Endovascular thrombectomy versus medical management for acute basilar artery occlusion stroke in the elderly

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ORIGINAL RESEARCH

Endovascular thrombectomy versus medical management for acute basilar artery occlusion stroke in the elderly

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ABSTRACT

BACKGROUND AND PURPOSE: The efficacy and safety of endovascular thrombectomy (EVT) for elderly basilar artery occlusion (BAO) stroke patients is unclear.

MATERIALS AND METHODS: This was an explorative retrospective analysis of the 2016-21 National Inpatient Sample in the United States. Elderly BAO stroke patients (80 years or older) with NIH stroke scale of at least 5 were included. Primary outcome was discharge to home. Secondary outcomes include in-hospital mortality and intracranial hemorrhage (ICH). Outcomes were compared between patients treated with EVT and those treated with medical management (MM) alone. Propensity score matching (PSM) was performed to control for confounders. Subgroup analyses were conducted for patients who did and did not receive intravenous thrombolysis (IVT).

RESULTS: 2,520 elderly BAO patients were identified; 830 received EVT, and 1,690 received MM alone. After PSM, 1,115 patients and 715 patients remained in the MM and EVT groups, respectively. Compared to PSM controls, EVT was not significantly associated with different rates of home discharge (17.5% vs. 12.2%, OR 1.36 [95%CI 0.76-2.44], p=0.30) or in-hospital mortality (31.5% vs. 32.9%, OR 1.00 [95%CI 0.63-1.60], p=0.99), but it was significantly associated with higher rates of ICH (18.2% vs. 7.3%, OR 2.69 [95%CI 1.41-5.15], p=0.003). Among patients who did not receive IVT, EVT was significantly associated with higher rates of home discharge (21.5% vs. 11.5%, OR 1.93 [95%CI 1.02-3.66], p=0.044), whereas EVT was not significantly associated with the same among those treated with IVT (5.6% vs. 15.0%, OR 0.28 [95%CI 0.05-1.46], p=0.13). Interaction analysis revealed that IVT was a negative modulator of EVT's positive association with home discharge (interaction p=0.031).

CONCLUSIONS: EVT was not significantly associated with more favorable hospitalization outcomes for elderly BAO stroke patients, and it was significantly associated with increased risk of ICH. EVT may be an effective treatment for patients who did not receive IVT.

ABBREVIATIONS: EVT = endovascular thrombectomy; BAO = basilar artery occlusion; ICH = intracranial hemorrhage; MM = medical management; PSM = propensity score matching; IVT = intravenous thrombolysis.

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SUMMARY SECTION

PREVIOUS LITERATURE: While recent randomized controlled trials showed that EVT for acute BAO stroke may be safe and effective in carefully selected patients, there remains a dearth of clinical data on the risks and benefits of BAO-EVT for the elderly stroke population.

KEY FINDINGS: In this nationwide study of 2,520 elderly BAO stroke patients aged 80 years or older, we found that EVT was not significantly associated with more favorable short-term hospitalization outcomes compared to MM. The efficacy of EVT appeared to be significantly influenced by IVT treatment, and EVT was associated with significantly improved outcomes for patients who did not receive IVT.

KNOWLEDGE ADVANCEMENT: These findings highlight important nuances in patient selection for BAO-EVT in the elderly population and identifies IVT treatment as a significant effect modulator.

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INTRODUCTION

Endovascular thrombectomy (EVT) is an effective treatment for acute ischemic stroke due to intracranial large vessel occlusion (LVO)[1,2]; however, its benefit over medical management for elderly stroke patients is less clear[3,4]. Elderly patients are an important and unique subgroup of stroke patients. Higher comorbidity burden, baseline cognitive deficits, leukoariosis, and reduced neuroplasticity have all been suggested to contribute to overall lower likelihood of good neurological outcomes despite successful stroke reperfusion treatment[3,5,6]. Despite these obstacles, currently available clinical data suggests that EVT is still likely beneficial for elderly stroke patients with anterior circulation LVOs, and current guidelines do not recommend restricting anterior circulation EVT treatment based on age alone[7,8].

While EVT may be effective for elderly stroke patients with anterior circulation LVO, whether this is true for basilar artery occlusion (BAO) is largely unknown. Historically, patient selection for BAO-EVT has been challenging. Early trials in 2020 and 2021 (BEST[9] and BASICS[10], respectively) failed to demonstrate BAO-EVT's efficacy, likely contributing to the employment of more stringent clinical and radiographical inclusion/exclusion criteria for the later positive ATTENTION[11] and BAOCHE[12] trials in 2023. With more stringent patient selection, the elderly population was significantly under-represented in the 2023 trials. In the ATTENTION trial[11], only 37 participants (out of a total of 340) were 80 years or older, and EVT was not significantly associated with significantly higher odds of good neurological outcomes in this subgroup. In the BAOCHE trial[12], patients older than 80 years were excluded. As such, there is currently no high-level clinical evidence of BAO-EVT's effectiveness among the elderly.

