Access to Endovascular Treatment in Remote Areas
Analysis of the Reperfusion Treatment Registry of Catalonia

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Background and Purpose—Since demonstration of the benefit of endovascular treatment (EVT) in acute ischemic stroke patients with proximal arterial occlusion, stroke care systems need to be reorganized to deliver EVT in a timely and equitable way. We analyzed differences in the access to EVT by geographical areas in Catalonia, a territory with a highly decentralized stroke model.

Methods—We studied 965 patients treated with EVT from a prospective multicenter population-based registry of stroke patients treated with reperfusion therapies in Catalonia, Spain (SONIIA). Three different areas were defined: (A) health areas primarily covered by Comprehensive Stroke Centers, (B) areas primarily covered by local stroke centers located less than hour away from a Comprehensive Stroke Center, and (C) areas primarily covered by local stroke centers located more than hour away from a Comprehensive Stroke Center. We compared the number of EVT×100,000 inhabitants/year and time from stroke onset to groin puncture between groups.

Results—Baseline characteristics were similar between groups. Throughout the study period, there were significant differences in the population rates of EVT across geographical areas. EVT rates by 100,000 in 2015 were 10.5 in A area, 3.7 in B, and 2.7 in C. Time from symptom onset to groin puncture was 82 minutes longer in group B (312 minutes [245–435]) and 120 minutes longer in group C (350 minutes [284–408]) compared with group A (230 minutes [160–407]; P<0.001).

Conclusions—Accessibility to EVT from remote areas is hampered by lower rate and longer time to treatment compared with areas covered directly by Comprehensive Stroke Centers. (Stroke. 2016;47:1381-1384. DOI: 10.1161/STROKEAHA.116.013069.)

Key Words: acute stroke ■ endovascular treatment ■ population rate ■ stroke care systems

Given the clinical benefit of endovascular treatment (EVT) in acute ischemic stroke (AIS) patients with large vessel occlusion, critical organizational changes to acute stroke care models are needed to deliver the new standard of care in an equitable way covering the whole population.1 Timely access to EVT may be unequal for AIS patients according to their geographical location.2 For patients living in remote areas, transfer from local centers to a Comprehensive Stroke Center (CSC) is time-consuming and may cause a loss of effectiveness of EVT.3 We aim to determine population-based EVT rate, treatment delay, and clinical outcomes by geographical areas in Catalonia, Spain.

Methods

Study Setting
The region of Catalonia includes a total population of 7.5 million inhabitants and an area of 32,000 km². The Catalan Stroke Program was established in 2006, a Stroke Code system to cover the entire territory of Catalonia, offering acute stroke care in 9 Primary
Stroke Centers and 5 CSC, the later located in the metropolitan area of Barcelona. In 2013, the stroke network was expanded by adding 12 new TeleStroke Centers (Figure 1). Patients with suspected acute stroke attended by the Emergency Medical Services are transferred to the nearest Stroke Center, regardless of hospital type and patient’s characteristics. Patients with suspected large vessel occlusion admitted to a Primary Stroke Center or a TeleStroke Centers are secondarily transferred to a CSC after initiating infusion of intravenous recombinant tissue-type plasminogen activator (IV r-tPA).

This observational study is based on data available in the SONIIA registry, a prospective government-mandated registry of AIS patients treated with reperfusion therapies, either IV r-tPA and EVT. Further details of the registry have been published elsewhere. For this study, we used data from consecutive patients treated with EVT since 2013 when the new Stroke Network including 21 referring hospitals was established. The SONIIA register satisfies all legal requirements mandated by the local law of protection of personal data.

For this analysis, the Catalan territory was divided into 3 areas based on their distance to the nearest CSC. Area A corresponds to the metropolitan area of Barcelona (2.9 million inhabitants) and includes health areas primarily covered by CSCs, which are reachable in ≤30 minutes. Area B (2.7 million inhabitants) includes areas primarily covered by local stroke centers (Primary Stroke Centers or TeleStroke Centers) located <1 hour away from a CSC (maximum distance 80 km). Finally, area C includes the provinces (1.9 million inhabitants) and is covered by local stroke centers located >1 hour away from a CSC (from 80 to 200 km; Figure 1).

