Impact of Onset-to-Reperfusion Time on Stroke Mortality
A Collaborative Pooled Analysis

Mikael Mazighi, MD, PhD; Saqib A. Chaudhry, MD; Marc Ribo, MD; Pooja Khatri, MD, MSc; David Skoloudik, MD; Maxim Mokin, MD; Julien Labreuche, BST; Elena Meseguer, MD; Sharon D. Yeatts, PhD; Adnan H. Siddiqui, MD; Joseph Broderick, MD; Carlos A. Molina, MD; Adnan I. Qureshi, MD; Pierre Amarenco, MD

**Background**—Onset-to-reperfusion time has been reported to be associated with clinical prognosis. However, its impact on mortality remained to be assessed. Using a collaborative pooled analysis, we examined whether early mortality after successful endovascular treatment is time dependent.

**Methods and Results**—In a collaborative pooled analysis of 7 endovascular databases, we assessed the impact of onset-to-reperfusion time in large-artery occlusion (internal carotid artery or middle cerebral artery) on outcomes. Successful reperfusion was defined as complete or partial restoration of blood flow within 8 hours from symptom onset. Primary outcome was 90-day all-cause mortality. Secondary outcomes included 90-day favorable outcome (modified Rankin Scale score, 0–2), 90-day excellent outcome (modified Rankin Scale score, 0–1), and occurrence of any intracerebral hemorrhage within 24 to 36 hours after treatment. A total of 480 cases with successful reperfusion (median time, 225 minutes) contributed to the present pooled analysis (120 with internal carotid artery occlusion and 360 with isolated middle cerebral artery occlusion). Increasing onset-to-reperfusion time was associated with an increased rate of mortality and intracerebral hemorrhage and with a decreased rate of favorable and excellent outcomes, without heterogeneity across studies. The adjusted odds ratio for each 30-minute time increase was 1.21 (95% confidence interval, 1.09–1.34; *P*<0.001) for mortality, 0.79 (95% confidence interval, 0.72–0.87) for favorable outcome, 0.78 (95% confidence interval, 0.71–0.86) for excellent outcome, and 1.21 (95% confidence interval, 1.10–1.33) for intracerebral hemorrhage.

**Conclusion**—Onset-to-reperfusion time affects mortality and favorable outcome and should be considered the main goal in acute stroke patient management. ([Circulation. 2013;127:1980-1985.](http://circ.ahajournals.org/))

**Key Words:** meta-analysis ■ stroke reperfusion injury ■ stroke

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**Clinical Perspective on p 1985**

In the setting of acute ischemic stroke therapy, reperfusion has been demonstrated to be a major goal to be achieved.1,2 The impact of reperfusion on favorable outcome and mortality is established.1 The close correlation between reperfusion and clinical outcomes is time dependent.3 In fact, spontaneous reperfusion is a common phenomenon,4 but only early reperfusion has a substantial impact on outcome. Evidence from intravenous recombinant tissue-type plasminogen activator (rtPA) trials shows that onset-to-treatment time (OTT) affects prognosis, with increased rates of favorable functional outcome as OTT is decreased.3 Onset-to-reperfusion time (ORT) has emerged as a new critical goal on the basis of transcranial Doppler studies monitoring arterial reperfusion that have shown that favorable outcome was more likely if the artery was opened within 30 minutes of stroke onset.6 Additional data have shown that reperfusion obtained within 3.5 hours was associated with a more favorable 3-month outcome in 93% of patients. Each 30-minute delay to reperfusion was followed by 20% fewer patients cured at 3 months.2 Similarly, in the Interventional Management of Stroke (IMS) pilot trials, good clinical outcome after angiographically successful reperfusion was significantly time dependent.7 The critical role of ORT has been demonstrated for functional outcome, but its effect on mortality and hemorrhagic complications remains to be proven. In this meta-analysis, we sought to assess the impact of ORT on mortality, functional outcome, and any intracerebral hemorrhage.

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From the Department of Neurology and Stroke Centre, Bichat University Hospital, INSERM U-698 and Paris-Diderot University, Paris, France (M. Mazighi, J.L., E.M., P.A.); Zeenat Qureshi Stroke Research Center, University of Minnesota, Minneapolis (S.A.C., A.I.Q.); Hospital Vall D’Hebron, Neurology, Barcelona, Spain (M.R., C.A.M.); Department of Neurology, University of Cincinnati Academic Health Center, Cincinnati, OH (P.K., J.B.); Department of Neurology, University Hospital, Ostrava, Czech Republic (D.S.); Department of Neurosurgery, University at Buffalo, State University of New York, Buffalo (M. Mokin, A.H.S.); and Division of Biostatistics and Epidemiology, Department of Medicine, Medical University of South Carolina, Charleston (S.D.Y.).