In this study, we performed an explorative analysis of a nationwide database of elderly patients (80 years or older) hospitalized for acute BAO stroke to investigate the comparative efficacy and safety of EVT and medical management (MM).

MATERIALS AND METHODS

Study Design

This was a retrospective study of the 2016 to 2021 National Inpatient Sample (NIS) database[13]. The NIS, which is part of the Healthcare Cost and Utilization Project (HCUP), is a database of stratified discharge information in the United States representing 20% of all hospitalizations. The NIS contains no patient identifiers; thus, this analysis was exempt from informed consent or institutional review board approval under the Health Insurance Portability and Accountability Act. This study complies with the STROBE guideline for retrospective cohort studies (supplementary materials).

Patient Population

Elderly patients (80 years or older) with basilar artery occlusion stroke were identified using International Classifications of Diseases – Tenth Revision – Clinical Modification (ICD-10-CM) codes. Patients with concomitant stroke in the anterior circulation were excluded. Finally, patients with minor stroke symptoms (NIH stroke scale less than 5) were excluded. All ICD-10 codes used in this study are detailed in Supplementary Table 1. The main study exposure of interest was endovascular thrombectomy, angioplasty, or stenting, which were identified using ICD-10-Procedural Coding System (ICD-10-PCS) codes (Supplementary Table 1). Patients were separated into the EVT and the non-EVT (medical management [MM]) arms.

Study Endpoints

The primary endpoint of this study was discharge to home with or without services. While routine discharge to home without services is a more commonly used endpoint for NIS studies and was the primary endpoint of the BARONIS study[14], elderly patients may have baseline disability and may already be using home services prior to stroke. Thus, routine discharge to home with self-care was included as a secondary endpoint. Other secondary endpoints include in-hospital mortality and any intracranial hemorrhage (ICH) identified by ICD-10-CM codes (Supplementary Table 1).

Other Variables of Interest

Patient age and sex were recorded. Stroke characteristics such as NIH stroke scale (NIHSS), intravenous thrombolysis (IVT) treatment, and stroke etiology (embolic, thrombotic, or unspecified), and additional sites of vascular occlusion (vertebral, cerebellar, and/or posterior cerebral arteries) were captured using ICD-10-CM codes. Comorbidities such as atrial fibrillation, hypertension, hyperlipidemia, smoking, diabetes, and dementia were also captured with ICD-10-CM codes, as were chronic use of antithrombotic medicines. Elixhauser comorbidity index was calculated for each patient to estimate overall medical comorbidity burden, and hospital length of stay (LOS) information was also collected for each patient.

Statistical Methods

Total numbers of patients were calculated using discharge-level weights. Patient characteristics were presented as mean (SD) or percentage (n), and differences between treatment arms were assessed using standardized mean difference (SMD), where values greater than 0.10 indicate substantial differentiation. The primary statistical model of this study was propensity score matching, where a multivariable regression model accounting for all covariables captured in this study was used to calculate propensity scores, and one-to-two nearest neighbor matching with maximum distance of 0.05 was performed to match EVT patients with similar MM patients. To compare differences in study outcomes between treatment groups, odds ratios and 95% confidence intervals were generated between the PSM cohorts. Comparisons between the unmatched cohorts were also reported, and multivariable logistic or Poisson regression models for the unmatched cohorts accounting for all captured variables in this study were used for sensitivity analyses. Secondary analyses that were decided *a priori* include assessments of the impact of ICH on outcomes as well as EVT outcomes stratified by IVT administration. In secondary analyses, an interaction term of IVT and EVT were introduced to identify the presence of significant effect modulation. Additional sensitivity analyses considering only patients who did not receive angioplasty or stenting were also conducted. P-values less than 0.05 were deemed statistically significant. All statistical analyses were performed using R, Version 3.6.2.

RESULTS

Patient Characteristics

2,520 patients hospitalized for acute BAO stroke were identified; 830 received EVT, and 1,690 received medical management alone. Among EVT patients, 105 (12.7%) received endovascular angioplasty or stenting. Differences in patient characteristics in the two treatment cohorts are presented in **Online Supplemental Data**. Compared to MM, EVT patients had higher rates of hyperlipidemia (62.0% vs. 55.0%), lower rates of smoking (15.7% vs. 22.2%), and lower rates of dementia (9.6% vs. 24.9%). Furthermore, EVT patients had more severe stroke symptoms compared to MM (mean NIH stroke scale 19.2 vs. 17.2). Next, we performed one to two propensity score matching for age, sex, etiology, additional sites of occlusion, hypertension, hyperlipidemia, diabetes, atrial fibrillation, smoking, dementia, antithrombotic medication use, Elixhauser comorbidity index, NIH stroke scale, and IVT treatment, yielding 1,115 and 715 patients in the MM and EVT groups, respectively. Overall, matching performed well, and patient characteristics were similar between the two groups as evidenced by low standardized mean differences (all <0.10, **Online Supplemental Data**).

