

Measuring What Matters: Patient Value in MAKO-Assisted Total Knee Arthroplasty

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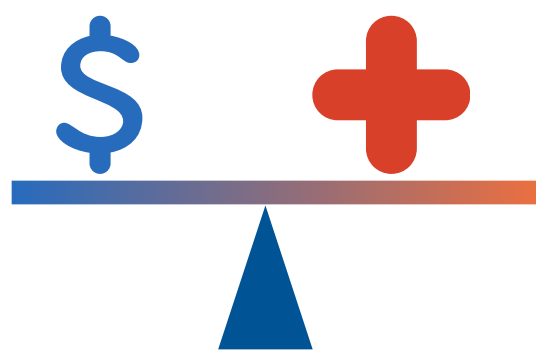
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MOTIVATION

Value-Based Healthcare

- Balance of patient relevant health outcomes and costs = **patient value**
- Overall goal:
 - Maximize value at the patient level



Assessing Patient Value

- Traditional health economic evaluations are limited
 - e.g., Cost-Benefit, Cost-Utility & Cost-Effectiveness Analyses
 - Rely on monetary valuations or single health outcomes
- But considering value requires a *holistic* view of patient well-being
 - Connection between multiple health outcomes and costs necessary

The case of MAKO-assisted TKA

- Robotic-arm assisted surgical system
- Enhances precision and accuracy for Total Knee Replacements



Source: orthopedie-roeselare.be



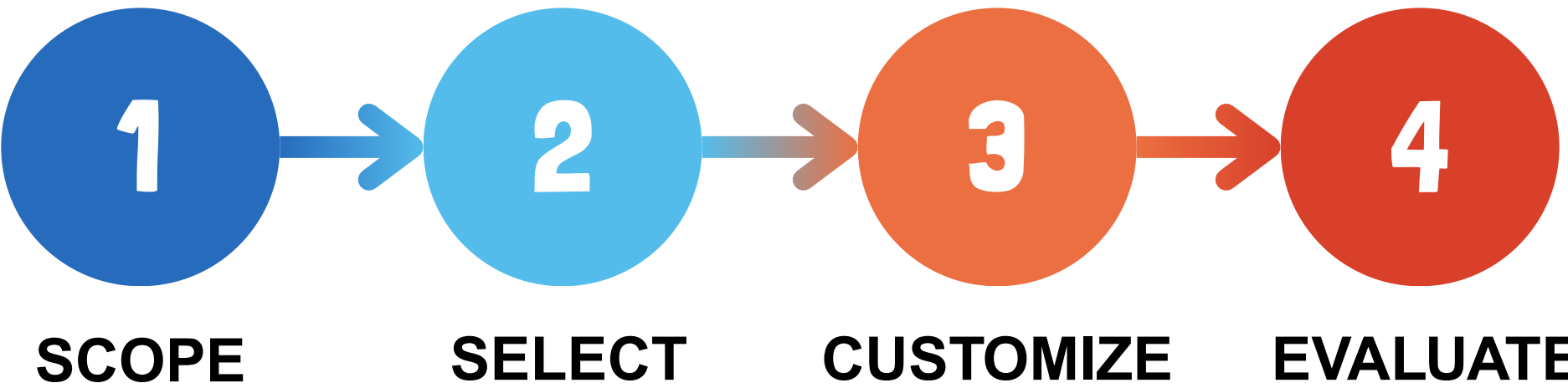
Research objectives:

- Assess and compare patient value for patients undergoing MAKO surgery
- Compare results with manual TKA

METHODS

4-step framework (Borzée et al., 2025) combining

- Time-Driven Activity-Based Costing (TD-ABC)**
 - To measure costs
- Data Envelopment Analysis (DEA)**
 - To link costs to multidimensional outcome set
 - To measure *relative* patient value
- Tobit Regression Analysis**
 - To examine value variability



RESULTS

1 Defining patient cohort and scope of care process

Patient cohort

- 114 patients undergoing MAKO surgery between 2018 - 2023 in AZ Delta (Roeselare)

