the use of thrombolytic agents is generally accepted as contraindicated if the etiology of infective endocarditis is suspected, making MT the de facto only option for intervention. To establish the odds of a favorable outcome in the particular population, it is necessary to note that the rate of neurologic complications during hospitalizations for infective endocarditis is high and associated with an increased risk of death. Large strokes, due to their association with ELVOs, the target population considered here, have been found to be independently associated with mortality compared with patients who had transient ischemic attacks or small strokes that remained clinically silent.

D’Anna performed an extensive review of the literature using the PRISMA framework. His conclusions represent the currently highest quality data point. He reports results of 30 patients reported in 19 published case series out of 431 screened records. Overall, MT was as effective as in patients presenting with ELVOs due to non-endocarditis etiologies. The median NIHSS score dropped from 15 before to 2.5 after the procedure. An intracranial hemorrhage occurred in 13.3% of patients, and the overall mortality at 90 days was 23.3%. Functional independence with an mRS score of less than 2 was achieved in 46.7% of patients. Of the notable randomized trials that established the usefulness of MT for large vessel occlusion, the results of this analysis were worse than some, but not all, falling somewhere in the middle: EXTEND-IA SWIFT PRIME showed 71% and 60% good outcome, respectively, and MR CLEAN showed 33%. A less rigorous review by Bolognese and coworkers found a similar number of favorable outcomes, defined here as mRS score ≤3 in 69% of patients.

MT in patients with ELVO presumed to be the result of infective endocarditis has not been formally studied with a randomized controlled trial. Such a trial seems unlikely given the agreed-upon unfavorable outcome of the use of thrombolytic agents. Therefore, MT appears to be a reasonable option, with the understanding that its general safety and efficacy have not been established with high-quality data.
Summary of data
- MT in patients with endocarditis appears to carry similar risks and benefits to those in patients without endocarditis.

Recommendations
- MT should not be withheld from patients with endocarditis (class IIb, level C-LD)

Pregnancy
The incidence of stroke in pregnancy in the USA, Western and Asian countries ranges from 4.3 to 210 per 100 000 gestations. Management of acute ischemic stroke due to large vessel occlusion in a pregnant patient is challenging, given the considerations for the developing fetus. In the largest study of stroke in pregnancy and the post partum period, Kittner et al found that the risk of stroke was greatest during the third trimester or puerperium, rather than throughout the entire 9 months of pregnancy. Although certain conditions have a particularly strong association with stroke in pregnancy (such as eclampsia), or with the post partum period (such as cerebral venous thrombosis), most cerebral infarctions are due to arterial occlusion.

Administration of thrombolytic agents in pregnancy for suspected stroke is a complex decision with limited evidence. Pregnancy was an exclusion criterion in all IV thrombolysis trials, and formal studies examining the effects of thrombolytic agents on the outcomes of human pregnancy do not exist. Alteplase (tPA) is far too large a molecule to cross the placenta, and there are no quality human or animal data documenting the teratogenicity of thrombolytic agents. More than 200 reports exist in the literature of pregnant patients who have received thrombolytic therapy for various indications.

Gartman systematically reviewed reports of pregnant patients who received tPA for neurologic indications (ie, acute stroke, venous sinus thrombosis), and showed no maternal deaths, no major bleeding events, and three fetal deaths/spontaneous abortions (none of which were attributed to thrombolytic administration). Complication rates of tPA in pregnancy are comparable with those in non-pregnant patients, with overall low risks of maternal mortality (1%), maternal hemorrhage (8%), and fetal loss (6%). The current AHA/ASA guidelines recommend IV tPA administration be considered when the expected benefits of treating life-threatening or potentially debilitating stroke outweigh the risk of uterine bleeding. Pregnancy was an exclusion criterion in the pivotal EVT clinical trials, and thus data from controlled clinical trials do not exist. Emergent EVT on the pregnant woman, like any other, requires the use of sedation and/or analgesics, iodinated contrast, and ionizing radiation. Neurointerventionalists should have a low threshold for consulting an anesthesiologist, especially for more complex cases, agitated patients, and/or for high-risk pregnancies. Iodinated contrast is a category B medication, and animal studies have not reported teratogenic or mutagenic effects from exposure. Human studies have not demonstrated any inhibitory effect of free iodide on neonatal thyroid gland function.