**Outcome Measures and Statistical Analysis**

The main outcome variable was the population rate of EVT (number of EVT×100000 inhabitants/year). Secondary outcomes were time from symptom onset to IV r-tPA, time to CSC arrival, and time to groin puncture. Successful arterial recanalization was considered as modified Thrombolysis in Cerebral Infarction (mTICI) perfusion score 2b-3. Good clinical outcome at 3 months was considered as modified Rankin scale score ≤2. Symptomatic hemorrhagic transformation was evaluated according to European Cooperative Acute Stroke Study II (ECASS II) criteria. Analysis was performed by year-periods to determine changes on EVT rate or delays throughout the years. Baseline characteristics and outcomes between groups were compared using Chi-square test for categorical variables and nonparametric Kruskal–Wallis test for continuous variables.

**Results**

From 2013 to 2015, a total of 965 patients received EVT in Catalonia: 662 (68%) in area A, 191 (20%) in area B, and 112 (12%) in area C. There were no significant differences between the 3 groups in baseline characteristics (age, sex, vascular risk factors, and stroke severity), except a lower proportion of primary EVT (patients with contraindications for IV r-tPA) in B and C drip-and-ship areas than in the A mother-ship area (Table).

The EVT rate was 3-fold higher for group A compared with group B and C for all the periods analyzed. In 2015, after the accomplishment of the Randomized Trial of Revascularization With Solitaire FR Device Versus Best Medical Treatment in the Treatment of Acute Stroke Due to Anterior Circulation Large Vessel Occlusion Presenting Within 8 Hours of Symptom Onset (REVASCAT) performed in Catalonia between November 2013 and December 2014, EVT rate increased 2-folds in all the areas. Currently, the EVT year rate is 10.5 per 100,000 inhabitants for group A, 3.7 for group B, and 2.7 for group C (Figure 2).

Time from symptom onset to groin puncture was 82 minutes longer for group B and 120 minutes longer for group C compared with group A. A longer time from symptom onset to CSC arrival was also observed in groups B and C, suggesting that delays were mostly because of interhospital transfers rather than in-hospital delays at the CSC (Table). For patients in group C, helicopter transportation was used in 34% of patients. This modality was associated with a shorter time from symptom onset to groin puncture (ground 367 [318–425] min versus air 320 [270–375] min; P=0.02).

There were no differences in symptomatic hemorrhagic transformation, postprocedure complete recanalization, functional outcome, and mortality rates at 3 months by the geographical areas (Table).

**Discussion**

In our region, patients living in areas not directly covered by a CSC are 3x less likely to receive EVT and are treated within longer times than patients living in areas primarily covered by CSCs.

The 2015 population EVT rate in areas of Catalonia directly covered by a CSC is high and probably close to the maximum estimated, but it drops significantly in referring areas. Zaidat et al reported a projected rate between 8.6 and 31 EVT/100,000 inhabitants/year, close to the 10/100,000 found in the metropolitan area of Barcelona. It is worth noting that after REVASCAT trial, the overall rate of EVT increased, but differences between areas were still marked. Clinical characteristics of patients from CSC and referring areas were similar, suggesting absence of selection bias explaining differences in the rate of EVT. Our data show a huge inequity between geographical areas, an effect that is
probably generalizable to many other countries. In a study of the 2011 US population, only 0.5% of AIS patients underwent EVT, and 56% of them were 60-minute drive away to an endovascular-capable hospital.7 Health systems need organizational changes to assure that patients who are candidates for EVT can have access to timely adequate care. In Catalonia, a decentralized stroke care model was progressively developed from 2006 to 2013 to ensure rapid access to IV r-tPA, which currently reaches 15% of AIS patients throughout the region.8 However, with the advent of EVT, such a decentralized model can be disadvantageous because time from onset to CSC arrival and to groin puncture are around 2 hours longer for transferred patients.

The main strength of our study is that data of patients treated with reperfusion therapies are based on a high-quality, prospective, mandatory, and monitored regional registry. As a limitation, we have no information about patients with large vessel occlusion who did not receive EVT, so we cannot deep into detail about the particular causes of the lower rate of EVT in patients from referring centers.

In summary, this study demonstrates that high rates of EVT is feasible in well-organized areas covered directly by CSC, but accessibility to EVT from remote areas is hampered by lower rate and longer time to treatment. Based on these results, strategies to shorten interhospital transfer times, alternatives to favor mother-ship models, and certification of new CSC should be considered.
Appendix

Collaborators of the Catalan Stroke Code and Reperfusion Consortium (Cat-SCR)


Disclosures

Redes temáticas de investigación cooperativa INVICTUS RD012/0014, Instituto de Salud Carlos III. A. Dávalos: Research Grant; Entity: Covidien; Explanation: Unrestricted grant to conduct REVASCAT trial. The other authors report no conflicts.

References

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