A Comparison of Three and Four State Economic Models for Cost-Effectiveness Analysis in Oncology

Devin Incerti1,2, Jeroen Jansen1,2

1Innovation and Value Initiative
2Precision Health Economics

Overview

- Cost-effectiveness analyses in oncology are typically based on model structures with 3 health states (stable disease, progressed disease, and death)
- But 3-state models do not explicitly incorporate 2L treatments
- We developed a model for NSCLC (the IVI-NSCLC model) that can simulate different model structures in a multi-state framework
  - 3-state models
  - 4-state models explicitly incorporating 2L treatments
- Differences in cost-effectiveness results between the 3- and 4-state models were compared
3-state model

\[ S_1 \xrightarrow{h^{S_1P_1}(u)} P_1 \xrightarrow{h^{P_1D}(u)} D \]

- \( S_1 \): Progression-free (stable disease) with 1L treatment
- \( P_1 \): Progression with 1L treatment, captures the survival with 2L and 2L+ without making a distinction between progression-free and progression phases
- \( D \): Dead
- \( h^{S_1P_1}(u) \): hazard for transitioning from progression-free to progression with 1L treatment at time \( u \)
- \( h^{S_1D}(u) \): hazard for transitioning from progression-free to dead with 1L treatment at time \( u \)
- \( h^{P_1D}(u) \): hazard for transitioning from progression on 1L to dead at time \( u \)

4-state model

\[ S_1 \xrightarrow{h^{S_1P_1}(u)} P_1 \xrightarrow{h^{P_1P_2}(u)} P_2 \xrightarrow{h^{P_2D}(u)} D \]

- \( S_1 \): Progression-free (stable disease) with 1L treatment
- \( P_1 \): Progression with 1L treatment
- \( S_2 \): Progression-free (stable disease) with 2L treatment
- \( P_2 \): Progression with 2L treatment, captures the survival with 2L+ without making a distinction between a progression-free and progression phase
- \( D \): Dead
- \( h^{S_1P_1}(u) \): hazard for transitioning from progression-free to progression with 1L treatment at time \( u \)
- \( h^{S_1D}(u) \): hazard for transitioning from progression-free to dead with 1L treatment at time \( u \)
- \( h^{S_2P_2}(u) \): hazard for transitioning from progression-free to progression with 2L treatment at time \( u \)
- \( h^{S_2D}(u) \): hazard for transitioning from progression-free to dead with 2L treatment at time \( u \)
- \( h^{P_2D}(u) \): hazard for transitioning from progression on 2L to dead at time \( u \)
Parameterized using multi-state network meta-analysis conducted separately by line (1L, 2L)

\[ S_{ik}(u) \xrightarrow{h_{ik}^{sp}(u)} P_{ik}(u) \xrightarrow{h_{ik}^{PP}(u)} D_{ik}(u) \]

- \( S_{ik}(u) \): progression-free (stable disease) in study i, treatment arm k at time u
- \( P_{ik}(u) \): progressed disease in study i, treatment arm k at time u
- \( D_{ik}(u) \): dead in study i, in treatment arm k at time u
- \( h_{ik}^{sp}(u) \): hazard rate for disease progression in study i, in treatment arm k at time u
- \( h_{ik}^{PP}(u) \): hazard rate for dying post-progression in study i, in treatment arm k at time u
- \( h_{ik}^{SP}(u) \): hazard rate for dying pre-progression in study i, in treatment arm k at time u\n
Incorporation of treatment effect parameters

Evidence synthesis models

Simulation models

1L evidence base

2L evidence base

3-state model

4-state model
Incorporation of treatment effect parameters

Evidence synthesis models

Simulation models

1L evidence base

2L evidence base

3-state model

4-state model

Treatment costs by health state

3-state model

4-state model

1L costs 2L costs

1L costs 2L costs 2L+ costs
Example analysis

3-state model

1L
1. Gefitinib
2. Osimertinib
3. T790M+
4. T790M-
5. PBDC³

2L
1. Gefitinib
2. Osimertinib
3. T790M+
4. T790M-
5. PBDC³

4-state model

1L
1. Gefitinib
2. Osimertinib
3. T790M+
4. T790M-
5. PBDC³

2L
1. Gefitinib
2. Osimertinib
3. T790M+
4. T790M-
5. PBDC³

2L+
1. PBDC³ + atezolizumab
2. PBDC³ + atezolizumab

PBDC = platinum-based doublet chemotherapy

Results: efficacy

Survival probability over years for PFS and OS.

- 3-state
- 4-state
- Gefitinib sequence
- Osimertinib sequence

Survival probability over years for PFS and OS.

- P0
- P1
- S1

PBDC³ + atezolizumab
Results: costs

![Graph showing costs for Gefitinib sequence and Osimertinib sequence in 3-state and 4-state models.](image)

Results: cost-effectiveness

<table>
<thead>
<tr>
<th></th>
<th>3-state model</th>
<th>4-state model</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Gefitinib sequence</td>
<td>Osimertinib sequence</td>
</tr>
<tr>
<td>Incremental QALYs</td>
<td>-</td>
<td>0.82 (0.25, 1.93)</td>
</tr>
<tr>
<td>Incremental costs ($)</td>
<td>-</td>
<td>151,009 (27,471, 387,111)</td>
</tr>
<tr>
<td>ICER ($ per QALY)</td>
<td>-</td>
<td>184,720</td>
</tr>
</tbody>
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Note: Estimates discounted at 3%. The gefitinib sequence is the reference treatment strategy.
Conclusion

- 2L treatments can have a significant impact on the efficacy of treatment sequences as well as treatment costs.
- The differences in efficacy can have impacts on non-treatment related costs such as inpatient costs.
- In general, a 4-state model will differ the most from a 3-state model when:
  - 2L and 2L+ treatments differ across the competing treatment sequences.
  - 2L and 2L+ treatment costs differ.
  - Disease progression is correlated with higher non-treatment costs.