The National Council on Radiation Protection and Measurements states that radiation exposure less than 50 mGy to the radiation risk to the fetus is considered negligible in comparison with baseline risks for all developmental abnormalities, but this risk increases significantly when exposure exceeds 150 mGy. The most important prenatal risk and deterministic effects occur at 8 to 15 weeks after conception, when the sensitive cortical brain cells are exposed to radiation greater than the threshold of 300 mGy. EVT procedures can involve cumulative radiation doses of approximately 1600±500 mGy. However, all available evidence and expert opinion suggest the determinimistic risks of radiation exposure should not be taken into consideration when deciding on whether to perform EVT. Notwithstanding, neurointerventionalists should fully use fluoroscopic radiation safety features as endorsed by the Society of Interventional Radiology and according to ALARA principles. An experienced interventionalist (rather than a trainee) should perform as primary operator when possible, again in support of reduced fluoroscopy times. Other strategies include reducing the rate of pulsed fluoroscopy, use of last image hold, limiting the beam on-time, minimizing angiography acquisitions, limiting the use of magnification, using tight collimation, raising the patient away from the X-ray tube, minimizing the image intensifier–patient distance, removing the grid, reducing the tube current, and limiting femoral angiography.

Use of lead shielding does not provide significant protection, but may lend a positive psychological reassurance to patients and their families. The safety and feasibility of EVT of ELVO in pregnancy is based solely on single-center case reports and one small case series, for a total of 14 patients. When examining these historical cases, despite the procedural diversity, 93% (13/14 subjects) achieved a TICI 2b or higher grade of recanalization, and all patients with follow-up data had an mRS score of 0–2 at final follow-up. Delivery outcomes consisted of seven normal full-term deliveries, one spontaneous abortion, two full-term Cesarean sections, one emergency Cesarean section with delivery of a healthy newborn, and three cases of unknown delivery status. No maternal or fetal deaths were reported. EVT is seemingly a safe and feasible procedure for treating AIS due to ELVO in pregnancy, and should be considered for patients presenting as such.

Doppler fetal monitoring should be performed in the first trimester and beyond, immediately before and after the procedure, to ascertain the health of the fetus. In certain circumstances, such as high-risk pregnancy and higher levels of sedation/analgesia, continuous fetal monitoring during the procedure may be appropriate. Postprocedurally, patients should receive an obstetrics consultation, and postprocedure fetal ultrasound is obtained in the first trimester to evaluate fetal viability.

Summary of data
- MT in pregnant patients is technically feasible with acceptable rates of recanalization and maternal and fetal clinical outcomes.

Recommendations
- Endovascular thrombectomy is a safe and feasible procedure for treating AIS due to ELVO in pregnancy, and should be considered for patients in a similar manner as would be indicated in a non-pregnant patient. (class IIa, level C-LD)
- Fluoroscopic radiation safety features should be fully used as well as a low threshold for anesthesia and obstetrics consultation in pregnant patients. (class IIb, level C-LD)

CONCLUSIONS
Further studies are needed in patients excluded from ‘standard’ thrombectomy and randomized trials. As technology and techniques for thrombectomy continue to develop, evaluating their application to diverse patient populations with a variety of features or conditions that have excluded them from earlier studies is essential.

trials is essential for appropriate dissemination of care. Given the rarity of some of these conditions, large randomized controlled trials may be impossible. Pragmatic design of multicenter trials and registries can help us better understand treatment for these patients.

Author affiliations
1Department of Neurology and Neurosurgery, Westchester Medical Center, Valhalla, New York, USA
2Department of Neurosurgery, Geisinger Health System, Wilkes-Barre, Pennsylvania, USA
3Department of Neurosurgery & Radiology, University of Miami Miller School of Medicine, Miami, Florida, USA
4Department of Radiology, University of Michigan Health System, Ann Arbor, Michigan, USA
5Department of Neurosurgery, Icahn School of Medicine at Mount Sinai, New York, New York, USA
6Department of Neurological Surgery, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA
7Department of Neurosurgery, Montefiore Hospital and Medical Center, Bronx, New York, USA
8Department of Neurosurgery, University of Miami School of Medicine, Miami, Florida, USA
9Department of Neurological Surgery, University of Washington, Seattle, Washington, USA
10Department of Interventional Neuroradiology, Goodman Campbell Brain and Spine, Philadelphia, Pennsylvania, USA
11Division of Neurosurgery, University of California, San Francisco, California, USA

