Stroke
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Stroke Association
A Division of American Heart Association

Intravenous Thrombolysis of Basilar Artery Occlusion : Predictors of Recanalization and Outcome

Tiina Sairanen, Daniel Strbian, Lauri Soinne, Heli Silvennoinen, Oili Salonen, Ville Artto, Ilkka Koskela, Olli Häppölä, Markku Kaste, Perttu J. Lindsberg and for the Helsinki Stroke Thrombolysis Registry (HSTR) Group

Stroke 2011, 42:2175-2179: originally published online July 7, 2011
doi: 10.1161/STROKEAHA.110.605584
Stroke is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514
Copyright © 2011 American Heart Association. All rights reserved. Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/42/8/2175

Data Supplement (unedited) at:
http://stroke.ahajournals.org/http://stroke.ahajournals.org/content/suppl/2011/07/07/STROKEAHA.110.605584.DC1.html

Subscriptions: Information about subscribing to Stroke is online at
http://stroke.ahajournals.org//subscriptions/

Permissions: Permissions & Rights Desk, Lippincott Williams & Wilkins, a division of Wolters Kluwer Health, 351 West Camden Street, Baltimore, MD 21202-2436. Phone: 410-528-4050. Fax: 410-528-8550. E-mail:
journalpermissions@lww.com

Reprints: Information about reprints can be found online at
http://www.lww.com/reprints

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011

Intravenous Thrombolysis of Basilar Artery Occlusion
Predictors of Recanalization and Outcome

Tiina Sairanen, MD, PhD; Daniel Strbian, MD, PhD; Lauri Soinne, MD, PhD; Heli Silvennoinen, MD, PhD; Oili Salonen, MD, PhD; Ville Artto, MD, PhD; Ilkka Koskela, MSc; Olli Häppölä, MD, PhD; Markku Kaste, MD, PhD; Perttu J. Lindsberg, MD, PhD; for the Helsinki Stroke Thrombolysis Registry (HSTR) Group

Background and Purpose—Basilar artery occlusion has a high mortality rate (85% to 95%) if untreated. We describe a large single-center cohort treated mostly with intravenous alteplase and heparin.

Methods—The cohort included 116 patients with angiography-verified basilar artery occlusion. We studied baseline characteristics, frequencies of recanalization and symptomatic intracranial hemorrhage, and 3-month outcome (modified Rankin Scale [mRS]).

Results—Thirty patients (25.9%) had mRS 0 to 2, 42 patients (36.2%) had moderate outcome (mRS, 0–3), 26 patients (22.4%) required daily help (mRS, 4–5), and 48 patients (41.4%) died. Eighteen patients (15.7%) developed symptomatic intracranial hemorrhage. In patients with post-treatment angiogram available (n=91), 59 patients (64.8%) had a complete or partial recanalization. Radiological location of basilar artery occlusion was known in 55 of 91 instances, and recanalization was associated directly with clot location at the top-of-basilar (odds ratio, 4.8 [1.1–22]; $P=0.048$). Independent outcome (mRS 0-2) was associated with lower age and National Institutes of Health Stroke Scale (NIHSS) score at baseline. Age, nil or minimal recanalization, and symptomatic intracranial hemorrhage were independently associated with fatal outcome. Sixteen of 71 patients (22.5%) who presented with coma eventually reached moderate outcome, and additional 8 patients (11.3%) progressed to mRS 4.

Conclusions—Whereas recanalization after intravenous thrombolysis strongly predicts survival and moderate outcome, therapeutic techniques should concentrate on clot location. Although most adverse baseline variables, age, symptom severity, but also coma are beyond control, it should not preclude thrombolysis, which may permit independent survival. **(*Stroke*. 2011;42:2175-2179.)**

Key Words: ischemic stroke ■ basilar artery occlusion ■ thrombolysis ■ recanalization ■ outcome

Close to one fifth of cerebral infarctions occur in the territory of posterior circulation. A small portion of these are angiographically verified basilar artery occlusions (BAO). The location and length of the vascular occlusion determines the clinical picture, ranging from mild motor deficits to tetraplegia.[1] Therapy decisions in BAO are hampered by the lack of randomized controlled trials comparing anticoagulants or antiplatelet agents with thrombolysis. Without recanalization, the likelihood of independent outcome (defined as mRS 0–2) is roughly 2% across a wide range of case series applying thrombolysis either intravenously (IVT) or intra-arterially (IAT) in varying protocols.[2] Here, we present the outcome of a large single-center cohort of thrombolysis-treated BAO patients, representing 10.5% (116/1104) of all stroke thrombolyses in our hospital between 1995 and 2008.[3]

