Cost-effectiveness of Direct Transfer to Angiography Suite of Suspected Large Vessel Occlusion Patients

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Henk van Voorst: Drafting/revision of the manuscript for content, including medical writing for content; Major role in the acquisition of data; Analysis or interpretation of data
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Abstract

Background and Objectives  Patients with acute ischemic stroke due to large vessel occlusion (LVO) deemed eligible for endovascular thrombectomy (EVT) are transferred from the emergency room to the angiography suite to undergo the procedure. Recently, the strategy of direct transfer of suspected LVO patients to the angiography suite (DTAS) has been shown to improve functional outcomes. The present study aims to evaluate the cost-effectiveness of the DTAS strategy versus initial transfer of suspected LVO patients (Rapid Arterial Occlusion Evaluation score >4 and National Institutes of Health Stroke Scale > 10) to the emergency room (ITER).

Methods  A decision-analytic Markov model was developed to estimate the cost-effectiveness of the DTAS strategy versus the ITER strategy from a Dutch healthcare perspective with a ten-year time horizon. The primary outcome was the incremental cost-effectiveness ratio (ICER) using Dutch thresholds of $59,135 (€50,000) and $94,616 (€80,000) per quality-adjusted life year (QALY). Uncertainty of input parameters was assessed using one-way sensitivity analysis, scenario analysis, and probabilistic sensitivity analysis.

Results  The DTAS strategy yielded 0.65 additional QALYs at an additional $16,089, resulting in an ICER of $24,925/QALY compared to the ITER strategy. The ICER varied from $27,169 to $38,325/QALY across different scenarios. The probabilistic sensitivity analysis showed that the DTAS strategy had a 91.8% and 97.0% likelihood of being cost-effective at a decision threshold of $59,135/QALY and $94,616/QALY, respectively.

Discussion  The cost-effectiveness of the DTAS strategy over ITER is robust for suspected LVO patients. Together with recently published clinical results, this means that implementation of the DTAS strategy may be considered to improve the workflow and outcome of EVT.

Keywords: angiography suite, cost-effectiveness, stroke, thrombectomy
INTRODUCTION

The mean prevalence of large vessel occlusion (LVO) in acute ischemic stroke is approximately 30% (7% - 61%), and the presence of LVO in acute ischemic stroke is associated with a higher risk of death compared to non-LVO. Endovascular thrombectomy (EVT) has become the standard treatment for acute ischemic stroke due to anterior circulation large vessel occlusion (LVO). EVT was cost-effective compared to medical treatment in various countries, but the effect remains highly time-dependent. Faster in-hospital processes of acute stroke care, such as emergency department door–to-reperfusion time, are associated with better 90-day functional outcomes for LVO patients treated with EVT. In fact, 10 minutes of faster EVT resulted in 13.5 disability-free life days saved in Dutch patients and 39 disability-free life days in the US patients. Therefore, optimal EVT treatment necessitates expediting the diagnostic process of acute stroke.

In most Western countries, LVOs are usually diagnosed with computed tomography angiography (CTA) performed in the emergency department. When deemed eligible, patients will then be transferred to the angiography suite to undergo EVT. However, a flat-panel computed tomography in the angiography suite also can rule out intracranial hemorrhage or large established ischemic lesions, which contraindicate EVT. After flat-panel CT, LVO can be confirmed by digital subtraction angiography (DSA). Recently, several studies have shown that direct transfer to the angiography suite (DTAS) of suspected LVO patients significantly decreased hospital workflow time and improved functional outcomes at 90 days for LVO patients. DTAS opens a potential strategy of workflow improvement for rapid delivery of EVT bypassing CTA in the emergency department. However, introducing DTAS could result in higher costs and unnecessary occupation of the angiography suite in non-LVO patients and increase the workload for the angiography team. A recent economic evaluation concluded that DTAS was cost-effective in suspected LVO patients within six hours from stroke onset in Spain. Therefore, the aim of this study is to evaluate the cost-effectiveness of DTAS compared with initial transfer to the emergency room (ITER) in suspected LVO patients from the Dutch healthcare perspective.
METHODS