Twitter Reade De Leacy @rdeleacymd and Isaac Josh Abecassis @drjoshabecassis


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ORCID iDs Clemens M Schirmer http://orcid.org/0000-0003-1743-8781
Stavropoulou I Tijmakaris http://orcid.org/0000-0002-1054-9414
Steven W Hett http://orcid.org/0000-0001-5885-7259

REFERENCES
2 Demchuk AM. Yes, intravenous thrombolysis should be administered in pregnancy when other clinical and imaging factors are favorable. Stroke 2013;44:864–5.
Standards


56 The image Gently Allc. Available: https://imagegently.org


<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Country</th>
<th>Patients</th>
<th>Type of Study</th>
<th>Primary Group (n)</th>
<th>Comparison Group (n)</th>
<th>Major Endpoints</th>
<th>Outcomes</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>Duffis et al.</td>
<td>2014</td>
<td>Multiple (8 Studies)</td>
<td>2,729</td>
<td>Meta-Analysis</td>
<td>≥ 80 years (467)</td>
<td>&lt; 80 years (2,262)</td>
<td>90DmRS, sICH, 90Dmortality, TIMI</td>
<td>&gt; 80 compared to &lt;80: TIMI 2-3 OR = 0.814, p=0.364, sICH OR = 1.604 p=0.04, mortality OR = 3.695 p&lt;0.001</td>
<td>&lt;80 compared to &gt;80: 90DmRS&lt;3 OR = 2.694, p&lt;0.001</td>
</tr>
<tr>
<td>Parrilla et al.</td>
<td>2015</td>
<td>Spain</td>
<td>150</td>
<td>Retrospective, Single Center</td>
<td>≥ 80 years (34)</td>
<td>&lt; 80 years (116)</td>
<td>TICI, sICH, PostProcedure NIHSS, 90DmRS, 90Dmortality</td>
<td>&gt; 80: TICI &gt; 2b =88.2%, sICH = 5.9%, PostProcedureNIHSS = 9.7, 90DmRS&lt;3 =13.8%, mortality = 35.2%</td>
<td>&lt; 80: TICI &gt; 2b = 93.9%, sICH = 2.6%, PostProcedureNIHSS = 6.5, 90DmRS&lt;3 = 56.9%, mortality = 17.2%</td>
</tr>
<tr>
<td>Hwang et al.</td>
<td>2015</td>
<td>Korea</td>
<td>156</td>
<td>Retrospective, Single Center</td>
<td>&gt; 80 years +EVT (56)</td>
<td>&gt; 80 years NO EVT (100)</td>
<td>90DmRS, 1yrmRS, sICH, 90Dmortality</td>
<td>EVT: 90DmRS&lt;3 = 35.7%, 1yrmRS &gt; 35.7%, sICH = 10.7%, mortality = 12.5%</td>
<td>NO EVT: 90DmRS&lt;3 = 11%, 1yrmRS = 14%, sICH = 2%, mortality = 8%</td>
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<tr>
<td>Goyal et al.</td>
<td>2016</td>
<td>Multiple (5 Trials)</td>
<td>198</td>
<td>Retrospective Analysis of Prospective Trial Data</td>
<td>≥ 80 years +EVT (107)</td>
<td>≥ 80 years NO EVT (91)</td>
<td>90DmRS, 90Dmortality</td>
<td>≥ 80 +EVT vs. NO EVT: mortality = 28% versus 45%, 90DmRS&lt;2 OR = 3.68</td>
<td></td>
</tr>
<tr>
<td>Khan et al.</td>
<td>2017</td>
<td>USA</td>
<td>193</td>
<td>Retrospective, Multiple (2) Centers</td>
<td>≥ 90 years (18)</td>
<td>&lt; 90 years (175)</td>
<td>90DmRS</td>
<td>≥ 90: 90DmRS&lt;3 = 11% &lt; 90: 90DmRS&lt;3 = 48%</td>
<td>Older age, higher initial NIHSS, and lower degree of recanalization independent predictors of poor outcome</td>
</tr>
<tr>
<td>Mohlenbruch et al.</td>
<td>2017</td>
<td>Germany</td>
<td>29</td>
<td>Retrospective, Single Center</td>
<td>≥ 90 years (29)</td>
<td>None</td>
<td>TICI, 90DmRS</td>
<td>TICI ≥ 2b = 75.9%, 90DmRS &lt; 3 = 17.2%</td>
<td>Low complication rate (only 1 minor), so suggest not excluding the elderly from MT</td>
</tr>
<tr>
<td>Alawieh et al.</td>
<td>2018</td>
<td>USA</td>
<td>1,346</td>
<td>Retrospective, Multiple (7) Centers</td>
<td>≥ 80 years (346)</td>
<td>&lt; 80 years (1,000)</td>
<td>TICI, sICH, 90DmRS</td>
<td>&lt; 80: TICI ≥ 2b = 88%, sICH = 4%, 90DmRS&lt;3 = 44%  ≥ 80: TICI ≥ 2b = 88%, sICH = 7%, 90DmRS&lt;3 = 21%</td>