Overall EVT Outcomes

In the total unmatched cohorts, EVT, compared to MM, was not significantly associated with different rates of home discharge (18.7% vs. 14.8%, OR 1.32 [95%CI 0.81-2.20], p=0.27; Table 1) or in-hospital mortality (31.6% vs. 27.8%, OR 1.25 [95%CI 0.83-1.89], p=0.28; Table 1); though it was significantly associated with higher rates of ICH (17.5% vs. 5.9%, OR 3.37 [95%CI 1.83 to 6.18], p<0.001; Table 1). These findings persisted when comparing the PSM cohorts, where EVT was not significantly associated with different rates of home discharge (17.5% vs. 12.2%, OR 1.36 [95%CI 0.76-2.44], p=0.30; Table 1, Figure 1) or in-hospital mortality (31.5% vs. 32.9%, OR 1.00 [95%CI 0.63-1.60], p=0.99; Table 1, Figure 1) with significantly higher rates of ICH (18.2% vs. 7.3%, OR 2.69 [95%CI 1.41-5.15], p=0.003; Table 1, Figure 1). Further sensitivity analyses with multivariable logistic regression of the total cohorts again revealed similar findings (Table 1).

Of note, EVT was significantly associated with higher rates of routine discharge to home to self-care, however, the proportion of patients achieving this outcome was low in both the EVT and MM arms (7.2% and 2.7% respectively, p=0.021; Table 1). This significant difference persisted after PSM and multivariable logistic regression analyses (Table 1).

In terms of hospital length of stay (LOS), median was 4 days (IQR 2 to 8) for the MM group, which was similar a median of 5 days (IQR 3 to 8) in the EVT group in both unadjusted and PSM analyses (Poisson regression rate ratio [RR] 1.05 [95%CI 0.89 to 1.23], p=0.59 and RR 1.03 [95%CI 0.86 to 1.23], p=0.73, respectively). With multivariable Poisson regression analysis, EVT remained not statistically associated with different LOS compared to MM (RR 0.99, [95%CI 0.83-1.17], p=0.90).

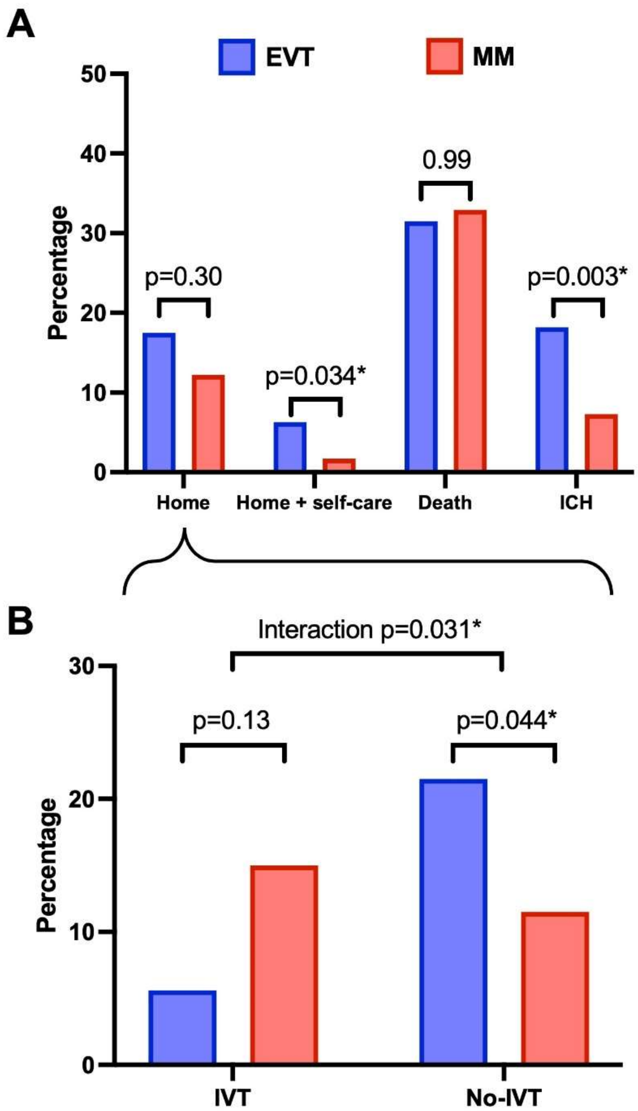

FIG 1. Hospitalization outcomes for elderly BAO patients treated with EVT versus MM alone after 2-to-1 propensity score matching for age, sex, stroke etiology, additional sites of vascular occlusion, stroke risk factors, antithrombotic medication use, comorbidity, NIH stroke scale, and IVT use. Panel A: Rates of home discharge, home discharge with self-care, in-hospital mortality, and ICH. Panel B: Rates of home discharge of stratified by IVT administration.

