Disruptive Innovation in Stroke Care

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Policy Context

- US, UK and other developed health economies are challenged to deliver high value healthcare and improve clinical outcomes, while containing growth in costs.
- Stroke is one (of many) examples in which changes to the care pathway for diagnosis and management are needed to improve morbidity, mortality and long term costs.
- We will argue that an innovative field based imaging device that would be widely available, could help accomplish these aims.
OECD Health Care Expenditure

Growth as percentage of GDP

- OECD countries
- Australia
- Canada
- France
- Germany
- Iceland
- Ireland
- Italy
- Japan
- Netherlands
- New Zealand
- Spain
- Switzerland
- United Kingdom
- United States
## Drivers of Growth in US Health Care Costs

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<thead>
<tr>
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<tbody>
<tr>
<td>Aging of the Population</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Changes in Third Party Payment</td>
<td>10</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Personal Income Growth</td>
<td>11-18</td>
<td>5</td>
<td>&lt;23</td>
</tr>
<tr>
<td>Prices in Health Care Sector</td>
<td>11-22</td>
<td>19</td>
<td>NA</td>
</tr>
<tr>
<td>Administrative Costs</td>
<td>3-10</td>
<td>13</td>
<td>NA</td>
</tr>
<tr>
<td>Defensive Medicine and Supplier-Induced Demand</td>
<td>0</td>
<td>NA</td>
<td>0</td>
</tr>
<tr>
<td>Technological Innovation</td>
<td>38-62</td>
<td>49</td>
<td>&gt;65</td>
</tr>
</tbody>
</table>

Source: Peter Orszag, Congressional Budget Office, 2008
Innovation

- In nearly every industry new product innovations initially are expensive, complicated, inaccessible and require skill (Christensen, 2008)
- In most industries, technological innovation proves to be cost reducing as process innovation follows product innovation (Utterback, 1978)
- Not observed in health care, as technological innovation has lead to cost inflation (Blume, 1992)
- Doctors need to access the latest, most sophisticated technologies to meet what they perceive to be the needs of their patients (Fuchs, 1974)
- Patients often consider availability of latest practices to be a measure of quality
A Way to View Failure of Innovation in Health Care to be Cost-Reducing

“Quality Adjusted Price Indexes”

- Initiated by Andrew Court, Automobile Industry Economist in 1939
- Popularized by Leading Academic Economists from 1970 to Present
- Concept is that each time automakers introduce new models, they are offered at higher prices, but also have new and innovative characteristics and attributes
- Quantitative approach is to assign value to these attributes and adjust growth in prices accordingly
A Way to View Failure of Innovation in Health Care to be Cost-Reducing (cont)

- The result for industry sectors, including automobiles, personal computer, consumer electronics, etc, is that adjusted growth rates in prices are highly negative.

- Similar approach applied to health care (pharmaceuticals, insurance premiums, etc) finds some moderation in growth rates compared to unadjusted price increases, but not nearly as dramatic as for many other industries.
Disruptive Technology

- Once in a while a new technology comes along with these characteristics (Christensen)
  - It is simplifying compared to current practices
  - It is less costly
  - Initially not as good
  - As the technology improves, it disrupts the standard of practice
Disruptive Technology: Steel Industry

Steel Quality

- 1975: 7%
- 1980: 12%
- 1985: 25-30%
- 1990: 

Quality of Integrated Mill's Steel

Quality of Mini-mill's Steel

Sheet Steel

Structural Steel

Angle Iron, bars and Rods

Rebar

Source: Christensen
Even Disruptive Technology in Health Care Doesn’t Always Produce the Desired Effect

<table>
<thead>
<tr>
<th>Treatment of Coronary Artery Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Old Standard of Practice:</strong> Coronary Artery Bypass Graft (CABG)</td>
</tr>
<tr>
<td><strong>Professional Group:</strong> Cardiac Surgeons</td>
</tr>
<tr>
<td><strong>Cost:</strong> $170,000 for surgery, pre-op, post-op and follow up care</td>
</tr>
<tr>
<td><strong>Disruptive Technology:</strong> Balloon Angioplasty with Stents</td>
</tr>
<tr>
<td><strong>Professional Group:</strong> Interventional Cardiologists</td>
</tr>
<tr>
<td><strong>Cost:</strong> $29,000</td>
</tr>
<tr>
<td><strong>Impact of Disruptive Technology:</strong> Huge growth in volume of patients receiving treatment. Health care costs rise greatly rather than fall</td>
</tr>
</tbody>
</table>
Stroke Care: Proposal for Innovative Field Based Imaging Device