Population, strategies, and setting

The ANGIOCAT trial was an open, randomized controlled trial with blinded endpoint assessment conducted in Spain. The study evaluated the functional outcome at 90 days after EVT for LVO patients following the DTAS or ITER workflow. The trial included 174 suspected LVO patients within six hours of symptom onset who had a Rapid Arterial Occlusion Evaluation (RACE) score >4 on scene or during transport and National Institutes of Health Stroke Scale (NIHSS) > 10 at arrival as scored by neurologists. LVO was confirmed in 147 patients (74 in DTAS and 73 in ITER). Based on the characteristics of patients in the ANGIOCAT trial, we generated a hypothetical cohort of 10,000 suspected LVO patients with a mean age of 74 years old. This was necessary as the DTAS strategy is currently no routine clinical practice in the Netherlands. In the DTAS strategy, suspected LVO patients (RACE >4 and NIHSS>10) would be directly transferred to the angiography suite for diagnostic evaluation, potentially followed with IVT and EVT. A flat-panel computed tomography was performed to rule out intracranial hemorrhage or a large established infarct. Subsequently, intravenous thrombolysis (IVT) could be administered. Patients would undergo EVT if angiography confirmed LVO. In the ITER strategy, suspected LVO patients were first transferred to the emergency room to confirm LVO by CT or CTA. If necessary, the treating physician could decide for the use of CT perfusion. When indicated, IVT would be administered directly after CT or CTA. Next, patients would be transferred to the angiography suite to undergo EVT when deemed eligible. Both strategies were applied to (hypothetical) patients directly admitted to comprehensive stroke centers in the Netherlands.

Model structure and assumption

We developed a one-year decision tree model and a nine-year Markov model to estimate the cost-effectiveness of the DTAS strategy versus the ITER strategy from a Dutch healthcare payer perspective (Figure 1). A 10-year model was chosen because the average life expectancy for a 75-year person was 12 years in the Netherlands. We assumed that workflow efficiencies and adverse events between the two strategies would be similar for non-LVO patients, but diagnosis costs in non-LVO patients were taken into account in the model.
Functional outcome is assessed 90 days after stroke in terms of the modified Rankin Scale (mRS) score, with higher scores indicating more severe disability. The DTAS and ITER strategies resulted in different mRS scores at 90 days after stroke in the ANGIOCAT trial. Recently, clinical trials reported excellent function (combining mRS 0 and mRS 1) as the primary outcome in stroke patients. In addition, mRS 2 and mRS 3 had similar health utility and costs. Hence, we included five states in our model: mRS 0-1, mRS 2-3, mRS 4, mRS 5, and death (mRS 6). We assumed that the mRS at 90 days might significantly improve or deteriorate in the first year after stroke but would remain stable thereafter. Therefore, patients’ mRS at one year was used as an entry state in the Markov model to estimate long-term outcomes in the subsequent nine years. During each one-year cycle, patients could remain in their mRS or make a transition to another mRS or ‘death due to all causes’ (Figures 1B and 1C). In the Markov model, long-term costs and effectiveness were attributed to mRS scores, and we assumed that other risk factors would be similar between groups.

Input parameters

Epidemiology and clinical parameters

We identified seven relevant studies comparing DTAS and ITER based on the recent systematic review. However, one trial did not report mRS score at 90 days, one case-control study reported mRS 0-2 only, and four studies had an observational design and were conducted in patients admitted first to primary stroke centers and then transferred to EVT-capable centers. Therefore, the ANGIOCAT trial was the only included study to assess short-term outcomes for patients in the DTAS and ITER groups (Table 1). The transition matrix of changing mRS from 90 days to 1 year and from 1 year onwards was identified by applying data from the extended follow-up of the MR CLEAN trial (Supplementary material eTables 1, 2, and 3). Quality of life, expressed in utility, was derived from a previous publication for the Dutch stroke population.

