

CT Angiography for the screening of patients with acute minor stroke: a cost-effectiveness analysis

By Dr. X Wu & Dr. A Malhotra

INTRODUCTION

Large vessel occlusion (LVO) accounts for one-third of ischemic strokes, but causes disproportionate morbidity and mortality in the stroke population.

Endovascular thrombectomy (EVT) has become the standard of care for patients with LVO in the anterior circulation with a National Institutes of Health Stroke Scale (NIHSS) score of ≥ 6 who present within 6 hours of symptom onset and in selected LVO patients presenting 6 to 24 hours after onset [1].

Definitive diagnosis of LVO by clinical scales is difficult and not accurate. EVT results are highly time-sensitive and early diagnosis of LVO is critical. Current guidelines recommend vascular imaging with CT angiography (CTA) for potential candidates for mechanical thrombectomy [1,2]. However, limiting CTA to patients with baseline NIHSS score ≥ 6 may reduce the proportion of potentially treatable patients, and many stroke centers have implemented a CTA-for-All stroke imaging policy [3]. The effectiveness of CTA for patients with minor stroke (NIHSS < 6) is not well-established in literature. Minor stroke is common and may represent up to two-thirds of patients with acute ischemic stroke. LVO has been reported in about 18% of patients with NIHSS between 0 and 4, and the presence of LVO is associated with high risk of clinical worsening and adverse outcomes. Multiple recent studies have shown better outcomes for EVT compared to medical management in acute, minor stroke patients (NIHSS < 6) with LVO.

We sought to assess the cost-effectiveness of CTA for detection of LVO in acute, minor stroke patients from a societal perspective [4].

STUDY DESIGN AND METHODOLOGY

A decision-analytic model was constructed using TreeAge Pro Suite 2019 (Cambridge, MA) over the lifetime span of patients from a societal perspective. The base case scenario in this model was a patient of age 65 years presenting with minor stroke (NIHSS < 6).

The 3 management strategies considered were:

- 1) No vascular imaging, and best medical management (including IVT for eligible patients);
- 2) CTA for all patients, and immediate thrombectomy (IMT) for LVO after intravenous thrombolysis (IVT) (if eligible); and
- 3) CTA for all patients, and best medical management (BMM) including IVT, with rescue thrombectomy for LVO patients with neurologic deterioration.

The model was of a life-time horizon; differential mortality rates were assigned, and recurrent stroke risk was accounted for as well. All clinical parameters were derived from the best available evidence in the literature with preference for recently published large-cohort studies.

RESULTS

Base case calculation showed CTA followed by immediate thrombectomy for LVO patients to have the lowest cost and highest health benefits. CTA followed by best medical management and possible rescue thrombectomy for LVO patients had slightly higher cost and lower health benefits. "No vascular imaging" had the highest cost and lowest health benefits. Probabilistic sensitivity analysis showed CTA followed by immediate thrombectomy to be the superior strategy in 98.9% of 10,000 iterations (simulating 10,000 patients by varying the input parameter values based on their confidence intervals).

Sensitivity analysis varying the proportion of LVO amongst all acute, minor stroke patients showed that "no vascular imaging" was cost-effective only when proportion of LVO is $< 0.16\%$. When the proportion was higher, CTA followed by immediate thrombectomy in LVO patients became more cost-effective. Two-way sensitivity

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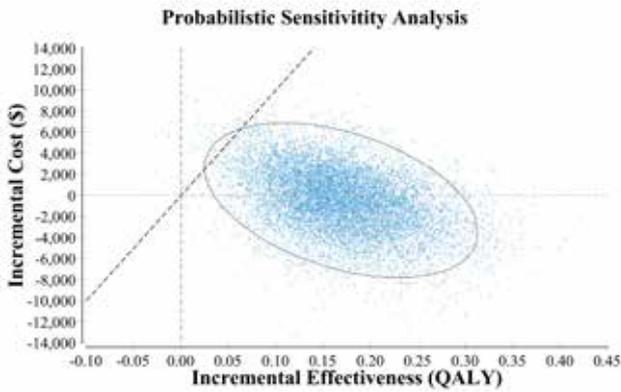


