Comprehensive Stroke Care Delivery Redesign

South Carolina Heart and Stroke Care Alliance

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Disclosures

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• The contents of this publication are solely the responsibility of the authors and do not necessarily represent the official views of the U.S. Department of Health and Human Services or any of its agencies.
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• Ashley Wennerstrom, PhD, MPH

1 Ochsner Medical Center, New Orleans, Louisiana
2 Tulane University School of Medicine, New Orleans, Louisiana
How do we fix it?

WHAT IS WRONG WITH STROKE CARE?
Adapt or perish, now as ever, is natures inexorable imperative.

HG Wells
1 in 6 people worldwide will have a stroke in their lifetime.
Epidemiology of Stroke Worldwide

• **Every 6 seconds**, stroke kills one person.
• **Every other second**, stroke attacks one person, regardless of age or gender.
• **15 million people** experience stroke each year; 6 million of them do not survive.
• **About 30 million people** have had a stroke; most have residual disabilities.
• **$36.5 Billion annually** in cost for stroke in US.
Stroke

Stroke is a complex costly disease

Stroke is a time sensitive disease

Stroke is an acute then chronic disease

• The initial stroke is often devastating -- but can be minimized:
  – Urgent tPA + ASA treatment is effective
  – Stroke units are effective.

• After the initial stroke risks are high for:
  – Morbidity / Mortality / Complications
  – Recurrent stroke / Hospital readmission
  – Infection and cardiovascular disease including MI.
I Submit the Following:

- Stroke care is fragmented
  - *We need more coordination*
- Stroke care is not about technology
  - *Stroke care is about teamwork*
- Stroke care is about two worlds:
  - *Scientifically proven treatment options*
  - *And the unproven*
- We more often are reactive than proactive
  - *Better engineered systems are needed*
Centers for Medicare Services
Innovations Grants

Three legs of the stool:

Improve Outcomes
Decrease Cost
Train the Future Work Force
CMS Innovations Grant

Improving Stroke Care
What is wrong with stroke care?
What innovations can fix it?

Systems re-engineering
Telemedicine
Technology-enabled stroke care
Coordinated Care
Nodes of Care for the Stroke Patient

- **Acute Stroke Node**
  - Diagnosis
  - ASA
  - t-PA

- **In-hospital Node**
  - Etiology
  - Stabilize
  - Complication
  - Early rehab

- **Subacute Node**
  - Rehab unit
  - Skilled nursing
  - Home care

- **Chronic Stroke Node**
  - Recurrence
  - Risk factor control
  - Recovery
Stroke Care

Acute Care Node
What is wrong with our acute stroke care delivery?
Nodes of Care for the Stroke Patient

Acute Stroke Node
- Diagnosis
- BP mgt
- ASA
- tPA

In-hospital Node
- Etiology
- Stabilize
- Early rehab
- Complications

Subacute Node
- Rehab unit
- Skilled nursing
- Home care

Chronic Stroke Node
- Recurrence
- Risk factor control
- Recovery
## Cost Benefit Analysis
### Acute Stroke – What Works?

<table>
<thead>
<tr>
<th>Risk Management</th>
<th>RR</th>
<th>Approximate costs</th>
<th>Applicability</th>
<th>Affordability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lancet 1999; 354:1457-63</td>
<td></td>
<td>Per death or dependency avoided (AUS$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>15%</td>
<td>$83</td>
<td>80%</td>
<td>ALL</td>
</tr>
<tr>
<td>Stroke Unit</td>
<td>4-14%</td>
<td>Depends on hospital costs; ? nil</td>
<td>80%</td>
<td>++</td>
</tr>
<tr>
<td>Wardlow Lancet, 2012; Boudreau, Stroke, 2014</td>
<td>mRS = 0-2</td>
<td>Lifetime cost savings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>53%</td>
<td>+25,000 (tPA)</td>
<td>10%</td>
<td>+++</td>
</tr>
</tbody>
</table>
The Challenges of Acute Stroke Care