Correspondence to M. Mazighi, MD, PhD, Department of Neurology and Stroke Centre, Bichat University Hospital, 46, Rue Henri Huchard, 75018 Paris, France. E-mail: mikel.mazighi@bch.aphp.fr

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Methods

Data Sources

Data from 7 studies of patients treated with endovascular treatment for acute ischemic stroke were combined to determine the impact of ORT on early all-cause mortality. There are 2 published single-arm pilot trials (IMS I and II) designed to assess the safety of combined intravenous/intra-arterial therapy for patients with large ischemic strokes (National Institutes of Health Stroke Scale [NIHSS] score ≥10).7,8 The remaining 5 studies are prospectively collected observational data from centers with experience in endovascular therapies. All studies were approved by local institutional review boards. Observational data sources included 1 center in France (University Bichat Hospital, Paris),1 center in Spain (Vall D’Hebron Hospital, Barcelona),10 a multicenter data set in the United States (University of Minnesota, Hennepin County Medical Centers, University of Medicine and Dentistry of New Jersey),11 1 center in the Czech Republic (University Ostrava Hospital),12 and 1 center in the United States (University of Buffalo, New York).13 A pooled analysis of the 2 IMS trials1 and a single-center experience study2 have previously reported the impact of ORT on good clinical outcome, but none has studied associations with 90-day mortality. The methodologies (study period, treatment specificities, baseline characteristics, and outcomes) of the 7 studies are summarized in Table 1.

Eligibility, Data Collection, and Definitions

Patients were eligible for inclusion in this study if they (1) had a large-artery occlusion (intracranial internal carotid artery or middle cerebral artery, M1 or M2) treated by an endovascular approach (thrombolysis or mechanical endovascular therapy) with or without prior use of intravenous thrombolysis; (2) had a successful angiographic reperfusion within 8 hours from symptom onset, defined as a complete or partial restoration of blood flow (Thrombolysis in Myocardial Infarction grade 2–3)14; and (3) had available information on vital status.

Data from individual patients were collected on a standardized form with predefined variables and were compiled and analyzed at the coordinating center (University Bichat Hospital, Paris). The following variables were collected: age; sex; initial stroke severity as assessed by the pretreatment NIHSS score; medical history, including main vascular risk factors (hypertension, diabetes mellitus, and current smoking); admission glucose level; occlusion site; prior use of intravenous fibrinolysis; use of intra-arterial fibrinolysis; use of mechanical endovascular therapy; time from onset to successful reperfusion monitored with conventional angiography during the intra-arterial procedure; functional outcome assessed by the modified Rankin Scale (mRS) score; and mortality and intracranial hemorrhage at 24 to 36 hours on cerebral imaging (magnetic resonance imaging or computed tomography scan). Intracranial hemorrhage was defined and classified according to the European Cooperative Acute Stroke Study (ECASS) as hemorrhagic infarction and parenchymal hemorrhage.15,16 The mRS score and mortality were assessed at discharge in 1 study11 and at 90 days in the remaining 6 studies (during face-to-face interviews or via telephone calls according to the study protocols).

The primary study outcome was all-cause mortality. Secondary outcomes included favorable outcome (defined as an mRS score of 0–2), excellent outcome (defined as an mRS score of 0–1), and any intracerebral hemorrhage.