<td>Age ≥ 80 independently predicted increased mortality and poor outcome, regardless of technique (ADAPT versus SOLUMBRA), location (anterior versus posterior circulation), or TICI</td>
</tr>
<tr>
<td>Hilditch et al.</td>
<td>2018</td>
<td>Multiple (17 Studies)</td>
<td>860</td>
<td>Systematic Review and Meta-Analysis</td>
<td>≥ 80 years (860)</td>
<td>None</td>
<td>TICI, sICH, 90DmRS &lt; 3</td>
<td>TICI ≥ 2b = 78%, sICH = 8%, 90DmRS&lt;3 = 27%</td>
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<tr>
<td>Authors</td>
<td>Year</td>
<td>Country</td>
<td>n</td>
<td>Design</td>
<td>Age Groups</td>
<td>Endovascular Treatment</td>
<td>NIHSS, mRS, mortality, sICH</td>
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<tr>
<td>Wu et al.</td>
<td>2019</td>
<td>China</td>
<td>23</td>
<td>Retrospective, Multiple (2) Centers</td>
<td>&gt; 90 years +EVT (14) &gt; 90 years NO EVT (9)</td>
<td>EVT: PostProcedure NIHSS = 0, 90DmRS&lt;3 = 71.4%, 90Dmortality = 28.6%, sICH = 0% NO EVT: PostProcedure NIHSS = 12, 90DmRS&lt;3 = 44.4%, 90Dmortality = 33.3%, sICH = 33.3%</td>
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<tr>
<td>Sussman et al.</td>
<td>2019</td>
<td>USA</td>
<td>108</td>
<td>Retrospective, Single Center</td>
<td>90-99 years (29) 80-89 years (79)</td>
<td>TICI, sICH, 90DmRS&lt;3, 90Dmortality &gt;90: TICI ≥2b = 79%, 90DmRS&lt;3 = 12.5%, sICH = 21.4%, 90Dmortality = 63% &gt;80: TICI ≥2b = 79%, 90DmRS&lt;3 = 19.7%, sICH = 6.4%, 90Dmortality = 40.9%</td>
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<tr>
<td>Meyer et al.</td>
<td>2019</td>
<td>Germany</td>
<td>79</td>
<td>Retrospective, Multiple (3) Centers</td>
<td>≥ 90 years (79) None</td>
<td>TICI, TTR, sICH, 90DmRS ≥90: TICI ≥2b = 69.6%, TTR &lt; 39 min, sICH = 5.1%, 90DmRS &lt; 3 = 16% No predictors of good outcome in subgroup analysis</td>
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<tr>
<td>Kawabata et al.</td>
<td>2019</td>
<td>Japan</td>
<td>59</td>
<td>Retrospective, Single Center</td>
<td>≥ 80 years (19) &lt; 80 years (40)</td>
<td>TICI, 90DmRS, 90Dmortality ≥90: TICI ≥2b = 89.5%, 90DmRS &lt; 3 or stable from preOP = 47.4%, 90Dmortality = 21.1% ≥80: TICI ≥2b = 67.5%, 90DmRS &lt; 3 or stable from preOP = 45%, 90Dmortality = 27.5% IV tPA, TICI &gt; 2b, and out of hospital onset independent predictors of good outcome</td>
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<tr>
<td>Majidi et al.</td>
<td>2020</td>
<td>USA</td>
<td>113</td>
<td>Retrospective, Single Center</td>
<td>≥ 80 years (113) None</td>
<td>TICI, TTR, sICH, 90DmRS&lt;3 (Good Outcome) TICI ≥2b = 89%, TTR &lt; 53 min, sICH = 5%, 90DmRS &lt; 3 = 22% (those with mRS &lt; 3 baseline), and stable = 32% Subgroup analysis of those with favorable outcomes at 90D compared to those with unfavorable (56), only difference was baseline NIHSS (14 versus 19, p = 0.03). Anesthesia subtype did not affect outcomes</td>
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<tr>
<td>Pinto et al.</td>
<td>2020</td>
<td>Portugal</td>
<td>144</td>
<td>Retrospective, Single Center</td>
<td>≥ 90 years (16) ≥ 80 years, &lt; 90 years (128)</td>
<td>TICI, TTR, sICH, 90DmRS&lt;3 (Good Outcome) &gt;90: TICI ≥2b = 81.3%, sICH = 6.3%, 90DmRS&lt;3 = 31.3% &gt;80: TICI ≥2b = 87.5%, sICH = 3.1%, 90DmRS&lt;3 = 22.6% No significant differences between 2 groups</td>
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<tr>
<td>Agarwal et al.</td>
