Acute Ischemic Stroke Management

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• I have not received an honorarium from Hoffman LaRoche (licensure of tPA) but have received honorarium from Medtronic (supplier of SOLITAIRE FR stentriever) for CME events

• No stocks or direct investments with pharmaceutical or device companies involved in stroke

• Co-founder/shareholder Quikflo Health start-up (acute stroke software)

• Several clinical trial responsibilities:
  • IMS-3- Exec committee, CT core lab PI
  • ESCAPE- Neuro-PI
  • REVASCAT- CT core lab co-PI
  • CLOTBUST-ER – CTA substudy PI
  • ARTSS-2 – CTA substudy core lab PI
  • ENCHANTED – International Advisory Committee
  • PRACTICE- DMC chair
  • DEFUSE 3- Safety monitor
  • ANNEXA-4 – Adjudication committee
Stroke Care Continuum

Primary Prevention

Stroke Onset
EMS Transport
ED Time
Stroke Team Assessment
Imaging
Acute Treatment

Reintegration
Rehabilitation
Clinical Worsening/Complication Prevention
Admission

Secondary Prevention
Stroke Care Continuum

Primary Prevention

Stroke Onset

EMS Transport  ED Time  Stroke Team Assessment  Imaging  Acute Treatment

Reintegration  Rehabilitation  Clinical Worsening/Complication Prevention  Admission

Secondary Prevention
What Makes a Difference?

• Stroke unit/organized stroke care
• Prevent/avoid complications of stroke
Early Dysphagia Screening by Trained Nurses Reduces Pneumonia Rate in Stroke Patients
A Clinical Intervention Study

Christoph Pall, MScN; Simon Fandler, MD; Kathrin Doppelhofer; Kurt Niederkorn, MD; Christian Enzinger, MD; Christian Vetta, MD; Esther Trampusch; Reinhold Schmidt, MD; Franz Fazekas, MD; Thomas Gattlinger, MD, PhD

Table. Demographics, Clinical Characteristics, and Outcome Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intervention Group n=186</th>
<th>Control Group n=198</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, y</td>
<td>70.4 (±14.7)</td>
<td>73.7 (±13.1)</td>
<td>0.093</td>
</tr>
<tr>
<td>Male sex, n (%)</td>
<td>88 (47.3)</td>
<td>102 (51.5)</td>
<td>0.235</td>
</tr>
<tr>
<td>Prestroke Rankin Scale, median (range)</td>
<td>0 (0–5)</td>
<td>0 (0–5)</td>
<td>0.377</td>
</tr>
<tr>
<td>NIHSS, median (range)</td>
<td>3 (0–23)</td>
<td>3 (0–22)</td>
<td>0.429</td>
</tr>
<tr>
<td>Admitting wards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke unit, n (%)</td>
<td>87 (46.8)</td>
<td>90 (45.5)</td>
<td>0.647</td>
</tr>
<tr>
<td>General ward, n (%)</td>
<td>96 (51.6)</td>
<td>102 (51.5)</td>
<td>0.985</td>
</tr>
<tr>
<td>Neurological ICU, n (%)</td>
<td>3 (1.6)</td>
<td>6 (3)</td>
<td>0.532</td>
</tr>
<tr>
<td>Dysphagia, n (%)</td>
<td>63 (33.9)</td>
<td>81 (40.9)</td>
<td>0.171</td>
</tr>
<tr>
<td>Mild, n (%)</td>
<td>19 (10.2)</td>
<td>27 (13.6)</td>
<td>0.302</td>
</tr>
<tr>
<td>Moderate, n (%)</td>
<td>21 (11.3)</td>
<td>21 (10.6)</td>
<td>0.830</td>
</tr>
<tr>
<td>Severe, n (%)</td>
<td>23 (12.4)</td>
<td>33 (16.7)</td>
<td>0.233</td>
</tr>
<tr>
<td>Time to screening, h, median (range)</td>
<td>7 (1–69)</td>
<td>20 (1–183)</td>
<td>0.001</td>
</tr>
<tr>
<td>Pneumonia, n (%)</td>
<td>7 (3.8)</td>
<td>23 (11.6)</td>
<td>0.004</td>
</tr>
<tr>
<td>Length of hospitalization, d, median (range)</td>
<td>8 (2–40)</td>
<td>9 (1–61)</td>
<td>0.033</td>
</tr>
<tr>
<td>In-hospital mortality, n (%)</td>
<td>2 (1.1)</td>
<td>12 (6.1)</td>
<td>0.012</td>
</tr>
</tbody>
</table>

ICU indicates intensive care unit; and NIHSS, National Institutes of Health Stroke Scale.

The association between delays in screening for and assessing dysphagia after acute stroke, and the risk of stroke-associated pneumonia

Benjamin D Bray,1 Craig J Smith,2 Geoffrey C Cloud,3 Pam Enderby,4 Martin James,5 Lizz Paley,9 Pippa J Tyrrell,2 Charles D A Wolfe,7,8 Anthony G Rudd,7,8 On behalf of the SSNAP Collaboration
Early Tube Feeding, PEG Can Wait

Effect of timing and method of enteral tube feeding for dysphagic stroke patients (FOOD): a multicentre randomised controlled trial

Figure 4: MRS at follow-up
DVT Prophylaxis: Enoxaparin 40 mg SC Daily

Comparison of the efficacy and safety of low molecular weight heparins for venous thromboembolism prophylaxis in medically ill patients

Christopher Dooley, Rajbir Kaur & Diana M. Sobieraj

Table 5. Results of traditional meta-analysis.

