A Decision Tree Model to Evaluate the Costs and Consequences of Using Dual Antibiotic Bone Cement Versus Single Antibiotic Bone Cement in Hip Hemiarthroplasty

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Introduction

- Surgical site infections (SSIs) have been reported to occur in approximately 4% of patients following hip hemiarthroplasties for fractured neck of femur.
- Use of antibiotic-laden bone cements in cemented hemiarthroplasties may help to reduce SSIs. The gentamicin-containing PALACOS® R+G has been used for this purpose.
- Dual antibiotic cements may further reduce SSIs by providing a broader spectrum of antibiotic activity and potentially enhancing antibiotic release from the cement. COPAL® G+C (gentamicin and clindamycin) is the only current dual antibiotic cement and has been compared to PALACOS® R+G in a randomised controlled trial (RCT).1

Objectives

- To evaluate the costs and consequences for the National Health Service (NHS) in England and Wales associated with the use of a dual antibiotic bone cement (COPAL® G+C) compared to a single antibiotic bone cement (PALACOS® R+G) in the treatment of fractured neck of femur with hemiarthroplasty.

Methods

Model structure

- A de novo decision tree model was developed in Microsoft Excel (Figure 1). This model considered events within death of 30 day mortality and development of SSIs and required for a revision procedure over the course of a 1 year time horizon.
- Deep and superficial SSIs were modelled as separate, mutually exclusive events.
  - Probability of requiring a revision procedure was modelled as conditional upon the occurrence or not of a deep SSI.
  - Probabilities of 30-day mortality and development of SSIs were derived from the RCT of the two interventions.1 Probabilities of requiring a revision procedure were based on calculation from published estimates and clinical expert opinion.2
  - SSI-related costs consisted of treatment-related costs and hospital stays. Average cost of a hospital stay was calculated according to the formula detailed in Box 1.

Results

- The total expected number of superficial SSIs, deep SSIs and revision procedures with COPAL® G+C and PALACOS® R+G is presented in Table 1.

Costs

- The total expected costs for a cohort of 100 patients treated with COPAL® G+C or PALACOS® R+G were £898,551.81 and £1,007,532.74, respectively. Therefore, COPAL® G+C was estimated to be associated with total expected cost savings of £108,929.47.

Sensitivity analysis

- OWSA found that the probability of mortality at 30 days, cost of non-critical bed days and cost of revision surgery were the inputs with the largest impact on model results (Figure 2).
- Results of scenario analyses are presented in Table 3. The scenario considering the removal of deep SSIs from the model had the biggest effect on the observed cost difference between the two bone cements.

Discussion

- To the author’s knowledge, this model is the first to compare single and dual antibiotic bone cements in hip hemiarthroplasty.
- The biggest driver of model results was found to be the estimate of mortality at 30 days; this represents a limitation of the model given that mortality at 30 days was found to be non-significant between the two intervention arms in the RCT informing the model.3
- Published values for the costs to the NHS and length of hospital stay associated with SSIs were found to be highly variable. Further quantification of these inputs represents an area for further research.

Conclusions

- The COPAL® G+C dual antibiotic bone cement has the potential to generate positive outcomes and cost savings for the NHS by reducing the frequency of SSIs and revision surgeries relative to a single antibiotic alternative.

References


Table 1. Unit costs applied in the model

<table>
<thead>
<tr>
<th>Cost Type</th>
<th>Item</th>
<th>Cost</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>COPAL® G+C 40g</td>
<td>£88.75</td>
<td>List price</td>
</tr>
<tr>
<td></td>
<td>PALACOS® R+G 40g</td>
<td>£48.03</td>
<td>List price</td>
</tr>
<tr>
<td>Hospital stay</td>
<td>Cost of hemiarthroplasty operation</td>
<td>£1,178.04</td>
<td>Edwards, 2009</td>
</tr>
<tr>
<td>NHS bed in non-critical care per day</td>
<td>£80.41</td>
<td>NHS National Schedule of Reference Costs 2013-2014 (CCU1, CCU2, CCU3 and CCU4)</td>
<td></td>
</tr>
<tr>
<td>Revision surgery</td>
<td>Revision surgery due to a deep SSI</td>
<td>£20,095.17</td>
<td>Vanhegan, 2012</td>
</tr>
<tr>
<td></td>
<td>Revision surgery without a deep SSI</td>
<td>£11,897.50</td>
<td>Vanhegan, 2012</td>
</tr>
<tr>
<td>SSI treatment</td>
<td>Superficial SSI treatment (debridement)</td>
<td>£97.00</td>
<td>NICE Medical Technology Guidance 17</td>
</tr>
<tr>
<td></td>
<td>Deep SSI treatment for a non-revision patient</td>
<td>£558.28</td>
<td>Calculated from Trumpf and Zimbler, 20056 and the BNF</td>
</tr>
</tbody>
</table>

Table 2. Outcomes from the decision tree (model of events)

<table>
<thead>
<tr>
<th>Event</th>
<th>Expected number with COPAL® G+C</th>
<th>Expected number with PALACOS® R+G</th>
<th>Expected number avoided with COPAL® G+C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial SSI during 1 year</td>
<td>0.5</td>
<td>1.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Deep SSI during 1 year</td>
<td>0.5</td>
<td>3.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Revision procedure</td>
<td>1.6</td>
<td>3.6</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table 3. Results of scenario analyses

Scenario                           | Total expected cost | Cost difference |
-----------------------------------|---------------------|-----------------|
Superficial SSIs only              | £854,516.16         | -£3,027.61      |
Deep SSIs only                     | £899,992.19         | -£8,476.98      |
Removing CCS                       | £898,551.81         | -£7,603.93      |
P(no revision surgery)             | £888,603.62         | -£10,999.55     |

Figure 1. Model structure

Figure 2. Results of one-way sensitivity analysis

Figure 3. Results of scenario analyses