Remotely supported prehospital ultrasound: real-time communication technology for remote and rural communities

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Rural stroke patients can be at a disadvantage...

“Time is brain” vs.

Distance from major centre of care

Routine transport delays due to remoteness
The challenges

• ~13,000 people across Scotland have a stroke each year – outcome could be improved if early thrombolysis given
  • ... but only if stroke is thrombosis, not haemorrhage!
• CT is gold standard for diagnosis
  • ... but transcranial ultrasound could be a portable alternative!
• Paramedics, BASICS GPs could get expert support via telemedicine
  • ... but rural and remote areas often have poor network coverage!
The SURS Project

Outline:

• Diagnosis: ischemic versus haemorrhagic stroke
  – in ambulance using transcranial ultrasound
• Using remote expert guidance
  – streaming US, video, audio
• Communications “Omni-Hub™” (Tactical Wireless, UK)
  – uses 2G/3G/4G, wi-fi or satellite, intelligent connectivity
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Questions:

• Can ultrasound images be transmitted from remote and rural areas using satellite to facilitate patient assessment?
• Can non-experts be guided to capture adequate ultrasound images after receiving some brief training?
• Can transcranial ultrasound reliably rule-out haemorrhage in stroke?
Streaming live images, audio and video to and from a remote expert *in real-time*
Progress so far

Loan of US machines

No dedicated TC probe!

Needs:

• Small footprint
• Low frequency: 1–2 MHz
• Software/settings optimised for the head
Progress so far

Proof of Concept

• Transmitting live ultrasound between ambulance and expert’s iPad ~30m away (via England!)

UK Government Demo

• Transmitting live ultrasound from ambulance in the Highlands to Oxfordshire (~860 km)
Progress so far

Healthy volunteer study

- Is the quality of images taken by remotely-guided novice scanners sufficient for diagnosis?
- Remote scans: thoracic (Morison’s pouch, aorta screen, pneumothorax scan), brain midline (3rd ventricle)
- 15 locations ➔ clinical experts (one site rejected for very poor connectivity)
Results

- 93.5% thoracic scanning success rate
- 67% brain scanning success rate
- Thoracic scans took (mean) 3 min each
- Brain scans took (mean) 5 min

<table>
<thead>
<tr>
<th>Median rating (range) (1-5 scale: 1 = worst; 5 = best)</th>
<th>Cellular (n=21)</th>
<th>Satellite (n=2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comms adequacy for diagnosis</td>
<td>4 (2–5)</td>
<td>3 (3–3)</td>
</tr>
<tr>
<td>Comms quality</td>
<td>2 (1–5)</td>
<td>3.5 (3–4)</td>
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</tbody>
</table>
Technical details

- **Cellular networks:** mostly EE and 3
- **Upload rate:**
  - Cellular mean: 835 Kbps (80–1900)
  - Satellite mean: 150 Kbps (80–160)
  - (8 MB home broadband: 400 Kbps)
- **Latency:**
  - Cellular mean: 113.6 ms (87–3000)
  - Satellite mean: 2072 ms (1500–3050)
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What’s next: SURS 2

• Collaboration with Philips: definitive study of ultrasound vs. CT for ruling out intracranial haemorrhage
• Brain ultrasound mapping and testing
• Image/transmission optimisation and computer-assisted diagnosis support
• Further fieldwork testing the optimised system
Applicable beyond stroke...

- Trauma assessments (FAST, pneumothorax, etc)
- Abdominal aortic aneurysm (AAA) screening
- Obstetrics
- GP, community based systems?
- Offshore (oil rigs, cruise ships)
Any questions..?

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