Improving Health Decisions; A Statistical Call to Arms

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Talk Outline

- The Stew
- Short Review
- What’s New
- Our View
The Stew
## Smoking Attributable Costs for 60 Million Who Started Under 21 Years Old, 1954-2000

<table>
<thead>
<tr>
<th>Disease: LC/COPD (millions case-years)</th>
<th>43.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease: CHD Group (millions case-years)</td>
<td>80.8</td>
</tr>
<tr>
<td>Dollars (billions)</td>
<td>1,087</td>
</tr>
<tr>
<td>Deaths (million years lost)</td>
<td>128.0</td>
</tr>
</tbody>
</table>

(13m persons)
How Big is 1 Trillion?

- 1,000,000,000,000 – a million millions
- 1 trillion seconds ago was 30,000 BC
- $1 trillion, as a stack of $100 bills, is 630 miles high
- $9,000 per household in the U.S.
Table. Estimates of Annual US Health Care Waste, by Category

<table>
<thead>
<tr>
<th></th>
<th>$ in Billions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Midpoint</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>$\text{in}\text{B}\text{llions}$</td>
<td>$\text{in}\text{B}\text{llions}$</td>
<td>$\text{in}\text{B}\text{llions}$</td>
</tr>
<tr>
<td>Failures of care delivery</td>
<td>26</td>
<td>36</td>
<td>45</td>
</tr>
<tr>
<td>Failures of care coordination</td>
<td>21</td>
<td>24</td>
<td>29</td>
</tr>
<tr>
<td>Overtreatment</td>
<td>67</td>
<td>77</td>
<td>87</td>
</tr>
<tr>
<td>Administrative complexity</td>
<td>16</td>
<td>36</td>
<td>56</td>
</tr>
<tr>
<td>Pricing failures</td>
<td>36</td>
<td>56</td>
<td>77</td>
</tr>
<tr>
<td>Fraud and abuse</td>
<td>30</td>
<td>64</td>
<td>98</td>
</tr>
<tr>
<td>Total</td>
<td>197</td>
<td>300</td>
<td>402</td>
</tr>
</tbody>
</table>

Note: Table entries represent the range of estimates of waste in each category from sources cited in the text. The total waste estimates are simply the sums of the waste category-level estimates. This simple summing is feasible because the categories are defined in such a way that wasteful behaviors could be assigned to at most 1 category and because, like Pocan and Socolow, we did not attempt to estimate interactions between or among the categories.

Online First

Eliminating Waste in US Health Care

Donald M. Berwick, MD, MPP
Andrew D. Hackworth, MPhil

No matter how polarized politics in the United States have become, nearly everyone agrees that health care costs are unsustainable. At almost 18% of the gross domestic product (GDP) in 2011, headed for 20% by 2020,1,2 the nation’s increasing health care expenditures reduce the resources available for other worthy government programs, erode wages, and undermine the competitiveness of US industry. Although Medicare and Medicaid are often in the limelight, the health care cost

$.3-.4T

Bad information/decisions
Short Review
Learning Healthcare System
HealthCare System of Systems Learning

Infrastructure

Prostate Cancer

Arrhythmia

Diabetes

MS
Plato’s Cave
40 year old man, no family history, tests positive for a life-threatening disease in a routine screen

What is his disease state; what action do you recommend?

Data from prior population of similar people

<table>
<thead>
<tr>
<th>Exam result</th>
<th>True disease status</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>15</td>
<td>985</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>5</td>
<td>8,995</td>
<td>9,000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>9,980</td>
<td>10,000</td>
<td></td>
</tr>
</tbody>
</table>
Two Goals for Biostatistics

• Create the analogue of the 2x2 table for more complex measurements

Population ⇔ Individual

• Build capacity to make tables for ever narrower sets of “otherwise similar” subgroups of individuals

Subset, Subset, Subset
What is this man’s chance of having an aggressive tumor?
(a) 1%  (b) 10%  (c) 50%  (d) 90%  (e) 99%
Bayesian Hierarchical Model for Health State/Trajectory ($\eta_{it}$) with Person-specific Indicator ($\delta_i$)
Effects of Exogenous (X) and Endogenous (Rx) Covariates on Health State/Trajectory with Person-specific Regression Coefficients ($\beta_i$)
Observations ($Y$) that Inform about Health State through Coefficients ($\varphi_i$)
Treatment Decisions Depend on Past Measured Outcomes through Parameters ($\zeta_i$)
Statistical Comments

