Operations Research modeling to optimize intervention design

COMpAAAS Consortium

U01 Intervention PI: R.S. Braithwaite, M.D.
Why Operations Research modeling?

• Limitless permutations of plausibly effective interventions for HIV+ with unhealthy alcohol and/or MSU and/or depression
  – How to prioritize?
  – How to tailor to high-need patients and settings?
    • Elderly
    • High comorbidity
    • Hep C
    • Newly entering care
  – How to get the best value?
Allocation A

Intervention basket 1

Intervention basket 2

Intervention basket 3
Allocation B

Intervention basket 1
Intervention basket 2
Intervention basket 3
Put comparative effectiveness in OR context

• **Comparative effectiveness research**
  – Compares the effectiveness of different interventions

• **Operations research modeling**
  – Compares alternative portfolios of effective interventions, rather than comparing single interventions in isolation)
  – “Portfolio” = ≥1 interventions applicable to a patient or patient group
    • May include specified sequence
U01 Operations Research Aims

• For patients with unhealthy alcohol use and/or MSU and/or depression
  – Aim 1. Synthesize data from VACS and results from literature to compare effectiveness of alternative interventions
  – Aim 2. Develop OR model to compare effectiveness of alternative intervention portfolios
  – Aim 3. Develop web-based interactive laboratory to facilitate intervention design/uptake
How Aims Fit Together

Data synthesis (Aim 1)

HIV Epidemic simulation (Proposed) → HIV Progression simulation (Done)

Operations Research model (Aim 2)

Web-based lab (Aim 3)
Pathways lowering transmission

- Fewer partners
- Less IDU
- Less risky IDU
- Lower risk - barrier (condom)
- Lower risk - non-barrier, (STD, circ, micr)
- Lower infectiousness (↑ ARV)

Less risk per event (horizontal or vertical)

- Infected
- Uninfected, High risk

Lower risk, Infected

Lower risk, uninfected
Why VACS Data Analysis?

• VACS has detailed, finely grained temporal data
• Possible to perform statistical analyses of their temporal relationship of alcohol/MSU/depression.
  – Are declines in binge drinking temporally proximate to declines in severity of depression symptoms?
  – If so, are they particularly likely to occur after, before, or contemporaneously?
• Different relationships may have different implications for intervention design.
Why OR modeling?

• In a health system with infinite resources and system capabilities all effective interventions could be given simultaneously
• In real world interventions must be prioritized
• Operations research models can compare different intervention portfolios
  – Individual versus stepped versus simultaneous
    • Stepped = Prioritized sequence with monitoring (First A, then B, then C; stop if patient responds)
  – Tailored versus untailored
    • Tailored = Individualised results based on particular patient characteristics or stakeholder requirements
UNIVERSE OF POSSIBLE INTERVENTIONS

Alcohol
A1: BMI
A2: CBI
A3: pharm

Drug
D1: BMI
D2: CBI
D3: pharm

Compliance with ARV
C1: Counsel
C2: DOT

Tobacco
D1: BMI
D2: NRT
D3: pharm

Depression
M1: CBI
M2: pharm

INTERVENTIONS APPLICABLE TO PARTICULAR PATIENT

Alcohol
A1: BMI
A2: CBI
A3: pharm

Compliance with ARV
C1: Counsel
C2: DOT

Depression
M1: CBI
M2: pharm

SINGLE INTERVENTION
STANDARD
A1

SINGLE INTERVENTION
TAILORED
M2

STEPPED INTERVENTION
STANDARD
A1 → C2 → M2

STEPPED INTERVENTION
TAILORED
M2 → C2 → A2

SIMULTANEOUS INTERVENTION
STANDARD
A1 + C2 + M2

SIMULTANEOUS INTERVENTION
TAILORED
M2 + C2 + A2
Why the web-based lab?

Allows for synergy and cross-talk

– Inform adaptive trial design
  • COMpAAAS-Intervention
– Target additional VACS data collection when modeling suggests high value of information
– Administer web-based interventions to those patient groups with greatest benefit.

• Make results more relevant for stakeholders
  – Level of evidence
  – Feasibility
  – Relevance in particular setting
# Hypothetical results

<table>
<thead>
<tr>
<th>RANK</th>
<th>Intervention</th>
<th># New HIV cases prevented</th>
<th>Cost</th>
<th>Feasibility</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Circumcision</td>
<td>0.50</td>
<td>$1300</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>Alcohol: brief motivational</td>
<td>0.43</td>
<td>$100</td>
<td>A</td>
<td>B</td>
</tr>
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<td>3</td>
<td>ARV initiation</td>
<td>0.39</td>
<td>$12000</td>
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<td>A</td>
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<tr>
<td>4</td>
<td>Behavioral: reduce # sexual partners</td>
<td>0.24</td>
<td>$300</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>5</td>
<td>Behavioral: promote condom use</td>
<td>0.18</td>
<td>$300</td>
<td>A</td>
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<tr>
<td>6</td>
<td>Screen depression &amp; treat if +</td>
<td>0.08</td>
<td>$600</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>7</td>
<td>Screen drug abuse &amp; treat if +</td>
<td>0.07</td>
<td>$800</td>
<td>B</td>
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Web-based output tailored to particular stakeholder

