S.P.I.D.E.R
STROKE PRE-HOSPITAL INFORMED DECISION-MAKING USING EEG RECORDINGS
A PILOT PROJECT RESEARCH PROTOCOL

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CRITICAL CARE PARAMEDIC
QUEENSLAND AMBULANCE SERVICE
ACUTE ISCHAEMIC STROKE
• Approx. 80% of acute strokes are ischaemic.
• AIS treatment is time dependent.
• Mortality of 1.3% in non-LVO stroke

LARGE VESSEL OCCLUSION STROKE
• 38.7% of AIS
• Mortality of LVO 26.2%.
• LVO accounts for 61.6% of dependence or death.

Ischemic Strokes Due to Large-Vessel Occlusions Contribute Disproportionately to Stroke-Related Dependence and Death: A Review
Konark Malhotra, Jeffrey Gormbain, and Jeffrey L. Saver
IDENTIFICATION OF ACUTE STROKE

Accuracy of stroke identification by paramedics in a metropolitan prehospital setting: a cohort study
Teresa A Williams, David Blacker, Glenn Arendts, Emily Patrick, Deon Brink, Judith Finn

SENSITIVITY OF 52.2%
SPECIFICITY OF 99.4%
PPV OF 45.7%

Paramedic Identification of Stroke:
Community Validation of the Melbourne Ambulance Stroke Screen
Janet E. Bray, Jenepher Martin, Greg Cooper, Bill Barger, Stephen Bernard, Christopher Bladin

<table>
<thead>
<tr>
<th>LAPSS</th>
<th>CPSS</th>
<th>MASS</th>
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</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>78% (67–87)</td>
<td>95% (86–98)</td>
</tr>
<tr>
<td>Specificity</td>
<td>85% (65–95)</td>
<td>56% (36–74)</td>
</tr>
<tr>
<td>PPV</td>
<td>93% (83–98)</td>
<td>85% (75–92)</td>
</tr>
<tr>
<td>NPV</td>
<td>59% (42–74)</td>
<td>79% (54–93)</td>
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<tr>
<td>Positive LR</td>
<td>5.27 (2.16–13.13)</td>
<td>2.13 (1.39–3.25)</td>
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<tr>
<td>Negative LR</td>
<td>0.26 (0.16–0.40)</td>
<td>0.1 (0.04–0.27)</td>
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<tr>
<td>Accuracy</td>
<td>80%</td>
<td>84%</td>
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Values in parentheses are 95% CIs. PPV = Positive predictive value; NPV = negative predictive value; LR = likelihood ratio.
# IDENTIFICATION OF LVO STROKE

<table>
<thead>
<tr>
<th>Study</th>
<th>Tool</th>
<th>Study population</th>
<th>LVO prevalence (%)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
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<tbody>
<tr>
<td>de la Ossa et al 2014</td>
<td>RACE</td>
<td>357</td>
<td>21</td>
<td>85</td>
<td>68</td>
<td>42</td>
<td>94</td>
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<tr>
<td>Kesinger et al 2015</td>
<td>NIHSS</td>
<td>305</td>
<td>68.9</td>
<td>51.9</td>
<td>87.4</td>
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<td>Teleb et al 2016</td>
<td>VAN</td>
<td>62</td>
<td>22.6</td>
<td>100</td>
<td>90</td>
<td>74</td>
<td>100</td>
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<tr>
<td>McMullan et al 2017</td>
<td>C-STAT</td>
<td>131</td>
<td>13</td>
<td>71</td>
<td>70</td>
<td></td>
<td></td>
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<tr>
<td>Zhao et al 2018</td>
<td>ACT-FAST</td>
<td>104</td>
<td>13.5</td>
<td>100</td>
<td>87.2</td>
<td>56.0</td>
<td>100</td>
</tr>
</tbody>
</table>
TECHNOLOGY TO ASSIST IDENTIFICATION

DEFINITIVE CARE OF ACUTE ISCHAEMIC STROKE

THROMBOLYSIS
• Up to 4.5 hours post onset
• NNT 5-9
• Remains controversial
• Can be delivered at primary stroke centres or with telemedicine support.
• LVO stroke achieves poor recanalisation

ENDOVASCULAR CLOT RETRIEVAL
• 6-24 hours post onset - patient selection.
• 9 positive trials
• NNT <3
• ICA, proximal MCA
• Eligible patient still receive thrombolysis
IMPROVEMENTS IN STROKE CARE ARE MULTIFACTORIAL

EDUCATION

CLINICAL GOVERNANCE

TECHNOLOGY

DECISION SUPPORT TOOLS

SYSTEMS OF CARE

CLINICAL EXPOSURE
QEEG IN ACUTE ISCHAEMIC STROKE (AIS)