<table>
<thead>
<tr>
<th></th>
<th>Enoxaparin vs. UFH RR (95% CI), p-value; I²</th>
<th>Enoxaparin vs. control RR (95% CI), p-value; I²</th>
<th>Certoparin vs. UFH RR (95% CI), p-value; I²</th>
<th>Nadroparin vs. control RR (95% CI), p-value; I²</th>
<th>UFH vs. control RR (95% CI), p-value; I²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mortality</strong></td>
<td>0.86 (0.65 to 1.13), 0.28; 0%</td>
<td>0.99 (0.86 to 1.13), 0.85; 0%</td>
<td>1.01 (0.56 to 1.82), 0.97; NA</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>VTE</td>
<td>0.69 (0.42 to 1.12), 0.14; 56.2%</td>
<td>1.02 (0.29 to 3.55), 0.98; NA</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>PE</td>
<td>0.34 (0.09 to 1.31), 0.12; 0%</td>
<td>0.51 (0.09 to 2.95), 0.46; NA</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>DVT</td>
<td>0.71 (0.45 to 1.10), 0.13; 46.3%</td>
<td>NR</td>
<td>0.85 (0.67 to 1.09), 0.20; NA</td>
<td>NR</td>
<td>0.13 (0.05 to 0.35), &lt;0.001; 0%</td>
</tr>
<tr>
<td>Major bleeding</td>
<td>0.58 (0.24 to 1.41), 0.23; 0%</td>
<td>0.93 (0.28 to 3.07), 0.91; NA</td>
<td>0.62 (0.26 to 1.52), 0.30; NA</td>
<td>0.52 (0.05 to 5.19), 0.58; NA</td>
<td>2.77 (1.12 to 6.86), 0.03; NA</td>
</tr>
<tr>
<td>Minor bleeding</td>
<td>1.06 (0.57 to 1.97), 0.84; 47.9%</td>
<td>NR</td>
<td>1.17 (0.53 to 2.60), 0.70; 78.3%</td>
<td>0.41 (0.15 to 1.16), 0.09; NA</td>
<td>NR</td>
</tr>
</tbody>
</table>

*When an I² value was not provided, there was an insufficient number of trials to calculate this statistic.

NR = not reported; NA = not applicable; RR = relative risk; CI = confidence interval; UFH = unfractionated heparin; VTE = venous thromboembolism; PE = pulmonary embolism; DVT = deep vein thrombosis.
Effectiveness of intermittent pneumatic compression in reduction of risk of deep vein thrombosis in patients who have had a stroke (CLOTS 3): a multicentre randomised controlled trial

Summary
Background Venous thromboembolism is a common, potentially avoidable cause of death and morbidity in patients in hospital, including those with stroke. In surgical patients, intermittent pneumatic compression (IPC) reduces the

CLOTS 3 trial: Above Knee SCDs saves lives!

Figure 3: Cumulative hazard of death during the 6 months after randomisation in the two treatment groups. IPC=intermittent pneumatic compression. Note that two patients in the IPC arm withdrew very early, did not have a date of withdrawal or death and are therefore not included in the baseline number at risk.
What Makes a Difference?

• Stroke unit/organized stroke care
• Prevent/avoid complications of stroke
• Don’t make things worse
Using a Criteria-Based Reminder to Reduce Use of Indwelling Urinary Catheters and Decrease Urinary Tract Infections

By Yin-Yin Chen, RN, PhD, Mei-Man Chi, RN, MS, Yu-Chih Chen, RN, PhD, Yu-Jiun Chan, MD, PhD, Shin-Shang Chou, RN, PhD, and Fu-Der Wang, MD
Do not treat BP aggressively in ischemic stroke

SCAST trial: Lancet 2011

Figure 4: Functional status at 6 months' follow-up
Distribution of mRS scores in the candesartan and placebo groups. mRS=modified Rankin Scale.

<table>
<thead>
<tr>
<th>Event</th>
<th>Candesartan (n=1017)</th>
<th>Placebo (n=1012)</th>
<th>Risk ratio (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death from any cause</td>
<td>84 (8%)</td>
<td>78 (8%)</td>
<td>1.07 (0.80-1.44)</td>
<td>0.65</td>
</tr>
<tr>
<td>Vascular death</td>
<td>63 (6%)</td>
<td>60 (6%)</td>
<td>1.05 (0.74-1.47)</td>
<td>0.80</td>
</tr>
<tr>
<td>Ischaemic stroke</td>
<td>58 (6%)</td>
<td>50 (5%)</td>
<td>1.15 (0.80-1.67)</td>
<td>0.44</td>
</tr>
<tr>
<td>Haemorrhagic stroke</td>
<td>10 (1%)</td>
<td>8 (1%)</td>
<td>1.24 (0.49-3.14)</td>
<td>0.64</td>
</tr>
<tr>
<td>Recurrent stroke (ischaemic, haemorrhagic, or unspecified)</td>
<td>69 (7%)</td>
<td>59 (6%)</td>
<td>1.16 (0.83-1.63)</td>
<td>0.38</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>16 (2%)</td>
<td>11 (1%)</td>
<td>1.45 (0.68-3.10)</td>
<td>0.34</td>
</tr>
<tr>
<td><strong>Stroke progression</strong></td>
<td><strong>65 (6%)</strong></td>
<td><strong>44 (4%)</strong></td>
<td><strong>1.47 (1.01-2.13)</strong></td>
<td><strong>0.04</strong></td>
</tr>
<tr>
<td>Symptomatic hypotension</td>
<td>3 (2%)</td>
<td>3 (2%)</td>
<td>1.73 (1.00-3.53)</td>
<td>0.03</td>
</tr>
<tr>
<td>Renal failure</td>
<td>18 (2%)</td>
<td>13 (1%)</td>
<td>1.38 (0.68-2.80)</td>
<td>0.37</td>
</tr>
<tr>
<td>Symptomatic venous thromboembolism</td>
<td>11 (1%)</td>
<td>6 (1%)</td>
<td>1.82 (0.68-4.91)</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Data are n (%).

Table 3: Secondary events during 6 months' follow-up
ENOS trial

Hold antihypertensive meds initially?