Table 1. Characteristics and Outcomes of the 7 Studies Contributing to the Present Individual Meta-Analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Included patients, n</th>
<th>Study period</th>
<th>Endovascular treatment, n (%)</th>
<th>Occlusion site, n (%)</th>
<th>Pretreatment NIHSS score, median (IQR), min</th>
<th>Onset-to-reperfusion time, median (IQR), min</th>
<th>Age, median (IQR), y</th>
<th>Male sex, n (%)</th>
<th>Hypertension, n (%)</th>
<th>Diabetes mellitus, n (%)</th>
<th>Current smokers, n (%)</th>
<th>Admission glucose, median (IQR), mg/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>166</td>
<td>April 2007–March 2012</td>
<td>Thrombolysis 138 (83.1)</td>
<td>ICA (isolated or tandem with MCA) 41 (24.7)</td>
<td>17 (12–20)</td>
<td>250 (214–315)</td>
<td>73 (59–84)</td>
<td>77 (46.4)</td>
<td>88 (53.0)</td>
<td>19 (11.5)</td>
<td>28 (17.2)</td>
<td>119 (101–148)</td>
</tr>
<tr>
<td>2</td>
<td>118</td>
<td>May 2005–June 2010</td>
<td>Mechanical 74 (44.6)</td>
<td>Isolated MCA 125 (75.3)</td>
<td>16 (10–20)</td>
<td>308 (260–391)</td>
<td>68 (58–79)</td>
<td>64 (54.2)</td>
<td>83 (74.1)</td>
<td>32 (28.6)</td>
<td>10 (11.6)</td>
<td>…</td>
</tr>
<tr>
<td>3</td>
<td>72</td>
<td>November 2006–November 2011</td>
<td>Previous use of intravenous thrombolysis, n (%)</td>
<td>123 (74.1)</td>
<td>19 (17–21)</td>
<td>306 (252–360)</td>
<td>73 (67–80)</td>
<td>36 (50.0)</td>
<td>46 (63.9)</td>
<td>28 (68.3)</td>
<td>21 (51.2)</td>
<td>72 (105–152)</td>
</tr>
<tr>
<td>4</td>
<td>41</td>
<td>December 2008–February 2011</td>
<td>Thrombolysis 41 (56.9)</td>
<td>ICA (isolated or tandem with MCA) 26 (36.1)</td>
<td>15 (10–19)</td>
<td>(176–325)</td>
<td>65 (56–71)</td>
<td>35 (51.4)</td>
<td>47 (65.3)</td>
<td>9 (12.5)</td>
<td>13 (19.4)</td>
<td>121 (105–171)</td>
</tr>
<tr>
<td>5</td>
<td>31</td>
<td>January 2001–October 2001</td>
<td>Mechanical 41 (100.0)</td>
<td>Isolated MCA 28 (63.9)</td>
<td>16 (19–24)</td>
<td>(274–354)</td>
<td>72 (54–77)</td>
<td>26 (30.6)</td>
<td>32 (78.1)</td>
<td>10 (24.4)</td>
<td>7 (17.1)</td>
<td>112 (95–129)</td>
</tr>
<tr>
<td>6</td>
<td>29</td>
<td>January 2003–February 2006</td>
<td>Previous use of intravenous thrombolysis, n (%)</td>
<td>31 (100.0)</td>
<td>15 (10–19)</td>
<td>(288–362)</td>
<td>72 (54–77)</td>
<td>5 (16.1)</td>
<td>41 (100.0)</td>
<td>25 (63.9)</td>
<td>6 (6.9)</td>
<td>110 (101–124)</td>
</tr>
<tr>
<td>7</td>
<td>23</td>
<td>January 2010–March 2011</td>
<td>Occlusion site, n (%)</td>
<td>29 (100.0)</td>
<td>16 (19–24)</td>
<td>(229–344)</td>
<td>72 (54–77)</td>
<td>13 (4.3)</td>
<td>17 (54.8)</td>
<td>3 (9.7)</td>
<td>6 (2.0)</td>
<td>116 (100–132)</td>
</tr>
</tbody>
</table>

ICA indicates internal carotid artery; IQR, interquartile range; MCA, middle cerebral artery; and NIHSS, National Institutes of Health Stroke Scale.

*Assessed at discharge.
**Statistical Analysis**

In primary pooled analysis, we used a 1-stage meta-analysis approach to assess the impact of ORT on each outcome in which a single logistic regression model with fixed study effects was fit with combined data. This model was further adjusted for the following prespecified confounding variables: age, sex, pretreatment NIHSS score, hypertension, diabetes mellitus, and current smoking. An additional adjustment was done for admission glucose level (after log-transformation), available in 6 studies. To examine the shape of associations, we categorized the ORT into quartiles and calculated the odds ratios (ORs) with corresponding 95% confidence intervals (CIs) for each quartile using the lowest quartile as the reference. Because associations were approximately log-linear, we also computed ORs for each 30-minute decrease in time to recanalization. A subgroup analysis was done by occlusion site (internal cerebral artery [ICA] versus isolated middle cerebral artery [MCA]). Heterogeneities across studies and subgroups were examined by formal interaction tests in unadjusted (including study as a covariable for subgroups analysis) and adjusted logistic regression models. A sensitivity analysis was performed after exclusion of the study with only discharge outcomes.