Figure 1: Scatterplot of 10 000 iterations in probabilistic sensitivity analysis. Each dot represents one of the 10 000 iterations of probabilistic sensitivity analysis, and the dashed line represents the willingness-to-pay (WTP) threshold. All dots below the WTP line represent simulations in which CT angiography followed by immediate thrombectomy is more cost-effective than CT angiography followed by best medical management.
QALY = quality-adjusted life-year.
Image reproduced from ref [4] , courtesy of Radiological Society of North America

analysis varying the cost of CTA and proportion of LVO patients showed that the threshold of LVO proportion at which vascular imaging became superior increased as the cost of CTA increased. When the cost of CTA was \$5,000, the LVO threshold proportion was 1.32%. No vascular imaging was found to be cost-effective if the probability after good outcome after IVT in LVO patients exceeded 82.0%, which is highly unlikely given the existing literature. When the proportion of LVO was lower than 0.16%, vascular imaging was not a cost-effective strategy irrespective of outcomes after IVT. CTA with immediate thrombectomy remained the most cost-effective strategy when the proportion of rescue thrombectomy and the probability of a good outcome after rescue thrombectomy were varied from 0 to 25% and from 55-80% respectively. The conclusion remained unchanged when varying the patient age from 55 to 85 years, although the net monetary benefit of CTA became smaller with advancing age.

SIGNIFICANCE OF RESULTS AND FUTURE DIRECTIONS

Previous studies have shown that no NIHSS score threshold can be applied to select subgroup of patients for vascular imaging without failing to capture large number of cases with clinically important occlusive lesions [5]. The validity of NIHSS scores in predicting arterial occlusion is also time-dependent, decreasing with increasing time from symptom onset to clinical evaluation.[6] Our study results showed vascular assessment for LVO by CT angiography (CTA) to be cost-effective in acute, minor stroke patients. The conclusions were robust in wide sensitivity analyses. CTA was cost-effective if the proportion of LVO in all minor stroke patients was greater than 0.16%. Even when the cost of CTA was increased to \$5,000 in sensitivity analysis, CTA was cost-effective if proportion of LVO was more than 1.32%. The literature reported prevalence of LVO in this patient population is significantly higher. There is heterogeneity in reported outcomes after thrombectomy in minor stroke patients with some studies advocating immediate thrombectomy while others favoring best medical management and rescue thrombectomy in patients with neurologic deterioration [7,8]. Our results show CTA and immediate thrombectomy to be more cost-effective in the likely clinical scenarios given the literature (proportion of rescue thrombectomy

“.. Our results show CTA and immediate thrombectomy to be more cost-effective..”

between 0 and 25% and good outcome after rescue thrombectomy in 55 to 80% of patients). However, this area needs further study and current randomized clinical trials are underway for acute minor stroke patients.

CONCLUSION

Screening for large vessel occlusion with CT angiography in patients with acute, minor stroke is cost-effective. Our