The mortality rate in the Markov model was estimated by combining results of the clinical trial and mortality data of the Dutch life tables for different age groups. The age-based risk for mortality for the Dutch general population was derived from Dutch survival
statistics (Central Bureau of Statistics). We assumed that the mortality rate over the 10-year period after stroke depended on the mRS and age (Supplementary material eTable 3).

**Cost parameters**

Direct medical costs were included in our models based on a Dutch healthcare perspective. Healthcare costs in LVO and non-LVO patients were derived from data repositories and expert opinion from the University Medical Center Groningen, published data, and the Dutch reference costs (Table 1 and Supplementary material eTable 4). All costs were converted to the reference year 2021 in Euros (€) by using the Dutch consumer price index and reported in USD ($) (€1=$1.1827 in 2021).

**Outcomes**

The primary outcome was the incremental cost-effectiveness ratio (ICER) calculated as the difference in the total costs between two strategies divided by the difference in the quality-adjusted life years (QALYs). The DTAS strategy was considered cost-effective if the ICER fell below the decision threshold of €80,000/QALY ($94,616). In addition, we applied the decision threshold of €50,000/QALY (per capita Gross Domestic Product per QALY) ($59,135) to consider the DTAS highly cost-effective in line with World Health Organization recommendations. In accordance with the Dutch guideline for economic evaluations in healthcare, we applied an annual discount rate of 4% and 1.5% for costs and QALYs, respectively, to take into account the impact of time preference on costs and effectiveness. All analyses and modeling were performed in Treeage Pro 2022 R1.2. The study was reported according to the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement.

**Scenario analyses**

Suspected LVO patients with RACE score >4 and NIHSS >10 were included in the base case analysis, as they were inclusion criteria in the ANGIOCAT trial. To explore the effect of inclusion criteria (i.e. without NIHSS >10 on admission), we applied the positive predictive value of RACE score >4 (0.42) from the PRESTO trial in scenario 1. Currently, the prehospital RACE scale is not routinely used in the Netherlands (except for some regions). Therefore, we also analyzed the
cost-effectiveness of the DTAS versus ITER strategies in suspected stroke patients by EMS paramedics with positive Face-Arm-Speech-Time (FAST) test\(^9\) (without the results of the RACE scale) to accurately reflect the current situation in the Netherlands (scenario 2). An incidence of 12% LVO in the cohort of suspected stroke patients was used in scenario 2 as a conservative assumption.\(^9\) In addition, a 4-year Markov model was applied for scenario 3 to further explore the effect of follow-up time on the strategies.

**Sensitivity analyses**

We employed one-way sensitivity analyses to assess the effect of uncertainty of the input parameters on the ICER. Input parameters with their range are summarized in the Supplementary material (eTable 5). Parameters for which sensitivity analysis indicated a high impact on the ICER were presented in a Tornado diagram.

A probabilistic sensitivity analysis was performed using Monte Carlo simulation with 10,000 iterations by drawing random values from input parameters’ distribution to evaluate uncertainty (Table 1 and eTable 6). The probabilities of each strategy being cost-effective at varying decision thresholds were presented using cost-effectiveness acceptability curves.

**Model validation**

We applied the Assessment of the Validation Status of Health Economic decision models (AdViSHE) tool\(^{28}\) in the process of model validation. The AdViSHE tool includes 13 items divided into five parts: validation of the conceptual model, input data validation, validation of the computerized model, operational validation, and other validation techniques.

**Standard Protocol Approvals, Registrations, and Patient Consents**

Ethics approval was not required as this work was based on a model-based analysis with published input parameters, and no individual patient data were used. This study was not registered.

**Data availability**

All relevant data are provided in the manuscript and its supplementary material.
RESULTS

Base case and scenario analyses

The DTAS strategy resulted in higher total costs ($16,089) but also yielded 0.65 more QALYs compared to the ITER strategy for each suspected LVO patient. Therefore, the DTAS strategy was cost-effective with an ICER of $24,925 per QALY gained, i.e., well below the decision threshold of $59,135 and $94,616. In the scenario analyses, the DTAS strategy remained a beneficial strategy also in a setting not using NIHSS>10 (an ICER of $27,169 per QALY) and without prehospital RACE (an ICER of $38,325 per QALY) in all suspected stroke patients. Furthermore, when a 4-year Markov model (scenario 3) was applied, the DTAS strategy remained the cost-effective strategy compared to the ITER strategy with an ICER of $34,050 per QALY (Table 2).

