Cost-utility and cost-effectiveness of Rapid Recovery after knee replacement: The payer's perspective

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Introduction

Knee replacement is one of the most frequently performed and effective orthopedic surgeries worldwide, and is usually performed once conservative treatment approaches have been tried and failed for end-stage osteoarthritis [4]. The growing number of knee replacements, together with the rapidly evolving medical technologies available [5], and the current economic climate causing strain on healthcare budgets, lead to the necessity to reduce hospitalization duration while minimizing costs [8]. Evidence from the literature has focused on the ability of the rapid recovery (RR) path to decrease the length of stay [8, 7], has confirmed cost savings for hospitals [9, 3], and suggested that also patients benefit from RR compared with conventional care (CC)[1, 2].
However, no study has so far investigated the payer's perspective regarding the cost-utility and cost-effectiveness of RR.
With this paper, I aim to evaluate the cost-effectiveness and the cost-utility of the RR care path for knee replacement as opposed to the CC path.

Methodology

Data

Data source: I exploit data originating from the German research project PROMoting Quality [6], consisting in a randomised controlled trial investigating the effect of a post-surgery alert in case the health improvements of hip and knee replacement patients were not as expected. The dataset contains information on 3,110 knee replacement patients, collected from 2019 to 2020 from nine German hospitals.
Variables: The dataset contains information on patients' demographics, previous treatments, comorbidities, post-treatment path, PROMs (including the EQ-5D-5L and KOOS) and hospital costs.
Sample size: The dataset for the estimation of the effects comprised of 2560 observations. The dataset for the estimation of the costs consisted in 285 observations.

Empirical strategy

1. Run causal forest model with inverse-probability weighted scores to identify the Average Treatment Effect of RR vs. CC
   - Dependent Variables: the absolute change between pre-surgery (admission to the hospital) and 12-month post-surgery EQ-5D-5L score for the cost-utility analysis, and KOOS score for the cost-effectiveness analysis (for ease of interpretation, the sign of the KOOS change was switched).
   - Independent Variables: the independent variable of interest is whether a patient is on the RR pathway (=being mobilized in less than 6 hours) or on the CC pathway. The control variables consist of socio-demographic variables (age, sex, living situation, job, job effort, and education), medical variables (pre-surgery KOOS score, height, weight, comorbidities, and pre-surgery hip and knee problems and treatments), and variables related to the surgery (hospital, duration, complications).
2. On the obtained ATEs, calculate the incremental cost-effectiveness ratio (ICER) and incremental net monetary benefits (INMB).
3. Run a probabilistic sensitivity analysis (PSA) through bootstrapping for 1000 times.
4. Use results from the PSA to plot probabilities of cost-utility and cost-effectiveness for different possible willingness to pay (WTP) thresholds.

Results

Cost-utility and cost-effectiveness estimates

RR significantly decreased patients costs but did not significantly increase their HR-QoL. Accordingly, a negative ICER of EUR -423,548.70/QALY was obtained. Assuming a WTP per QALY of EUR 50,000 for Germany, the INMB for RR was calculated as EUR 809.24.