**Time**
- Public awareness
- Medical system care delivery design

**Geography**
- Variability in access
- Variability in appropriate care delivery

**Personnel**
- Variability in training and expertise
### Time is Brain -- Quantified

#### Pace of Neuronal Circuitry Loss in Acute Ischemic Stroke
**(Supra-tentorial)**

<table>
<thead>
<tr>
<th></th>
<th>Neurons lost</th>
<th>Synapses lost</th>
<th>Myelinated fibers lost</th>
<th>Accelerated aging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per stroke</td>
<td>1.2 billion</td>
<td>8.3 trillion</td>
<td>4470 miles</td>
<td>36y</td>
</tr>
<tr>
<td>Per hour</td>
<td>120 million</td>
<td>830 billion</td>
<td>447 miles</td>
<td>3.6y</td>
</tr>
<tr>
<td>Per minute</td>
<td>1.9 million</td>
<td>14 billion</td>
<td>7.5 miles</td>
<td>3.1 wk</td>
</tr>
<tr>
<td>Per second</td>
<td>32,000</td>
<td>230 billion</td>
<td>218 yards</td>
<td>8.7 hr</td>
</tr>
</tbody>
</table>
Combined Analysis: NINDS, ECASS I+II, ATLANTIS

Global outcome (mRS 0–1, Barthel Index 95–100, NIHSS 0–1) day 90, adjusted odds ratio with 95% confidence interval, n=2775

Meta-analysis of Randomized Trials
(Emberson J. Lancet August 2014)

- Stroke Thrombolysis Trialists’ Collaborative group
- 6756 patients; 9 trials
- Outcome: Good outcome with no significant disability at 3-6 months, mRS 0 or 1.
- For every 100 patients treated additional 10 have full recovery.
- Treatment within 3 hr.
  - Good outcome 32.9% VS 23.1%
  - **OR 1.75** 95% CI 1.35-2.27
- Type 2 parenchymal hemorrhage, symptomatic
  - 6.8% VS 1.3%
  - **OR 5.55** 95% CI 4.01-7.70 p<0.0001
TPA for Acute Stroke Report Card

• How are we doing in providing tPA to acute stroke cases?

  Better in some centers

  Overall poor 3-5% delivery
What is wrong with acute stroke care?

**Time**
- Public awareness
- Medical system care delivery design

**Geography**
- Variability in access

**Personnel**
- Variability in training and expertise
Stroke Care: Geographic Mal-distribution

• US Hospitals < 100 beds (AHA)
  – >50% are in rural areas
  – Limited radiology and neurology

• 64% of US hospitals did not give tPA
  – Based on Medpar data over a 2 year period 2005-7.

• 40% of US population reside in counties without a hospital that administered tPA
  • To at least 2.5% of its patients with stroke.
Mal-distribution of US Stroke Centers

INVESTIGATORS REPORTED that the number of primary stroke centers increases as the population density increases.
What is wrong with acute stroke care?

**Time**
- Public awareness
- Medical system care delivery design

**Geography**
- Variability in access
- Variability in delivery of appropriate care

**Personnel**
- Variability in training and expertise
- Variability in delivery of appropriate care
Stroke Care: Geographic Mal-distribution

  – 83.7% adult
  – 42.3% involved in stroke care
  – 47% felt comfortable or promoted tPA for acute stroke cases
  – 20% of population have no neurological services.
Accuracy of Stroke Diagnosis
(Hand, PJ. Stroke, 2006)

- Observational prospective study: urban teaching hospital.
- 336 patients with 350 presentations.
- Final diagnosis: Stroke 69%  Stroke mimic in 31%
- Stroke mimic diagnoses included:
  - Seizure 21.1%
  - Sepsis 12.8%
  - Toxic/metabolic 11.0%
  - Space occupying lesion 9.2%
  - Acute confusional state 6.4%
  - Acute mononeuropathy 5.5%
  - Functional/medically unexplained 5.5%
  - Dementia 3.7%
  - Migraine 2.8%
  - Spinal cord lesion 2.8%
  - Other 3.7%
Acute Stroke Care Report Card

It is not that we are doing nothing

It is that what we are doing is not working well enough

Thus the opportunity to innovate
Acute Stroke Care Deficiencies

TELEMEDICINE SOLUTION?
Science and Invention 1924

“Specialists Brought to Every Town”
Hub and Spoke Model of Care
Efficacy of Telemedicine for Stroke
STROKE DOC Trial
Lancet Neurol 2008;7:787-95)

• Randomized, blinded, prospective study
• Compared telemedicine consults with phone consults