<td>2020</td>
<td>USA</td>
<td>205</td>
<td>Retrospective, Single Center</td>
<td>≥ 90 years (46, 39 included in propensity) ≤ 69 years (159, 39 included in propensity)</td>
<td>Good discharge disposition (home, rehab), sICH, TICI ≥90: good discharge = 44%, sICH = 2.6%, TICI ≥2b = 90% ≤69: good discharge = 51%, sICH = 10.3%, TICI ≥2b = 90% Used propensity score matching to account for confounders. No major differences between the groups</td>
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<tr>
<td>Meyer et al.</td>
<td>2020</td>
<td>Germany</td>
<td>203</td>
<td>Retrospective, Multiple (3) Centers, Plus National Registry Data</td>
<td>≥ 90 years (203) None</td>
<td>TICI, sICH, 90DmRS&lt;3 (Good Outcome) TICI ≥2b = 75.9%, sICH = 3%, 90DmRS ≤ 3 = 21.6%, mortality = 27.1, 90Dmortality = 48.9% ASPECT score and NIHSS independent predictors of good outcome</td>
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<tr>
<td>Andrews et al.</td>
<td>2020</td>
<td>USA</td>
<td>403</td>
<td>Retrospective, Single Center</td>
<td>80-89 (86), and ≥ 90 years (14) &lt;80 years (303)</td>
<td>TICI, mortality, dischargemRS &lt;80: TICI ≥2b = 87.1%, mortality = 11.8%, sICH = 10.9%, dischargemRS&lt;2 = No differences between groups</td>
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<tr>
<td>Study</td>
<td>Year</td>
<td>Country</td>
<td>Sample Size</td>
<td>Design</td>
<td>Age Group</td>
<td>Methodology</td>
<td>Outcome Measures</td>
<td>Details</td>
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<tr>
<td>Janssen et al.</td>
<td>2020</td>
<td>Belgium, Switzerland, Canada, Sweden</td>
<td>112</td>
<td>Retrospective, Multiple (3) Centers, Plus National Registry Data</td>
<td>≥ 90 years (112)</td>
<td>None</td>
<td>TICI, 90Dmortality, 90DmRS</td>
<td>after multivariate modeling</td>
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<tr>
<td>Ahn et al.</td>
<td>2020</td>
<td>Korea</td>
<td>82</td>
<td>Retrospective, Single Center</td>
<td>≥ 80 years (82)</td>
<td>None</td>
<td>90DmRS</td>
<td>younger age and lower pre-stroke mRS independent predictors of good clinical outcomes</td>
<td></td>
</tr>
<tr>
<td>Ospel et al.</td>
<td>2020</td>
<td>Netherlands</td>
<td>3,279</td>
<td>Retrospective analysis of Prospectively collected data, National Registry, Subgroup Analysis</td>
<td></td>
<td></td>
<td></td>
<td>Benefit in all groups, regardless of age or ASPECT</td>
<td></td>
</tr>
<tr>
<td>Zhao et al.</td>
<td>2020</td>
<td>Multiple (16 Studies)</td>
<td>3,954</td>
<td>Systematic Review and Meta-Analysis</td>
<td>≥ 80 years (1,059), &lt; 80 years (2,895)</td>
<td></td>
<td></td>
<td>Better outcomes noted for studies published between 2017 and 2019 compared to earlier</td>
<td></td>
</tr>
<tr>
<td>Bai et al.</td>
<td>2021</td>
<td>Multiple (13 Studies)</td>
<td>657</td>
<td>Systematic Review and Meta-Analysis</td>
<td>≥ 90 years (657)</td>
<td>None</td>
<td>90DmRS, 90Dmortality, sICH, TICI</td>
<td></td>
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<tr>
<td>Fujita et al.</td>
<td>2021</td>
<td>Japan</td>
<td>150</td>
<td>Retrospective Analysis of Prospective National Registry Data (46 centers)</td>
<td>≥ 90 years +EVT (49), ≥ 90 years NO EVT (101)</td>
<td>None</td>
<td>90DmRS, sICH</td>
<td>EVT group had significantly higher ASPECT, shorter time to LKW, and more frequent IV tPA, all</td>
<td></td>
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</tbody>
</table>