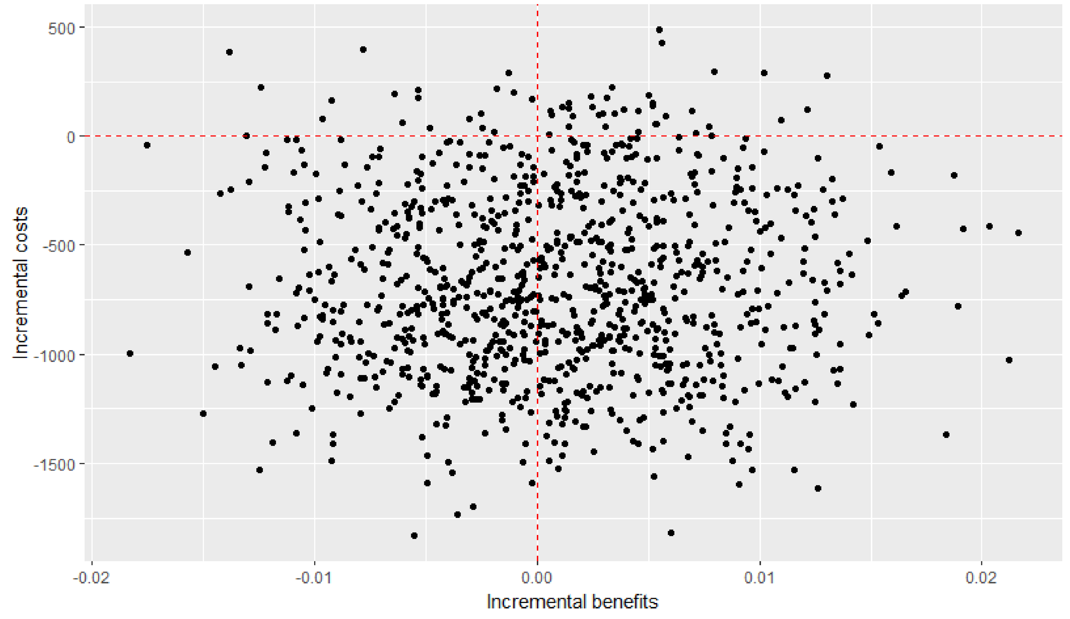

Figure 1: Cost-utility plane with EQ-5D-5L

The cost-utility plane in Figure 1 shows how the majority of the simulated points fall either on the bottom left or on the bottom right of the quadrant, meaning that there is no clear dominant strategy.
On the other hand, RR significantly decreased costs and increased health benefits of patients as calculated through the disease-specific instrument KOOS. Therefore, a negative ICER of EUR -305.43 for one point improvement in the KOOS score was obtained. The INMB is calculated at EUR 74,938.93. The cost-effectiveness plane in Figure 2 shows how the majority of the simulated points fall in the bottom right quadrant, indicating RR as the dominant strategy.

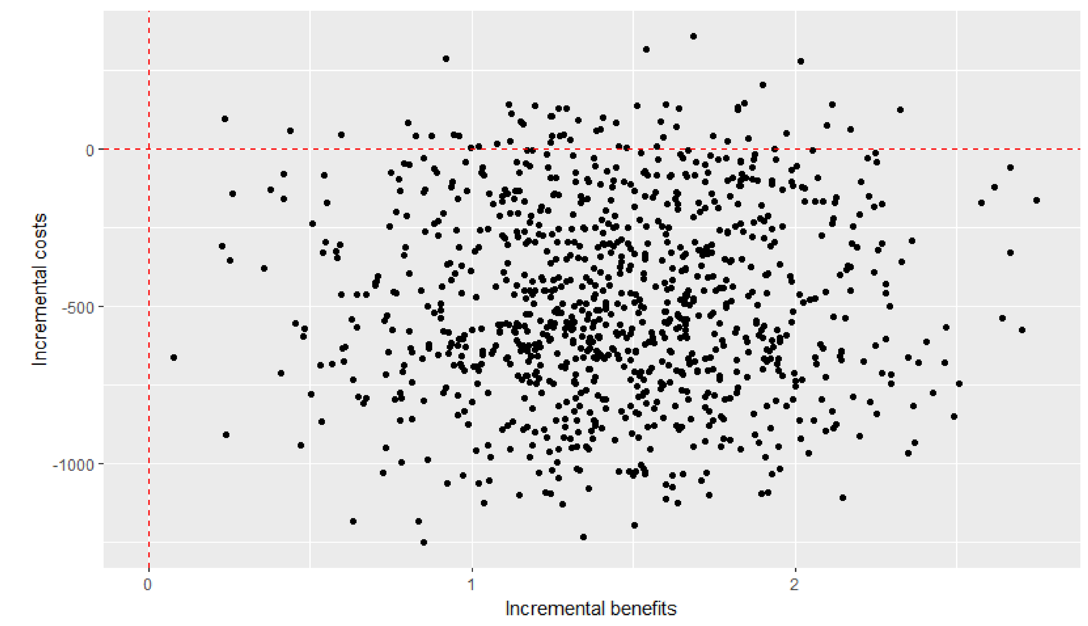

Figure 2: Cost-effectiveness plane with KOOS

Cost-effectiveness acceptability frontier (CEAC)

