Using linked data for an economic evaluation of the Melbourne Mobile Stroke Unit

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Pragmatic real-world vs the holy grail RCT

- There will never be enough patients, time or funding to perform all the RCTs necessary to answer all the important questions about comparative effectiveness in unique populations.

- Registries are simpler, cruder instruments that are capable of enrolling very large numbers of patients in clinical practice in a very cost-effective manner.
Melbourne Mobile Stroke Unit

- Specialised stroke ambulance with a CT scanner, paramedics, stroke nurse and neurologist (launched Nov 2017)
- Time is brain – improved outcomes from earlier delivery of reperfusion
- MSU enables pre-hospital assessment and treatment of patients with suspected stroke
  - Faster provision of thrombolysis
  - Time saved from avoiding inter-hospital transfer for thrombectomy
- Economic evaluation is necessary to determine “value-for-money” and inform the allocation of limited healthcare resources
Limited evidence of cost-effectiveness

While it has been demonstrated that MSUs improve the provision of acute therapies, the evidence of cost-effectiveness is not as strong (Walter et al, 2018).

Two economic evaluations of MSUs conducted to date
• Saarland, Germany (Dietrich et al, 2014)
• PHANTOM-S - Berlin, Germany (Gyrd-Hansen et al, 2015)

Other economic evaluations planned:
• **BEnefits of Stroke Treatment Delivered Using a Mobile Stroke Unit (BEST-MSU)**
  • Houston, Texas, USA (Yamal et al, 2017)
  • Cohort study comparing week on / week off MSU
    https://clinicaltrials.gov/ct2/show/NCT02190500
Preliminary cost effectiveness estimates for Melbourne MSU

Simulation modelling comparing MSU to standard care using best available evidence:

- Published literature: clinical effectiveness of reperfusion interventions
- MSU clinical data reports (2018 operations)
  - 505 attendances over 200 days of operation
  - 58 patients receiving thrombolysis/ECR
- Finance reports
- Consultation with the program leads and senior operational staff
  - Melbourne Health, Ambulance Victoria
Costs and benefits

<table>
<thead>
<tr>
<th>Costs</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>Annuitised purchase and set-up costs*</td>
<td>$387,953</td>
</tr>
<tr>
<td>Costs of additional thrombolysis provided</td>
<td>$17,436</td>
</tr>
<tr>
<td>Non-wage operational costs</td>
<td>$174,674</td>
</tr>
<tr>
<td>Radiographer, Neurologist and Nurse costs</td>
<td>$781,078</td>
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<tr>
<td>Paramedic costs</td>
<td>$374,861</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$1,736,398</strong></td>
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</table>

Cost offsets

<table>
<thead>
<tr>
<th>Cost offsets</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Emergency department</td>
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</tr>
<tr>
<td>Ischaemic stroke provided ECR</td>
<td>$9,310</td>
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<tr>
<td>Ischaemic stroke provided tPA</td>
<td>$6,516</td>
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<tr>
<td>Untreated stroke</td>
<td>$29,355</td>
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<tr>
<td>Non-stroke</td>
<td>$39,344</td>
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<tr>
<td>Time savings for paramedics</td>
<td>$118,508</td>
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<tr>
<td>Transfers to hospital avoided</td>
<td>$4,019</td>
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<tr>
<td>Inter-hospital transfers for ECR avoided</td>
<td>$28,260</td>
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<tr>
<td><strong>Total cost offsets</strong></td>
<td><strong>$235,313</strong></td>
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</table>

DALYs Avoided

- 7.68, 16%
- 27.94, 60%
- 11.28, 24%

- From additional provision of thrombolysis
- From faster provision of thrombolysis
- From faster provision of ECR
Multivariable probabilistic analysis

Values x $10^5$

$20,301$ $46,162$

$2.5\%$ $95.0\%$ $2.5\%$

Additional cost per DALY avoided
Data linkage to enhance economic evaluations

Heart Foundation Vanguard Grant (2019)

Data sources (from 2017 and 2018):

- Mobile Stroke Unit (2018 only)
- Australian Stroke Clinical Registry
  - National Death Index
- Ambulance Victoria
- Hospital administrative datasets (VAED/VEMD)
  - Clinical costing
Mobile Stroke Unit Data Collection

Data collected on MSU treated and MSU cancelled cases

Patient characteristics
• Vascular risk factors
• Clinical symptoms and onset
• Stroke severity

