A Cost-Effectiveness Analysis of Charcot Reconstruction, Transtibial Amputation and Lifetime Bracing for Adults with Diabetes

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Financial Disclosures

None
• Charcot Foot prevalence: 0.8% - 7.5%
• Increased interest in surgically reconstructing non-ulcerated, non-plantigrade feet
• **Value is poorly understood**
• There is no current widely adopted treatment algorithm in existence for the neuropathic, non-plantigrade foot
• The decision to pursue CR in the U.S. is currently based almost entirely on surgeon preference
What does the Literature Tell Us?

Crude Cost Analysis

Many experts currently hold the opinion that successful deformity correction in patients with Charcot foot has the potential to greatly improve quality of life, foster greater walking independence, and improve longevity. Detractors suggest that the surgery is not justified given the cost of care and risks associated with the surgery.

Comparative effectiveness financial modeling will likely be an effective tool for addressing difficult resource allocation questions such as the subject of this investigation. This investigation, although rudimentary, suggests...
Purpose

To compare the cost-effectiveness of three treatment strategies for adults suffering from Charcot arthropathy in the U.S. healthcare system: Charcot reconstruction (CR), primary transtibial amputation (TTA), and lifetime bracing.

Additionally, we aim to identify the optimal time for reconstruction, from health system’s perspective.
Methods

- All available literature reporting on outcomes & costs for three strategies
- A Markov model was used to compare the strategies in three clinical scenarios (cohorts):

No Ulcer  Ulcer  Infected Ulcer
Methods

Base Case Scenario: 50 year old adult with moderate/severe midfoot Charcot Arthropathy

Primary Outcomes: Quality adjusted life years (QALYs) and incremental health care costs – reported as ICER

Costs reported in 2019 US Dollars
Discount rate: 3%

\[
\text{ICER} = \frac{\text{Cost}_{\text{Intervention}} - \text{Cost}_{\text{Comparator}}}{\text{Effectiveness}_{\text{Intervention}} - \text{Effectiveness}_{\text{Comparator}}}
\]
Relevant Costs

Index Surgery (TTA & CR)

Hardware

Infection

Wound Care (New Ulcer)

Surgical Complications

Bracing

Postoperative Care

Prostheses
Assumptions

- Patients cannot undergo multiple reconstructions
- Co-morbidities were evenly distributed
- Willingness-to-Pay: $100,000 for 1 additional QALY
- Health Care System’s Perspective
- Everyone in infected ulcer cohort underwent surgical debridement to eradicate infection before undergoing their strategy
  - CR was done as a staged procedure (external fixation, followed by internal fixation once infection cleared)
Events occurring during a cycle, will determine the next health state transition:

- Development of New Ulcer
- New Infection
- Amputation
Events:

• Complications from surgery (major, minor, death, amputation)

These events are also true for the TTA strategy
For patients with no ulcer, both bracing and CR are cost-effective.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Lifetime Costs, 2019 $</th>
<th>QALYs</th>
<th>Incremental Costs</th>
<th>Incremental QALYs</th>
<th>ICER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transtibial Amputation</td>
<td>$48,181.97</td>
<td>2.41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime Bracing</td>
<td>$100,796.64</td>
<td>9.96</td>
<td>$52,614.77</td>
<td>7.55</td>
<td>$6,970.76</td>
</tr>
<tr>
<td>Charcot Reconstruction</td>
<td>$124,098.58</td>
<td>11.59</td>
<td>$23,301.95</td>
<td>1.63</td>
<td>$14,339.25</td>
</tr>
</tbody>
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For patients with an ulcer, bracing and CR continue to be cost-effective.

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<tr>
<td>Lifetime Bracing</td>
<td>$102,808.99</td>
<td>9.05</td>
<td>$54,627.12</td>
<td>6.63</td>
<td>$8,234.41</td>
</tr>
<tr>
<td>Charcot Reconstruction</td>
<td>$129,969.96</td>
<td>10.08</td>
<td>$27,160.96</td>
<td>1.04</td>
<td>$26,217.08</td>
</tr>
</tbody>
</table>

Willingness-to-Pay $100,000
Sensitivity Analysis

- Non-Ulcerated and Ulcerated cohorts were robust to sensitivity analyses.
- No plausible thresholds found.
- No re-ordering noted.
For patients with an infected ulcer, bracing is most cost-effective

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<tr>
<td>Lifetime Bracing</td>
<td>$142,991.48</td>
<td>8.73</td>
<td>$94,807.62</td>
<td>6.32</td>
<td>$15,010.87</td>
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<tr>
<td>Charcot Reconstruction</td>
<td>$204,263.64</td>
<td>9.05</td>
<td>$61,272.16</td>
<td>0.32</td>
<td>$193,242.45</td>
</tr>
</tbody>
</table>

Willingness-to-Pay $100,000
Sensitivity Analysis – **Infected Ulcer Cohort**

Bracing VS. Charcot Reconstruction

- Complication Rate after CR
- Utility of Patients with Ulcer
- Cost of Reconstruction

ICER

EV: 193,242.15
Sensitivity Analysis – Infected Ulcer Cohort

• If complications rates after CR are less than 50%, then CR’s ICER is below the 100k threshold (current literature ranges 40%-70%)

• If the cost of CR is less than $40,000, then CR’s ICER is below the 100k threshold (current literature mean ~ $57,000)

• Other variations are not plausible

• No re-ordering noted
Key Takeaway Results

- TTA was the cheapest strategy in every stage of disease, but also produced the least QALYs.
- CR was the most effective strategy in the non-ulcerated and ulcerated patient.
- For a patient with an infected ulcer, lifetime bracing after eradication of infection was the most cost-effective strategy compared to TTA.
<table>
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<th>Limitations</th>
<th>Strengths</th>
</tr>
</thead>
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<td>Can only be interpreted from the healthcare system standpoint (societal costs not considered)</td>
<td>This analysis fills an important gap in the literature for a topic that has no current guidelines</td>
</tr>
<tr>
<td>Limited by current available literature</td>
<td>This is the only cost-effectiveness analysis performed on this topic to our knowledge</td>
</tr>
<tr>
<td>Assumed co-morbidities were equally distributed</td>
<td>Included literature which included patients with all co-morbidities</td>
</tr>
</tbody>
</table>
Conclusions

Charcot Reconstruction is most cost-effective when performed early (i.e. in the non-ulcerated and ulcerated patient)

Bracing is a cost-effective option in all stages of disease, but offers less potential for increased quality of life → opportunity for shared decision making
References (select)