Care pathway

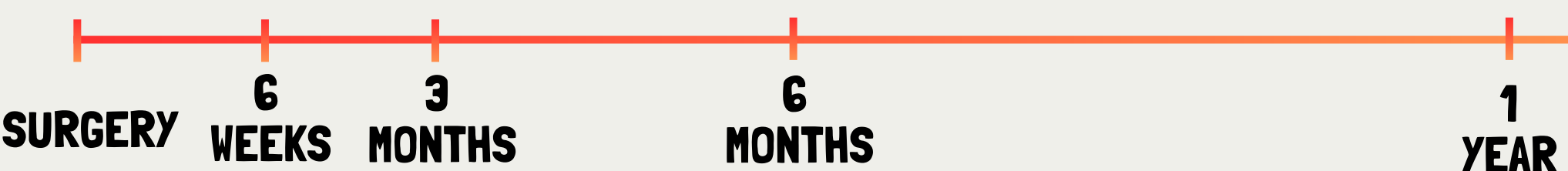
- From initial consultation and medical imaging, to hospital discharge

2 Variable selection

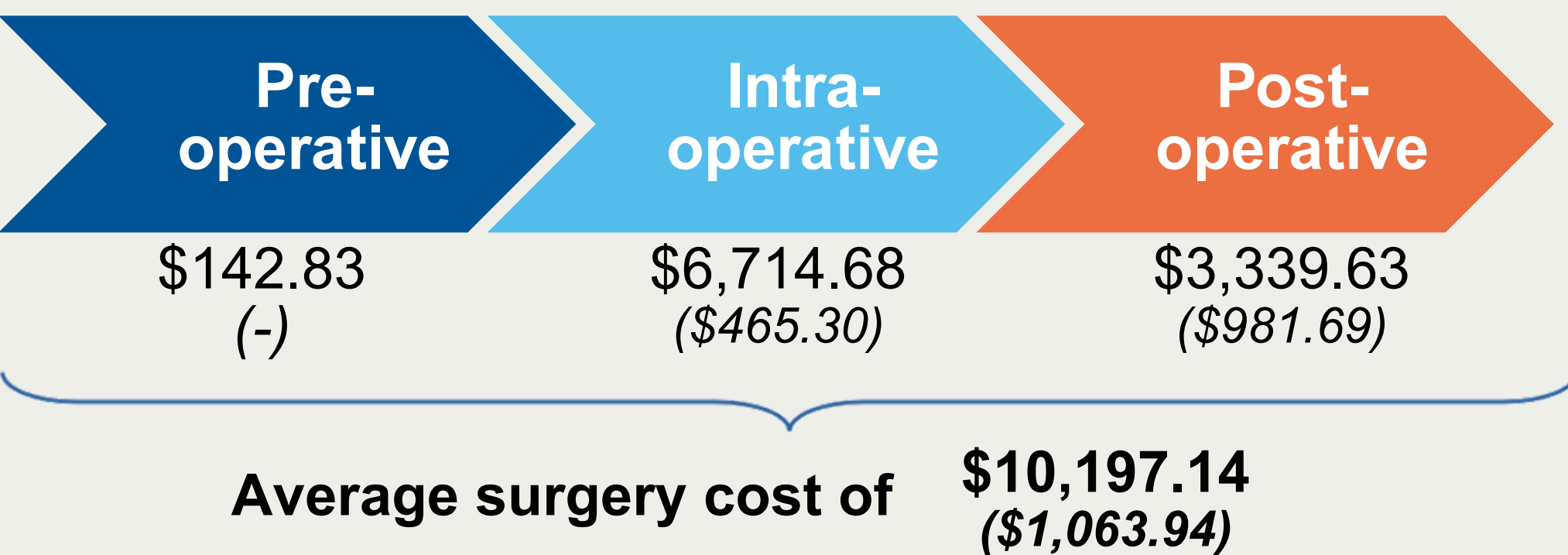
Patient-Relevant Health Outcomes

All outcomes that matter to patients (~ ICHOM set)