Materials and Methods

Patients

This study was approved by local authorities and conducted at the Department of Neurology, Helsinki University Central Hospital. All consecutive stroke patients treated with thrombolysis at Helsinki University Central Hospital are registered prospectively.[3] Thrombolysis for clinically suspected BAO was performed in 119 patients during the study period. Two patients did not have sufficient angiographic examinations before treatment, and 1 foreign patient was lost to follow-up. Thus, the final study cohort includes 116 patients with angiography-confirmed BAO and 3-month follow-up.

Data on medical history, acute treatment details, and outcome were obtained from the Safe Implementation of Treatments in Stroke (SITS) registry from 2003 onward.[4] All data were checked and additional data were acquired from medical hospital records. The cohort treated between 1995 and 2003 was described in detail.[5]

Pretreatment angiography (time-of-flight, computed tomography, or digital subtraction) was evaluated by a neuroradiologist in a

Received October 12, 2010; accepted March 1, 2011.

From the Department of Neurology (T.S., D.S., L.S., V.A., I.K., O.H., M.K., P.J.L.), Helsinki University Central Hospital, Helsinki, Finland; Helsinki Medical Imaging Center (H.S., O.S.), Helsinki, Finland; Research Program Unit, Molecular Neurology (T.S., P.J.L.), Biomedicum Helsinki, University of Helsinki, Finland.

The online-only Data Supplement is available at http://stroke.ahajournals.org/cgi/content/full/STROKEAHA.110.605584/DC1.

Correspondence to Tiina Sairanen, MD, PhD, Department of Neurology, HUCH, Haartmaninkatu 4, 00290 Helsinki, Finland. E-mail tiina.sairanen@hus.fi

© 2011 American Heart Association, Inc.

Stroke **is available at http://stroke.ahajournals.org** **DOI: 10.1161/STROKEAHA.110.605584**

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011

Table 1. Demographics, Medical History, Baseline, and Follow-Up Clinical and Radiological Characteristics of Thrombolysis-Treated BAO Patients

Characteristic	All Patients N=116	mRS 0–2 N=30	mRS 3–5 N=38	Dead N=48	Alive N=68	Alive vs Dead *P* Value
Age (y); mean (median)	63 (64, 19)	54 (59, 30)	63 (62.5, 20)	69 (69, 18)	59 (61, 22)	<0.0001
Male sex; n (%)	83 (71.6)	25 (83.3)	26 (68.4)	32 (66.7)	51 (75.0)	0.327
Diabetes; n (%)	12 (10.3)	0 (0)	26 (68.4)	8 (16.7)	4 (5.9)	0.060
Atrial fibrillation, n (%)	25 (21.6)	1 (3.3)	9 (23.7)	15 (31.3)	10 (14.7)	0.033
NIHSS score*; median (IQR)	23 (18)	10 (10)	24 (18)	29 (10)	14 (17)	<0.0001
OTT, min; median (IQR)	523 (730)	423 (545)	689 (1041)	531 (557)	525 (788)	0.691
Intubation/mechanical ventilation; n (%)	71 (61.2)	12 (40)	21 (55.3)	38 (79.2)	33 (48.5)	0.001
Convulsions; n (%)*	12 (10.5)	2 (6.7)	2 (5.4)	8 (17)	4 (6%)	0.058
Blood glucose before treatment†, mmol/l; median (IQR)	7.1 (3.1)	7.1 (2.9)	6.7 (1.5)	7.7 (3.7)	6.8 (2.2)	0.056
Peak blood glucose within 24 h*, mmol/l; median (IQR)	6.8 (2)	5.9 (2.0)	6.8 (2)	7.2 (3)	6.6 (2)	0.004
Systolic blood pressure before, mm Hg; median (IQR)	147 (38)	139 (40)	149 (34)	158 (39)	145 (31)	0.200
IV antihypertensive before; n (%)	25 (21.6)	3 (10)	13 (34.2)	9 (18.8)	16 (23.5)	0.538
Nil or minimal recanalization‡; n (%)	32 (35.2)	4 (13.8)	10 (31.3)	18 (56.3)	14 (43.8)	0.001
Complete or partial recanalization‡; n (%)	59 (64.8)	25 (86.2)	22 (68.8)	12 (20.3)	47 (79.7)	0.001
sICH per ECASS§, n (%)	18 (15.7)	0 (0)	2 (5.3)	16 (34.0)	2 (2.9)	<0.0001