Since angioplasty and stenting may be associated with increased rates of ICH due to early initiation of post-procedural antithrombotic medications, we performed a sensitivity analysis to confirm EVT's association with elevated rates of ICH among patients who did not undergo angioplasty or stenting. Here, EVT remained statistically significantly associated with higher odds of ICH in unmatched (OR 3.64 [95%CI 1.96-6.76] p<0.001), PSM (OR 2.91 [95%CI 1.50-5.63], p=0.002) and multivariable logistic regression analyses (OR 3.56 [95%CI 1.76-7.26], p<0.001).

Impact of ICH on Outcomes

Among the 245 patients who experienced ICH, only 15 (6.1%) were discharged home and 115 (46.9%) died during the hospitalization. In comparison, among the 2,275 patients who did not experience ICH, 390 (17.1%) were discharged home and 625 (27.5%) died (p=0.047 and 0.004 compared to ICH subgroup, respectively). After multivariable adjustment for all captured variables, ICH remained strongly associated with lower odds of home discharge (OR 0.29 [95%CI 0.07-1.14], p=0.077) and significantly associated with higher odds of in-hospital mortality (OR 2.12 [95%CI 1.09-4.11], p=0.026).

Table 1: Study Outcomes

	MM	EVT	OR for EVT [95%CI]	p-value

Unmatched cohort				
Home discharge	14.8% (250/1,690)	18.7% (155/830)	1.32 [0.81-2.20]	0.27
Routine discharge	2.7% (45/1,690)	7.2% (60/830)	2.85 [1.17-6.92]	0.021
In-hospital mortality	27.8% (470/1,690)	31.6% (270/830)	1.25 [0.83-1.89]	0.28
Intracranial hemorrhage	5.9% (100/1,690)	17.5 (145/830)	3.37 [1.83-6.18]	<0.001
PSM cohorts				
Home discharge	12.2% (135/1,115)	17.5% (125/715)	1.36 [0.76-2.44]	0.30
Routine discharge	1.7% (20/1,115)	6.3% (45/715)	3.68 [1.10-12.3]	0.034
In-hospital mortality	32.9% (365/1,115)	31.5% (225/715)	1.00 [0.63-1.60]	0.99
Intracranial hemorrhage	7.3% (81/1,115)	18.2% (130/715)	2.69 [1.41-5.15]	0.003
Multivariable logistic regression				
Home discharge	-	-	1.53 [0.88-2.68]	0.13
Routine discharge	-	-	3.16 [1.28-7.79]	0.013
In-hospital mortality	-	-	1.04 [0.64-1.69]	0.86
Intracranial hemorrhage	-	-	3.43 [1.68-6.98]	<0.001

EVT Outcomes Stratified by IVT Treatment

Next, we investigated whether EVT may have different efficacy and safety outcomes among patients who were and were not treated with IVT. Among IVT treated patients, EVT was associated with numerically lower but statistically similar rates of home discharge (7.7% vs. 18.6%, OR 0.37 [95%CI 0.10 -1.40], p=0.14; Table 2). Among non-IVT treatment patients, EVT was significantly associated with higher rates of home discharge (22.0% vs. 13.8%, OR 1.77 [95%CI 1.03-3.04], p=0.040; Table 2). Further interaction analysis revealed that IVT treatment was a significant negative modulator of EVT's efficacy in terms of rates of home discharge (interaction p=0.033; Table 2). Analyses of the PSM cohorts yielded similar results (interaction p=0.031; Table 2, Figure 1), as did further sensitivity analyses with multivariable logistics regression models (interaction p=0.059; Table 2). IVT did not significantly modulate EVT's association with rates of in-hospital mortality of ICH (interaction p>0.05 for both outcomes in PSM, and multivariable logistic regression analyses).

Finally, as angioplasty and stenting may be associated with higher rates of hemorrhage (by way of post-procedure antithrombotic use) and poor outcomes, we performed a sensitivity analysis excluding patients who underwent these procedures. Here, intravenous thrombolysis continued to significantly suppress the EVT's association home discharge in unadjusted, PSM, and multivariable logistic regression analyses for patients who did not undergo angioplasty or stenting (interaction p=0.028, 0.049, and 0.029, respectively).