Finally, we repeated the pooled analysis with the use of a 2-stage meta-analysis approach in which individual logistic regression models were fit for each study and summarized by use of random-effects meta-analysis. Because of the small sample sizes in the individual studies, we included only age and pretreatment NIHSS score in the multivariable analysis. We quantified the between-study heterogeneity in estimates by calculating the $I^2$ statistics.

Statistical testing was conducted at the 2-tailed α level of 0.05. Data were analyzed with SAS software version 9.3 (SAS Institute, Cary, NC) and the Cochrane Collaboration’s Review Manager software (RevMan, edition 4.2.10).

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### Table 2. Outcomes Rates by Quartile of Onset-to-Reperfusion Time

<table>
<thead>
<tr>
<th></th>
<th>Onset-to-Reperfusion Time, min</th>
<th>$P$ for Trend or OR per 30 min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;228 (n=120)</td>
<td>228–285 (n=122)</td>
</tr>
<tr>
<td><strong>All-cause mortality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n (%)</td>
<td>13 (10.8)</td>
<td>21 (17.2)</td>
</tr>
<tr>
<td>Crude OR (95% CI)*</td>
<td>1.00 (Referent)</td>
<td>2.02 (0.94–4.34)</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)†</td>
<td>1.00 (Referent)</td>
<td>1.71 (0.74–3.96)</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)‡</td>
<td>1.00 (Referent)</td>
<td>2.78 (1.04–7.40)</td>
</tr>
<tr>
<td><strong>Favorable outcome</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n (%)</td>
<td>81 (67.5)</td>
<td>63 (51.6)</td>
</tr>
<tr>
<td>Crude OR (95% CI)*</td>
<td>1.00 (Referent)</td>
<td>0.53 (0.31–0.91)</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)†</td>
<td>1.00 (Referent)</td>
<td>0.56 (0.29–1.08)</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)‡</td>
<td>1.00 (Referent)</td>
<td>0.42 (0.20–0.90)</td>
</tr>
<tr>
<td><strong>Excellent outcome</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n (%)</td>
<td>62 (51.7)</td>
<td>42 (34.4)</td>
</tr>
<tr>
<td>Crude OR (95% CI)*</td>
<td>1.00 (Referent)</td>
<td>0.49 (0.29–0.84)</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)†</td>
<td>1.00 (Referent)</td>
<td>0.54 (0.28–1.04)</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)‡</td>
<td>1.00 (Referent)</td>
<td>0.41 (0.19–0.89)</td>
</tr>
<tr>
<td><strong>Intracerebral hemorrhage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n (%)</td>
<td>15 (12.5)</td>
<td>35 (28.7)</td>
</tr>
<tr>
<td>Crude OR (95% CI)*</td>
<td>1.00 (Referent)</td>
<td>2.65 (1.33–5.29)</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)†</td>
<td>1.00 (Referent)</td>
<td>2.05 (0.98–4.29)</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)‡</td>
<td>1.00 (Referent)</td>
<td>2.27 (0.98–5.23)</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; and OR, odds ratio.

1 Logistic regression analysis adjusted for studies.
2 Logistic regression analysis adjusted for studies, age, sex, pretreatment National Institutes of Health Stroke Scale (NIHSS) score, hypertension, diabetes mellitus, and current smoking.
3 Logistic regression analysis adjusted for studies, age, sex, pretreatment NIHSS score, hypertension, diabetes mellitus, current smoking, and log glucose values at admission (multivariate analysis performed in 6 studies including 362 patients).

### Results

A total of 480 patients with ICA (n=120) or isolated MCA (n=360) occlusion treated with successful angiographic reperfusion within 8 hours from symptom onset were included in the present individual meta-analysis. The recanalization therapy and patient characteristics varied by study, as described in Table 1. Overall, 304 patients (63%) received a prior intravenous rtPA dose before endovascular treatment, 340 patients (71%) received an intra-arterial rtPA dose, and 266 patients (55%) had mechanical recanalization (after intra-arterial rtPA administration in 126 cases). ORT ranged across studies (in median values) from 225 minutes to 323 minutes. Overall, the median age was 70 years; 53% were men; and the median pretreatment NIHSS score was 17. All-cause mortality occurred in 96 patients (20%), favorable outcome in 235 patients (49%), excellent outcome in 164 patients (34%), and any intracranial hemorrhage in 131 patients (27%).