Moderate outcome (mRS 0–3) vs 4–6 is displayed in Supplemental Table S1, http://stroke.ahajournals.org.

mRS indicates modified Rankin scale; BAO, basilar artery occlusion; NIHSS, National Institutes of Health Stroke Scale; OTT, onset-to-treatment time; IV, intravenous; sICH, symptomatic intracranial hemorrhage; IQR, interquartile range.

*n=114.

†n=102.

‡Post-treatment angiography available in 91 patients (78.4%).

§n=115, 1 patient died within 24 hours post-thrombolysis without repeated head scan.

blinded fashion. Recanalization in post-treatment angiograms was dichotomized as complete to partial (corresponding with TIMI 3 or 2), and minimal to nil (corresponding with TIMI 1 or 0).[6] Imaging was repeated at 24 hours after thrombolysis (except for 1 patient who died within 24 hours) and at any time clinical deterioration occurred and ICH was suspected. Symptomatic ICH (sICH) was defined according to ECASS II criteria.[7]

Although not ideally suitable for vertebrobasilar circulation strokes, baseline National Institutes of Health Stroke Scale (NIHSS) was available in 114 of 116 patients (98%). For patients requiring intubation, NIHSS scores were evaluated before intubation, or sedation was stopped before the evaluation. The same is true for NIHSS scoring during follow-up. Modified Rankin Scale (mRS) at 3 months was assessed either by face-to-face appointment or by telephone interview of patients and their caregivers by video-trained and certified stroke neurologists.[8,9] Stroke etiology was designated by stroke neurologists according to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) criteria,[10] based on review of all medical and radiological records.

Statistical Analysis

Distributions of the continuous variables were studied and tested for normality. Univariate comparisons were performed with Student *t* test or Mann-Whitney *U* Rank Sum test for continuous variables, and with Pearson χ^2 test for categorical variables. Three-month outcome of mRS 0 to 2 was defined as independent, mRS 3 to 5 as dependent, mRS 0 to 5 as alive, and mRS 6 as deceased. For moderate outcome (mRS 0 to 3), see Supplemental Table S1, http://stroke.ahajournals.org. For multivariate analysis testing associations of baseline parameters with 3-month outcome and recanalization, a model of logistic regression was constructed, including potential confounders as identified by previous research. In case of 3-month outcome, all of the previously recognized predictors were highly significant also in our univariate analysis. In addition, highest blood glucose within 24 hours was also included because of high level of significance. In case of regression model for recanalization, only sparse data exist from previous research, for which covariates were chosen based on the univariate analysis ($P<0.1$). The data are given as OR (95% CI) with the corresponding probability value. Two-sided values of $P<0.05$ were considered significant. SPSS 17.0 software (SPSS Inc) was used.

Results

The demographics, medical history, baseline, and follow-up clinical and radiological characteristics are summarized in Table 1. According to the TOAST criteria, the etiology was large-artery atherosclerosis in 38/116 patients (32.8%), cardioembolism in 30 patients (25.9%), other determined etiology in 12 patients (10.3%; including vertebral dissection, n=11), and undetermined (including multiple potential etiologies) in 36 patients (31%). The proportion of patients with undetermined etiology is sizeable; otherwise, the etiologic grouping is in balance with other reports.[5,11]

BAO was diagnosed using digital subtraction angiography in 3 patients, with magnetic resonance angiography in 64 patients (55.2%), and computed tomographic angiography in 49 patients (42%). The majority of BAO patients were treated with only IVT (109/116, 94%). Seven patients (6%) received only IAT. None of the patients received mechanical intra-arterial treatment. According to our written institutional BAO therapy protocol, 96% patients (111/116) also received full-dose anticoagulation with either intravenous unfractionated heparin (102/111; 92%) or low molecular weight heparin (9/111). Anticoagulation treatment was initiated either immediately after or before thrombolysis after exclusion of ICH on the admission head scan. The activated partial thromboplastin time target was between 75 and 100 seconds.