Table 2: Rates of home discharge stratified by IVT use

	MM	EVT	OR [95%CI]	p-value	Interaction p-value
Unmatched cohorts					
Received IVT	18.6% (65/350)	7.7% (15/195)	0.37 [0.10-1.40]	0.14	0.033
No-IVT	13.8% (185/1,340)	22.0% (140/635)	1.77 [1.03-3.04]	0.040	
PSM cohorts					
Received IVT	15.0% (35/235)	5.6% (10/180)	0.28 [0.05-1.46]	0.13	0.031
No-IVT	11.5% (100/880)	21.5% (115/535)	1.93 [1.02-3.66]	0.044	
Multivariable logistic regression					
Received IVT	-	-	0.38 [0.07-1.93]	0.24	0.059
No-IVT	-	-	2.10 [1.12-3.91]	0.020	

DISCUSSION

In this retrospective explorative analysis of a national database of hospital admissions in the United States, we found that EVT for acute BAO stroke was not significantly associated with more favorable short-term outcomes compared to medical management alone, while it was associated with significantly higher rates of hemorrhage. Subgroup analyses revealed that while EVT may be superior to medical management without IVT, its short-term efficacy is significantly diminished for patients treated with IVT. These findings highlight the need for careful risk-benefit assessments of EVT for elderly BAO stroke patients, particularly regarding hemorrhagic risk and concurrent IVT treatment.

The elderly population represents a significant portion of stroke patients worldwide, and optimal management of acute stroke for the elderly has been an area of clinical uncertainty[3]. Older age is a well-known risk factor for EVT futility, possibly due to poor collateral circulation and penumbra sustenance, leading to faster infarct growth and higher rates hemorrhagic transformation[3,6,15]. Baseline cognitive deficits, leukoariosis, and brain atrophy may also impede post-stroke recovery[5].

Currently available clinical data suggests that EVT is beneficial for anterior circulation LVOs among elderly patients[16,17], however, the efficacy and safety of EVT for elderly BAO patients is largely unknown. Unlike EVT in the anterior circulation, BAO-EVT has been consistently associated with higher risk of symptomatic intracranial hemorrhage in randomized trials[18], perhaps due to anatomical features of the posterior fossa and higher risk of symptomatic mass effect. This heightened hemorrhagic risk may be particularly problematic for elderly patients, as older age itself is an independent risk factor for hemorrhagic transformation[19,20]. In the current study, we observed a significantly higher risk of ICH among elderly BAO stroke patients treated with EVT compared to those treated with MM alone. This, in addition to our secondary findings showing that ICH was significantly associated with worse hospitalization outcomes, emphasizes the need for careful patient selection for BAO-EVT among the elderly population, specifically regarding ICH risk. Radiographic markers of early ischemic changes on computed tomography (CT) such as posterior circulation Alberta Stroke Program Early CT Score (pc-ASPECTS[21]) may be a helpful tool to for hemorrhagic risk stratification, however, its interpretation in the setting of chronic white matter disease (which is prevalent among elderly patients) and artifacts in the posterior fossa may be challenging[22]. Future studies should consider investigating whether adjunctive use of CT perfusion metrics[23], collateral status[24], or magnetic resonance imaging (MRI[25]) may be helpful to further optimize hemorrhagic risk stratification for elderly BAO patients[26].

While our primary analysis did not reveal significant short-term benefit of EVT for elderly BAO patients measured by rate of discharge to home, our subgroup analyses revealed that EVT may be associated with significantly higher odds of home discharge compared to MM among patients who were not treated with IVT. Current guidelines recommend administering IVT for all eligible stroke patients regardless of EVT candidacy[7,8]; however, combined IVT and EVT has not been formally trialed in the BAO stroke population. Observational data have suggested that IVT prior to BAO-EVT may be associated with more favorable outcomes compared to EVT alone[27], however, whether this is true for elderly patients is unclear. Underlying deficits in the coagulation pathway may be associated less favorable EVT outcomes, and it may accentuate the detrimental effects of hemorrhagic transformation[28]. An analysis of the National Inpatient Sample in the United States suggested that IVT prior to EVT may yield diminished benefit for elderly anterior circulation LVO stroke patients, possibly due to higher hemorrhagic risk[29]. This phenomenon, in addition to inherently higher risk of symptomatic hemorrhage associated with BAO-EVT[18], may have culminated in the net negative modulatory effect of IVT on EVT's efficacy in the current study. Another possible explanation of IVT's negative impact on EVT's efficacy for BAO strokes is that IVT may compete with the efficacy of EVT. In a recent observational cohort study, Räty et al. suggested that IVT alone may be a potent treatment for BAO that compared favorably to the efficacy of EVT[30]. BAO treated with IVT may also be associated with higher rates of pre-EVT recanalization[31]. Thus, for elderly BAO stroke patients, prior IVT treatment may not only increase hemorrhagic risk but also erode the net benefit of EVT via its own clinical efficacy. Future studies are needed to further explore the interplay between EVT and IVT for elderly BAO stroke patients.