Sensitivity analyses

One-way sensitivity analyses showed that the mortality rate in the ITER group, the proportion of mRS 0-1, mRS 4 in the DTAS group, and the costs of EVT had a high impact on the ICER (eFigure 1). The mortality rate in the ITER group was the most influential variable on the ICERs ranging from $18,407 to $27,958. Likewise, when the proportion of mRS 0-1 in the DTAS group was adjusted from a minimum value of 22.70% to a maximum value of 34.06%, ICERs ranged from $30,567 to $21,322 respectively. The ICERs in one-way sensitivity analysis varied from $18,407 to $30,567 but remained far below the threshold of $94,616 (Supplementary material eTable 7).

The scatter plots of probabilistic sensitivity analyses showed that under the decision threshold of $94,616, DTAS in base case, scenario 1, scenario 2, and scenario 3 had the corresponding 97.0%, 95.7%, 91.3%, and 93.4% probabilities of economic advantages (Figure 2). Figure 3 demonstrates a probability of being cost-effective for DTAS and ITER strategies based on different decision thresholds. In the base case, when the threshold ranged from $59,135 to $94,616, the DTAS strategy was cost-effective for 91.8% to 97.0% of the simulations, respectively (Figure 3A). Probabilistic sensitivity analyses showed the robustness of cost-
effectiveness of the DTAS strategy in scenarios (Figures 3B to 3D). Model validation based on the AdViSHE tool is provided in the Supplementary material (eAppendix 1).

DISCUSSION

Our results indicate that the DTAS strategy is cost-effective over a period of 10 years compared to the ITER strategy, with an ICER of $24,925, for suspected LVO patients with RACE>4 and NIHSS>10 within six hours of stroke onset. Even though the DTAS strategy was more costly than the ITER strategy, the DTAS strategy yielded 0.65 more QALYs and better functional outcomes at 90 days after stroke. Our findings are in line with previously published studies showing that earlier EVT treatment results in more disability-free life. A recent study from Spain reported that the DTAS strategy was dominant (lower costs and more QALYs) compared to the ITER strategy, while the ICER of DTAS was $24,925 in the Netherlands. Small differences in incremental QALYs were reported in the previous study (0.82 QALYs in lifetime horizon) compared to our findings (0.65 QALYs in 10 years). However, the DTAS strategy appeared to save €51,505 per patient in Spain, while DTAS would add costs ($16,089) in our study. Different long-term costs and the model structure may explain these differences. For example, the Spanish study included seven health states (mRS 0, mRS 1, mRS 2, mRS3, mRS4, mRS 5, and mRS6) without taking into account possible mRS improvement after 90 days. Our model contained five health states (mRS 0-1, mRS 2-3, mRS 4, mRS 5, and mRS6) while allowing actually observed mRS improvement.

Improvement of clinical outcomes in the DTAS group is most likely explained by less time delays in the DTAS approach (door-to-puncture time of 18 minutes in the DTAS group versus 42 minutes in the ITER group). Another potential explanation for better outcomes observed in the DTAS group is a higher rate of EVT in the DTAS group compared to the ITER group in the ANGIOCAT trial (100% versus 87.7%). Recently, the pooled results of eight studies in a systematic review also showed that the DTAS strategy reduced door-to-puncture (29-minute reduction) and door-to-reperfusion times (32-minute reduction) compared to the ITER strategy. In addition, the DTAS strategy tended to be associated with better functional outcomes at 90 days (odds ratio (OR) of 1.38 [95% CI: 0.97-1.95] without any difference in 90-day mortality between the two strategies (OR 0.74 [95% CI: 0.48-1.15])). Results of ongoing
trials comparing the DTAS and ITER strategies will provide more evidence on the impact of DTAS on 90-day outcomes.\textsuperscript{32, 33}