- Overall satisfaction
- EQ-5D: health related quality of life
- NRS Pain scores: on load & at rest
- KOOS-PS: physical functionality of the knee



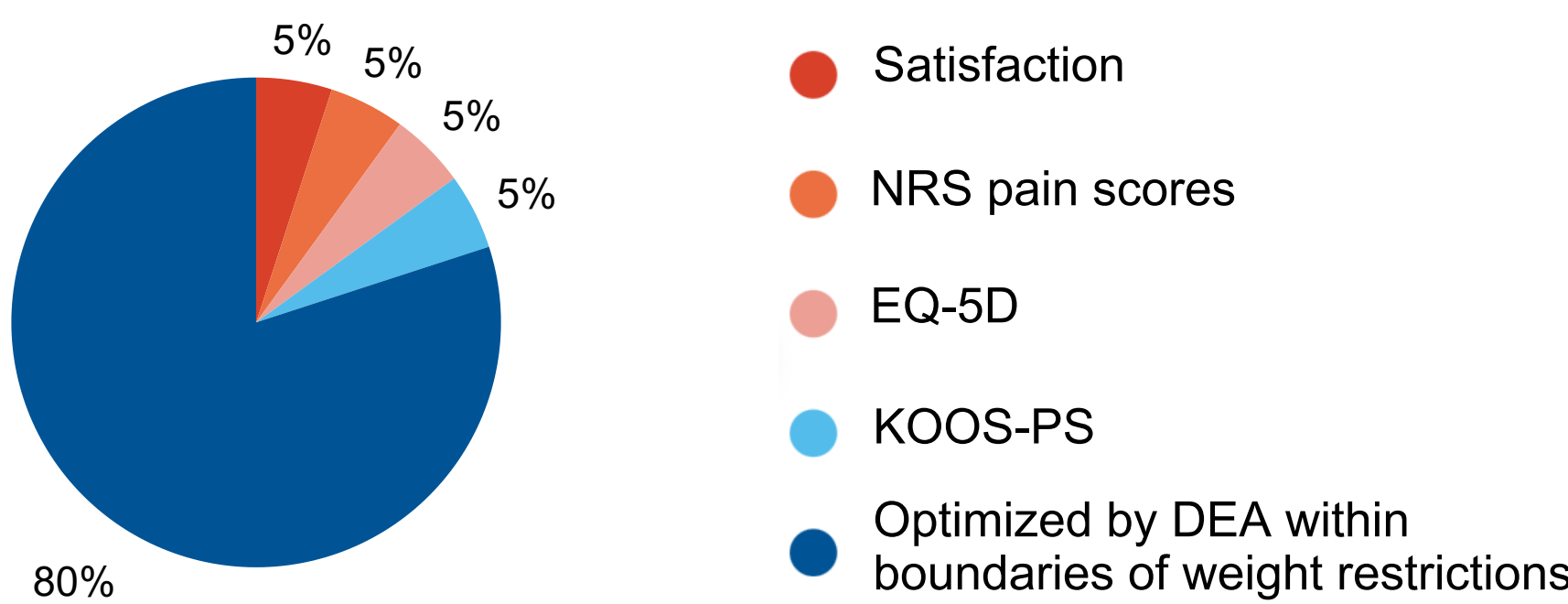
Individual surgery costs based on TD-ABC



3 Customizing model to fit the medical context

To ensure meaningful contribution of all outcomes:

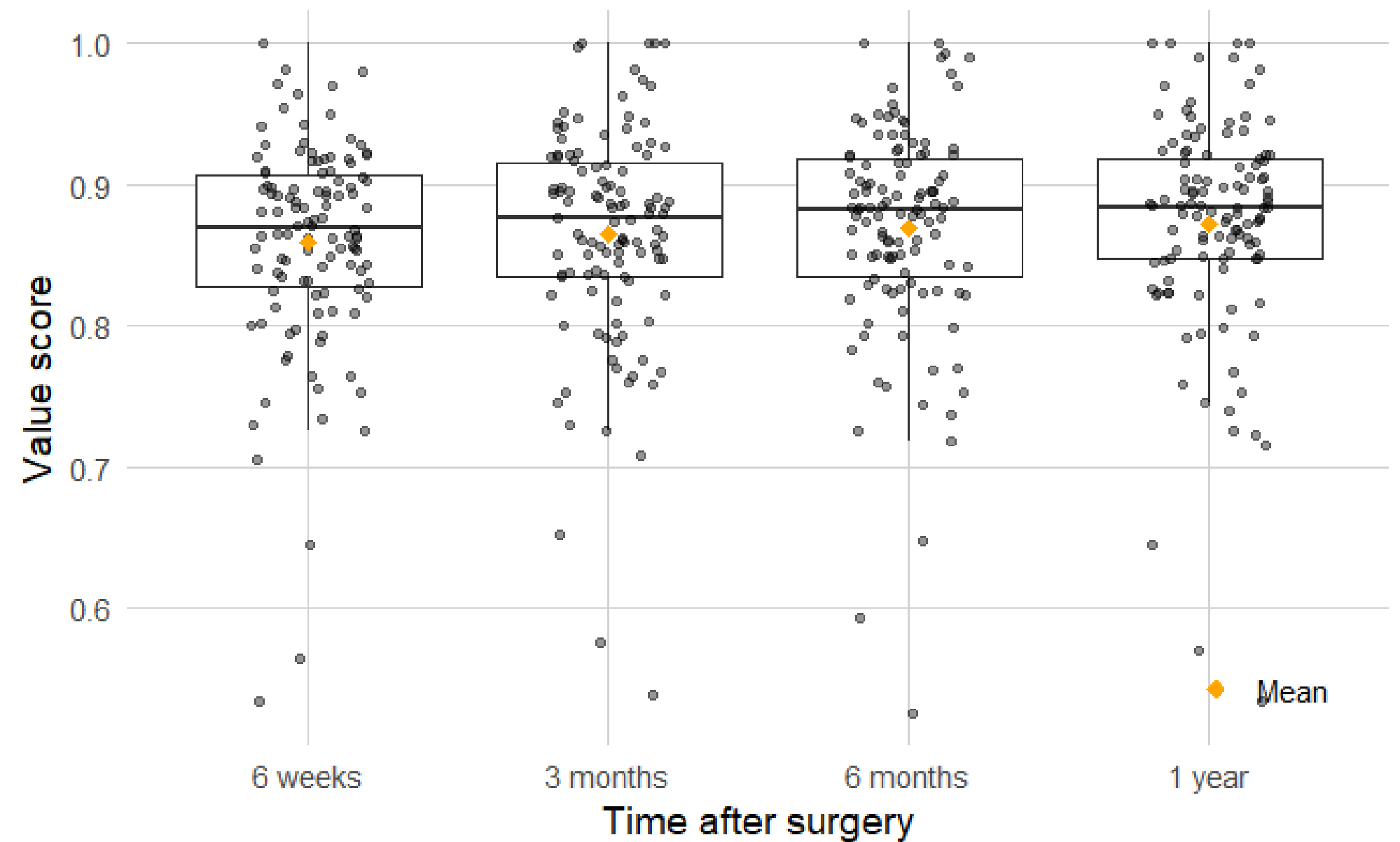
- Minimum weight = 5% (avoids zero weights)
- Relative weights express outcome priorities



4 Peer-based value evaluation

Value scores over time

Figure 1: Boxplots with jittered scatter points showing value scores at post-operative follow-up times



- DEA on all time points combined (456 DMUs)
- No significant value gain observed at 1 year vs. 6 weeks post-op
- Value score variability decreases over time

Value variability within patient population

Tobit regression results ($p < 0.001$):