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011

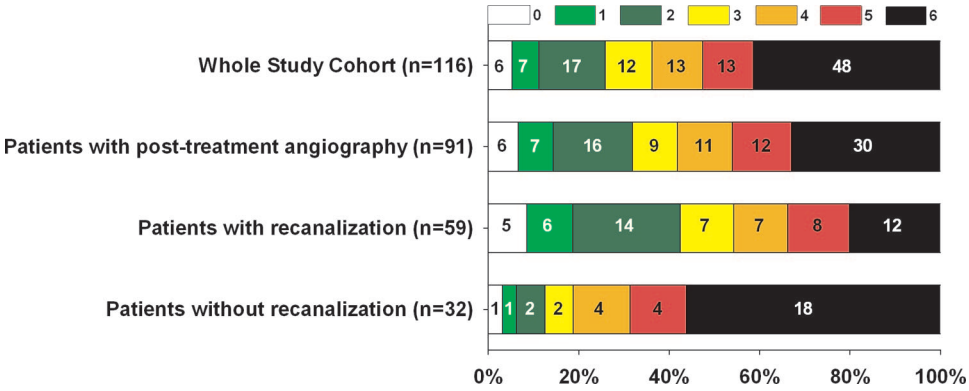

Figure. Outcome at 3 months. Patients with post-treatment angiography are additionally dichotomized in to those with and without recanalization. The vast majority of patients with missing post-treatment angiography (n=25) died (n=18) or had dependent outcome (n=6).

Recanalization

Post-treatment angiograph was performed in 78.4% of patients (91/116) and not in 25 patients (21.6%), 4 of whom died within 24 hours from treatment onset. In 84% of the patients with no follow-up angiogram (21/25), the 3-month outcome was nonindependence or death (Figure). Of 91 patients, 66 patients (72.5%) underwent magnetic resonance angiography, 24 patients (26.4%) underwent computed tomographic angiography, and 1 patient (1%) had digital subtraction angiography. Fifty-nine patients (64.8%) showed a complete or partial recanalization, and 32 patients (35.2%) had nil or minimal recanalization. Demographic characteristics, medical history, and physiological variables of patients with different level of recanalization are shown in Table 2.

Starting in 2002, radiological data were recorded digitally and permitted a detailed investigation of the whole basilar artery length in 74 patients, Of these, both pre- and post-treatment angiographs were available from 55 patients (Table 2). In multivariate analysis adjusted for diabetes, NIHSS at baseline, and onset-to-treatment time <6 hours, only the top-of-basilar clot location (n=23) was associated with partial or complete recanalization with OR 4.8 (1.1–22), P=0.048.

Table 2. Univariate Analyses on Recanalization of BAO (n=91)

Parameter	TIMI 0–1 (n=32)	TIMI 2–3 (n=59)	*P* Value
Age, y; median (IQR)	62 (23)	63 (22)	0.962
Male sex; n (%)	18 (56.3)	43 (72.9)	0.107
Diabetes; n (%)	6 (18.8)	2 (3.4)	0.013
Atrial fibrillation; n (%)	3 (9.4)	11 (8.6)	0.242
NIHSS, median (IQR)	29 (15)	14 (17)	0.001
OTT, min; median (IQR)	556 (587)	447 (785)	0.124
OTT<6 h; n (%)	8 (25)	26 (44.1)	0.073
Glucose before; median (IQR)	7.1 (2.6)	6.9 (3.0)	0.207
Highest glucose in 24 h; median (IQR)	6.8 (2.0)	6.6 (2.0)	0.992
Only top-of-basilar clot location (n=23); n (%)*	3 (15.8)	20 (55.6)	0.004
Caudal BAO location (n=3), n (%)*	2 (10.5)	1 (2.8)	0.229
Midbasilar included (n=29), n (%)*	14 (73.7)	15 (41.7)	0.024

From the year 2002 on, the radiological data is in electronic format and the quality of the head scans and the angiograms allowed a detailed investigation of the whole length of the basilar artery (n=74). Both a pre-and post-treatment angiograph were available in 55 patients.

BAO indicates basilar artery occlusion; OTT, onset-to-treatment time; NIHSS, National Institutes of Health Stroke Scale; IQR, interquartile range.

*Nineteen patients had TIMI 0–1 (59.4%) and 36 had TIMI 2–3 (61.0%).

Rates of sICH

Eighteen of 115 patients (15.7%) with control head scan developed sICH,[7] which was strongly associated with mortality (Tables 1 and 3).