Our study has several limitations. First, the NIS only provides hospitalization outcomes, therefore, only short-term outcomes were assessable. Moreover, while discharge to home is a favorable outcome, it is not a direct measure of neurological function. Thus, findings reported in this study should be interpreted with caution, and future investigations are needed to assess longer-term neurological outcomes for elderly BAO-EVT patients. Second, the NIS does not report detailed information regarding the location of BAO, which may be an important factor for treatment decisions and predictor of clinical. Third, information regarding clinical (e.g. treatment time windows, time elapsed from thrombolysis to EVT, Glasgow coma scale, etc.) and radiographic biomarkers (e.g. pcASPECTS, MRI findings, etc.) are not available, and these factors may have confounded our findings. Third, patients with anterior circulation insufficiency may be heavily dependent on vascular supply from the posterior circulation to supply the cerebral hemispheres, which can be seen in conditions such as Moyamoya disease[32]. BAO stroke may be particularly devastating for these patients, and we were unable to fully assess this confounder as this information is not provided in the NIS. However, given that our analysis accounts for NIH stroke scale and thus the variability of symptom severity among the study cohort, our results are likely robust to confounding from anterior circulation insufficiency. Fourth, uncaptured neurological and non-neurological baseline disability among the elderly population may have influenced EVT treatment decisions and introduced treatment bias[33]. EVT providers may also take more conservative measures for elderly patients in terms of pursuing additional distal occlusions (e.g. posterior cerebral artery[34]), the number of EVT attempts, and final angiographic goal, which may culminate in overall reduced EVT efficacy[35,36]. Fifth, the NIS does not report more granular outcomes such as embolism to new territories, angiographic outcomes. Furthermore, while presence of ICH can be identified using the NIS[29,34,37], information on clinical or radiographic grading of hemorrhagic complications (e.g. symptomatic vs. asymptomatic, hematoma versus hemorrhagic infarction, etc.) are not available. Future prospective studies that capture these variables are needed to fully elucidate the efficacy and safety of EVT for elderly BAO stroke patients. Finally, the time-period of this study ended at 2021, which was prior to recent advances in EVT devices and techniques as well as the publication of the 2023 landmark trials demonstrating the safety and efficacy of BAO-EVT[11,12]. Future investigations are needed to confirm our findings in more contemporary clinical settings.

CONCLUSIONS

In this explorative nationwide analysis of elderly BAO stroke patients in real-world practice, we found that EVT was not significantly associated with higher rates of favorable short-term hospitalization outcomes measured by discharge to home, while it was associated with increased risk of intracranial hemorrhage. Subgroup analyses revealed that EVT may be beneficial for patients who were not treated with IVT, and that IVT may exert a negative modulatory effect on EVT's efficacy.