Assessment, treatment and transport
• Imaging and diagnosis
• Reperfusion therapies: thrombolysis and endovascular clot retrieval
• Anticoagulant reversal agents, antiseizure medications and antihypertensive medications
• Time to assessment, treatment and transport
AuSCR Hospital Participation

72 sites actively contributing data

9 hospitals joining 2019

Opt-out rate: 2.2%

Approved hospitals: 85

91,648 Stroke/TIA Episodes

42,509 Patients Followed Up

<table>
<thead>
<tr>
<th>State</th>
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<th>Episodes</th>
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<tr>
<td>QLD</td>
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<tr>
<td>ACT</td>
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</tbody>
</table>
Active Program Datasets

**Identifying information**
- Date of birth
- Gender
- Contact details (including next of kin)
- Hospital name

**Clinical processes**
- Use of tPA
- Access to a stroke unit
- Discharge antihypertensives
- Discharge care plan

**Hospital outcomes data**
- Date of discharge or death
- Discharge destination

**Timeliness of care delivery**
- Arrival by ambulance
- Date/time of stroke onset
- Date/time of ED arrival
- Date/time of admission
- Transfer from other hospital

**Risk adjustment**
- ICD-10 codes
- Ethnicity
- Ability to walk on admission
- First ever stroke status
- Inpatient stroke
- NIHSS on presentation

**AuSCR Green**
Core AuSCR dataset (original minimum processes of care dataset)

**AuSCR Red**
AuSCR Green + SAMA + Telemedicine + extra tPA variables

**AuSCR Navy**
NSW-specific dataset based on the Red Program

**AuSCR Black**
Red + ECR variables

**AuSCR Violet**
NSW-specific dataset based on the Black Program

SAMA: Swallow screen, Hyperacute Aspirin, Mobilisation, Antithrombotics
ECR: Endovascular Clot Retrieval
Follow-up: 90-180 days post stroke/TIA

Coordinated by AuSCR office:

- Place of residence & living alone status
- Recurrent stroke event post discharge
- Re-admission to hospital
- Modified Rankin Scale (mRS)
- Quality of Life (EuroQoL5D)
- For those < 18: age-appropriate QOL
Ambulance Victoria

Available for matches in the AuSCR
Call taker and dispatch details
Paramedic details
Screening and assessment
Pre-hospital transport and arrival
Pre-notification of hospital
Pick-up location
Stroke onset

VEMD/VAED

Linkage to the AuSCR
5-year look back for risk adjustment
1-year look forward for outcomes

Emergency department presentations
Hospital admissions
ICD-10 coding of all contacts to determine:
• Prevalence of comorbidities
• Charlson comorbidity index
• Frailty risk score
Study design to estimate cost-effectiveness

The MSU will be compared usual care (standard ambulance services and acute stroke care in hospital) as follows:

1) **A historical control design**: comparison of patients in the pre-MSU period with patients in the first 12 months of MSU operation.

2) **A prospective case-control design** comparison of patients treated with equivalent patients when the MSU was unavailable during the first 12 months of MSU operation.

The data from these two components will be summarised and sensitivity analyses performed to provide best case/worst case scenarios

**Population**: Patients with suspected stroke within a 20 km operational radius from the Royal Melbourne Hospital or location of the MSU.

**Perspective**: Broad health sector with consideration of cost to patients. Costs based on the health service utilisation observed in the linked datasets and from patient outcomes at discharge from hospital or follow-up.
Study outcomes:
- Cost per patient with disability avoided using the modified Rankin Scale.
- Cost per nursing home admission avoided.
- Cost per quality adjusted life year (QALY) gained from responses to the EQ-5D-3L questionnaire.
Benefits of data linkage for economic evaluation

Ability to select comparator (control) cohorts

- AuSCR, Ambulance Victoria, VAED/VEMD data available to select patients similar in clinical and demographic characteristics and hospital presentation details to MSU-treated patients
- MSU data collection program limited to cases MSU dispatched/attended so MSU-treated patients compared to a counterfactual scenario in preliminary economic evaluation

Standardised patient-level costs and outcomes

- Hospital contacts and deaths available up to one year post-stroke
- Outcomes in preliminary economic evaluation estimated from care provided
- Estimates of societal costs and quality of life still required from direct patient follow-up
Summary

The costs of operating the MSU are considerable. Economic evaluation is required to understand the return on investment and support the expansion of the MSU service to other locations.

Pragmatic use of ‘real-world’ data, including the national registry. This work will provide evidence to guide policy for management of hyperacute stroke care to reduce death and disability.

The economic model and the data linkage infrastructure will be able to be used in future research.
Thank you

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