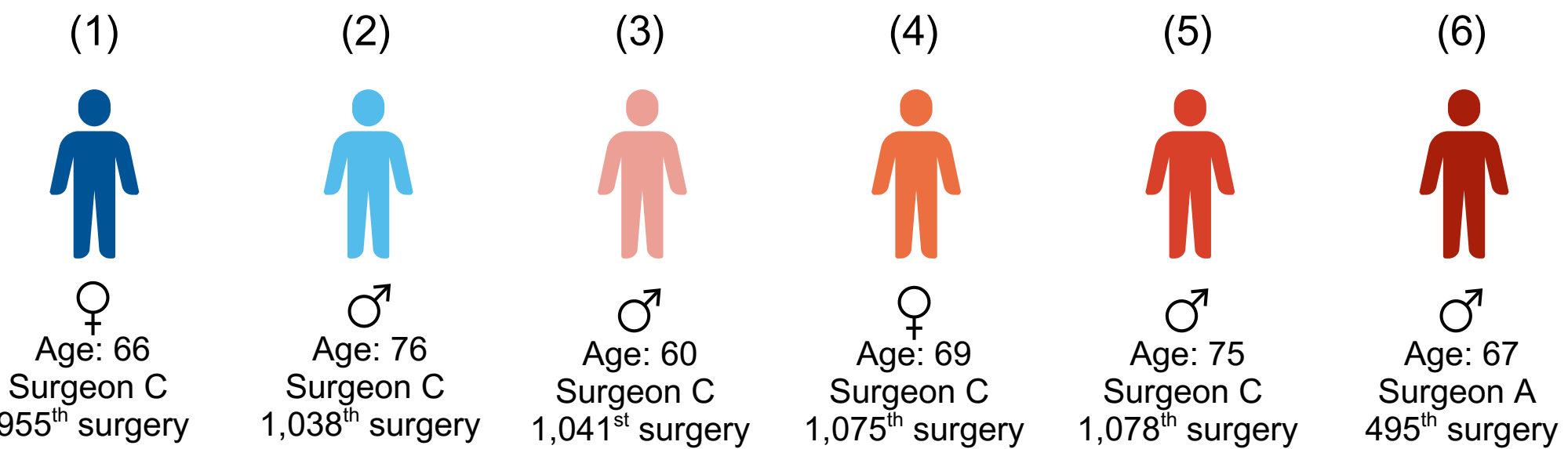
Learning Curve	log(number of prior MAKO surgeries per surgeon)	↑ Value
Operating Surgeon	Surgeons B & C compared to Surgeon A	↓ Value
Age	Older patients	↓ Value

Value drivers ~ cost drivers

- Increased costs ≠ improved outcomes → lower value

Value frontier

6 patients on the value frontier after 1 year (value score = 1)



What if one outcome is relatively more important than the others?

- Patients (2), (4) & (6) on frontier regardless of subjective valuation of outcome set
- Patient (1) no longer on frontier when EQ-5D is deemed most important
- Patients (3) and (5) no longer on frontier when KOOS-PS is deemed most important

Value comparison: MAKO vs. manual surgery

Data

- Data from 7 patients undergoing manual TKA (prior to MAKO introduction) added to dataset → 121 patients in total

