The return of the 5 year plan

Mathematical programming for allocation of health care resources

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Medical Research Council
Health Services Research Collaboration
This study

- Builds on existing decision framework
- Applying mathematical programming to a stylised but relevant policy problem
  - Profile of costs over time
  - Equity concerns are constraints
  - Allowing examination of equity-efficiency trade offs
Data

- Data from 6th wave UK NICE appraisals
  - Flu treatments (adults, elderly, residential elderly, children)
  - Rituximab (<60 years old, elderly)
  - Long acting insulin (type 1 diabetics, type 2 diabetics)
- Data available for each treatment:
  - costs for each year 1-15 (compared to 'current care')
  - total QALYs (compared to 'current care')
  - Prevalence and incidence
- Assume decision can be reviewed at 5 years
Maximise total (discounted) health benefits

subject to
- Total cost $\leq$ overall budget
- Interventions can be MIXED or PURE
Optimal solution

% receiving intervention vs Budget (£million)

Flu 1

Flu 2, 3 & 4

0 100 200 300 400

0 100
Optimal solution

% receiving intervention vs. Budget (£million)

Flu 1
Flu 2, 3 & 4
Optimal solution

% receiving intervention

Budget (£million)

Flu 1
Diab 1
Flu 2,3 & 4
Diab 2
Optimal solution
Shadow Price of budget constraint

- £10500 / QALY
- £42900 / QALY

Shadow Price (QALYs / £m) vs. Budget (£million)
## Opportunity Loss of budget rules

<table>
<thead>
<tr>
<th>Budget rule</th>
<th>Health gain (QALY)</th>
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<td>All in 1st 5 years</td>
<td>4879</td>
<td>2438</td>
<td>£75m</td>
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Indivisibility and horizontal equity

- Optimum solution allows mixed treatment options for some patient groups
- Requirement for horizontal equity is a constraint
- Can explore the opportunity loss of this equity concern on one or more programmes or populations
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<td>Equity popn. 1 (type 1 diabetes)</td>
<td>3066</td>
<td>520</td>
</tr>
<tr>
<td>Equity popn. 2 (age&lt;60, lymphoma)</td>
<td>3547</td>
<td>19</td>
</tr>
<tr>
<td>Equity popn 1 and popn 2</td>
<td>3066</td>
<td>520</td>
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Equity between populations

- Usually acceptable to differentiate on basis of age
- Other more controversial examples might be gender or social class
## Equity between populations

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<td>Equity: programme 1 (lymphoma: older = younger)</td>
<td>3579</td>
<td>7</td>
</tr>
<tr>
<td>Equity: programme 2 (diabetes: type 1 = type 2)</td>
<td>3126</td>
<td>460</td>
</tr>
<tr>
<td>Equity prog 1 and prog 2</td>
<td>3122</td>
<td>464</td>
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Conclusions

- **What has been done?**
  - Used linear programming to assist a policy-relevant decision

- **What does it show?**
  - Shadow price varies with overall budget
  - The profile of cost over time is important
  - Different equity concerns have different implications for efficiency

- **Further work**
  - Uncertainty
  - Fixed costs and other non-linear functions
  - Repeat decisions
  - Resource as well as budget constraints
End of presentation