As a sensitivity analysis, the CEACs in Figure 3 show the probability of cost-utility using the EQ-5D-5L, in Panel A, and of cost-effectiveness using the KOOS, in Panel B, for a set of WTP thresholds. The results confirm that cost-effectiveness is reached at any WTP. Cost-utility is instead reached with higher probability at a WTP of around EUR 17,500.

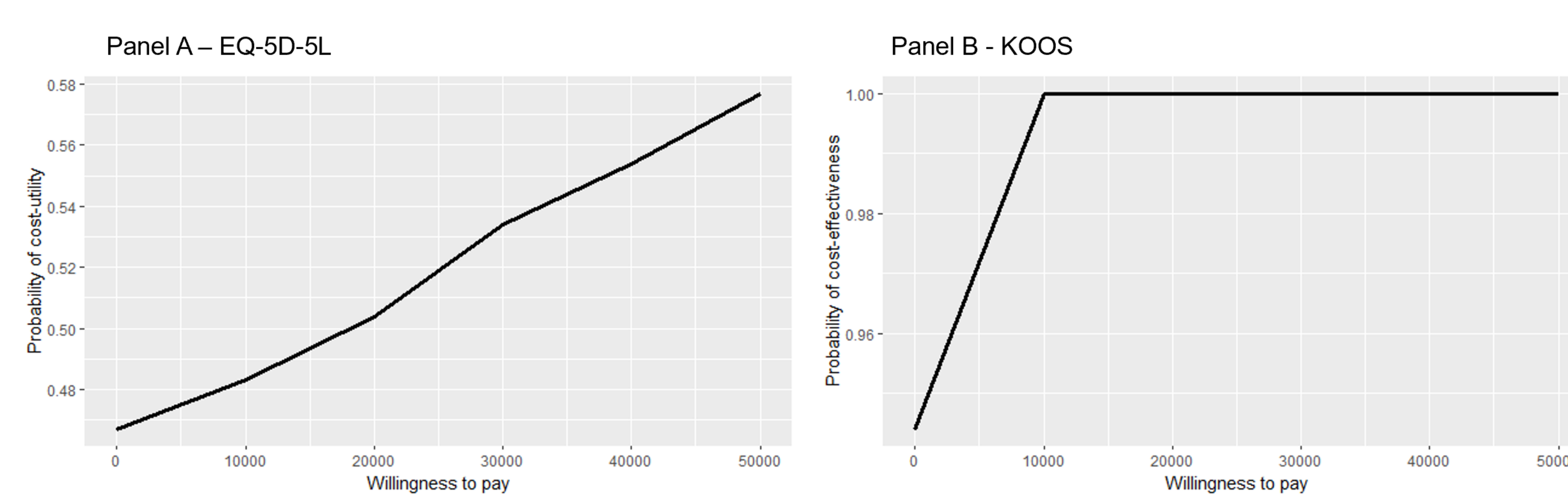

Figure 3: Cost-effectiveness acceptability frontiers: Panel A with EQ-5D-5L, Panel B with KOOS

Conclusion

An innovative approach to determine the cost-utility and cost-effectiveness of RR for knee replacements from the payer's perspective was implemented, by exploiting a machine learning methodology for the analysis of retrospective observational data.
The results show that RR is a cost-effective alternative from the German payer's perspective for the post-operative recovery path of knee replacement patients. RR instead shows only potential cost-utility at the conventional WTP threshold for Germany. This is in line with the main aim of RR being joint functionality improvement.

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