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None

REFERENCES

1. Goyal M, Menon BK, van Zwam WH, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. *Lancet* 2016;387:1723–31.
2. Jovin TG, Nogueira RG, Lansberg MG, et al. Thrombectomy for anterior circulation stroke beyond 6 h from time last known well (AURORA): a systematic review and individual patient data meta-analysis. *The Lancet* 2022;399:249–58.
3. Chen H, Jindal G, Miller TR, et al. Stroke Thrombectomy in the Elderly: Efficacy, Safety, and Special Considerations. *Stroke: Vascular and Interventional Neurology* 2023;3.
4. Malhotra A, Wu X, Payabvash S, et al. Comparative Effectiveness of Endovascular Thrombectomy in Elderly Stroke Patients. *Stroke* 2019;50:963–9.
5. Kaginele P, Beer-Furlan A, Joshi KC, et al. Brain Atrophy and Leukoaraiosis Correlate with Futile Stroke Thrombectomy. *J Stroke Cerebrovasc Dis* 2021;30:105871.
6. Shahid AH, Abbasi M, Larco JLA, et al. Risk Factors of Futile Recanalization Following Endovascular Treatment in Patients With Large-Vessel Occlusion: Systematic Review and Meta-Analysis. *Stroke: Vascular and Interventional Neurology* 2022;2.
7. Turc G, Bhogal P, Fischer U, et al. European Stroke Organisation (ESO) - European Society for Minimally Invasive Neurological Therapy (ESMINT) Guidelines on Mechanical Thrombectomy in Acute Ischemic Stroke. *J Neurointerv Surg* 2023;15:e8–e8.
8. Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke* 2019;50.
9. Liu X, Dai Q, Ye R, et al. Endovascular treatment versus standard medical treatment for vertebrobasilar artery occlusion (BEST): an open-label, randomised controlled trial. *Lancet Neurol* 2020;19:115–22.
10. Langezaal LCM, van der Hoeven EJRJ, Mont'Alverne FJA, et al. Endovascular Therapy for Stroke Due to Basilar-Artery Occlusion. *New England Journal of Medicine* 2021;384:1910–20.
11. Tao C, Nogueira RG, Zhu Y, et al. Trial of Endovascular Treatment of Acute Basilar-Artery Occlusion. *New England Journal of Medicine* 2022;387:1361–72.
12. Jovin TG, Li C, Wu L, et al. Trial of Thrombectomy 6 to 24 Hours after Stroke Due to Basilar-Artery Occlusion. *New England Journal of Medicine* 2022;387:1373–84.
13. Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project. *https://hcup-us.ahrq.gov/*.
14. Dicpinigaitis AJ, Dick-Godfrey R, Gellerson O, et al. <scp>Real-World</scp> Outcomes of Endovascular Thrombectomy for Basilar Artery Occlusion: Results of the <scp>BArONIS</scp> Study. *Ann Neurol* 2023;94:55–60.
15. Chen H, Colasurdo M, Phipps MS, et al. The BAND score: a simple model for upfront prediction of poor outcomes despite successful stroke thrombectomy. *Journal of Stroke and Cerebrovascular Diseases* https://doi.org/10.1016/j.jstrokecerebrovasdis.2024.107608.
16. Zhao W, Ma P, Zhang P, et al. Mechanical Thrombectomy for Acute Ischemic Stroke in Octogenarians: A Systematic Review and Meta-Analysis. *Front Neurol* 2020;10:1355.
17. Sussman ES, Martin B, Mlynash M, et al. Thrombectomy for acute ischemic stroke in nonagenarians compared with octogenarians. *J Neurointerv Surg* 2020;12:266–70.
18. Adusumilli G, Kobeissi H, Ghozy S, et al. Endovascular thrombectomy after acute ischemic stroke of the basilar artery: a meta-analysis of four randomized controlled trials. *J Neurointerv Surg* 2023;15:e446–51.
19. Larrue V, von Kummer R, del Zoppo G, et al. Hemorrhagic Transformation in Acute Ischemic Stroke. *Stroke* 1997;28:957–60.
20. Alshekhlee A, Mohammadi A, Mehta S, et al. Is Thrombolysis Safe in the Elderly? *Stroke* 2010;41:2259–64.
21. Schaefer PW, Yoo AJ, Bell D, et al. CT Angiography-Source Image Hypoattenuation Predicts Clinical Outcome in Posterior Circulation Strokes Treated With Intra-Arterial Therapy. *Stroke* 2008;39:3107–9.
22. Ahmed RA, Dmytriw AA, Regenhardt RW, et al. Posterior circulation cerebral infarction: A review of clinical, imaging features, management, and outcomes. *Eur J Radiol Open* 2023;11:100523.
23. Cereda CW, Bianco G, Mlynash M, et al. Perfusion Imaging Predicts Favorable Outcomes after Basilar Artery Thrombectomy. *Ann Neurol* 2022;91:23–32.
24. Khunte M, Wu X, Avery EW, et al. Impact of collateral flow on cost-effectiveness of endovascular thrombectomy. *J Neurosurg* 2022;137:1801–10.
25. Colasurdo M, Chen H, Gandhi D. MR Imaging Techniques for Acute Ischemic Stroke and Delayed Cerebral Ischemia Following Subarachnoid Hemorrhage. *Neuroimaging Clin N Am* 2024;34:203–14.
26. Colasurdo M, Chen H, Gandhi D. Imaging Large Ischemic Strokes: Time for New Insight. *American Journal of Neuroradiology* https://doi.org/10.3174/ajnr.A8157.
27. Cai L, Wang L, Campbell BC V., et al. Endovascular thrombectomy with versus without intravenous thrombolysis in patients with acute basilar artery occlusion: a systematic review and meta-analysis. *J Neurol* https://doi.org/10.1007/s00415-024-12353-w.
28. Chen H, Ahmad G, Colasurdo M, et al. Mildly elevated INR is associated with worse outcomes following mechanical thrombectomy for acute ischemic stroke. *J Neurointerv Surg* 2023;15:e117–22.
29. Chen H, Khunte M, Colasurdo M, et al. Intravenous thrombolysis prior to endovascular thrombectomy in elderly stroke patients: An analysis of the National Inpatient Sample database. *J Neurol Sci* 2023;454:120842.
30. Räty S, Virtanen P, Ritvonen J, et al. IV Thrombolysis in Basilar Artery Occlusion. *Neurology* 2024;102.
31. Colasurdo M, Chen H, Schrier C, et al. Predictors for large vessel recanalization before stroke thrombectomy: the HALT score. *J Neurointerv Surg* https://doi.org/10.1136/jnis-2023-020220.
32. Liu Z, Han C, Zhao F, et al. Collateral Circulation in Moyamoya Disease. *Stroke* 2019;50:2708–15.
33. Chen H, Khunte M, Colasurdo M, et al. Associations of Osteoarthritis With Thrombectomy Utilization and Outcomes for Large Vessel Acute Ischemic Stroke. *Stroke* 2023;54:518–26.
34. Chen H, Khunte M, Colasurdo M, et al. Thrombectomy vs Medical Management for Posterior Cerebral Artery Stroke: Systematic Review, Meta-Analysis, and Real-World Data. *Neurology* 2024;102:e209315.
35. Chen H, Colasurdo M, Schrier C, et al. Optimal Angiographic Goal and Number of Passes for Octogenarians Undergoing Endovascular Stroke Thrombectomy. *World Neurosurg* https://doi.org/10.1016/j.wneu.2024.03.123.
36. Wu X, Khunte M, Gandhi D, et al. Implications of achieving TICI 2b vs TICI 3 reperfusion in patients with ischemic stroke: a cost-effectiveness analysis. *J Neurointerv Surg* 2020;12:1161–5.
37. Chen H, Khunte M, Malhotra A, et al. Endovascular thrombectomy versus medical management for moderate-to-severe anterior cerebral artery

occlusion stroke. *J Neurol* https://doi.org/10.1007/s00415-024-12582-z.