Cost comparison

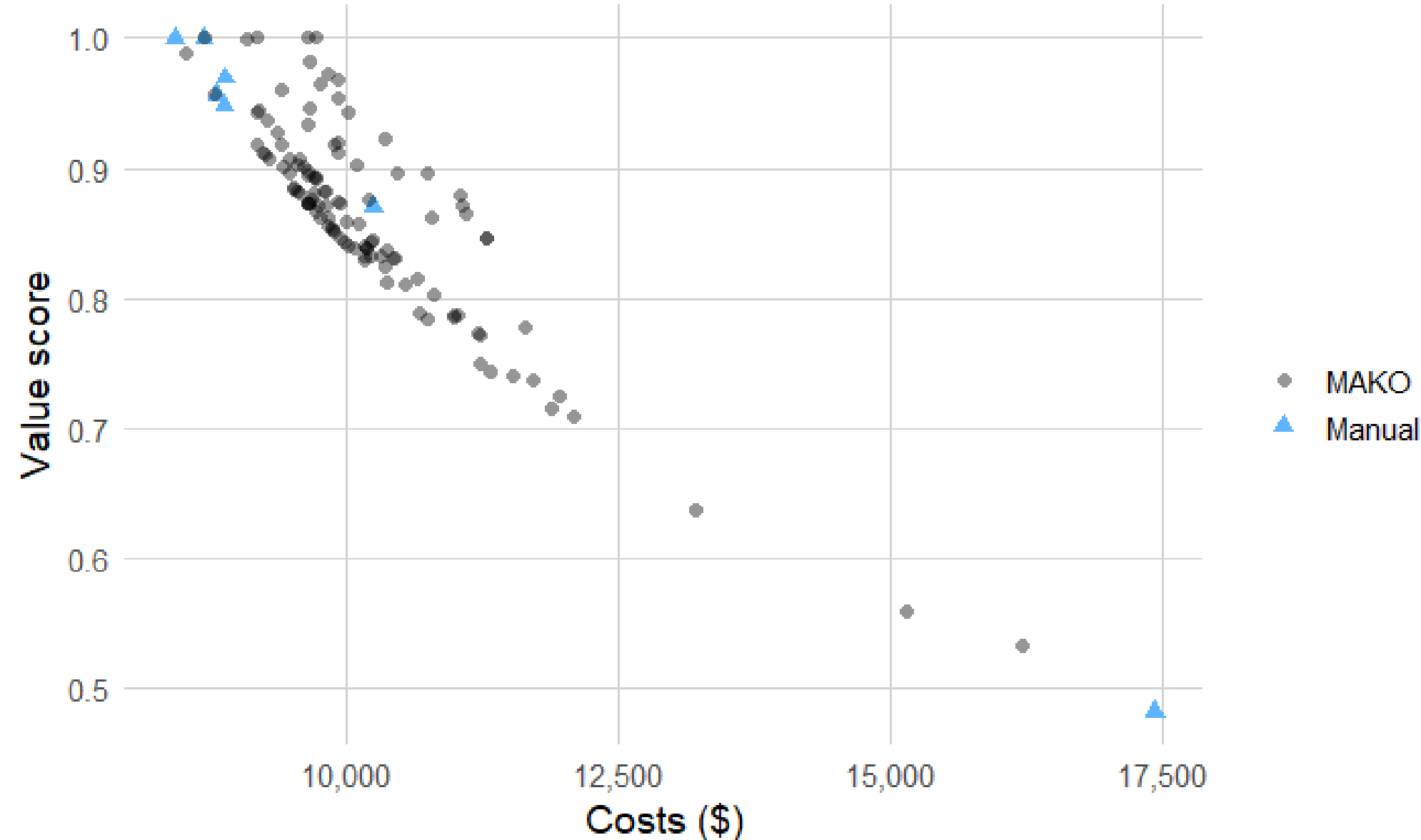
- Surgery: Manual \$5,450.40 < MAKO \$6,714.68
- Recovery: Manual \$4,634.34 > MAKO \$3,339.63

Translation to value

- Similar findings on short and longer term
- Despite limited data: manual cases perform relatively well
 - 2 are on the frontier (value score = 1)
 - 3 are close to the frontier (value score close to 1)
 - 1 moderate performer, and 1 outlier due to extended recovery

→ Higher technology costs of MAKO do not clearly translate into greater value compared to manual surgery

Figure 2: Value scores vs. costs for MAKO and manual surgeries at 1 year post-op



CONCLUSION

Comprehensive value assessment of patients undergoing MAKO or manual TKA surgery, following the novel 4-step framework that combines TD-ABC and DEA to calculate individual value scores.

Main findings

- Value at 6 weeks post-op is good predictor for value after 1 year
- Significant learning curve for robot-assisted surgery
- Significant impact of operating surgeon on value
- Older patients tend to experience lower value
- MAKO vs. manual: increased costs do not result in increased value

Future research:

- Dynamic DEA models taking into account the baseline values
- Analysis with more (manual TKA) data points
- Include readmissions in outcome set

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REFERENCES

Borzée, J., Cardoen, B., Cherchye, L., De Rock, B., & Roodhooft, F. (2025). Linking outcomes to costs: A unified measure to advance value-based healthcare. Omega, 133, 103270.