Now sort by feasibility and require LOE $\geq$ B

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## Personalized health report: Visit 1

<table>
<thead>
<tr>
<th>Healthy activity</th>
<th>How much longer you could live</th>
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<tbody>
<tr>
<td>Stop smoking</td>
<td>3.5 more years</td>
</tr>
<tr>
<td>Improve blood pressure control</td>
<td>2.3 more years</td>
</tr>
<tr>
<td>Improve diet</td>
<td>1.7 more years</td>
</tr>
<tr>
<td>Improve cholesterol control</td>
<td>1.5 more years</td>
</tr>
<tr>
<td>Get screened for colon cancer</td>
<td>0.5 more years</td>
</tr>
<tr>
<td>Mammogram</td>
<td>0.3 more years</td>
</tr>
<tr>
<td>Get screened for diabetes</td>
<td>0.2 more years</td>
</tr>
<tr>
<td>PAP smear</td>
<td>0.1 more years</td>
</tr>
<tr>
<td>Get screened for HIV</td>
<td>0.1 more years</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>10.2 more years</strong></td>
</tr>
</tbody>
</table>
Personalized health report: Visit 1

How much longer you could live

- Stop smoking
- Improve blood pressure control
- Improve diet
- Improve cholesterol control
- Get screening for colon cancer
- Mammogram
Personalized health report: Visit 1

How much longer you could live: 10.2 years total

- Activities you have done already
- Activities in plan
- Activities beyond plan
## Personalized health prescription: Visit 1

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Personalized health plan: Visit 1

Bring with you to next visit (8/7/11  9AM)

1. **Stop smoking**
   - Set quit date for 6/1/11
   - Using nicotine patch as prescribed
   - Using nicotine gum when urge to smoke

2. **Improve blood pressure control**
   - Increasing dose of amlodipine from 5mg to 10mg
   - Monitor at home, call clinic with results in 1 week

3. **Improve cholesterol control**
   - Increase dose of simvastatin from 20mg to 40mg
   - Repeat fasting lipid blood test 1 week before next visit

4. **Get mammogram**
   - Appointment 7/5/11 10AM

5. **Get blood test for diabetes**
   - Blood draw today

6. **Get PAP smear**
   - Appointment 7/5/11 11AM
Personalized health plan: Visit 2

1. **Stop smoking**
   - Set quit date for 6/1/11
   - Using nicotine patch as prescribed
   - Using nicotine gum when urge to smoke

2. **Improve blood pressure control**
   - Increasing dose of amlodipine from 5mg to 10mg
   - Monitor at home, call clinic with results in 1 week

3. **Improve cholesterol control**
   - Increase dose of simvastatin from 20mg to 40mg
   - Repeat fasting lipid blood test 1 week before next visit

4. **Get mammogram**
   - Appointment 7/5/11 10AM

5. **Get blood test for diabetes**
   - Blood draw today

6. **Get PAP smear**
   - Appointment 7/5/11 11AM
Congratulations: By stopping smoking and improving your cholesterol you are adding 5.0 more years to your life!!!
Personalized health report: Visit 2

How much longer you could live: 10.2 years

- Activities you have done already
- Activities in plan
- Activities beyond plan
Personalized health report: Visit 2

How much longer you could live

- Improve blood pressure control
- Mammogram
- Get screened for diabetes
- PAP smear
## Personalized health prescription: Visit 2

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<td>Get screened for diabetes</td>
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<td>YES</td>
</tr>
<tr>
<td>PAP smear</td>
<td>0.1 more years</td>
<td>YES</td>
</tr>
<tr>
<td><strong>ADDITIONAL YEARS YOU COULD ADD</strong></td>
<td><strong>2.9 more years</strong></td>
<td></td>
</tr>
</tbody>
</table>
Personalized health plan: Visit 2

*Bring with you to next visit (9/14/11 9AM)*

1. **Improve blood pressure control**
   - Increasing dose of amlodipine from 5mg to 10mg
   - Monitor at home, call clinic with results in 1 week

2. **Get mammogram**
   - Appointment 8/5/11 10AM

3. **Get blood test for diabetes**
   - Blood draw today

4. **Get PAP smear**
   - Appointment 8/5/11 11AM
COMpAAAS: Coordinating Center

Web-based lab

- COMpAAAS: Observation
- COMpAAAS: Intervention
- COMpAAAS: OR Model

Stakeholders → Patients

Accessible tailored results