• Telemedicine was superior in:
  – Correct treatment decision
    • 98% vs 82% OR 10.9 CI 2.7-44 p=0.0009
  – Protocol violations less

• Telemedicine was equivalent to phone in:
  – Post lytic ICH rates
  – Mortality rates
Telestroke Cost Effectiveness
(Nelson RE. Neurol 2011; 77:1590-98)

- Decision-analytic model at 90-day and lifetime horizon
- Quality-adjusted life years (QUALYs) along with costs to generate incremental cost-effectiveness ratio (ICERs)+

**ICER/QUALY**

- 90-day $108,363
- Lifetime $2,449

**ICER/QUALY Ratio <$50,000/QUALY***

- 90-day 37.5%
- Lifetime 99.7%

*Commonly accepted as cost effective in US
+ Monte Carlo simulations
Barriers to Telehealth Implementation

Percentage of Physicians Identifying Statement as a Barrier n=106

- Patients do not like it: 5.70%
- Patient quality of care issues: 13.30%
- Lack of Physician Understanding: 42.90%
- Physicians lack incentives to use it: 56.20%
- Inability to bill for services rendered: 61%
- Credentialing: 69.50%
ASSERT Telestroke System 2014

Drip and Ship/Drip and Keep

1 CSC

1 PSC

38 Stroke Ready

25-350 bed facilities

All GWTG
Hub and spoke hospital ischemic stroke rtPA administration rates: 6 months pre-telestroke compared to a recent 6 month period post-telestroke
What does Telemedicine Offer?

• More accurate diagnosis
• Increased utilization of proven therapies
• Improved triage
• Encourage guideline based care
• Better utilization of vascular neurologists
• Opportunity to partner
• Opportunity to impact care quality
Appropriate Transfers

- Getting the Right patient to the Right Place at the Right time
- Keep Patients Close to Home
Stroke Care

In-Hospital Node
Nodes of Care for the Stroke Patient

Acute Stroke Node
- Diagnosis
- ASA
- tPA

In-hospital Node
- Stabilize
- Etiology
- Complications
- Rehab

Subacute Node
- ECF
- Rehab unit
- Home

Chronic Stroke Node
- Recurrence
- Risk factor control
- Recovery
Stroke patients remain at risk after their incident stroke. ONGOING CARE POST STROKE IS IMPORTANT.
Complications occurred in 85% of cases

Types of complications
  – Neurological worsening
    – Medical
  – Morbidity-related
<table>
<thead>
<tr>
<th>Complications within 7 days of onset</th>
<th>% Occurrence 1254 patients</th>
<th>Disability Adjusted life years Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurological</td>
<td>21.1%</td>
<td></td>
</tr>
<tr>
<td>Stroke progression</td>
<td>17.1%</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>24.2%</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>12.0%</td>
<td></td>
</tr>
</tbody>
</table>

**Multi-variant Predictor of poor outcome**

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95% CI</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurological</td>
<td>5.47</td>
<td>(3.63-8.24)</td>
<td>2.15 (1.72-2.59)</td>
</tr>
<tr>
<td>Medical</td>
<td>3.47</td>
<td>(2.30-5.23)</td>
<td>1.99 (1.59-2.40)</td>
</tr>
<tr>
<td>Stroke progression</td>
<td>7.48</td>
<td>(4.73-11.84)</td>
<td></td>
</tr>
<tr>
<td>Hemorrhagic transformation</td>
<td>3.57</td>
<td>(1.33-9.56)</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>4.44</td>
<td>(2.20-8.99)</td>
<td></td>
</tr>
</tbody>
</table>
Consequences of Stroke: New deficits

<table>
<thead>
<tr>
<th>New or Worsened deficit</th>
<th>Risk of new deficit OR</th>
<th>(95% CI)</th>
<th>% Developing New Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory deficit</td>
<td>2.45</td>
<td>1.34-4.46</td>
<td>9</td>
</tr>
<tr>
<td>Urinary incontinence</td>
<td>1.86</td>
<td>1.31-2.66</td>
<td>19</td>
</tr>
<tr>
<td>Motor impairment</td>
<td>1.61</td>
<td>1.16-2.24</td>
<td>33</td>
</tr>
<tr>
<td>Falls</td>
<td>1.50</td>
<td>1.12-2.0</td>
<td>30</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>1.49</td>
<td>1.09-2.03</td>
<td>33</td>
</tr>
</tbody>
</table>