One-way sensitivity analysis and probabilistic sensitivity analysis support the robustness of our results. Cost-effectiveness was sensitive to the mortality rate in the ITER, the proportion of mRS 0-1, mRS4 in the DTAS, and the costs of EVT. The DTAS strategy remained beneficial, with an ICER still below the threshold of $94,616 when variables increased or decreased by 20%. Also, the DTAS strategy was cost-effective in the scenario in which the DTAS approach was applied to all suspected stroke patients with a positive FAST test, reflecting current practice in large parts of the Netherlands. However, introducing the DTAS strategy for all suspected stroke patients will markedly increase the workload for the angiography team and lead to the unnecessary occupation of the angiography suite by non-LVO patients, making it unfeasible for standard use in clinical practice. Furthermore, the DTAS strategy increases the risk of adverse events, such as groin hematoma. Therefore, the DTAS strategy may be considered for patients with a high likelihood of LVO, i.e., identified through triage using acceptable accuracy prehospital stroke scales. That may make the DTAS strategy more feasible in clinical practice. RACE is one of the best performing prehospital stroke scales to detect LVO patients in the Netherlands.\textsuperscript{9, 29} In addition, the DTAS strategy should be implemented for LVO patients potentially having the most benefit from the DTAS strategy, thus avoiding angiography suite overload. For example, Requena et al. indicated that the DTAS approach had the largest effect on LVO patients admitted in the early time window, from 0 to 3 hours after symptom onset.\textsuperscript{34} As such, the DTAS approach is potentially introduced in the highly suspected LVO patients (RACE >4 and NIHSS>10) in the early window. In addition, broad EVT criteria (i.e., low RACE score with LVO, late window) for applying the DTAS fall beyond the scope of our current analysis.

Our model integrates the mRS score at three months and one year after stroke onset to estimate long-term outcomes. The mRS three-month post-stroke is commonly measured as the endpoint of randomized controlled trials and used as a proxy for modelling long-term clinical and economic outcomes in previous cost-effectiveness studies.\textsuperscript{35, 36} These studies assumed that patients would not improve on the mRS beyond 90-day post-stroke. However, more recent
studies suggest that intermediate-term outcomes fluctuate over time, showing that from 91 days up to 365 days, patients may improve, remain in the same state, or even deteriorate.\textsuperscript{37, 38} As such, the overall impact of new strategies might be over- or underestimated. The incorporation of short-term outcomes (90 days after stroke) and middle-term outcomes (one year after stroke) in our model provides a more robust extrapolation of long-term stroke consequences. This approach is supported by evidence from the extension of follow-up patients in the MR CLEAN trial.\textsuperscript{20}

A systematic review on post-stroke care reported that rehabilitation services were the main cost driver of stroke burden.\textsuperscript{30} Therefore, the cost-effectiveness results of DTAS in the Netherlands suggest that DTAS is potentially cost-effective in other settings with a high stroke burden. For example, the post-stroke care costs were highest in the USA ($4,644 per patient month), followed by Denmark ($3,026), the Netherlands ($2,214), and Norway ($2,147).\textsuperscript{30} In addition, 10-minute earlier EVT provided better net monetary benefit in the USA ($10,593)\textsuperscript{5} compared to the Netherlands ($3,085).\textsuperscript{4} Other factors, such as the prevalence of LVO and sensitivity of prehospital triage, may contribute to the feasibility of introducing DTAS in clinical practice. The presence of LVO in the stroke population seems similar in the Netherlands (12\%)\textsuperscript{9} and the USA (11\%).\textsuperscript{39} The American Heart Association and American Stroke Association (AHA/ASA) recommends stroke scales to predict LVO, such as Cincinnati Prehospital Stroke Scale (CPSS), Los Angeles Motor Scale (LAMS), RACE, and Facial palsy, Arm weakness, Speech changes, Time, Eye deviation, Denial/ neglect (FAST-ED) scale. Given comparable performance of these (0.57-0.67), each emergency medical service region should choose an easy-to-use tool and monitor adherence and accuracy of the pre-hospital scale.\textsuperscript{40} In addition, our model with published input parameters may be employed in other settings to assess the cost-effectiveness of the DTAS strategy at different decision thresholds (i.e., $100,000 per QALY in the USA\textsuperscript{41}, €22,000 - €33,000 per QALY in Denmark\textsuperscript{42}). Future work should confirm the economic benefit of the DTAS strategy in other settings.