One-Way Sensitivity Analysis

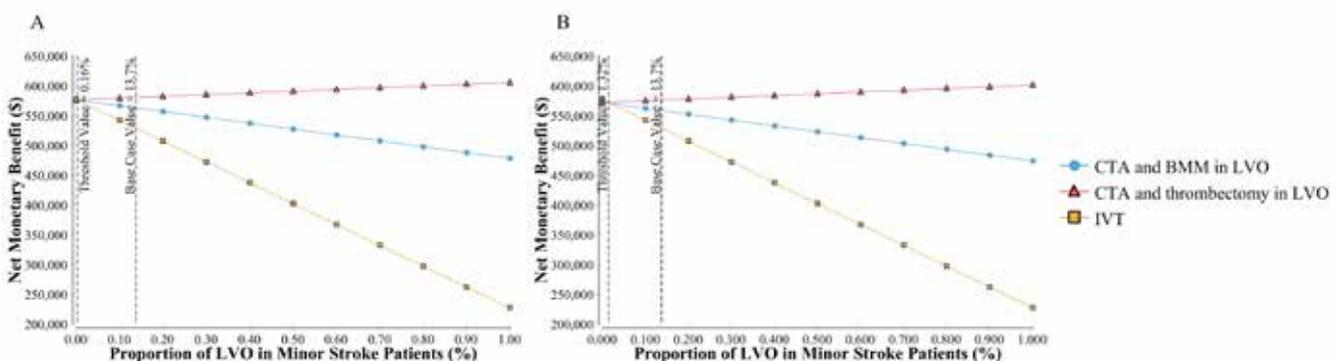


Figure 2: One-way sensitivity analyses varying proportion of large-vessel occlusion (LVO) in patients with minor stroke in which cost of CT angiography (CTA) is at, A, base-case and, B, \$5000. A higher net monetary benefit is more favorable. BMM = best medical management, IVT = intravenous tissue plasminogen activator. Image reproduced from ref [4] , courtesy of Radiological Society of North America.

One-Way Sensitivity Analysis

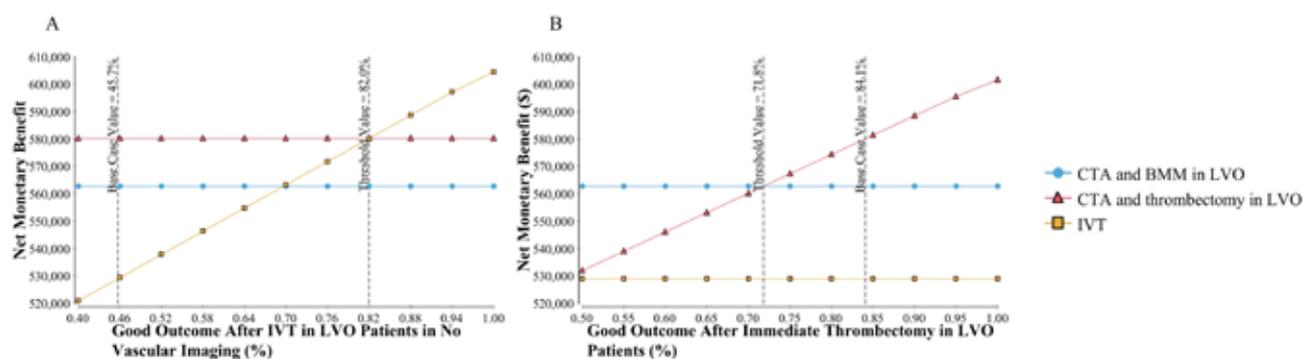


Figure 3: One-way sensitivity analyses varying, A, proportion of good outcome after CT angiography (CTA) followed by immediate thrombectomy and, B, proportion of good outcome after intravenous tissue plasminogen activator (IVT) in patients without vascular imaging. A higher net monetary benefit is more favorable. BMM = best medical management, IVT = intravenous tissue plasminogen activator, LVO = large vessel occlusion. Image reproduced from ref [4], courtesy of Radiological Society of North America

study emphasizes the utility of early CTA detection of LVO to improve health outcomes and reduce overall costs. The costs incurred in faster and better selection of patients for EVT should be seen in the overall context of cost savings from better outcomes.

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Book Review

Venous Interventional Radiology

By Laura Findeiss

Pub by Thieme, July 2020 ; 230 pages; €119.99

The book *Venous Interventional Radiology*, by prominent interventional radiologist Laura Findeiss and an impressive group of contributors is a highly practical vascular interventional radiology reference that covers a full spectrum of venous disease. The richly illustrated book starts with an opening chapter on venous anatomy, physiology, and epidemiology.

Disease-specific chapters cover common to complex disorders, from varicose veins and venous ulceration, to thromboembolic disease and pulmonary embolism. Each chapter presents the latest minimally invasive image-guided interventions for the diagnosis and management of a specific disease. Clinical cases provide discussion of patient presentation/symptoms, clinical evaluation, procedural and non-invasive management strategies, and follow-up, all of which are key to delivering comprehensive patient care.