Health and Retirement Study (Diviani AA. Stroke 2011;42:1821-25) Compared 631 single stroke survivors with 631 age and gender matched controls
In-Hospital Mortality for Stroke
National Inpatient Database 2006-10
(Naderi N. AAN, 2013)

• 2,567,100 admitted with diagnosis of stroke
  – 82% ischemic
  – 70% White
  – 52% female
  – Mean age 71 years

• Co-mobidities:
  – Hypertension 77%
  – Diabetes 31%
  – A fib 21%
  – Hyperlipidemia 41%
  – CAD 24%
  – Smoking 21%

• Mortality:
  – Overall 8.42%
  – 5.43% ischemic
  – 22.35% hemorrhagic
Solution to Lower Complications?

Stroke units

Stroke Central
Stroke Care
What works?

• **Stroke units Work**


• Studies included:
  – 12 trials stroke unit vs. general ward
  – 6 trials assessment/rehab unit VS general ward
  – 4 trials of stroke unit vs. assessment/ rehab unit

• **Stroke unit care had better outcome for:**
  – Death OR 0.83 (0.69-0.98)
  – Death or dependency OR 0.69 (0.59-0.82)
  – Death or institutionalization OR 0.75 (0.65-0.87)
Stroke Care Report Card

Are we implementing stroke unit care?

NO

- % of hospitals with stroke unit
  - UNDER USED
  - US 18% (Goldstein, L. Stroke 2000; 31:66-70).
  - 23% Australia
  - 50% UK
  - 80% Scandinavian countries
  - 5% Japan
Stroke Systems of Care
The JC Models

Comprehensive Stroke Centers
- Research/Education
- NeurolCU/Stroke unit
- Interventional capable

Primary Stroke Centers
- Acute treatment capable 24/7
- In-hospital care Stroke unit
- Quality control

Stroke Capable Facilities
- Telmed or phone-enabled
- May not keep all patients; no stroke unit
- Some quality control (GWTG)
What we must do?
Inpatient care

• Each patient gets the right evaluation and treatment at the right time

• Stroke is a 24/7 illness and we must get it right at 2AM and 2PM.

• Avoid complications
  – Unnecessary urinary catheters
  – Unnecessary line infections
  – Pneumonia >>> Mobilize patients
  – Fractures
  – BP management >> usually overtreatment
How will we be successful?

Inpatient care

• Decrease length of stay
  – Testing done the day it is ordered
  – Weekend testing
  – Get the medication consistently and on time
  – Monitor patients aggressively at night

• Avoid unproven testing and therapy
  – Follow the guidelines
  – OK to challenge each other
  – Variation is OK but should be explained
Stroke Central Concept

• Improve communication
• Facilitate collaboration
• Utilize personnel more efficiently
• Increase adherence to metrics
• 24/7/365 monitoring and call center
• Technology enabled
  – E-Hospital EPIC module
  – Telemedicine units: ER, NICU, Stroke unit, Rehab
  – Home-based care (Stroke Mobile)
Stroke Central
Metrics of Success

Decreased length of stay

Decreased cost per case

Decreased complication rate
Stroke Central
Metrics of Success

• Decreased length of stay
  • 1 day less
• Decreased cost per case
  • 10% less
• Decreased complication rate
• 20% decrease in pneumonia
  • 10% decrease in UTI
Post Stroke Care Delivery

Recurrence
Readmission
Risk Factor Management
Nodes of Care for the Stroke Patient

Acute Stroke Node
- Diagnosis
- ASA
- tPA

In-hospital Node
- Etiology
- Stabilize
- Early rehab
- Complications

Subacute Node
- Rehab unit
- Skilled nursing
- Home care

Chronic Stroke Node
- Recurrence
- Risk factor control
- Recovery

Recurrence
What happens after stroke?