Outcome

The 3-month mRS distribution is shown in Figure. Univariate and multivariate analysis of the parameters associated with independent outcome is shown in Tables 1 and 3. For moderate outcome mRS 0 to 3, see Supplemental Table S2. The impact of recanalization (n=91) on 3-month outcome is given in Figure.

Table 3. Multivariable Models Testing Association With Independent 3-Month Outcome (mRS 0–2) and With Death

	Independent Outcome		Death	
Parameter	OR (95% CI)	*P*	OR (95% CI)	*P*
Age per y	0.95 (0.9–0.999)	0.044	1.09 (1.0–1.17)	0.008
NIHSS per point	0.92 (0.85–0.99)	0.024	1.08 (0.99–1.2)	0.102
Intubation/ventilator support	0.57 (0.13–2.5)	0.454	6.6 (0.8–52)	0.074
Peak blood glucose within 24 h per mmol/l	0.9 (0.6–1.4)	0.648	1.3 (0.86–1.9)	0.211
Partial or complete recanalization	3.9 (0.8–19)	0.098	0.12 (0.02–0.59)	0.009
sICH per ECASS	Indefinite	0.998	14.6 (1.4–157)	0.027

Adjusted for variables known from previous research.[11,12,15,16]

For associations with moderate outcome (mRS 0–3), see Supplemental Table S2.

NIHSS indicates National Institutes of Health Stroke Scale; sICH, symptomatic intracranial hemorrhage; OR, odds ratio; CI, confidence interval.

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011

Discussion

Clinical decisions on management approaches to recanalize BAO depend on the immediately available resources in a given hospital. They should be guided by high-quality patient registries and representative case series because randomized controlled trials are lacking. To our knowledge, the present report describes the largest single-center BAO cohort (n=116) treated in a strictly homogenous way (ie, according to a written institutional protocol with IVT combined with intravenous heparin). The main findings of this study are that the frequency of recanalization depended on the clot location (Table 2) and that sICH was associated with fatal outcome (Table 3). In addition, recanalization was essential for moderate outcome (see Supplemental Table S2). The outcome results are similar with the largest multinational BAO registry (BASICS),[17] which includes patients treated with both IVT and/or IAT protocols.

The frequency of recanalization (65%) exceeds that in other studies,[18] including our own previously published recanalization percentage of 52%,[5] and reaches the efficacy of IAT.[11,12] In the present study, of the patients with nil or minimal recanalization, 60% died. Good medical care in our semi-intensive stroke unit could partly explain low mortality of BAO patients compared with historical cohorts of 75% to 90% mortality.[19,20] Overall mortality of 41% equals the case fatality with conventional treatment with antithrombotic agents or anticoagulation.[17] Hence, aiming at recanalization with intravenous thrombolysis did not lead to excessive mortality, but it is unclear why 65% recanalization rate was not accompanied with higher survival rate than with conventional treatment. There might be profound differences in the study cohorts. Only one fifth of our patients with recanalization died. The location of the BAO was associated with the frequency of recanalization, the highest being for occlusion at the top-of-basilar artery (87%). This is in line with some smaller series.[12,13] The more extensive BAO could also explain the more severe condition of the patient on admission (ie, requiring intubation and ventilator support), which was associated with nonindependence or death.

Symptomatic ICH was observed in 18 patients (15.7%) and was independently associated with mortality (OR, 14.6; 95% CI, 1.4–157). In the multinational BASICS registry, the rate of sICH was 6% after IVT and 14% after IAT, but recognition of sICH was based entirely on the investigators' judgment in each of the participating 48 centers and was not a predefined outcome.[11] A recent prospective single-center registry (IAT; 76 patients with/without bridging treatment) reported a rate of sICH similar to ours, 19%.[12] Based on common empirical knowledge of pre-emptive anticoagulation to prevent reocclusion, our treatment protocol for BAO instructs to start concomitant standard anticoagulation. This seems to be reasonably safe in terms of sICH because 84% of our patients with full-dose anticoagulation did not have sICH. Therefore, we believe that the frequency of sICH in our cohort was not predominantly caused by anticoagulation, a treatment used in almost all stroke centers.[2,11]