This study has some limitations. Firstly, we used mRS at three months from the ANGIOCAT trial in Spain due to the lack of data from the Netherlands. Recently, the systematic review of two RCTs and five observational studies showed that the DTAS strategy was
associated with faster onset to treatment times and improved functional outcomes.\textsuperscript{13} We used data from one single-center RCT (ANGIOCAT) instead of pooled data due to the heterogeneity of outcome measures and included patients. Secondly, our model did not consider adverse events in the DTAS group for non-LVO patients because ANGIOCAT results reported no procedural complication in the DTAS group.\textsuperscript{6} This, again, emphasizes that the DTAS strategy should focus on highly suspected LVO instead of all stroke patients to avoid unnecessary invasive angiographic examination. Notably, flat panel CT angiography could potentially avoid unnecessary invasive angiography. Thirdly, due to the lack of cost parameters, we could not estimate an ICER of introducing the DTAS strategy with prehospital RACE assessment compared to the current practice in the Netherlands, such as the ITER without prehospital RACE. Calculation of costs associated with implementing the RACE scale is complex because the RACE score could also influence patient routing decisions. For example, patients with a high likelihood of having an LVO (RACE >4) could be transported directly to a comprehensive stroke center to avoid the transfer of patients to hospitals without EVT capabilities.\textsuperscript{43} Hence, costs related to the implementation of the RACE scale should be considered as shared costs among different strategies in acute stroke management. In addition, we did not analyze the cost-effectiveness of the DTAS strategy during daytime and nighttime, indicating around-the-clock DTAS availability. However, the ANGIOCAT trial excluded 70 patients due to an unavailable angiography suite and 120 off-hours admission patients because the neurovascular team could not be onsite before patient arrival.\textsuperscript{6} Therefore, only a small number of selected patients could benefit due to the capacity of the angiography suite and personnel. When evidence from the ongoing trials becomes available, the effect of the DTAS strategy during off-hours should be taken into account in economic evaluations. Lastly, this study was conducted using the Dutch healthcare perspective, and only direct medical costs were included in the model. Therefore, the burden of stroke may have been underestimated. However, the average age of suspected LVO patients was 74 years old in our study, and costs related to return to work do not apply in our cohort. Future studies on a younger population may include indirect costs such as productivity loss.
Personnel factors should be considered to maximize the effect of DTAS in clinical practice. The hospital should take into account the capacity of the angiography team to prevent delays for other patients due to occupied interventionalists for non-LVO patients in the DTAS strategy. Furthermore, the angiography team must be well-trained before introducing the DTAS strategy. Sulzenko et al. reported that the lack of trained personnel during off-hours resulted in a small number of patients that could be treated according to the DTAS strategy. The benefit of time-saving in the DTAS strategy will be lost if there is not enough medical staff in the angiography team or not well-trained staff.

This study demonstrates that the DTAS strategy may be a cost-effective approach in suspected LVO patients (RACE>4 and NIHSS>10) when compared to the ITER strategy from the Dutch healthcare perspective. With faster treatment, improved functional outcomes and favorable economic evaluation, the DTAS, combined with prehospital triage for LVO, should be considered a potential strategy to optimize the acute stroke care pathway.
References

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### Table 1 Input parameters

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<th>Model inputs</th>
<th>Base case</th>
<th>Distribution</th>
<th>Reference</th>
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<tr>
<td>Positive predictive value of RACE &gt;4 and NIHSS &gt;10</td>
<td>84.48%</td>
<td>Uniform</td>
<td>ANGIOCAT trial&lt;sup&gt;6&lt;/sup&gt;</td>
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<tr>
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<td>Dirichlet</td>
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<td>CLOT MR CLEAN&lt;sup&gt;4&lt;/sup&gt;</td>
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**Costs<sup>5</sup> ($)**

