Socio-economic Impact Assessment Scenario of Cardiac Modelling Tools

Karl Stroetmann (WP19 – Task 3, D 19.6)

MD-Paedigree Final Technical Review, Brussels, July 06 – 07, 2017
1. Objectives
2. Modeling disease stage & progression - Cardiomyopathy Clinical Pathways
3. Clinical impact modeling approach – Markov Process analysis
4. Comparative benefit-cost analysis of clinical pathways
5. Summary and conclusions
Objectives

• Specify a socio-economic **impact scenario** and **benefit-cost** approach
• Apply the analysis tool (Markov Chain) for an **exploratory impact assessment**
• **Compare** results for **present standard of care** and **MD-Paedigree-based** new care processes
• **Discuss** assessment results
Clinical impact assessment process

1. For present standard of care (SOC):
   - Summarise explorative scenarios in operational clinical pathway model
   - Transfer clinical pathway/disease states into probabilistic model (Markov Chain or Process)
   - Identify and estimate transition and absorption state probabilities
   - Define the number of cycles over which the model is to be run
   - Calculate Markov probabilities for each cycle
   - Estimate costs for each state and cycle
   - Multiply cost estimates with estimated probabilities for each cycle

2. Repeat for innovative (CDS tool supported) care

3. Compare overall outcome estimates
   - Differences in resource usage
   - Differences in disease states \(\times\) utility of change \(\left[=\text{QALYs}\times\text{VSL}\right]\)
Modelling disease stage & progression: Cardiomyopathy clinical pathways
Markov-Chain disease states model

Paedigree SoC

Mild HF

Moderate HF

Severe HF

Moderate HF

Mild HF

Severe HF

Moderate HF

Mild HF

Severe HF

Severe HF

Moderate HF

MechSupp/Transplant

Dead

MechSupp/Transplant

Dead
Treatment improvements due to MD Paedigree tools

• Improved risk stratification of patients
• Better diagnostic decisions and prediction of disease progression
• Better therapeutic decisions
# Transition (per cycle = one year) and absorption probabilities – SOC and delta to CDS tool

**Table 2: Transition (per cycle = one year) and absorption probabilities – Standard-of-Care**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1. Mild HF</td>
<td></td>
<td>0.85</td>
<td>0.13</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Moderate HF</td>
<td></td>
<td>0.10</td>
<td>0.78</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Severe HF</td>
<td></td>
<td>0.07</td>
<td>0.78</td>
<td>0.11</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>4. Mechanical support/transplant (absorption state)</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
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<td></td>
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<tr>
<td>5. Death (absorption state)</td>
<td></td>
<td></td>
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<td></td>
<td>1.00</td>
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</tbody>
</table>

**Table 8: Estimates of changes of probabilities – from Standard-of-Care to Innovative (CDS-based) Care**

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mild HF</td>
<td></td>
<td>+ 0.05</td>
<td>- 0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Moderate HF</td>
<td></td>
<td>+ 0.10</td>
<td>- 0.07</td>
<td>- 0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Severe HF</td>
<td></td>
<td></td>
<td>+ 0.03</td>
<td>+ 0.03</td>
<td>- 0.04</td>
<td>- 0.02</td>
</tr>
<tr>
<td>4. Mechanical support/transplant - not modelled (absorption state)</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Death (absorption state)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
</tbody>
</table>

To be included in final calculation for D19.6.
Number of children per age per year

Average: 7.85 years old
Cardiomyopathy Markov-Chain probability analysis – 10 cycles (SOC v. CDS tool)
Comparative benefit-cost analysis of clinical pathways – cost data

- The costing model is populated with:
  - transition probability data
  - hospital/clinical average cost data
  - data of length and number of treatments/consultations
  - for standard of care (SoC) pathways, as well as for
    - innovative MD-Paedigree (CDS) tools pathways
- Costs are based on hospital (bed-day) and intervention costs of clinical partners

To be included in final calculation for D19.6.
### Cost data (SOC, CDS tool; delta)

**St. of Care**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1. Start cycle (year)</td>
<td>0.00</td>
<td>2,000</td>
<td>17,300</td>
<td>72,500</td>
<td>95,000</td>
<td></td>
</tr>
<tr>
<td>2. Cycle2</td>
<td>0.00</td>
<td>2,000</td>
<td>17,300</td>
<td>72,500</td>
<td>27,700</td>
<td></td>
</tr>
<tr>
<td>3. Cycles 3 ff</td>
<td>0.00</td>
<td>2,000</td>
<td>17,300</td>
<td>72,500</td>
<td>7,100</td>
<td></td>
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**New model of care**

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<td>1. Start cycle (year)</td>
<td>0.00</td>
<td>2,000</td>
<td>17,300</td>
<td>72,500</td>
<td>95,000</td>
<td></td>
</tr>
<tr>
<td>2. Cycle2</td>
<td>0.00</td>
<td>1,000</td>
<td>15,000</td>
<td>68,500</td>
<td>27,700</td>
<td></td>
</tr>
<tr>
<td>3. Cycles 3 ff</td>
<td>0.00</td>
<td>1,000</td>
<td>15,000</td>
<td>68,500</td>
<td>7,100</td>
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**Delta**

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</tr>
</thead>
<tbody>
<tr>
<td>1. Start cycle (year)</td>
<td>-1,000</td>
<td>-2,300</td>
<td>-4,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cycle2</td>
<td>-1,000</td>
<td>-2,300</td>
<td>-4,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cycles 3 ff</td>
<td>-1,000</td>
<td>-2,300</td>
<td>-4,000</td>
<td></td>
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</tbody>
</table>