Although the primary outcome was neutral for the comparison of continue versus stop antihypertensive drugs, patients assigned to continue their blood pressure-lowering drugs did worse than did those who stopped their drugs for several secondary measures of outcome—discharge destination, activities of daily living (measured by Barthel index), and cognition (modified telephone Mini-Mental State Examination and Telephone Interview for Cognition Scale). These
Avoid Full Dose IV Heparin Induced Hemorrhagic Transformation
Avoid mobilization first 24 hours

AVERT trial

Figure 2: Patients achieving each mRS score at 3 months
mRS=modified Rankin Scale.

[OR] 0.73, 95% CI 0.59–0.90; p=0.004)
Figure 1: Potential population effect of stroke interventions in a district of one million population
The population effect is shown for a hypothetical district of 1,000,000 population with 2,500 strokes per year. Estimates are shown for the number of extra independent survivors (modified Rankin scale score 0–2 points) resulting from an intervention during 1 year. The assumptions and calculations are detailed by Gilligan and colleagues and Langhorne and colleagues. BP = blood pressure. *Acute aspirin treatment. †0–6 h of thrombolysis. ‡Prevention.
What Makes a Difference?

• Stroke unit/organized stroke care
  • Prevent/avoid complications of stroke
  • Don’t make things worse

• Neurosurgical stroke
  • Malignant stroke decompression
Infarcts grow a lot in the first day unless we reperfuse them!
2 Options to Restore Flow: Dissolving or Removing the Clot

- **IV tPA: dissolving**
- **EVT: removing**

![Diagram of blood clot dissolving with IV tPA and EVT techniques](image-url)
Intravenous rtPA

Balance between benefit and risk

Recanalization vs Bleeding
clot migration or allergic reactions
Biologically Speeds Recanalization But Slowly
What are the tPA contraindications?

Exclusion criteria

- Significant head trauma or prior stroke in the previous 3 mo
- Symptoms suggest SAH
- Arterial puncture at noncompressible site in previous 7 d
- History of previous intracranial hemorrhage
- Intracranial neoplasm, AVM, or aneurysm
- Recent intracranial or intraspinal surgery
- Elevated blood pressure (systolic >185 mm Hg or diastolic >110 mm Hg)
- Active internal bleeding
- Acute bleeding diathesis, including but not limited to:
  - Platelet count <100,000/mm³
  - Heparin received within 48 h resulting in abnormally elevated aPTT above the upper limit of normal
  - Current use of anticoagulant with INR >1.7 or PT >15 s
  - Current use of direct thrombin inhibitors or direct factor Xa inhibitors with elevated sensitive laboratory tests appropriate factor Xa activity assays
- Blood glucose concentration <50 mg/dL (2.7 mmol/L)
- CT demonstrates multilobar infarction (hypodensity >1/3 cerebral hemisphere)
IV TPA Time is Brain
6756 pts/9 trials
# MRJ-Guided Thrombolysis for Stroke with Unknown Time of Onset


## Table 2. Primary and Secondary Efficacy Outcomes (Intention-to-Treat Population). *

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Alteplase Group (N = 254)</th>
<th>Placebo Group (N = 249)</th>
<th>Effect Variable</th>
<th>Adjusted Value (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary efficacy end point</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Favorable outcome at 90 days — no./total no. (%)‡</td>
<td>131/246 (53.3)</td>
<td>102/244 (41.8)</td>
<td>Odds ratio</td>
<td>1.61 (1.09 to 2.36)</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Secondary efficacy end points</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median score on modified Rankin scale at 90 days (IQR)§</td>
<td>1 (1 to 3)</td>
<td>2 (1 to 3)</td>
<td>Common odds ratio</td>
<td>1.62 (1.17 to 2.23)</td>
<td>0.003 ¶</td>
</tr>
<tr>
<td>Correlation between treatment response at 90 days and deficit level at baseline — no./total no. (%)</td>
<td>72/246 (29.3)</td>
<td>44/244 (18.0)</td>
<td>Odds ratio</td>
<td>1.88 (1.22 to 2.89)</td>
<td>0.004 ¶</td>
</tr>
<tr>
<td>Global Outcome Score at 90 days***</td>
<td></td>
<td></td>
<td>Odds ratio</td>
<td>1.47 (1.07 to 2.04)</td>
<td>0.02 ¶</td>
</tr>
<tr>
<td>Median score on Beck Depression Inventory at 90 days (IQR)¶¶</td>
<td>6.0 (2.0 to 11.0)</td>
<td>7.0 (2.0 to 14.0)</td>
<td>Mean difference (log_e)</td>
<td>-0.04 (-0.22 to 0.15)</td>
<td>0.69 ¶</td>
</tr>
<tr>
<td>Total score on EQ-5D at 90 days¶¶</td>
<td>1.9±2.1</td>
<td>2.4±2.4</td>
<td>Mean difference</td>
<td>-0.52 (-0.88 to -0.16)</td>
<td>0.004 ¶</td>
</tr>
<tr>
<td>Score on visual analog scale on EQ-5D at 90 days¶¶</td>
<td>72.6±19.7</td>
<td>64.9±23.8</td>
<td>Mean difference</td>
<td>7.64 (3.75 to 11.51)</td>
<td>&lt;0.001 ¶</td>
</tr>
<tr>
<td>Median infarct volume at 22–36 hr (IQR) — ml ¶¶</td>
<td>3.0 (0.8 to 17.7)</td>
<td>3.3 (1.1 to 16.6)</td>
<td>Mean difference (log_e)</td>
<td>-0.16 (-0.47 to 0.15)</td>
<td>0.32 ¶</td>
</tr>
</tbody>
</table>

