Financial Disclosure

None of the authors have a financial relationship with any products or companies that relate to this project except as below.

Henry Feldman is an unpaid advisory board member to a neurologic diagnostic software company: SimulConsult Inc. No part of this presentation relates to this product.
Straw Polls
Case Presentation

73 year old Right Handed Female with Type 2 Diabetes, High Cholesterol and Hypertension who presents during dinner at a restaurant with sudden onset right facial droop, right arm weakness and difficulty speaking. Her family calls EMS, and she is brought to the local hospital.
### Stroke

- **US:** 780,000 strokes per year causing 150,000 deaths
- **Cost US:** $65.5 Billion in 2005
- **Kills more women than men (40 vs 60% of deaths)**
- **UK:** 150,000+ strokes per year causing 60,000+ deaths
- **Cost £8 Billion in 2005** (4-6% of NHS expenditure)
- **Very low rate of thrombolysis (<1%) and stroke unit utilization**

---

**References:**
# Perspective

<table>
<thead>
<tr>
<th></th>
<th>Stroke</th>
<th>Breast Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence</td>
<td>470,000</td>
<td>250,000</td>
</tr>
<tr>
<td>Deaths</td>
<td>90,000</td>
<td>40,000</td>
</tr>
</tbody>
</table>
## Demographics

<table>
<thead>
<tr>
<th></th>
<th>MA</th>
<th>USA</th>
<th>London</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pop</td>
<td>6.5M</td>
<td>302M</td>
<td>7.2M</td>
<td>59M</td>
</tr>
<tr>
<td>&gt;65</td>
<td>604,481</td>
<td>24,672,708</td>
<td>891,590</td>
<td>9,340,999</td>
</tr>
<tr>
<td></td>
<td>(9.3%)</td>
<td>(9.2%)</td>
<td>(12.4%)</td>
<td>(15.8%)</td>
</tr>
<tr>
<td>Strokes</td>
<td>13,071</td>
<td>780,000</td>
<td>8920</td>
<td>150,000</td>
</tr>
<tr>
<td>Stroke Deaths</td>
<td>3,559</td>
<td>150,000</td>
<td>3657</td>
<td>60,000</td>
</tr>
</tbody>
</table>


Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health, Massachusetts Deaths 2006


What is a Stroke?

Coronal section of the brain showing middle cerebral artery

Atherosclerotic clot

Blood clot

Tissue Plasminogen Activator (tPA)

Friday, October 23, 2009
Treatment Window

Time to tPA therapy = brain lost

Maximum Window for IV tPA is 3 hours

Experimental: 6 hours with IA tPA
Our points of comparison

600 bed
Teaching Hospital
Urban Setting
Stroke Center
Fee for Service/Managed Care

500 bed
Teaching Hospital
Urban Setting
NHS or Similar Funding
# Stroke Therapy Protocols

<table>
<thead>
<tr>
<th>Symptom Recognition</th>
<th>Prehospital Transport &amp; Triage</th>
<th>Acute Stroke Therapy</th>
<th>In-Hospital Stabilization</th>
<th>Rehabilitation</th>
</tr>
</thead>
</table>

Friday, October 23, 2009
US vs. UK Protocols

- Both countries use very similar protocols, although the UK protocol is more detailed in specifying actions at a given stage of the protocol.
Symptom Recognition Stage

- Patients are notoriously poor judges of recognizing symptoms of stroke
- In Boston ~700/13000 (5%) arrived within the 3 hour window
- Large public education campaigns have not improved this for various reasons on either side of the Atlantic
- Without good recognition the therapy is not as important, as it is unusable
Pre-Hospital Stage

- Efficient dispatch and transport systems exist in both countries (911 and 999)
- En-Route stroke assessment in both protocols
- Preferred transfer to stroke center if available
- Notification of stroke center by EMS
- Oxygen
Acute Stroke Management

• Here is the primary area of difference between US and UK, not in protocol but in delivered practice

• US model is to equate acute stroke to acute ST-elevation Myocardial Infarction (code model)

• In the US the “code stroke team” meets patient at the door of ED, alerted by EMS
Acute Stroke Management

• In the US “Code-Stroke” team are stroke board certified Neurology physicians, along with ED and critical care staff

• In the UK stroke consult in ED is a stroke nurse coordinator
Acute Stroke Management

- In the US, on arrival a stat neurology exam by stroke neurologist, NIH Stroke scale recorded, EKG, IV placed, Basic Labs, Stat head-CT (CT/CT-A) all within 15-minutes of arrival, and if indicated tPA within 45 minutes of arrival and patient moved to monitored setting.