In general, half of BAO patients presented with coma at the time of treatment.[2] Seventy-one of our patients (61%) were intubated and needed mechanical ventilation at the time of thrombolysis treatment decision. Despite the fact that coma and mechanical ventilation were independently associated with nonindependence or death, 34% of these patients (24/71) achieved mRS 0 to 4 (ie, avoided institutionalization or death), and 16 patients (22.5%) reached mRS 0 to 3. These results are in line with the BASICS registry, where in thrombolysed patients with coma, tetraplegia, or locked-in state on presentation, good outcome at 1 month was noted in 17% (34/196 patients, IAT) to 26% (19/72 patients, IVT).[11] Therefore, withholding thrombolysis in the absence of contraindications is a self-fulfilling prophecy leading to bad outcome in such patients.[21]

Our study has some limitations. The multivariate models used to study associations of baseline parameters with outcome and recanalization are likely overgeneralized because of small number of events. Such overgeneralization of the model may lead to overestimation of the variance in outcome explained by baseline predictors. Yet, our cohort is the largest single-center data on BAO published to date. Another limitation is lack of post-treatment angiography in 25 patients; however, most of these patients were deceased (Figure). In addition, although activated partial thromboplastin time values, which are relevant for frequency of sICH, were routinely followed up frequently, they were not systematically stored in our registry.

To conclude, recanalization of BAO with intravenous alteplase decreased mortality and showed a trend in association for independent outcome, and it was associated with higher likelihood of moderate outcome. Present data suggest that the selection of the route of administration of thrombolytics and/or mechanical recanalization could be decided according to clot location and its length. Although coma on presentation is a negative prognostic variable, recanalization therapies should not be withheld from comatose and intubated patients with BAO, given that almost one fourth of such patients end up with independent outcome.

Acknowledgements

The Helsinki Stroke Thrombolysis Registry Group also includes Atula Sari, Curtze Sami, Liebkind Ron, Meretoja Atte, Mustanoja Satu, Piironen Katja, Pitkäniemi Janne, Putaala Jukka, Rantanen Kirsi, Tatlisumak Turgut, and Tiainen Marjaana.

Sources of Funding

Financial support came from the Helsinki University Central Hospital governmental subsidiary funds for clinical research (D.S., T.S., P.J.L.), the Academy of Finland (P.J.L.), the Sigrid Jusélius Foundation (P.J.L.), and the Finnish Medical Foundation (D.S., T.S.).

Disclosures

T.S. received modest honoraria for speaking (Boehringer Ingelheim). M.K. received honoraria and travel expenses in the Steering Committee of ECASS, ECASS II, ECASS III, DIAS, DIAS-2, and DIAS-4 trials; consulted for Boehringer-Ingelheim, PAION AG, Forest Research Laboratories, Inc., and Lundbeck A/G; and was a speaker in educational meetings sponsored by Boehringer-Ingelheim (modest).

References

1. Tatu L, Moulin T, Bogousslavsky J, Duvernoy H. Arterial territories of the human brain: Cerebral hemispheres. *Neurology*. 1998;50:1699–1708.