* Adjusted for baseline factors and selected interaction terms. ** Includes patients with unfavorable outcomes at 90 days. ¶ Includes patients with favorable outcomes at 90 days. ¶¶ Includes patients with either favorable or unfavorable outcomes at 90 days. ¶¶ Includes patients who completed the 90-day assessment. ¶¶ Includes patients who completed the 90-day EQ-5D assessment. ¶¶ Includes patients who completed the 90-day visual analog scale assessment. ¶¶ Includes patients who completed the 90-day infarct volume assessment.
Table 1. Demographic and Clinical Characteristics of the Patients at Baseline.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Alteplase Group (N = 254)</th>
<th>Placebo Group (N = 249)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ±SD — yr</td>
<td>65.3±11.2</td>
<td>65.2±11.9</td>
</tr>
<tr>
<td>Male sex — no. (%)</td>
<td>165 (65.0)</td>
<td>160 (64.3)</td>
</tr>
<tr>
<td>Reason for unknown time of symptom onset — no. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nighttime sleep</td>
<td>227 (89.4)</td>
<td>222 (89.2)</td>
</tr>
<tr>
<td>Daytime sleep</td>
<td>12 (4.7)</td>
<td>11 (4.4)</td>
</tr>
<tr>
<td>Aphasia, confusion, or other</td>
<td>15 (5.9)</td>
<td>16 (6.4)</td>
</tr>
<tr>
<td>Median interval between last time the patient was known to be well and symptom recognition (IQR) — hr</td>
<td>7.2 (4.7–8.7)</td>
<td>7.0 (5.0–9.0)</td>
</tr>
<tr>
<td>Medical history — no. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arterial hypertension</td>
<td>135 (53.1)</td>
<td>131 (52.6)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>43 (16.9)</td>
<td>39 (15.7)</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>93 (36.6)</td>
<td>85 (34.1)</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>30 (11.8)</td>
<td>29 (11.6)</td>
</tr>
<tr>
<td>History of ischemic stroke</td>
<td>37 (14.6)</td>
<td>31 (12.4)</td>
</tr>
<tr>
<td>Median NIHSS score (IQR)†</td>
<td>6 (4–9)</td>
<td>6 (4–9)</td>
</tr>
<tr>
<td>Vessel occlusion on time-of-flight MRA — no./total no. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any</td>
<td>84/249 (33.7)</td>
<td>84/246 (34.1)</td>
</tr>
<tr>
<td>Intracranial internal carotid artery</td>
<td>24/249 (9.6)</td>
<td>11/246 (4.5)</td>
</tr>
<tr>
<td>Middle cerebral artery main stem</td>
<td>35/249 (14.1)</td>
<td>37/246 (15.0)</td>
</tr>
<tr>
<td>Middle cerebral artery branch</td>
<td>32/249 (12.9)</td>
<td>36/246 (14.6)</td>
</tr>
<tr>
<td>Other†</td>
<td>12/249 (4.8)</td>
<td>12/246 (4.9)</td>
</tr>
<tr>
<td>Median lesion volume on diffusion-weighted imaging (IQR) — ml</td>
<td>2.0 (0.8–7.9)</td>
<td>2.5 (0.7–8.8)</td>
</tr>
<tr>
<td>Median time from symptom recognition to MRI (IQR) — hr</td>
<td>2.6 (1.9–3.3)</td>
<td>2.6 (2.1–3.3)</td>
</tr>
<tr>
<td>Median time between end of MRI and treatment initiation (IQR) — hr</td>
<td>25 (16–35)</td>
<td>26 (18–37)</td>
</tr>
<tr>
<td>Median time from symptom recognition to treatment initiation (IQR) — hr</td>
<td>3.1 (2.5–3.8)</td>
<td>3.2 (2.6–3.9)</td>
</tr>
<tr>
<td>Interval between last time that the patient was last known to be well and treatment initiation (IQR) — hr</td>
<td>10.3 (8.1–12.0)</td>
<td>10.4 (8.1–12.1)</td>
</tr>
</tbody>
</table>
Figure 2. Relationship Between International Normalized Ratio and Risk of Symptomatic Intracranial Hemorrhage in Warfarin-Treated Patients (Baseline INR ≤2.0)

Solid line indicates risk of symptomatic intracranial hemorrhage (sICH); dashed lines, 95% confidence intervals. Logistic regression modeling was conducted to examine the relationship between international normalized ratio (INR) and binary outcome of sICH. The Stone and Koo additive spline method was fitted to generate the plot; adequacy of linearity was tested using likelihood ratio statistic by comparing the linear and nonlinear logistic models.
4. The use of intravenous alteplase in patients taking direct thrombin inhibitors or direct factor Xa inhibitors has not been firmly established but may be harmful (Class III; Level of Evidence C). The use of intravenous alteplase in patients taking direct thrombin inhibitors or direct factor Xa inhibitors is not recommended unless laboratory tests such as aPTT, INR, platelet count, ecarin clotting time, thrombin time, or appropriate direct factor Xa activity assays are normal or the patient has not received a dose of these agents for >48 hours (assuming normal renal metabolizing function).
Use of Intravenous Recombinant Tissue Plasminogen Activator in Patients With Acute Ischemic Stroke Who Take Non–Vitamin K Antagonist Oral Anticoagulants Before Stroke

Table 4. Primary and Secondary Outcomes After Propensity Score Matching

<table>
<thead>
<tr>
<th>No. Events/Total No. of Patients (%)</th>
<th>NOACs (n=245)</th>
<th>Warfarin with INR&lt;1.7 (n=245)</th>
<th>No Oral Anticoagulant (n=245)</th>
<th>Odds Ratio NOACs vs No (95% CI)</th>
<th>Odds Ratio Warfarin vs No (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptomatic intracranial hemorrhage &lt;36 h</td>
<td>12/245 (4.9)</td>
<td>12/245 (4.9)</td>
<td>15/245 (6.1)</td>
<td>0.79 (0.36–1.72)</td>
<td>0.79 (0.36–1.72)</td>
</tr>
<tr>
<td>Life-threatening or serious systemic hemorrhage &lt;36 h</td>
<td>1/245 (0.4)</td>
<td>1/245 (0.4)</td>
<td>1/245 (0.4)</td>
<td>1.00 (0.06–16.1)</td>
<td>1.00 (0.06–16.1)</td>
</tr>
<tr>
<td>Any rt-PA complication*</td>
<td>16/245 (6.5)</td>
<td>23/245 (9.4)</td>
<td>24/245 (9.8)</td>
<td>0.64 (0.33–1.24)</td>
<td>0.95 (0.53–1.74)</td>
</tr>
</tbody>
</table>