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<td>DTAS strategy</td>
<td>2,206</td>
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<tr>
<td>Costs in year 1 of mRS scores 0-1/ 2-3/ 4/5/6</td>
<td>41,365/ 84,073/ 139,214/ 119,680/ 26,146</td>
<td>Gamma</td>
<td>CLOT MR CLEAN&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>Costs in year 2 of mRS scores 0-1/ 2-3/ 4/5/6</td>
<td>7,349/ 15,629/ 53,490/ 69,877/ 524</td>
<td>Gamma</td>
<td>CLOT MR CLEAN&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>Costs in year 2 onwards of mRS scores 0-1/ 2-3/ 4/5/6</td>
<td>4,499/ 13,293/ 38,437/ 68,108/ 464</td>
<td>Gamma</td>
<td>CLOT MR CLEAN&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>DTAS: direct transfer to angiography suite; EVT: endovascular thrombectomy; ITER: initial transfer to emergency room, IVT: intravenous thrombolysis; LVO: large vessel occlusion; mRS: modified Rankin Scale</sup>

<sup>5</sup>Costs were adjusted to the year 2021 by the Dutch consumer price index and reported in $.
Table 2 Cost-effectiveness results per patient

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Cost per patient ($)</th>
<th>Incremental cost per patient ($)</th>
<th>QALY per patient</th>
<th>Incremental QALY per patient</th>
<th>ICER ($/QALY)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base case: RACE &gt;4 and NIHSS &gt;10</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITER</td>
<td>92,634</td>
<td>-</td>
<td>2.42</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DTAS</td>
<td>108,723</td>
<td>16,089</td>
<td>3.06</td>
<td>0.65</td>
<td>24,925</td>
</tr>
<tr>
<td><strong>Scenario 1: without NIHSS &gt;10</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITER</td>
<td>46,443</td>
<td>-</td>
<td>1.70</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DTAS</td>
<td>55,162</td>
<td>8,719</td>
<td>2.03</td>
<td>0.32</td>
<td>27,169</td>
</tr>
<tr>
<td><strong>Scenario 2: without RACE &gt;4 and NIHSS &gt;10</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITER</td>
<td>13,822</td>
<td>-</td>
<td>1.20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DTAS</td>
<td>17,336</td>
<td>3,514</td>
<td>1.29</td>
<td>0.09</td>
<td>38,325</td>
</tr>
<tr>
<td><strong>Scenario 3: a 4-year Markov model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITER</td>
<td>75,202</td>
<td>-</td>
<td>1.34</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DTAS</td>
<td>86,917</td>
<td>11,714</td>
<td>1.68</td>
<td>0.34</td>
<td>34,050</td>
</tr>
</tbody>
</table>

DTAS: direct transfer to angiography suite; ITER: initial transfer to emergency room; ICER: incremental cost-effectiveness ratio; QALY: quality-adjusted life year
**Figure 1 Cost-effectiveness model structure.** **A.** Decision tree mode; **B.** 1-year cycle Markov model for patients with mRS 0-1; **C.** 1-year cycle Markov model for patients with mRS 2-3

*LVO: large vessel occlusion; M: Markov model; mRS: modified Rankin scale; RACE: rapid arterial occlusion evaluation*
Figure 2 Probabilistic sensitivity analysis – cost-effectiveness plane. A. Base case; B. Scenario 1; C. Scenario 2; D. Scenario 3
Figure 3 Cost-effectiveness acceptability curves at different decision thresholds. A. Base case; B. Scenario 1; C. Scenario 2; D. Scenario 3
Cost-effectiveness of Direct Transfer to Angiography Suite of Suspected Large Vessel Occlusion Patients

Chi P Nguyen, Maarten M.H. Lahr, Durk-Jouke van der Zee, et al.

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