A Strategic Planning Framework for Stroke Prevention and Treatment Policy

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Global Burden of Non-communicable Diseases with a Focus on Vascular Disease
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Evidence and the policy cycle

Identify problem ➔ Collect data ➔ Evaluate alternatives ➔ Select solutions ➔ Implement

Evaluate alternatives ➔ Identify problem
Evaluate alternatives

- Epidemiology Studies
- Randomized Trials
- Patient Preference Data
- Administrative Data
- Expert Opinion

Bridging Model

Options

Outcomes
Background

Crude Incidence Rates (CIR) of stroke for overall, male and female population in Singapore, 2008-2012

Stroke is the leading cause of long-term physical disability in Singapore
Management of Stroke

Acute
- Rapid arrival to emergency department
- Use of tissue plasminogen activator (tPA)

Sub-acute
- Deep vein thrombosis (DVT) prophylaxis
- Prevention of aspiration
- Rapid mobilization

Rehabilitation
Inpatient/outpatient rehabilitation

Secondary Prevention
Pharmacologic interventions to manage risk of atrial fibrillation, hypertension, and hyperlipidemia
Strategic Planning to Reduce the Burden of Stroke Among Veterans Using Simulation Modeling to Inform Decision Making

Kristen Hassmiller Lich, PhD; Yuan Tian, MSc; Christopher A. Beadles, MD, PhD; Linda S. Williams, MD; Dawn M. Bravata, MD; Eric M. Cheng, MD, MS; Hayden B. Bosworth, PhD; Jack B. Homer, PhD; David B. Matchar, MD

Background and Purpose—Reducing the burden of stroke is a priority for the Veterans Affairs Health System, reflected by the creation of the Veterans Affairs Stroke Quality Enhancement Research Initiative. To inform the initiative’s strategic planning, we estimated the relative population-level impact and efficiency of distinct approaches to improving stroke care in the US Veteran population to inform policy and practice.

Methods—A System Dynamics stroke model of the Veteran population was constructed to evaluate the relative impact of 15 intervention scenarios including both broad and targeted primary and secondary prevention and acute care/rehabilitation on cumulative (20 years) outcomes including quality-adjusted life years (QALYs) gained, strokes prevented, stroke fatalities prevented, and the number-needed-to-treat per QALY gained.

Results—At the population level, a broad hypertension control effort yielded the largest increase in QALYs (35517), followed by targeted prevention addressing hypertension and anticoagulation among Veterans with prior cardiovascular disease (27856) and hypertension control among diabetics (23100). Adjusting QALYs gained by the number of Veterans needed to treat, thrombolytic therapy with tissue-type plasminogen activator was most efficient, needing 3.1 Veterans to be treated per QALY gained. This was followed by rehabilitation (3.9) and targeted prevention addressing hypertension and anticoagulation among those with prior cardiovascular disease (5.1). Probabilistic sensitivity analysis showed that the ranking of interventions was robust to uncertainty in input parameter values.

Conclusions—Prevention strategies tend to have larger population impacts, though interventions targeting specific high-risk groups tend to be more efficient in terms of number-needed-to-treat per QALY gained. (Stroke. 2014;45:2078-2084.)

Key Words: comparative effectiveness research • computer simulation • health planning • stroke • Veterans
Problem

Challenge for Stroke Quality Enhancement Research Initiative (QUERI) in Stroke Prevention and Control:

1. Limited resources.
2. Numerous policy options.
3. Multiple stakeholders, multiple visions.
Problem & Model Objective

Challenge for Stroke Quality Enhancement Research Initiative (QUERI) in Stroke Prevention and Control:

1. Limited resources.
2. Numerous policy options.
3. Multiple stakeholders, multiple visions.

Objective: Engage the QUERI planning committee in setting priorities for improving stroke care.
Method: Develop a model to estimate relative population-level impact and efficiency of 15 distinct approaches for stroke management.

3. *Multiple stakeholders, multiple visions.*
System Dynamics VA Stroke Model Structure