Fig. 1. Association with ICH and DOAC intake time. The rate of ICH after reperfusion therapy is higher in patients ≤4 h from last intake than patients ≤4 h (≤4 h, 5/13 [38%] and >4 h, 4/39 [10%], p = 0.033).
Case 1

- 58 year old hypertensive
- 200 minutes from onset
- Fluctuating pure motor hemiparesis
- Initial BP 200/100 lowered easily by labetolol dose
- BP now 170/85
- CT scan good
- No recent ICH or bleeding
- On ASA and Clopidogrel
- No visible occlusion on CTA
2-3 fold increase iv tPA SICH risk

Table 2. Final Multivariate Scoring Model Using Risk Factors for SICH per SITS-MOST After Stratification of Continuous Variables

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>OR (95% CI)</th>
<th>P Value</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin + clopidogrel</td>
<td>3.2 (1.9–5.2)</td>
<td>&lt;0.001</td>
<td>3</td>
</tr>
<tr>
<td>Aspirin monotherapy</td>
<td>1.8 (1.5–2.1)</td>
<td>&lt;0.001</td>
<td>2</td>
</tr>
</tbody>
</table>

Risks and Benefits Associated With Prestroke Antiplatelet Therapy Among Patients With Acute Ischemic Stroke Treated With Intravenous Tissue Plasminogen Activator

Figure 2. Preadmission Antiplatelet Therapy and Symptomatic Intracranial Hemorrhage (sICH)
Low-Dose versus Standard-Dose Intravenous Alteplase in Acute Ischemic Stroke

Standard Dose IV tPA: More death but more excellent outcomes

Figure 1. Functional Outcomes at 90 Days, According to Score on the Modified Rankin Scale.
Shown is the raw distribution of scores on the modified Rankin scale at 90 days in the group that received a low dose of alteplase (0.6 mg per kilogram of body weight) and the group that received the standard dose of alteplase (0.9 mg per kilogram). Scores on the modified Rankin scale range from 0 to 6, with 0 indicating no symptoms, 1 symptoms without clinically significant disability, 2 slight disability, 3 moderate disability, 4 moderately severe disability, 5 severe disability, and 6 death.
**Low Versus Standard-Dose Alteplase in Patients on Prior Antiplatelet Therapy**

The ENCHANTED Trial (Enhanced Control of Hypertension and Thrombolysis Stroke Study)


Vijay, K.; Sharma, M.D.; Thiang, H.; Nguyen, M.D.; Ph.D.; Guo, W.; M.D.;


on behalf of the ENCHANTED Investigators

---

**No prior antiplt**

<table>
<thead>
<tr>
<th></th>
<th>Low dose</th>
<th>Standard dose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No antiplatelet</strong></td>
<td>n=1208</td>
<td>n=1261</td>
</tr>
<tr>
<td><strong>OR (95%CI)</strong></td>
<td><strong>1.07 (0.93, 1.23)</strong></td>
<td></td>
</tr>
</tbody>
</table>

**4% more excellent outcomes with standard dose**

**Prior antiplt**

<table>
<thead>
<tr>
<th></th>
<th>Low dose</th>
<th>Standard dose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antiplatelet</strong></td>
<td>n=394</td>
<td>n=336</td>
</tr>
<tr>
<td><strong>OR (95%CI)</strong></td>
<td><strong>0.76 (0.59, 0.98)</strong></td>
<td></td>
</tr>
</tbody>
</table>

**5.5% more good outcomes AND 5% lower mortality with low dose**

1.5% sICH low dose versus 3.8% sICH standard dose if antiplatelet use
Case 2

- 64 year old diabetic, smoker
- 120 minutes from onset
- Severe deficits
- CT scan good
- No recent ICH or bleeding
- Not on antithrombotic
- CTA shows carotid T occlusion
Clot Volume Matters for IV tPA Recanalization and IV tPA Only Efficacy

The Importance of Size: Successful Recanalization by Intravenous Thrombolysis in Acute Anterior Stroke Depends on Thrombus Length
Christian H. Riedel, Philip Zimmermann, Ulf Jensen-Kondering, Robert Stingel, Günther Deuschl and Olav Jansen

Stroke 2011, 42:1775-1777; originally published online April 7, 2011
doi: 10.1161/STROKEAHA.110.609693

8 mm threshold for IV tPA
Location of Baseline Intracranial Thrombus

- Terminal ICA I Occlusion
- Terminal ICA L Occlusion
- Terminal ICA T Occlusion
- Proximal M1 Occlusion
- Distal M1 Occlusion
- Proximal M2 Occlusion
- Distal M2 Occlusion
- ACA A2 Occlusion
IV TPA Very Disappointing in Carotid occlusion

A Intracranial internal carotid artery thrombus

Graph showing the time from intravenous alteplase start to recanalization assessment in minutes against successful recanalization estimated percentage.
Residual Blood Flow on CTA

Residual blood flow grade 0

Residual blood flow grade 1

Residual blood flow grade 2
Residual flow creates surface area for IV TPA to work