**ORT and All-Cause Mortality**

As shown in Table 2 and Figure 1, the probability for all-cause mortality increased with increasing ORT ($P<0.001$). There was no heterogeneity in association between studies ($P$ for interaction=0.83). After adjustment for studies, age, sex, pretreatment NIHSS score, hypertension, diabetes mellitus, and current smoking, we calculated an adjusted OR for all-cause mortality of 1.21 (95% CI, 1.09–1.34; $P<0.001$) associated with each
30-minute increase in recanalization time. Similar results were found after additional adjustment for admission glucose level (adjusted OR, 1.19; 95% CI, 1.05–1.35; \(P=0.006\)) and in sensitivity analyses using a 2-stage approach (Figure 2A) or after exclusion of the study that collected only discharge mortality (adjusted OR, 1.19; 95% CI, 1.06–1.33; \(P=0.003\)).

When analysis was stratified by site of occlusion (ICA versus isolated MCA), we found a significant quantitative interaction in analysis adjusted for study (\(P\) for interaction=0.040) and in our fully adjusted analysis (\(P\) for interaction=0.050); the effect size of ORT on mortality was larger in patients with ICA occlusion than in patients with isolated MCA (Figure 3).

**ORT and Functional Outcomes**

In contrast to mortality, the rate of favorable outcome (mRS score, 0–2) decreased significantly with increasing ORT (Figure 1), with an adjusted OR for each 30-minute time increase of 0.79 (95% CI, 0.72–0.87; \(P<0.001\)). Similar results were found with the excellent outcome definition (mRS score, 0–1; Table 2). Whatever the outcome definition, there was no significant heterogeneity between studies (Figure 2B and 2C) or between the site of occlusion (Figure 3). Sensitivity analysis excluding the study that collected mRS at discharge (rather than at 90 days) yielded similar results, with an adjusted OR of 0.80 (95% CI, 0.72–0.89) for both outcome definitions.

**ORT and Any Intracerebral Hemorrhage**

Similar to mortality data, the rate of any intracerebral hemorrhage complications increased with increasing ORT, with no significant heterogeneity across studies (Table 2 and Figure 1D). In main analysis, an adjusted OR of 1.21 (95% CI, 1.10–1.33; \(P<0.001\)) for each 30-minute time increase was estimated. A similar nonsignificant quantitative interaction between reperfusion time and site of occlusion was found (Figure 2).

**Discussion**

In the present collaborative pooled analysis, ORT determines favorable outcome and mortality. The shorter the ORT is, the better the outcome is, as illustrated by reduced mortality rates and increased proportion of independent patients. The effect of ORT on mortality was stronger in patients with ICA occlusion than in patients with isolated MCA.

ORT has not been considered in the past because most studies assessed reperfusion at only 1 time point (mainly at 24 hours), limiting the analyses to the impact of OTT rather than ORT. Earlier data have shown that reperfusion documented within 6 hours of symptom onset was more strongly associated with good clinical outcomes than reperfusion documented within 24 hours.1 The majority of this evidence was based on transcranial Doppler monitoring studies. The present pooled analysis is based on conventional angiography monitoring.
(the gold standard for arterial imaging), which confers a precise evaluation of reperfusion and its timing. These results indicate the critical need to add ORT to OTT as a critical treatment goal in acute stroke therapy. OTT represents the rapidity and efficiency of processes before the start of a reperfusion therapy, whereas ORT represents OTT plus the additional time from onset of reperfusion therapy to successful reperfusion. Shifting the focus to ORT, particularly for endovascular therapy, will provide effective comparisons of treatment strategies. Measurement of ORT in patients treated with intravenous rtPA could be done with transcranial Doppler, whereas cerebral angiography would be used to measure ORT in subjects undergoing endovascular therapy.

In the setting of combined intravenous and intra-arterial therapy, the present findings support a direct approach rather than a rescue approach in intravenous rtPA–treated patients in which intra-arterial therapy is delayed until the effectiveness of the intravenous rtPA infusion is assessed after the hour of infusion. If the patient has a miraculous recovery before intra-arterial therapy, one could use clinical judgment about not performing an angiogram. However, the patient can still fluctuate.