(Neuroepidemiology 1999; 18:75-84)

• Community-based study in Netherlands
  – 25% die in the first month.
  – Cumulative mortality rates
    • 1\textsuperscript{st} year 37%
    • 2\textsuperscript{nd} year 46%
    • 3\textsuperscript{rd} year 54%
  – Risk of death 2\textit{x general population} over 3 years
    • 70% died from cardiovascular diseases, complications of stroke, or recurrent stroke
    • Stroke severity, age, atrial fibrillation, and CHF predicted mortality
# Comparative Effectiveness and Cost

## Secondary Stroke Prevention Strategies

*Lancet* 1999;354:1457

<table>
<thead>
<tr>
<th>Prevention Strategy</th>
<th>Cost per event avoided (A$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking cessation</td>
<td>(0-19) 6,000</td>
</tr>
<tr>
<td>Drug</td>
<td></td>
</tr>
<tr>
<td>Diuretic for ↑ BP</td>
<td>1,350</td>
</tr>
<tr>
<td>ASA for all in sinus rhythm</td>
<td>2,000</td>
</tr>
<tr>
<td>Anticoagulants for atrial fibrillation</td>
<td>1,200</td>
</tr>
<tr>
<td>ACE inhibitor for ↑ BP</td>
<td>18,000</td>
</tr>
<tr>
<td>ASA + DP for all in sinus rhythm</td>
<td>18,500</td>
</tr>
<tr>
<td>Statins for ↑ cholesterol</td>
<td>41,000</td>
</tr>
<tr>
<td>Clopidogel for all in sinus rhythm</td>
<td>74,000</td>
</tr>
<tr>
<td>CEA for symptomatic carotid stenosis</td>
<td>182,000</td>
</tr>
<tr>
<td>Secondary Prevention</td>
<td>Quality Indicator</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Hypertension</td>
<td>On Treatment</td>
</tr>
<tr>
<td></td>
<td>Controlled</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>On treatment</td>
</tr>
<tr>
<td></td>
<td>Controlled</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>Advised to quit</td>
</tr>
<tr>
<td></td>
<td>Advice documented</td>
</tr>
<tr>
<td></td>
<td>% stopped</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>On treatment</td>
</tr>
<tr>
<td></td>
<td>Controlled</td>
</tr>
</tbody>
</table>

How good are we at secondary stroke prevention?

NOT GOOD ENOUGH
Challenges in Chronic Stroke Care

• What is wrong with what we have?
  – Secondary stroke prevention
    • Big dividend interventions are hard:
      – Smoking cessation
      – Weight loss
      – Dietary changes
    • Big dividend interventions require intrinsic lifestyle changes
    • Family is often not involved
    • Episodic care in offices not effective
    • Rehab units are expensive.
Stroke Risk Factors
Targeted Interventions

- **Inherited factors** – Can’t change > Manage
  - BP susceptibility
  - Diabetes susceptibility

- **Lifestyle factors** – Family interventions
  - Smoking
  - Obesity
  - Adherence to medical regimen

- **Environmental factor** – Family interventions
  - Socioeconomic
  - Cultural
Cogs in Chronic Stroke Care Delivery

- Stroke Patient
- Family
- Stroke Mobile Nurse
- Lay educator
Stroke Mobile Process

- 12 monthly in-home visits post discharge
- Family centered approach
- Focus on education and behavior modification
- Visits conducted by RN and Lay Health Educator
- Use of Telemedicine to address acute issues
Secondary Stroke Care
Stroke Mobile Model

What is different?

– Comprehensive post stroke care delivery in home
– Family must be involved
– Nurse to evaluate physical, social, and emotional aspects of recovery
– Lay educator to work with family for lifestyle changes
– Culturally sensitive education program.
– Family involved for primary prevention
– Links to Stroke Central
CMS Grant Outcomes

• ER/EMS > Telestroke
  – tPA delivery
  – Transport times
• Inpatient > Stroke Central
  – Mortality
  – Complications
  – Cost per case/ length of stay
• Outpatient > Stroke Mobile
  – 30-day mortality / 30-day mRankin
  – Readmission/ Recurrence rate
• Continuum of care
  – 1-year bundled cost per case
# Stroke Central / Stroke Mobile
## Preliminary Results