Figure 2. Estimated Successful Recanalization From the Start of Intravenous Alteplase to Recanalization Assessment Stratified by Residual Flow (n = 470 Patients)
Distal M1 MCA occlusion and beyond sweet spot for IV TPA
<table>
<thead>
<tr>
<th>Time from onset</th>
<th>iv tPA “sweet spot” Bridge to EVT</th>
<th>iv tPA modest net benefit</th>
<th>Conservative tx avoid tPA Don’t bridge to EVT</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 90 min</td>
<td>90-180 min</td>
<td>180-270 min</td>
<td>&gt;270 min</td>
</tr>
<tr>
<td>Age</td>
<td>all ages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP/glucose</td>
<td>normal</td>
<td>high</td>
<td>very high</td>
</tr>
<tr>
<td>NIHSS</td>
<td>6-10 11-21</td>
<td>disabling &lt;5</td>
<td>&gt;21 nondisabling &lt;5</td>
</tr>
<tr>
<td>On antithrombotics</td>
<td>DOACs with normal labs</td>
<td>Prior antiplts: single*  dual*  INR&gt;1.7</td>
<td></td>
</tr>
<tr>
<td>Leukoaraiosis</td>
<td>none</td>
<td>severe</td>
<td></td>
</tr>
<tr>
<td>NCCT EIC</td>
<td>ASPECTS 8-10</td>
<td>ASPECTS 5-7</td>
<td>ASPECTS 3-4  ASPECTS 0-2</td>
</tr>
<tr>
<td>Thrombus</td>
<td>Short thrombus</td>
<td>Long/large</td>
<td></td>
</tr>
<tr>
<td>characteristics</td>
<td>MCAo - distal M1</td>
<td>no occlusion  ICAo</td>
<td></td>
</tr>
<tr>
<td>Thrombus</td>
<td>Residual flow</td>
<td>no residual flow</td>
<td></td>
</tr>
<tr>
<td>occlusion</td>
<td>HU increase in clot on CTA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>location/CTA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>features</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Endovascular Treatment

- Mechanical thrombectomy
  - Stent retriever devices
  - Aspiration devices
  - Combination approaches

- Extracranial carotid intervention
- Intracranial stenosis intervention
- Intra-arterial drug delivery (tPA)
A Randomized Trial of Endovascular Treatment for Acute Stroke

Randomized Assessment of Rapid Endovascular Treatment with Stenting and Activated Clot lysis for Intracranial Hyperacute Stroke

STENTRIEVER (early 2012)

3RD GENERATION

Engage the thrombus with stent retrieve deployment, which also temporarily restores flow across the occlusion. Proximal balloon inflation allows device retrieval into the guide while minimizing the risk of emboli.
Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials


Summary
Background In 2015, five randomised trials showed efficacy of endovascular thrombectomy over standard medical care in patients with acute ischaemic stroke caused by occlusion of arteries of the proximal anterior circulation. In this meta-analysis we, the trial investigators, aimed to pool individual patient data from these trials to address remaining questions about whether the therapy is efficacious across the diverse populations included.
Overall Treatment Effect
NNT = 2.6
No increased bleeding
Reduction in Mortality trend

<table>
<thead>
<tr>
<th>Category</th>
<th>Intervention population, % (n/N)</th>
<th>Control population, % (n/N)</th>
<th>Risk difference</th>
<th>Risk ratio (95% CI)</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptomatic intracranial haemorrhage</td>
<td>4.4% (28/634)</td>
<td>4.3% (28/653)</td>
<td>0.1%</td>
<td>1.06 (0.63–1.80); p=0.82</td>
<td>1.07 (0.62–1.83); p=0.81</td>
</tr>
<tr>
<td>Parenchymal haematoma type 2</td>
<td>5.1% (32/629)</td>
<td>5.3% (34/641)</td>
<td>-0.2%</td>
<td>0.99 (0.61–1.61); p=0.97</td>
<td>0.99 (0.60–1.63); p=0.97</td>
</tr>
<tr>
<td>Mortality at 90 days</td>
<td>15.3% (97/633)</td>
<td>18.9% (122/646)</td>
<td>-3.6%</td>
<td>0.82 (0.63–1.07); p=0.15</td>
<td>0.77 (0.54–1.10); p=0.16</td>
</tr>
</tbody>
</table>

Table 4: Safety outcomes at 90 days
Conclusions

In summary, the results of this study suggest that the risk of local vessel injury after stent-retriever use may be increased when repeated device passes are required and when thrombectomy is preceded by systemic r-tPA administration. Moreover,
Patients much improved the next day

<table>
<thead>
<tr>
<th>Baseline NIHSS score</th>
<th>Intervention population (n=615)</th>
<th>Control population (n=630)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIHSS score at 24 h</td>
<td>10.4 (8.7)‡</td>
<td>14.2 (7.8)‡</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IRQ)</td>
<td>8 (3–16)‡</td>
<td>15 (9–19)‡</td>
</tr>
<tr>
<td>Change in NIHSS score from baseline to 24 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>-6.4 (8.2)</td>
<td>-2.6 (6.6)</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>-7 (-12 to -1)*</td>
<td>-2 (-6 to 1)‡</td>
</tr>
</tbody>
</table>
7.3 hour onset to groin puncture time window for EVT

NNTs

Favors endovascular thrombectomy

Favors medical therapy alone

Common Odds Ratio Using 6-Level mRS

Time From Symptom Onset to Expected Arterial Puncture, min

Non linear analysis of OTR (TICI 2b/3) by outcome

More excellent outcomes if ultraearly reperfusion

Mechanical Thrombectomy Technique
Is Getting Better Quickly

Continuous aspiration prior to intracranial vascular embolectomy (CAPTIVE): a technique which improves outcomes

Ryan A McTaggart,1,2 Eric L Tung,1,2 Shadi Yaghjii,2,3 Shawna M Cutting,2,3 Morgan Hemendinger,2,3 Heather I Gale,1 Grayson L Baird,1,4 Richard A Haas,1,4,5 Mahesh V Jayaraman1,2,3,5

Aspiration catheter
right up to clot

Pull stent retriever and aspiration catheter as one unit
Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct


Thrombectomy for Stroke at 6 to 16 Hours with Selection by Perfusion Imaging

CTP or MRI To Identify Small Cores

Raw CBF map  RAPID Segmentation

<30% relCBF

Raw Diffusion MRI  ADC  RAPID Segmentation

ADC<620x10^6 mm^2/sec

iSchemaView RAPID version 4.6
Interaction Between Time from Onset to Randomization vs Treatment Effect

P = 0.023

OR per 60 min:
0.98 [0.92, 1.05]
P = 0.558

OR per 60 min:
0.83 [0.74, 0.94]
P = 0.004

Outcome: AURORA cohort

90-Day Good Outcome vs Onset to Randomization: All Subjects
## Benefit if TPA, M/F, Age

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>n</th>
<th>cOR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18–49</td>
<td>158</td>
<td>1.36 (0.75–2.46)</td>
</tr>
<tr>
<td>50–59</td>
<td>218</td>
<td>2.85 (1.72–4.72)</td>
</tr>
<tr>
<td>60–69</td>
<td>333</td>
<td>2.58 (1.49–4.48)</td>
</tr>
<tr>
<td>70–79</td>
<td>371</td>
<td>2.41 (1.55–3.74)</td>
</tr>
<tr>
<td>18–79</td>
<td>1080</td>
<td>2.44 (1.70–3.50)</td>
</tr>
<tr>
<td>≥80</td>
<td>198</td>
<td>3.68 (1.95–6.92)</td>
</tr>
</tbody>
</table>

**Sex** (p\text{\_interaction} = 0.34)
- Male: 676, cOR: 2.54 (1.92–3.36)
- Female: 601, cOR: 2.38 (1.46–3.88)

**Alteplase** (p\text{\_interaction} = 0.43)
- Yes: 1090, cOR: 2.45 (1.68–3.57)
- No: 188, cOR: 2.43 (1.30–4.55)

### Total
- Total: 1278, cOR: 2.49 (1.76–3.53)

*Figure 2: Forest plot showing adjusted treatment effect for mRS at 90 days in prespecified subgroups with p values for heterogeneity across subgroups*
Benefit unclear if low NIHSS

<table>
<thead>
<tr>
<th>NIHSS</th>
<th>Count</th>
<th>Risk Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 10</td>
<td>177</td>
<td>1.20</td>
<td>[0.81; 1.78]</td>
</tr>
<tr>
<td>11-15</td>
<td>307</td>
<td>1.70</td>
<td>[1.19; 2.43]</td>
</tr>
<tr>
<td>16-20</td>
<td>473</td>
<td>2.03</td>
<td>[1.42; 2.90]</td>
</tr>
<tr>
<td>≥ 21</td>
<td>321</td>
<td>1.80</td>
<td>[1.09; 2.96]</td>
</tr>
<tr>
<td>Total</td>
<td>1278</td>
<td>1.73</td>
<td>[1.43; 2.09]</td>
</tr>
</tbody>
</table>

Favours Control ← Risk Ratio → Favours Intervention
Imaging features and safety and efficacy of endovascular stroke treatment: a meta-analysis of individual patient-level data


**Summary**

Evidence regarding whether imaging can be used effectively to select patients for endovascular thrombectomy varies widely. Our analysis reveals that the adjusted odds ratio (95% CI) for favorable outcomes in patients undergoing thrombectomy, compared with those in the control group, is 1.68 (0.90-3.14) for M2, 1.57 (0.93-2.66) for distal M1, 1.95 (1.46-2.59) for proximal M1, 2.68 (1.88-3.82) for internal carotid artery, and 2.00 (1.69-2.38) for overall. The interaction term (0.316) indicates no significant difference in the odds ratio across different imaging variables.

**Figure 1:** Forest plot of endovascular treatment effect on primary outcome (modified Rankin Scale shift at 90 days), by baseline imaging variable categories.
<table>
<thead>
<tr>
<th>Endovascular treatment around the edges of EBM</th>
<th>Endo “sweet spot”</th>
<th>Endo modest net benefit</th>
<th>No endo tx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from onset</td>
<td>&lt;150 min</td>
<td>150-240 min</td>
<td>240-420 min</td>
</tr>
<tr>
<td>tPA eligibility</td>
<td>Does not matter, do not wait for tPA decision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>No differences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>young</td>
<td>elderly (good premorbid status)</td>
<td></td>
</tr>
<tr>
<td>NIHSS</td>
<td>&gt;10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occlusion location/size</td>
<td>Large</td>
<td>medium</td>
<td></td>
</tr>
<tr>
<td>ASPECTS and collaterals</td>
<td>ICA cervical T/L proxM1</td>
<td>distal M1</td>
<td></td>
</tr>
</tbody>
</table>

| mRS 0-2 benefit | 40% | 30% | 20% | 10% | 0% | HARM |
| mRS shift >1 pt | 50% | 40% | 30% | 20% | 10% | 0% | HARM |
| Mortality reduction | 15% | 10% | 5% | 0% | HARM |
Other Ongoing and Planned Trials

MR CLEAN IV
SWIFT DIRECT
MOST
MR CLEAN MED
ESCAPE NA-1 Trial

Neuroprotection by Freezing Ischemic Penumbra Evolution Without Cerebral Blood Flow Augmentation With a Postsynaptic Density-95 Protein Inhibitor

Buys time for reperfusion

Reduces free radical prod’n

<table>
<thead>
<tr>
<th>Country (In order of activation)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADA</td>
<td>249</td>
</tr>
<tr>
<td>USA</td>
<td>206</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>7</td>
</tr>
<tr>
<td>AUSTRALIA</td>
<td>20</td>
</tr>
<tr>
<td>IRELAND</td>
<td>4</td>
</tr>
<tr>
<td>KOREA</td>
<td>10</td>
</tr>
<tr>
<td>UK</td>
<td>0</td>
</tr>
<tr>
<td>GERMANY</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>501</strong></td>
</tr>
</tbody>
</table>