SUPPLEMENTAL FILES

Online Supplemental Data: Patient Characteristics.

	Unmatched				Propensity Score-Matched		
Characteristic – mean (SD) or % (n)	*Total (N=2,520)*	*MM (N=1,690)*	*EVT (N=830)*	*SMD*	*MM (N=1,115)*	*EVT (N=715)*	*SMD*
Age (years)	85.6 (3.5)	85.8 (3.4)	85.2 (3.5)	0.172	85.4 (3.4)	85.4 (3.5)	0.039
Female Sex	59.9% (1,510)	61.5% (1,040)	56.6% (470)	0.099	56.1% (625)	55.9% (400)	0.014
Stroke etiology							
Embolism	23.2% (585)	24.9% (420)	19.9% (165)	0.125	21.5% (240)	23.1% (165)	0.079
Thrombosis	39.1% (985)	32.2% (545)	53.0% (440)	0.416	42.2% (470)	47.6% (340)	0.007
Unspecified	37.7% (950)	42.9% (725)	27.1% (225)	0.355	36.3% (405)	29.4% (210)	0.063
Additional site(s) of vascular occlusion							
Vertebral artery	8.7% (220)	9.5% (160)	7.2% (60)	0.086	8.5% (95)	7.0% (50)	0.041
Cerebellar artery	5.8% (145)	5.0% (85)	7.2% (60)	0.085	6.3% (70)	7.7% (55)	0.054
Posterior cerebral artery	8.1% (205)	7.7% (130)	9.0% (75)	0.047	8.1% (90)	7.7% (55)	0.024
Stroke risk factors							
Atrial fibrillation/flutter	42.1% (1,060)	40.8% (690)	44.6% (370)	0.075	45.7% (510)	44.8% (320)	0.028
Hypertension	88.5% (2,230)	87.9% (1,485)	89.8% (745)	0.062	90.1% (1,005)	88.8% (635)	0.035
Hyperlipidemia	57.3% (1,445)	55.0% (930)	62.0% (515)	0.145	60.5% (675)	59.4% (425)	0.050
Diabetes	27.8% (700)	26.9% (455)	29.5% (245)	0.057	27.8% (310)	30.1% (215)	0.023
Smoking	20.0% (505)	22.2% (375)	15.7% (130)	0.180	22.4% (250)	18.2% (130)	0.077
Dementia	19.8% (500)	24.9% (420)	9.6% (80)	0.516	10.3% (115)	11.2% (80)	0.083
Baseline antithrombotic medications							
Anticoagulant	13.9% (350)	14.2% (240)	13.3% (110)	0.028	14.3% (160)	14.0% (100)	0.031
Antiplatelet	26.4% (665)	27.5% (465)	24.1% (200)	0.080	25.6% (285)	25.2% (180)	0.000
Elixhauser comorbidity index	15.4 (8.4)	14.9 (8.3)	16.6 (8.5)	0.198	15.6 (8.3)	16.1 (8.1)	0.042
NIH stroke scale	17.9 (9.5)	17.2 (9.5)	19.2 (9.5)	0.208	18.4 (9.7)	19.4 (9.5)	0.042
Intravenous thrombolysis	21.6% (545)	20.7% (350)	23.5% (195)	0.066	20.6% (230)	25.2% (180)	0.099

Supplementary Table 1: ICD-10 codes used for study

	ICD-10
Inclusion	
Basilar artery occlusion	I63.02x, I63.12x, I63.22x
Treatments	
Mechanical Thrombectomy	03CG3Z7, 03CG3ZZ, 03CG4ZZ, 03CG4Z6
tPA in a different facility within the last 24 hours	*Z92.82*
tPA in current facility	*3E03317*
Exclusion	
Internal Carotid Artery Occlusion	I63.03x, I63.13x, I63.23x
Anterior cerebral artery occlusion	I63.32x, I63.42x, I63.52x
Middle Cerebral Artery Occlusion	I63.31x, I63.41x, I63.51x

	ICD-10 codes
Hyperlipidemia	*E78.00, E78.01, E78.1, E78.2, E78.3, E78.41, E78.49, E78.5*
Atrial Fibrillation or Flutter	*I48.0, I481.1, I48.19, I48.20, I48.21, I48.3, I48.4, I48.91, I48.92*
Intracerebral hemorrhage	*I60.x, I61.x, I62.x*