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011

2. Lindsberg PJ, Mattle HP. Therapy of Basilar Artery Occlusion: A Systematic Analysis Comparing Intra-Arterial and Intravenous Thrombolysis. *Stroke*. 2006;37:922–928.
3. Meretoja A, Putaala J, Tatlisumak T, Atula S, Artto V, Curtze S, et al. Off-label thrombolysis is not associated with poor outcome in patients with stroke. *Stroke*. 2010;41:1450–1458.
4. Wahlgren N, Ahmed N, Dávalos A, Ford GA, Grond M, Hacke W, et al. Thrombolysis with alteplase for acute ischaemic stroke in the Safe Implementation of Thrombolysis in Stroke-Monitoring Study (SITS-MOST): an observational study. *Lancet*. 2007;369:275–282.
5. Lindsberg PJ, Soinne L, Tatlisumak T, Roine RO, Kallela M, Häppölä O, et al. Long-term outcome after intravenous thrombolysis of basilar artery occlusion. *JAMA*. 2004;292:1862–1866.
6. The TIMI Study Group: The thrombolysis in myocardial infarction (TIMI) trial. *N Engl J Med* 1985;312:932–936.
7. Hacke W, Kaste M, Fieschi C, von Kummer R, Davalos A, Meier D, et al. Randomised double-blind placebo-controlled trial of thrombolytic therapy with intravenous alteplase in acute ischaemic stroke (ECASS II). *The Lancet*. 1998;352:1245–1251.
8. Quinn TJ, Lees KR, Hardemark HG, Dawson J, Walters MR. Initial experience of a digital training resource for modified Rankin scale assessment in clinical trials. *Stroke*. 2008;38:2257–2261.
9. Lyden P, Brott T, Tilley B, Welch KM, Mascha EJ, Levine S, et al. Improved reliability of the NIH Stroke Scale using video training. NINDS TPA Stroke Study Group. *Stroke*. 1994;25:2220–2226.
10. Adams H, Jr, Bendixen B, Kappelle L, Biller J, Love B, Gordon D, et al. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST trial of org 10172 in acute stroke treatment. *Stroke*. 1993;24:35–41.
11. Schonewille WJ, Wijman CA, Michel P, Rueckert CM, Weimar C, Mattle HP, et al. Treatment and outcomes of acute basilar artery occlusion in the basilar artery international cooperation study (BASICS): a prospective registry study. *Lancet Neurol*. 2009;8:724–730.
12. Nagel S, Schellinger PD, Hartmann M, Juettler E, Huttner HB, Ringleb P, et al. Therapy of acute basilar artery occlusion: Intraarterial thrombolysis alone vs bridging therapy. *Stroke*. 2009;40:140–146.
13. Cross D, III, Moran C, Akins P, Angtuaco E, Diringer M. Relationship between clot location and outcome after basilar artery thrombolysis. *AJNR Am J Neuroradiol*. 1997;18:1221–1228.
14. Arnold M, Nedeltchev K, Schroth G, Baumgartner RW, Remonda L, Loher TJ, et al. Clinical and radiological predictors of recanalisation and outcome of 40 patients with acute basilar artery occlusion treated with intra-arterial thrombolysis. *J Neurol, Neurosurg Psychiatry*. 2004;75:857–862.
15. Putaala J, Sairanen T, Meretoja A, Lindsberg PJ, Tiainen M, Liebkind R, et al. Post-thrombolytic hyperglycemia and 3-month outcome in acute ischemic stroke. *Cerebrovasc Dis.* 2011:31;83–92.
16. Strbian D, Soinne L, Sairanen T, Häppölä O, Lindsberg PJ, Tatlisumak T, et al. for the Helsinki stroke thrombolysis registry group. Ultraearly thrombolysis in acute ischemic stroke is associated with better outcome and lower mortality. *Stroke*. 2010;41:712–716.
17. Schonewille W, Algra A, Serena J, Molina CA, Kappelle LJ. Outcome in patients with basilar artery occlusion treated conventionally. *J Neurol, Neurosurg Psychiatry*. 2005;76:1238–1241.
18. Lindsberg PJ, Soinne L, Roine RO, Tatlisumak T. Options for recanalization therapy in basilar artery occlusion. *Stroke*. 2005;36:203–204.
19. Archer C, Horenstein S. Basilar artery occlusion: Clinical and radiological correlation. *Stroke*. 1977;8:383–390.
20. Wijdicks EFM, Scott JP. Outcome in patients with acute basilar artery occlusion requiring mechanical ventilation. *Stroke*. 1996;27:1301–1303.
21. Holloway RG, Benesch CG, Burgin WS, Zentner JB. Prognosis and decision making in severe stroke. *JAMA*. 2005;294:725–733.

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011

ONLINE SUPPLEMENT to

Intravenous thrombolysis of basilar artery occlusion – predictors of recanalization and outcome

Cover title**: Predictors of outcome in BAO thrombolysis**

Tiina Sairanen, MD, PhD[1,3], Daniel Strbian, MD, PhD[1], Lauri Soinne MD, PhD[1], Heli Silvennoinen, MD, PhD[2], Oili Salonen, MD, PhD[2], Ville Artto, MD, PhD[1], Ilkka Koskela, Msc[1], Olli Häppölä, MD, PhD[1] Markku Kaste, MD, PhD[1], Perttu J. Lindsberg MD, PhD[1,3] For the Helsinki Stroke Thrombolysis Registry (HSTR) Group.

[1]Department of Neurology, Helsinki University Central Hospital (HUCH), Haartmaninkatu 4, 00290 Helsinki, Finland

[2]Helsinki Medical Imaging Center, HUCH, Haartmaninkatu 4, 00290 Helsinki, Finland

[3]Molecular Neurology Research Program, Biomedicum Helsinki, Haartmaninkatu 8, 00029 HUS, Finland.