- In the UK the Stroke Coordinator on call notified (Nurse), Stat neurology exam by ED staff and stroke coordinator, EKG, IV placed, Basic Labs, Head-CT within 24 hours of arrival.
Rates of Thrombolysis

For eligible patients in tPA Window

US Hospital: 98%

UK Hospital: 1%

Friday, October 23, 2009
Private CT scan in UK: ~ £250
Private MRI in UK: ~ £200
CT Cost to NHS: £30-72/£55-173 (day/night)

Source: www.comparecatscancost.com, www.comparemricost.com, privatehealth.co.uk
Cost of a CT-Scanner

For Stroke imaging, the latest high-detector scanners are not needed. Approximate cost is $500,000 new. Scanner can last over 10 years.
Stroke Hospital Models

Within Stroke Center Catchment Area

Triage
In US may give tPA prior to transfer

EMS Transfer

Outside Stroke Center Catchment Area

EMS

Non-Stroke Hospital

EMS

Stroke Center

Triage Bypass

Home

EMS

Home

EMS

Home

Within Stroke Center Catchment Area

EMS
Outside Catchment Area

- tPA should be given at stroke centers with ICU level care
- Goal to get patient to stroke center within the tPA window
- Prehospital triage system can bypass non-stroke centers themselves
Inside Catchment Area

- Maximum level of care provided
- Integrated pre-hospital care model

Home ➞ EMS ➞ Stroke Center
## Rehab Protocol

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In-Hospital</strong></td>
<td>Evaluated by PT/OT, mostly discharge planning</td>
<td>Evaluated by neuro/stroke-rehab, actual rehab performed in hospital</td>
</tr>
<tr>
<td><strong>Post-Hospital</strong></td>
<td>Stroke SNF vs. home PT/OT based on patient</td>
<td>Stroke SNF vs. home PT/OT based on patient</td>
</tr>
</tbody>
</table>
Average Length of Stay

Source: Length of hospital stay for elderly people is substantially higher in the NHS compared with Kaiser Permanente and US Medicare programmes, Evidence Based Healthcare, Volume 8, Issue 3, Pages 113-115 (June 2004), David P. Sklar, MD


NHS Bed: £217-243/d)
Stroke Anecdotes

“If my pager goes off with a stroke, I would finish up my current appointment and would eventually make my way to A&E or wait to see the patient at the end of the day. With a Code STEMI (heart attack) we come running with anesthesia, cardiology, etc...” - Dr. Shane Reti, NHS/NZ HS

In the US Acute Stroke and STEMI are considered equivalent. In Advanced Cardiac Life Support, they are one module; hence the term “code stroke”
Financial Incentive Anecdote

“I get paid the same whether it is a stroke or a foot infection, so there is no financial incentive to treat a stroke...”  - Dr. Shane Reti, Dr. Shane Reti, NHS/NZ HS

“I love treating an acute stroke, I get paid for a level 3 (highest) admission, probably plus “critical care time” (even higher) and could make $500 just for walking in to see the patient. The hospital gets an additional $6000 to give tPA alone...”  - Dr. Henry Feldman, Harvard Medical Faculty Physicians
Long Term Question

Q: As a healthcare system, is it cheaper in the long run to aggressively treat acute stroke with a CT-scan and tPA to prevent/lower long-term disability?

A: Literature seems to suggest in the UK this is a cheaper long term strategy even factoring capital costs. In the US it certainly seems to be. In the UK where a single payor (government) is responsible for all phases of the care, incentives to have cost savings over the long term align well.

Follow-Up

• Model each phase with best-modeled costs for each system. Perform mix-and-match to optimize cost performance
  • Note limitation, is post-stroke disability costs, QALY and outcomes poorly documented in literature
  • New Paradigm of Low Cost field thrombolysis

• Further investigation into why protocols are not implemented in the field at NHS
  • Cultural investigation as to why culture around STEMI and Stroke are different

• Follow up of new Stroke NHS initiative
Research Project

- Low cost ruggedized and simplified CT scan in rural settings for in-the-field diagnosis and tPA administration by EMS
Traditional

Pre-Hospital

Time Critical

Dependent on travel time

Leisurely
Concept

Time Critical
Pre-Hospital

Leisurely
Reason for Likely Success

- NHS EMS has trialled field administration of tPA for heart attack at Manchester
- Cost sharing across health system (in US would be more complicated due to fragmented payer system)
- NHS intranet low-performer, but NHS EMS built own high-performance network
- Informatics has allowed easy data transfer and simplified technology for CT
Authors

Corey Fehnel, MD
Henry Feldman, MD
Stan Finkelstein, MD
Shane Reti, QSM, MBChB

James Barlow PhD
Steffen Bayer, PhD
Questions