What is wrong with stroke care delivery? National data

<table>
<thead>
<tr>
<th>What is wrong with stroke care delivery? National data</th>
<th>Stroke Central/Stroke Mobile Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complications occur in 85% of in-hospital strokes</td>
<td>UTI ↓ by 19% (1 day)</td>
</tr>
<tr>
<td>Stroke recurrence occurs in 20% of cases in 90 days</td>
<td>↓ by 11%</td>
</tr>
<tr>
<td>Stroke readmission occurs in 12.7% of cases</td>
<td>↓ by 15%</td>
</tr>
<tr>
<td>tPA utilization in 5% of cases</td>
<td>By 300%↑</td>
</tr>
<tr>
<td>Cost per case</td>
<td>↓ Total direct cost 8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>On Treatment</th>
<th>Controlled</th>
<th>Controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP management</td>
<td>80%</td>
<td>27-44%</td>
</tr>
<tr>
<td>Smoking cessation</td>
<td>67%</td>
<td>15%</td>
</tr>
<tr>
<td>Statin</td>
<td>47%</td>
<td>42%</td>
</tr>
<tr>
<td>Diabetes</td>
<td>76%</td>
<td>30%</td>
</tr>
</tbody>
</table>
TPA Utilization

Before

After

38.0% 4.0%

Stroke Recurrence

National

Ochsner

20.0% 17.8%

Stroke Readmission

National

Ochsner

12.7% 10.8%

BP at Control

National

Ochsner

95.0% 44.0%
Stroke Central Financials

**CTI/Case**
- Pre Stroke Central: $4,937
- Post Stroke Central: $5,891
  - 19% increase

**Cost/Case**
- Pre Stroke Central: $9,999
- Post Stroke Central: $9,752
  - 2.5% decrease

**ALOS**
- Pre Stroke Central: 6.07 days
- Post Stroke Central: 5.47 days
  - 10% decrease

**Complication Mix**
- Additional cost / case 2013:
  - PN: $20K
  - UTI: $15K
- Graph showing complication rates from 2011 to 2014.
  - PNEUMONIA
    - 2011: 4.2%
    - 2012: 4.5%
    - 2013: 3.7%
    - 2014: 3.5%
  - UTI
    - 2011: 5.3%
    - 2012: 4.5%
    - 2013: 4.5%
    - 2014: 4.2%
What does the future ask of us?

A lot but nothing we can’t do

- Get it right the first time
  - Diagnosis
  - Procedure
  - Medication
- Be proactive
  - Encourage your team to be proactive
  - Don’t react to problems >> prevent them
- Recognize and correct errors
- Don’t be complacent
- Ask for help >> This is a team effort
- Be time conscious
  - Tomorrow may not be as good as today
The Future

• Global cellphone subscribers in 2013
  – 47% cell phone penetration

• Global estimates for 5 years
  – 67% cell phone penetration

• 84% of US teens have cell phone

• Mobile health: emergency assistance, treatment compliance, remote patient monitoring, health education, telemedicine.
Telehealth Goals

• Four primary targets
  ▪ Improve clinical outcomes (ED visits, readmissions, health status)
  ▪ Lower costs of care
  ▪ Patient/family satisfaction
  ▪ Improve access to care
Telehealth: Higher Quality of Life and Lower Cost

- **Home Care**
  - Independent, Healthy Living
  - Ageing in Place
  - Chronic Disease Management

- **Residential Care**
  - Assisted Living Rehabilitation
  - Skilled Nursing Facility

- **Acute Care**
  - Specialty Clinic
  - Community Hospital
  - ICU

<table>
<thead>
<tr>
<th>Care Level</th>
<th>Estimated Cost of Care/Day</th>
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<td>Independent, Healthy Living</td>
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<tr>
<td>Chronic Disease Management</td>
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<td>Assisted Living Rehabilitation</td>
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<td>Specialty Clinic</td>
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<tr>
<td>Community Hospital</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>ICU</td>
<td>$10,000,000</td>
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</table>

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**Quality of Life**

- **Independent, Healthy Living**
- **Ageing in Place**
- **Chronic Disease Management**
- **Assisted Living Rehabilitation**
- **Skilled Nursing Facility**
- **Specialty Clinic**
- **Community Hospital**
- **ICU**
Population Medical Segments

- Minimize readmission
- Minimize recurrence
- Primary care and Specialty based
- Intensive home monitoring
- Home based care

- Improved outcome
- Reduce cost
- Minimize readmission & recurrence
- Risk factor management
- Hub and spoke consultation
  - ER, hospital
  - Home care
  - Specialty based