- Stroke care does not require high-resolution capability of stationary hospital based CT-scanning units
- Significantly cheaper
- Require less space
- Mobile
- Uses a less skilled operator
- Economy of scale for low incidence per operator use of expensive consultant to read result
- Time to treatment reduced
**Stroke Background**

- UK has about 150,000 strokes per year, US has around 780,000
- One type of stroke can be treated with “clot busting medications” such as tPA
- At our last presentation we discussed that while in the US almost all eligible stroke patients were treated with tPA and in the UK, the majority were not, this has changed in major metropolitan areas with installation of stroke centers
  - In rural areas however, strokes are still not routinely treated with tPA due to lack of advanced imaging
Stroke Types

- By definition, strokes are due to a disruption in blood flow to an area of the brain, there are however 2 causes of this which necessitate major changes in therapy:
  - **Ischemic Stroke:** This is due to a vessel being blocked by either clot or a combination of clot and cholesterol plaque
    - This requires use of a clot busting agent (thrombolytic)
    - You have a small number of hours (the window) to administer
  - **Hemorrhagic Stroke:** This is due to a blood vessel tearing and bleeding into the brain.
    - Clot busting agents will worsen this stroke

- The key is not diagnosing but rather determining the type of stroke, as this changes management
Stroke Diagnosis Technology

- Current state of the art is use of a non-contrast agent based CT-scan of the brain. This shows bleeding.
Why This Approach Is Ripe For Disruption

- CT-Scanners are very expensive ($150,000-$1m) and require specialized facilities and operators
  - In the US they are very common due to reimbursement strategy, but in the UK they are much less so
- The output of a CT-scan is currently interpreted by a radiologist typically at the site of the CT-scan
  - In a busy center this makes sense, but in low incidence areas such as rural areas, this is very cost inefficient
- In rural areas the ability to bring a patient to the CT-scan in time, while their brain is dying, is problematic
  - There are “portable” CT-scanners but they are still quite expensive and would take up most of an ambulance
The UK has already demonstrated that field based administration of tPA is safe and effective in MI (Heart Attack) therapy by lower-level providers (Paramedics).

The ability to give tPA or not in an MI, is based purely on background/history of the patient, and does not require additional imaging (other than the EKG).

In stroke care you need an image of the brain to determine the risk of worsening the stroke with tPA.

Note: in New Zealand they do not, and accept the 6% mortality from this.

We propose to move imaging to the field with simplified technology using, less skilled operators in low incidence areas.
Ultrasound Technology

- Ultrasound has been used to image the brain, in babies, however in adults the solid skull prevents good imaging
  - The skull radiates sound in all directions like a spherical speaker
  - The skull distorts sound in and out variably based on the location on the skull
  - The thinnest portion of the skull is at the temporal bone
- Ultrasound devices are currently very inexpensive ($10,000) and are the size/weight of an iPad
  - Field ruggedized versions exist already, but there is no sensor on the market that can image the brain of an adult
Acoustic Coupling Problem
Noise Cancellation
Ultrasound Helmet
Disruptive Additions

- Computer power is so inexpensive and available, that digital signal processing to measure and compensate for the skull distortion is now available at low cost.
- Noise cancellation technology is now extremely inexpensive and available as single chips.
- Ability to send images around the world, even via 3G is now a standard part of all imaging devices.
Why This Makes a Difference

- With a direct imaging technology on the ambulance, remote reading by a centralized radiologist, we can directly give tPA in the field with rapid treatment, long term disability is reduced
- Modern 3G networks allow direct field support by advanced providers anywhere in the world
Herd Immunity Function

- Early modeling work, seems to suggest that you don’t even need to equip every ambulance with the technology to meet the full demand.
  - Micro-regional distribution would allow deployment in low incidence areas rapidly
Ongoing Questions

- Would the NHS (or another health care system) be able to make the organizational change required to completely change the stroke model from hospital to pre-hospital based care?
- Would this approach improve clinical outcomes?
- Would this reduce costs? What changes to payment and funding rules would be required?
- Would this approach have broader applicability than just stroke?
Disruptive technologies offer the potential to address the widely observed phenomenon that technological innovation in health care – differently from in other industries – tends to be cost increasing.

This effect is the opposite of what is commonly seen in other industries.

Field-based imaging using ultrasound promises to substantially improve stroke care by enabling the more widespread use of tPA.

While the technological hurdles are high, the process innovation hurdles are even higher.
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