• Can be partially identifiable models that require external prior information
• Hypothesis generating models
• Aid in selecting/designing embedded RCTs
• Many call these “Causal” or “Structural Equation” Models when assumptions added
• “Predicting Intervention Effects (π) Models”
What’s New (at JHM)

- inHealth Precision Medicine Centers of Excellence (PMCOEs)
- Precision Medicine Analysis Platform (PMAP)
JHM Precision Medicine Centers of Excellence

2 => 8 => 30 => ALL

1. Prostate Cancer
2. Multiple Sclerosis
3. Autoimmune Disease (Scleroderma, Myositis,...)
4. Arrhythmia
5. Pancreatic Cancer
6. Bladder Cancer
7. Obesity/Diabetes – JHHC Populations
8. Neurofibromatosis
Prostate Cancer

Bal Carter, Yates Coley, Ken Pienta, Mufaddal Mamawala, Scott Zeger, TIC, APL, IT@JH, JHTV
\[ \Pr(\text{Aggressive Tumor}) = 8\% \]
Predicted Prostate Cancer Outcomes

If 100 men with a similar age, diagnosis, and PSA and biopsy history had their prostate surgically removed today, what cancer grade would be found?

Click on a section of the pie chart to learn about longterm outcomes for men in each grade group or see outcomes for all 100 men like you.

If 100 men like you had their prostates surgically removed today, after 5 years...

- 92 would be cured
- 8 would have PSA recurrence
- <1 would have metastatic disease

Grade group 1
Grade group 2
Grade group 3
Grade group 4-5
### Steps to Make Healthcare Decisions More Nearly Coherent

<table>
<thead>
<tr>
<th>Component</th>
<th>Prostate Cancer active surveillance example</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Frame unmet health need</td>
<td>Half of active surveillance prostatectomies yield indolent cancers</td>
</tr>
<tr>
<td>• Specify biomedical model</td>
<td>Predictors of indolence: PSA, biopsies, family history, genomic score, MRI</td>
</tr>
<tr>
<td>• Wrangle relevant data into a clinical cohort database (CCDB)</td>
<td>Brady Institute, Bal Carter Active Surveillance clinical cohort database with 1300 men; recent collection of genomes, MRIs</td>
</tr>
<tr>
<td>• Design and test decision support tool</td>
<td>Coley, et al (a, b): Bayesian hierarchical model</td>
</tr>
<tr>
<td>• Design and test users’ interface for population health manager, clinician and/or patient</td>
<td>Technology Innovation Center ($300K)</td>
</tr>
<tr>
<td>• Design and test on-going curation</td>
<td>JHM Committee</td>
</tr>
<tr>
<td>• Devise business model to sustain/improve tool</td>
<td>JHM?</td>
</tr>
<tr>
<td>• Scale to nation(s) through consortia</td>
<td>Partners</td>
</tr>
</tbody>
</table>
Bouillabaisse

Boole – a – Bayes
Scaling Models Across Clinics

- Biomedical, clinical and data scientist partnerships in each PMCOE

- IT infrastructure
  - Precision Medicine Analytics Platform (PMAP)

- Scalable strategies, policies, and procedures for more rapid construction of new models
  - Precision Medicine Centers of Excellence (PMCOEs) at JHM

- Business model that rewards science-based, value-producing clinics
Our View
Johns Hopkins Healthcare (JHHC) spends ~$2.5 Billion per year on healthcare for 500,000 members

~ $1 Billion spent per year produces little improvement in health status

So we build statistical models that support coherent decisions that improve outcomes, reduce costs — reinvest a small part of the $1 Billion

Forget JHHC – Think KP
Main Points Once Again

• The Stew
  – The U.S. can no longer waste $1 Trillion per year on healthcare (and continue as a liberal democracy)

  – A large fraction of waste (1/3-1/2) is the result of uncertainty about health state, trajectory and risks/benefits of interventions that is exploited by current perverse incentives

• What’s New – Biostatisticians are building models that reduce uncertainty and improve decisions
Our View – just a small part of the $1 trillion wasted be reinvested in changing the American healthcare system

Move over Jeff; Yates in Back


Thank you