Correspondence: Dr. Tiina Sairanen, Department of Neurology, HUCH, tiina.sairanen@hus.fi; +358-9-4711*; FAX: +358-9-47171796.

Supplementary tables: 2

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011

Table S1. **Demographics, medical history, baseline and follow-up clinical and radiological characteristics of thrombolysis-treated BAO patients by dichotomized outcome (mRS 0-3 vs. 4-6).**

	All patients n=116	mRS 0-3; n=42	mRS 4-6; n=74	*P* Value
Age, years; mean[*]	63 (64,19)	56 (61, 23)	67 (67, 19)	<0.0001
Gender, n (%) of males	83 (71.6)	32 (76.2)	51 (68.9)	0.404
Diabetes, n (%)	12 (10.3)	1 (2.4)	11 (14.9)	0.034
Atrial fibrillation, n (%)	25 (21.6)	5 (11.9)	20 (27)	0.057
NIHSS score[†,*]	23 (18)	13 (16)	28 (12)	<0.0001
OTT, min[*]	523 (730)	490 (748)	541 (745)	0.644
Intubation/mechanical ventilation, n (%)	71 (61.2)	16 (38.1)	55 (74.3)	<0.0001
Convulsions, n (%)[†]	12 (10.5)	2 (4.8)	10 (13.9)	0.126
Blood glucose before treatment[‡], mmol/l[*]	7.1 (3.1)	6.8 (2.8)	7.1 (3.4)	0.204
Peak blood glucose within 24 h[†,] mmol/l[*]	6.8 (2)	6.2 (2.0)	7.2 (3.0)	0.001
Systolic blood pressure before, mmHg[*]	147 (38)	146 (32)	155 (39)	0.486
IV antihypertensive before, n (%)	25 (21.6)	8 (19)	17(23)	0.621
Nil or minimal recanalization[§,] n (%)	32 (35.2)	6 (15.8)	26 (49.1)	0.001
Complete or partial recanalization[§], n (%)	59 (64.8)	32 (84.2)	27 (50.9)	0.001
sICH per ECASS, n (%)[**]	18 (15.7)	0 (0)	18 (24.7)	<0.0001

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011

Table S2. **Multivariable models for prediction of moderate 3-month outcome**

	Moderate outcome mRS 0-3	
Parameter	OR (95% CI)	P Value
Age, per year	0.95 (0.9-0.998)	0.043
NIHSS, per point	0.95 (0.9-1.03)	0.190
Intubation/ventilator support	0.137 (0.03-0.6)	0.011
Peak blood glucose within 24 h, per mmol/l	0.97 (0.68-1.4)	0.868
Partial or complete recanalization	5.1 (1.2-22.3)	0.031
sICH per ECASS	Indefinite	0.998

References:

(1) Cucchiara B, Kasner SE, Tanne D, Levine SR, Demchuk A, Messe SR, Sansing L, Lees KR, Lyden P, for the SAINT Investigators . Factors Associated With Intracerebral Hemorrhage After Thrombolytic Therapy for Ischemic Stroke: Pooled Analysis of Placebo Data From the Stroke-Acute Ischemic NXY Treatment (SAINT) I and SAINT II Trials. Stroke 2009;40:3067-3072.

(2) Strbian D, Soinne L, Sairanen T, Häppöla O, Lindsberg PJ, Tatlisumak T, Kaste M, for the Helsinki Stroke Thrombolysis Registry Group,. Ultraearly Thrombolysis in Acute Ischemic Stroke Is Associated With Better Outcome and Lower Mortality. Stroke 2010;41:712-716.

(3) Putaala J, Sairanen T, Meretoja A, Lindsberg PJ, Tiainen M, Liebkind R, Strbian D, Atula S, Artto V, Rantanen K, Silvonen P, Piironen K, Curtze S, Häppölä O, Mustanoja S, Pitkäniemi J, Salonen O, Silvennoinen H, Soinne L, Kuisma M, Tatlisumak T, Kaste M. Post-Thrombolytic Hyperglycemia and 3-Month Outcome in Acute Ischemic Stroke. Cerebrovasc Dis 2011 2011:83-92.

Downloaded from http://stroke.ahajournals.org/ at MT SINAI SCHOOL MEDICINE on July 26, 2011