Source: OPBG
Costs per state and cycle – present and innovative care

Present Standard of Care (SoC)  Innovative Care (CDS)
Tangible benefits (in € m) – freed resources (reallocation or cash savings)

<table>
<thead>
<tr>
<th></th>
<th>Cost in € (state cost per cycle x probability)</th>
<th>Cost for 100 patients over 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild HF</td>
<td>Moderate HF</td>
</tr>
<tr>
<td>Sums Present St. of Care</td>
<td>8,080</td>
<td>47,213</td>
</tr>
<tr>
<td>Sums MD Paedigree Tool based</td>
<td>5,978</td>
<td>31,939</td>
</tr>
<tr>
<td>Difference (Savings)</td>
<td>2,103</td>
<td>15,274</td>
</tr>
</tbody>
</table>

For ten years of treatment, across all disease states for 100 children, resource savings of around € 3.5 m (≈18%) are estimated.
To be included in final calculation for D19.6.

### Intangible benefits (in € m) – increase in QoL and death avoided (QALYs)

<table>
<thead>
<tr>
<th>State</th>
<th>Savings in life years in that state (Markov analysis)</th>
<th>For 100 patients over 10 years</th>
<th>Utility value for improved QALY</th>
<th>Sum of QALYs for all patients under treatment</th>
<th>Total Value (per full QALY: € 50k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate HF</td>
<td>0.630</td>
<td>63.047</td>
<td>0.2</td>
<td>12.61</td>
<td>630,474</td>
</tr>
<tr>
<td>Severe HF</td>
<td>0.150</td>
<td>14.974</td>
<td>0.5</td>
<td>7.49</td>
<td>374,360</td>
</tr>
<tr>
<td>Death</td>
<td>0.182</td>
<td>18.185</td>
<td>1</td>
<td>18.18</td>
<td>909,243</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td></td>
<td>18.185</td>
<td></td>
<td><strong>38.28</strong></td>
<td><strong>1,914,077</strong></td>
</tr>
</tbody>
</table>

For ten years of treatment, across moderate & severe disease states for 100 children, intangible benefits from increased QoL and death avoided are estimated at roughly € 2 m
• For a cohort of 100 children over ten years, benefits from re-deployable resources are estimated at € 3.5m - MD Paedigree tools may lead to >15% lower resource consumption
• Cost estimates are average costs, not marginal ones
• Adequate interpretation of the benefits estimated depends on the business model of a given hospital
• Health system framework conditions will also impact on the behaviour of hospital management:
  ➢ Bismarck-/Fee-for-service model respectively DRG-based reimbursement: perverse incentive to treat expensive diseases
  ➢ Beveridge/NHS model: government can impose reduction in service (e.g. bed) capacity
• Overall, a considerable **positive benefit-cost ratio** (here: \(\approx 18\%\)) is plausible
• **Intangible benefits** (QALYs) are estimated at € 2m
• Further **empirical evidence from (pre-)clinical trials** for exploitation planning and health system decision makers on implementing model-driven technologies is urgently needed
• The **incentives for healthcare providers** and their business models need to be better understood (and perhaps changed)
Appendix: Presentations & publications

Model-driven paediatric cardiomyopathy pathways – a clinical impact assessment

Karl A. Stroetmann a,b, Rainer Thiel c

a Senior Research Associate, empirica Communication & Technology Research
Bonn, Germany
b Adjunct Assistant Professor, School of Health Information Science, University of Victoria, BC, Canada
c Senior Consultant, empirica Communication & Technology Research
Bonn, Germany

e-mail: karl.stroetmann@empirica.com

Abstract. Intermediate results from an ongoing health technology assessment exercise of a simulation model of paediatric cardiomyopathy are reported. Comprehensive data on paediatric cardiomyopathy/heart failure, treatment options, incidence and prevalence, prognosis for different outcomes to be expected were collected. Based on this knowledge, a detailed clinical pathway model was

• Model-driven paediatric cardiomyopathy pathways – a clinical impact assessment

International conference addressing Information Technology and Communication in Health (ITCH 2017 - Building capacity for health informatics in the future), Feb. 17-19, 2017, Inn at Laurel Point, Victoria, BC, Canada

• Patient-centred health platforms: Developing a strategic approach

Lead convener, Pre-conference workshop - International conference addressing Information Technology and Communication in Health (ITCH 2015 - Driving quality in informatics: Fulfilling the promise), Feb. 26, 2015, Inn at Laurel Point, Victoria, BC, Canada

• ICT for health, systems biology, and the future of personalised, integrated medicine

Joint faculty workshop for Computer Science and School of Business, University of Northern British Columbia (UNBC), Prince George, BC, Canada, March 02, 2015
• The ideas, insights and data presented are derived from the Large Integrating Research Project Model Driven Paediatric European Digital Repository, which receives funding from the European Commission Directorate General for Communications Networks, Content and Technology under Grant Agreement No: 600932 in the context of its Framework Programme Seven (FP7). This support is gratefully acknowledged.

• Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of the information presented. The views expressed are solely those of the author(s) and do not necessarily reflect those of the European Commission or any other organisation.

• We are most grateful to colleagues at the participating organisations as well as external experts who contribute and critically review project work.