Study drug to reperfusion: 31 min (-21 - 243 min)
Onset to reperfusion: 244 min (73 min - 869 min)
Treatable Partially Reversible Disease Now

Just Human and Economic Barriers Left

There are no constraints on the human mind, no walls around the human spirit, no barriers to our progress except those we ourselves erect.
$1000 CDN/per minute delay to reperfusion

Average change in cost-effectiveness per 1 min delay:
- An additional $100 to be invested for same QALY gain (societal perspective $160)

Decrease in net monetary benefit (NMB) of EVT per 1 min delay:
- about $1000 (for either healthcare or societal perspective)

\[
NMB = (\text{Lifetime QALYs} \times \text{Willingness-to-Pay}) - \text{Lifetime Costs}
\]
Alberta Acute Stroke Treatment 2018
Comprehensive stroke centre

30-60-90 DTN DTGP DTR rule

Door to tPA bolus < 30 min

tPA bolus to groin puncture < 30 min

groin puncture to first reperfusion < 30 min
Alberta Acute Stroke Treatment 2018

Comprehensive Stroke Centre
Primary Stroke Centre
• **Primary Stroke Centres**
  • Geographically challenged areas
  • Telestroke capability to hub CSC
  • **CT/CTA 24/7**
Computed tomographic angiography in stroke and high-risk transient ischemic attack: Do not leave the emergency department without it!

Brett R Graham, Bijoy K Menon, Shelagh B Coutts, Mayank Goyal and Andrew M Demchuk

Table 2. Indications for emergent/urgent CT-angiography of head/neck.

<table>
<thead>
<tr>
<th>Emergency CT/CTA (minutes; without creatinine)</th>
<th>Urgent CT/CTA (hours; with eGFR &gt; 30 ml/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acute stroke with major deficits &lt;12 h from onset (motor, speech)</td>
<td>3. High-risk TIA (motor or speech symptoms that occurred in the past 48 h)</td>
</tr>
<tr>
<td>2. Sudden stupor or coma with hemiparesis or quadriplegia</td>
<td>4. Rule out carotid or vertebral artery dissection—focal neurological symptoms in the setting of neck, pain, recent trauma, etc.</td>
</tr>
<tr>
<td></td>
<td>5. Amaurosis Fugax or central retinal artery occlusion.</td>
</tr>
<tr>
<td></td>
<td>6. Minor stroke—patients with persistent minor deficits &gt;12 h.</td>
</tr>
</tbody>
</table>

CT: computed tomography; CTA: computed tomography angiography; eGFR: estimated glomerular filtration rate; TIA: transient ischemic attack.

*The following is an approach utilized by the Calgary Health Zone to identify cases that warrant an urgent or emergent CTA from the aortic arch to the vertex. Isolated dizziness or numbness, as well as isolated sensory symptoms, do not require urgent or emergent CTA as they are low yield, but may be ordered after consultation with a stroke physician.*
The overall rate of hemodialysis in the CTA/CTP group was 0.07% (3 of 4373).
Modeling Stroke Patient Transport for All Patients With Suspected Large-Vessel Occlusion

Jesalyn K. Holodinsky, MSc; Tyler S. Williamson, PhD; Andrew M. Demchuk, MD; Henry Zhao, MBBS; Luke Zhu; Michael J. Francis, Mayank Goyal, MD; Michael D. Hill, MD, MSc; Nooren Kamal, PhD

60 min Between thrombolysis and EVT center

<table>
<thead>
<tr>
<th>Factor</th>
<th>Time, min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset to first medical contact</td>
<td>30</td>
</tr>
<tr>
<td>Ambulance response and scene time</td>
<td>30</td>
</tr>
<tr>
<td>Door to needle (thrombolysis center)</td>
<td>60</td>
</tr>
<tr>
<td>Door in door out</td>
<td>Door-to-needle time + 60</td>
</tr>
<tr>
<td>Door to needle (EVT center)</td>
<td>30</td>
</tr>
<tr>
<td>Door-to-groin puncture</td>
<td>60 (mothership), 30 (drip and ship)</td>
</tr>
</tbody>
</table>

Ischemic stroke with large-vessel occlusion can be treated with alteplase and/or endovascular therapy; however, the administration of each treatment is time sensitive.
Modeling Stroke Patient Transport for All Patients With Suspected Large-Vessel Occlusion

<table>
<thead>
<tr>
<th>Factor</th>
<th>Time, min</th>
</tr>
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<tbody>
<tr>
<td>Onset to first medical contact</td>
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<td>30</td>
</tr>
<tr>
<td>Door to needle (thrombolysis center)</td>
<td>30</td>
</tr>
<tr>
<td>Door in door out</td>
<td>Door-to-needle time + 20</td>
</tr>
<tr>
<td>Door to needle (EVT center)</td>
<td>30</td>
</tr>
<tr>
<td>Door-to-groin puncture</td>
<td>60 (mothership), 30 (drip and ship)</td>
</tr>
</tbody>
</table>

**Importance:** Ischemic stroke with large-vessel occlusion can be treated with alteplase and/or endovascular therapy; however, the administration of each treatment is time sensitive.

60 min Between thrombolysis and EVT center

<30 minutes farther and still better direct to CSC
Rural Zone (PSC far and CSC far)
3 way rural field consultation
Conclusions

• IV TPA: Better for MCA occlusion/small pervious clot

• EVT: Better for proximal/carotid occlusion/long clots

• Both therapies complementary but very time sensitive!
Conclusions

• Stroke centre designation and redirect policies essential

• NCCT with thin section and immediate mCTA crucial

• Don’t waste time at all: DTN and DIDO times must be minimized at your PSC
Thank-you for your attention!
Email me if you need anything: ademchuk@ucalgary.ca