**Outcome Measures:**
- **TICI:** Thrombolysis in Cerebral Infarction score
- **90DmRS:** 90-day modified Rankin Scale
- **90Dmortality:** 90-day mortality
- **sICH:** Symptomatic intracranial hemorrhage

**Outcome Details:**
- **34.7%:** 80-89: TICI > 2b = 84.9%, mortality = 8.1%, sICH = 7%, discharge mRS = 28.6%
- **80-89: TICI > 2b = 84.9%, mortality = 8.1%, sICH = 7%**
- **80-89: TICI > 2b = 100%, mortality = 7.1%, sICH = 7.7%**
- **80-89: TICI > 2b = 74.6%, 90Dmortality = 62.3%, 90DmRS < 3 = 16.4%**
- **80-89: TICI > 2b = 74.6%, 90Dmortality = 62.3%, 90DmRS < 3 = 16.4%**
- **80-89: TICI > 2b = 74.6%, 90Dmortality = 62.3%, 90DmRS < 3 = 16.4%**
- **80-89: TICI > 2b = 74.6%, 90Dmortality = 62.3%, 90DmRS < 3 = 16.4%**
may have confounded analysis.
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Country</th>
<th>Patients</th>
<th>Type of Study</th>
<th>Primary Group (n)</th>
<th>Comparison Group (n)</th>
<th>Major Endpoints</th>
<th>Outcomes</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nogueira et al.</td>
<td>2008</td>
<td>Multiple</td>
<td>305</td>
<td>Retrospective analysis of prospective trial data</td>
<td>Abnormal Bleeding = INR &gt; 1.7 or PTT &gt; 45 sec or platelet &lt; 100K/ul (35)</td>
<td>Normal Bleeding = INR ≤ 1.7 and PTT ≤ 45 sec and platelet ≥ 100K/ul (270)</td>
<td>Abnormal: TIMI 2-3 = 60%, sICH = 8.6%, 90DmRS &lt;3 = 9%</td>
<td>Normal: TIMI 2-3 = 65%, sICH = 8.5%, 90DmRS &lt;3 = 35%</td>
<td>Only 6/35 (17%) of the primary group had thrombocytopenia. Abnormal bleeding group also had worse pre stroke health states, likely confounding results</td>
</tr>
<tr>
<td>Monch et al.</td>
<td>2019</td>
<td>Germany</td>
<td>294</td>
<td>Retrospective, single center</td>
<td>Initial thrombocytopenia (&lt; 150K/ul) (29)</td>
<td>Normal Platelet (≥ 150 K/ul) (265)</td>
<td>sICH, 90Dmortality, 90DmRS</td>
<td>Thrombocytopenia: sICH = 10.3%, 90Dmortality = 48.3%, 90DmRS&lt;3 = 24%</td>
<td>Only significant difference was mortality. No adjustment for prestroke functional status. Also performed analysis of patients with and without a drop in platelet counts (DPC) after presentation, showing that a DPC &gt; 26% predicted mortality and worse clinical outcomes too</td>
</tr>
<tr>
<td>Desai et al.</td>
<td>2019</td>
<td>USA</td>
<td>555</td>
<td>Retrospective, single center</td>
<td>Thrombocytopenia (&lt;150K/ul) (74)</td>
<td>Normal Platelet (≥ 150 K/ul) (481)</td>
<td>sICH, 90Dmortality, 90DmRS</td>
<td>Thrombocytopenia: sICH = 8.1-10.81%, 90Dmortality = 43.24%, 90DmRS&lt;3 = 24.32%</td>
<td>Mortality and mRS worse. Used 3 separate definitions of sICH, with one having a statistical difference between groups, but 2 others did not. Performed subgroup analysis stratifying thrombocytopenic patients into (1) &lt;100K/ul and (2) 100-150K/ul, with no real differences. Multivariate analysis: thrombocytopenia not related to rate of sICH.</td>
</tr>
</tbody>
</table>