- Base of access
- Disease prevention
- Transient disease care at lowest cost
  - Kiosk
  - Home
  - Workplace
- Medical home-primary care based
- Direct to consumer
- American well
What is percent of primary care visits in Denmark currently conducted via telemedicine?
What is percent of primary care visits in Denmark currently conducted via telemedicine? 
80%
Patients’ Trust in TeleHealth

76% of patients would choose telehealth over human contact

Digital Impact on Customer Experience

70% of patients comfortable communicating with doctors via texting, email or video

Cisco Customer Experience Report for Healthcare. Conducted by InsightExpress, February 2013. Survey of 1,547 patients and 403 health practitioners in U.S.
What is the percent of persons in the US who prefer telehealth encounters over in-person visits?
What is the percent of persons in the US who prefer telehealth encounters over in-person visits?

70%
Coordinated Telehealth for Population Management

Accountable Care

ISUs  ED  Med/Surg  SNF  LTA  Clinics  Specialists  Home
Digital Health market evolution

Digital Health Market (Global View)

High (20%+)
- Traditional Medical Devices: $129B
- EMR: $7B

Medium (-20%)
- RPM: $6B
- Predictive Analytics (US): $1B
- Telemedicine: $11B

Low (<20%)
- Mobile Health: $3B
- Sensors: $0.7B

Future: 2020+
- Traditional Medical Devices: $198B
- EMR: $18B
- Remote Patient Monitoring: $21B
- Predictive Analytics (US): $11B
- Mobile Health: $40B
- Sensors: $16B

Source: GE Analysis

GE Healthcare Proprietary and Confidential Information
Thanks for your Interest

Let’s Improve Stroke Care Together
The Problem with Stroke Treatment

• FDA approved treatment for ischemic stroke
  – tPA
  – 3 hours
  – Utilization Nationally @ 4%

• Consequences of failure to treat
  – Disability
  – Brain ages more than a decade

• In 2008, 5 of 100 hospital in LA had ever delivered IV tPA

• Variability in access to expertise
Background

• Direct & indirect cost of stroke in the U.S.

• Projected costs by 2030
  – $185 Billion  (Go, et al, 2013)

• Stroke patients are vulnerable to non-adherence to care in the critical first year
Outcome Measures

• Blood Pressure Control
• Morisky Medication Adherence Scale: Careless about taking medication
• Hill-Bone Compliance Scale: Add salt to food
• National Health and Nutrition Examination Survey (NHANES): Some form of exercise
• National Health and Nutrition Examination Survey (NHANES): Sleeping
• Patient Health Questionnaire (PHQ-9) for Depression
• Montreal Cognitive Assessment (MoCA)
• Caregiver Strain Index
# Good Outcome with Stroke Thrombolysis

*Lancet 2014*

<table>
<thead>
<tr>
<th>Time to treatment</th>
<th>Alteplase (%)</th>
<th>Control (%)</th>
<th>OR good outcome</th>
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<tr>
<td>&lt;3.0 hr</td>
<td>32.9</td>
<td>23.1</td>
<td>1.75 (1.35-2.27)</td>
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<tr>
<td>&gt;3.0 to ≤4.5 hr</td>
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<td>30.1</td>
<td>1.26 (1.05-1.51)</td>
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<tr>
<td>&gt;4.5 hr</td>
<td>32.6</td>
<td>30.6</td>
<td>1.15 (0.95-1.40)</td>
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<thead>
<tr>
<th>Age</th>
<th>Alteplase (%)</th>
<th>Control (%)</th>
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<td>39.4</td>
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<td>&gt;80</td>
<td>17.6</td>
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Future for Rural Facilities

- Half of US hospitals <100 beds
- No available neurologist, psychiatrist, etc.
- Remote communities are underserved
- 90% or rural hospitals surveyed were receptive to telehealth solution
- E consults reduce costs
- Appropriate retention at hospital close to home
- Avoidance or risk and cost of patient transport.
Subacute and Chronic Nodes

What is wrong with our current post event chronic stroke care?
Stroke Central Personnel

- Stroke Central
  - 4 Advanced Practice Nurses
  - 1 Registered Nurse
  - 1 Program Director
  - 1 Vascular Neurologist
<table>
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<tr>
<th>AHA/ASA Measure 2014</th>
<th>NQF</th>
<th>CDC /GWTG</th>
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