Although the intra-arterial element of combined therapy has been suggested to determine the final reperfusion rate, intravenous rtPA may increase the speed at which reperfusion is achieved. Although all patients in this collaborative meta-analysis were treated with endovascular therapy, we cannot comment specifically on the method of reperfusion. The greater size effect of short ORT in ICA occlusions compared with MCA occlusions suggests that ORT is more critical in larger strokes. The relationship between ORT and outcome was linear, but the range of ORT in this study was actually fairly narrow and <6 hours. Therefore, our findings may not be applicable for very delayed ORT (ie, >6 hours).

More important, we cannot exclude that the selected centers were not representative of all stroke centers with endovascular facilities, because this was a collaborative project rather than a systematic literature-based center-selection approach. Additional limitations in this study involve the heterogeneity of patient selection for endovascular therapy and the modalities in each center. In IMS I and II, computed tomography angiography, computed tomography perfusion, or magnetic resonance imaging was not used to select patients, whereas the other studies used arterial imaging or perfusion imaging (mainly computed tomography perfusion). The patient selection based on multimodal imaging did not affect clinical outcome, but it is possible that very short ORT outplays the benefit of multimodal imaging compared with plain computed tomography. One may state that additional imaging is unimportant if patients can be treated fast enough, but this study was not designed to test this hypothesis, so no conclusion can be made on this specific point. Despite these limitations, there is no significant heterogeneity in impact of ORT on outcomes across studies. Our data include few subjects with mild or moderate strokes or any strokes in the posterior circulation. Thus, our data represent only a subset of stroke patients eligible for acute stroke therapy.

Conclusion

Our study supports ORT as the main goal in acute stroke patients eligible for reperfusion therapies. In the setting of combined intravenous and intra-arterial therapies, an approach that mandates rapid transition from intravenous rtPA to endovascular therapy should probably be preferred rather than rescue strategies that potentially delay ORT. Just like what has been necessary for successful treatment with intravenous rtPA, the present findings emphasize that the endovascular community needs to reorganize its systems and patient intake to minimize delay in the times from door to groin puncture and from groin puncture to recanalization if it hopes to be successful.

Source of Funding

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Disclosures

Dr Mokin received a significant research grant from Toshiba Medical; and is a consultant/advisory board member for Codman & Shurtleff, Inc, Genentech, Abbott Vascular, American Association of Neurological Surgeons courses, Genentech, and Neocure Group LLC; has ownership in Hotspur, Intratech Medical, StimSox, and Valor Medical; and is a consultant/advisory board member for Codman & Shurtleff, Inc, Concentric Medical, ev3/Covidien Vascular Therapies,
GuidePoint Global Consulting, and Penumbra. Dr Khatri was sponsored for travel as an unpaid consultant, is a member of the IMS III Trial Executive Committee, and is the neurology principal investigator for the THERAPY Trial and the principal investigator for the PRISMS Trial. The other authors report no conflicts.

References


CLINICAL PERSPECTIVE

In the setting of acute ischemic stroke therapy, reperfusion has been demonstrated to be a major goal to be achieved. The close correlation between reperfusion and clinical outcomes is time dependent, and evidence from intravenous recombinant tissue-type plasminogen activator trials showed that onset-to-treatment time affects prognosis. Onset-to-reperfusion time has been reported to be associated with clinical prognosis. However, its impact on mortality remained to be assessed. Using a collaborative pooled analysis, we examined whether early mortality after successful endovascular therapy was time dependent in large-artery occlusion within 8 hours from symptom onset. Among 480 cases with successful reperfusion, increasing onset-to-reperfusion time was associated with an increased rate of mortality and intracerebral hemorrhage and a decreased rate of favorable and excellent outcomes. The adjusted odds ratio for each 30-minute time increase was 1.21 (95% confidence interval, 1.09–1.34; P<0.001) for mortality, 0.79 (95% confidence interval, 0.72–0.87) for favorable outcome, and 0.78 (95% confidence interval, 0.71–0.86) for excellent outcome, and 1.21 (95% confidence interval, 1.10–1.33) for intracerebral hemorrhage. These findings support onset-to-reperfusion time as the main goal in acute stroke patients eligible for reperfusion therapies. In the setting of combined intravenous and intra-arterial therapies, an approach that mandates rapid transition from intravenous recombinant tissue-type plasminogen activator to endovascular therapy should probably be preferred over rescue strategies that potentially delay onset-to-reperfusion time. Just like what has been necessary for successful treatment with intravenous recombinant tissue-type plasminogen activator, the present findings emphasize that the endovascular community needs to reorganize its systems and patient intake to minimize delay in door to groin puncture and groin puncture to recanalization if it hopes to be successful.
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