

COMMENTARY

Efficiency of stroke networks for referral of mechanical thrombectomy: The more the better?

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Endovascular therapy (EVT) has revolutionized stroke care, with the publication of several landmark stroke trials since 2015 [1]. At the same time, EVT imposes major changes on systems of stroke care. While EVT is highly efficacious, its use is restricted to stroke patients with large vessel occlusion (LVO) and these form a minority of stroke patients only. Moreover, EVT demands advanced brain and vascular imaging technology, stroke and neurointerventional teams. Stroke centers providing stroke unit care and thrombolysis are commonly referred to as Primary Stroke Centers (PSCs) while those additionally offering EVT are termed Comprehensive Stroke Centers (CSCs). With the differentiation of two different forms of healthcare infrastructure (PSCs and CSCs), and (at least) three different types of stroke patients (those who “need” EVT, those who may need EVT, and those who do not), the healthcare system has become inevitably more complex.

Several solutions have been tested: Preclinical identification of stroke patients with LVO [2], bypassing the closest PSC and heading directly to a CSC [3] or bringing the neurointerventionalist to the patient at the PSC (“flying intervention team”) [4]. All these concepts aim to shorten time from symptom onset to reperfusion because time is one major determinant of EVT success [2]. Time may be influenced by several variables that may constitute targets for stroke care improvement.

In this issue of the *European Journal of Neurology*, van Meenen et al. [5] focus on inter-hospital transfer and the effect of the volume of referred patients (from PSC to CSC) on treatment times and functional outcomes. With respect to EVT, procedural volume and

patient outcomes are related [6]. Therefore, referral volume for EVT from PSC to CSC is indeed an important factor of interest. Van Meenen et al. report on a large dataset using high-standard statistical analyses including multiple imputations to minimize the impact of missing data. One would expect high-volume PSCs to outperform low-volume PSCs. Interestingly, and unexpectedly, EVT referral volume was not associated with PSCs-door-to-groin time, CSC-door-to-groin time nor 90-day modified Rankin Scale score in this nationwide analysis [5].

Performance and outcomes of treatment in PSCs have been generally overlooked in most stroke studies as the focus has been primarily on CSC and EVT procedural workflow [7]. The strength of this analysis lies in the reporting of 65 PSC stroke metric granular data at a national level. An overall median (interquartile range) PSC-door-to-CSC-door time of 105 (85–129) min speaks to the high efficiency of the Netherlands network.

In the Netherlands, the country in which the groundbreaking MR CLEAN trial was conducted [8] there may be little room for improvement in optimizing hub-and-spoke transfer networks through formalized protocols for eligibility, referral, transfer and their training to reduce “door-in-door-out times.” The resounding success of the MR CLEAN trial raises the question of whether the trial itself, the only LVO stroke trial to have been implemented at a national level, played a role in optimizing the efficiency of stroke referral systems of care for thrombectomy, or whether such interfacility stroke transfers were robust pre-trial. Moreover, the Netherlands is a densely populated country. The

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median ambulance travel time was 19 min [5] which was remarkably short. Within such a well-organized system, it may be more difficult to discern potential effect-modifying variables, as the authors rightly state.

The highly efficient model in the Netherlands is akin to that of the Catalonia region in Spain, as was demonstrated with the RACECAT trial (NCT02795962). In that cluster randomized study, preliminary data suggest that there was no difference in patient outcomes of patients who presented primarily to a PSC as compared to those who were transferred directly to a CSC.

While these two stroke systems of care are exemplary, these results may not be representative or realistic for other countries with less developed health systems, lower standards in PSCs or longer travel times between PSC and CSC. Even in developed countries, transfer times can be significantly prolonged.

Future studies are warranted to evaluate the effect of PSC referral volume for EVT on treatment times and functional outcomes in less densely populated countries or with less developed health systems. This will inform decision makers who are organizing optimal stroke care networks. Optimal solutions may be tailored to the local, regional or even national circumstances. In the present analysis, van Meenen et al. present a worthwhile and well-elaborated argument to this ongoing challenge and discussion.

CONFLICTS OF INTEREST

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AUTHOR CONTRIBUTIONS

Christian H. Nolte: Conceptualization (equal); Data curation (equal); Formal analysis (equal); Funding acquisition (equal); Investigation

(equal); Methodology (equal); Project administration (equal); Resources (equal); Software (equal); Supervision (equal); Validation (equal); Visualization (equal); Writing – original draft (equal); Writing – review and editing (equal). **Thanh N. Nguyen:** Conceptualization (equal); Data curation (equal); Formal analysis (equal); Funding acquisition (equal); Investigation (equal); Methodology (equal); Project administration (equal); Resources (equal); Software (equal); Supervision (equal); Validation (equal); Visualization (equal); Writing – original draft (equal); Writing – review and editing (equal).

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