For more information on the model: http://vastrokemodel.weebly.com/
### Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>QALYs Gained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension control for all VA users&lt;sup&gt;PP&lt;/sup&gt;</td>
<td>35,517 (27,302, 48,540)</td>
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<tr>
<td>Hypertension control and anticoagulation for those with prior CVD&lt;sup&gt;PP&lt;/sup&gt;</td>
<td>27,856 (19,493, 40,131)</td>
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<tr>
<td>Hypertension control for diabetics&lt;sup&gt;PP&lt;/sup&gt;</td>
<td>23,100 (16,990, 32,481)</td>
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<tr>
<td>Rehabilitation&lt;sup&gt;TR/R&lt;/sup&gt;</td>
<td>18,974 (12,845, 27,872)</td>
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<tr>
<td>Management of recently diagnosed TIA&lt;sup&gt;SP&lt;/sup&gt;</td>
<td>10,838 (6,391, 17,304)</td>
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<tr>
<td>Anticoagulation for all with AF&lt;sup&gt;PP&lt;/sup&gt;</td>
<td>9,568 (2,553, 18,205)</td>
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<tr>
<td>Comprehensive post-stroke management&lt;sup&gt;SP&lt;/sup&gt;</td>
<td>6,315 (2,970, 10,985)</td>
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<td>Dysphagia screening&lt;sup&gt;TR/R&lt;/sup&gt;</td>
<td>2,574 (1,239, 4,994)</td>
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<tr>
<td>Hypertension control for VA users with SBP&gt;160&lt;sup&gt;PP&lt;/sup&gt;</td>
<td>2351 (1,762, 3,221)</td>
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<tr>
<td>DVT Prophylaxis&lt;sup&gt;TR/R&lt;/sup&gt;</td>
<td>2,001 (565, 4,690)</td>
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<td>Thrombolytic therapy&lt;sup&gt;TR/R&lt;/sup&gt;</td>
<td>1,180 (405, 2,213)</td>
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<td>CEA for post-TIA&lt;sup&gt;SP&lt;/sup&gt;</td>
<td>748 (194, 1,434)</td>
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<td>Timely to hospital within 60 minutes of symptoms onset&lt;sup&gt;TR/R&lt;/sup&gt;</td>
<td>733 (342, 1,270)</td>
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<tr>
<td>Accuracy/timeliness of TIA diagnosis&lt;sup&gt;SP&lt;/sup&gt;</td>
<td>723 (190, 2,555)</td>
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<tr>
<td>CEA for post stroke&lt;sup&gt;SP&lt;/sup&gt;</td>
<td>344 (87, 747)</td>
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Results
Results

• Broad-based prevention, such as improving hypertension management for all Veterans, was powerful in terms of cumulative benefits to the population.
  • More efficient primary prevention should target high-risk subgroups of Veterans either with more severe condition of multiple stroke risk factors.

• The model served as a tool for policy makers to focus research on crucial points of uncertainty to improve decision-making.
Cost-Effectiveness of National Program to Improve Uptake of Post-Stroke Outpatient Rehabilitation Service: A Population-Based Dynamic Approach
Stroke Rehabilitation in Singapore

Only 10% receive inpatient rehabilitation.

Distribution of 3-month Modified Rankin Scale (mRS) for Rehabilitation-Eligible Stroke Patients

Based on a clinical trial of inpatient rehabilitation (Rønning et al., 1998)
Stroke Rehabilitation in Singapore

Only 10% receive inpatient rehabilitation.

Distribution of 3-month Modified Rankin Scale (mRS) for Rehabilitation-Eligible Stroke Patients

Based on a clinical trial of inpatient rehabilitation (Rønning et al., 1998)
Problem & Modeling Objective

- The utilization of post-discharge stroke rehabilitation in Singapore is low. In Singapore, only 33.3% of eligible stroke patients actually utilize the prescribed outpatient rehabilitation service. (Koh et al. 2012)

- Accounting for the efficacy of stroke rehabilitation, what is the value of increasing uptake of rehabilitation services in Singapore?

Methods: System Dynamics Stroke Rehabilitation Model

Aging

Non-Stroke Singapore Age 15 and Above

First Stroke

First Stroke Within 90 days

3-month Period

Recurrent Strokes

Non-Stroke Death

Death

Stroke after 90 days by Modified Rankin Scale (mRS)

Stroke Patients ineligible for Rehab

Stroke Patients eligible & getting Rehab

Stroke Patients eligible & not getting Rehab

3-month Period

Recurrent Strokes

Death

Recurrent Stroke Stroke Within 90 days

Recurrent Strokes

Recurrent Strokes
Results: 5-Year Outcome of Doubled Uptake Rate (66%)

- Quality-adjusted life years (QALYs) gained = 142 QALYs
- Incremental Costs = SGD v3.32 M
- Incremental Cost-Effectiveness Ratio (ICER) = SGD 23,380/QALY
Results: 5-Year Outcome of Doubled Uptake Rate (66%)

Quality-adjusted life years (QALYs) gained = 142 QALYs
Incremental Costs = SGD v3.32 M
Incremental Cost-Effectiveness Ratio (ICER) = SGD 23,380/QALY
Results: Net Economic Benefit

Willingness-To-Pay = 60,000 SGD/QALY

- 10% Efficacy of Inpatient Rehabilitation
- 20% Efficacy of Inpatient Rehabilitation
- 30% Efficacy of Inpatient Rehabilitation (Base case)
Work in progress: stroke strategic planning in Singapore

• Recognition of opportunities to improve stroke care (e.g., arrival time to ED, use of tPA, secondary prevention, use of rehabilitation)

• Stroke Services Improvement (SSI) team was formed in February 2014 by Ministry of Health to implement improvement efforts for stroke care in Singapore

• In collaboration with the SSI team and MOH, we are developing a Singapore model inform planning and evaluation of these efforts.
Lessons Learned

• Modeling provides a common framework for understanding complex issues
• Many of the issues in stroke policy are general and benefit from international collaboration
• Many issues are local
• Engage stakeholders early and often
Collaborators

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Thank You
Mathematical Models to Inform Strategic Planning

**Time Series Models**
Describe trends

**Multivariate Statistical Models**
Identify historical trend drivers and correlates

**Dynamic Simulation Models**
Anticipate new trends, learn about policy consequences, and set justifiable goals

Increasing:
- Depth of causal theory
- Robustness for longer-term projection
- Value for developing policy insights
- Degrees of uncertainty
- Leverage for change

Homer, 2010