- EEG measures activity of large groups of synchronised neurons.
- EEG requires trained experts to interpret.
- Alpha wave is healthy while delta wave indicates ischaemia.
- QEEG provides a simple measurement analogous to heart rate or blood pressure.
ELECTROENCEPHALOGRAPHY (EEG)

- ACUTE STROKE TO LEFT MCA
- NIHSS OF 7
- (A) SHOWS A RAW EEG TRACING WITH ALPHA AND DELTA WAVES
- (B) SHOWS TOPOGRAPHICAL MAP OF MEAN DELTA AND ALPHA POWER ACROSS THE SCALP
QUANTITATIVE ELECTROENCEPHALOGRAPHY (QEEG)

- QEEG correlates with stroke severity, radiographic findings and response to treatment. (Foreman & Claassen, 2012)
- Delta/alpha power ratio (DAR) demonstrates the highest accuracy for discriminating AIS to controls. (Finnigan, Wong & Read, 2016)
- DAR <3.7 was 100% specific for absence of IS. DAR >3.7 was 100% sensitive for the presence of IS. (Finnigan, Wong & Read, 2016)
STUDY OVERVIEW

This is Novel research and a potential solution for our decentralised population.
STUDY OBJECTIVES

• To investigate the ability of EEG markers to enable pre-hospital distinction between ischaemic stroke cases and all other patients with neurologic symptoms.

• To investigate the ability of EEG markers to enable pre-hospital distinction between LVO versus non-LVO, ischaemic stroke cases.

• To compare the performance of the Melbourne Ambulance Stroke Screen (standard care) with EEG markers, in these comparisons.
STUDY LOCATION

- ROYAL BRISBANE AND WOMENS HOSPITAL CATCHMENT.
- POPULATION – 211 589
  - 31 314 OVER 65
  - 140/KM²
  - MELBOURNE = 450/KM²
STUDY METHODS

DATA COLLECTION AND MANAGEMENT
DATA COLLECTION

- EEG will be recorded during transport to RBWH, from 5 electrodes positioned on the scalp. This will commence as soon as feasible after consent and continue until arrival at RBWH.
- Application time is less than 2 minutes once trained.
- EEG recordings will be made using a portable Nicolet Brain Monitor system (Natus Medical Inc.).
- After admission to RBWH, patients will receive standard-of-care neurological assessments and CT brain scans. Results of these will be used to assign participants to one of three groups:
  - Large vessel occlusion (LVO) ischaemic stroke cases.
  - Non-large vessel occlusion (non-LVO) ischaemic stroke cases.
  - All other eligible patients with neurologic symptoms.
DATA ANALYSIS

• MASS and EEG measures will be compared between groups using independent groups analysis of variance (ANOVA; or an analogous non-parametric procedure, if normality testing deems this appropriate)

• Binary logistic regression modeling will determine which variable(s) provide the most accurate prediction of group (diagnostic category) for each respective aim
FUTURE TECHNOLOGY

ETHICAL CONSIDERATIONS

• Royal Brisbane and Womens Hospital Human Research Ethics Committee - Approval HREC/18/QRBW/32.
• Minimal discomfort from electrode placement
• Study participants will be assigned a non-identifying study ID.
• Permission will be sought from the Queensland Civil and Administrative Tribunal to allow a substitute decision maker (patients' next of kin or close relative) to be approached to provide informed consent on the patient's behalf (retrospectively) where appropriate.
• Patients may withdraw consent at any stage
• Waiver of consent granted - As per section 2.3.10 of the national statement.
  • Paramedics will use judgement in applying device.
  • Due to nature of emergency care - delayed informed consent
  • consent will be gained post admission to RBWH.
STUDY FUNDING AND SUPPORT

• GRANT FUNDING FROM RBWH FOUNDATION
• EQUIPMENT ON LOAN FROM UNIVERSITY OF QUEENSLAND
• STAFF AND LOGISTICS SUPPORT FROM QAS
STUDY CRITERIA
INCLUSION CRITERIA

• Screening positive on the Medical Priority Dispatch System™ (MPDS®) CPSS-based Stroke Diagnostic Tool administered via phone by the QAS Emergency Medical Dispatcher.
  AND/OR

• Evidence of a neurologic event in the opinion of an attending QAS paramedic.

• Within the Royal Brisbane and Women's Hospital (RBWH) catchment area and to be transported and admitted to RBWH.

EXCLUSION CRITERIA

• Under 18 years of age
• Pregnancy
• Previous craniotomy
STUDY POPULATION

• We aim to recruit 55 patients in each of the following groups:
  • Non-large vessel occlusion (non-LVO) ischaemic stroke cases.
  • Large vessel occlusion (LVO) ischaemic stroke cases.
  • All other eligible patients with neurologic symptoms.
RECRUITMENT STRATEGY

STANDARD RESPONSE

CLINICAL DEPLOYMENT SUPERVISOR

STUDY PARAMEDIC
REFERENCES


