



Universität St.Gallen

School of Medicine

# The potential of a PROM-based DHI in knee and hip replacement to unburden the healthcare system post-surgery – Secondary analyses of the PROMoting Quality RCT

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*DGGÖ Conference*  
*5. March 2024*

**PROM**oting  
Quality

From insight to impact.



# Background and objectives

- Global healthcare systems increasingly suffer from shortages of healthcare workers [1,2] and are under pressure from exploding healthcare costs [3]. Demographic change will worsen this situation [1,4,5].
- Digitalized PROM-based monitoring systems have the potential to improve mid-to-long-term outcomes, and in turn decrease follow-up treatments and costs
- While effectiveness of these tools has been shown to improve outcomes [6] and decrease healthcare utilization [7,8] for cancer care, it is unknown for other indications.

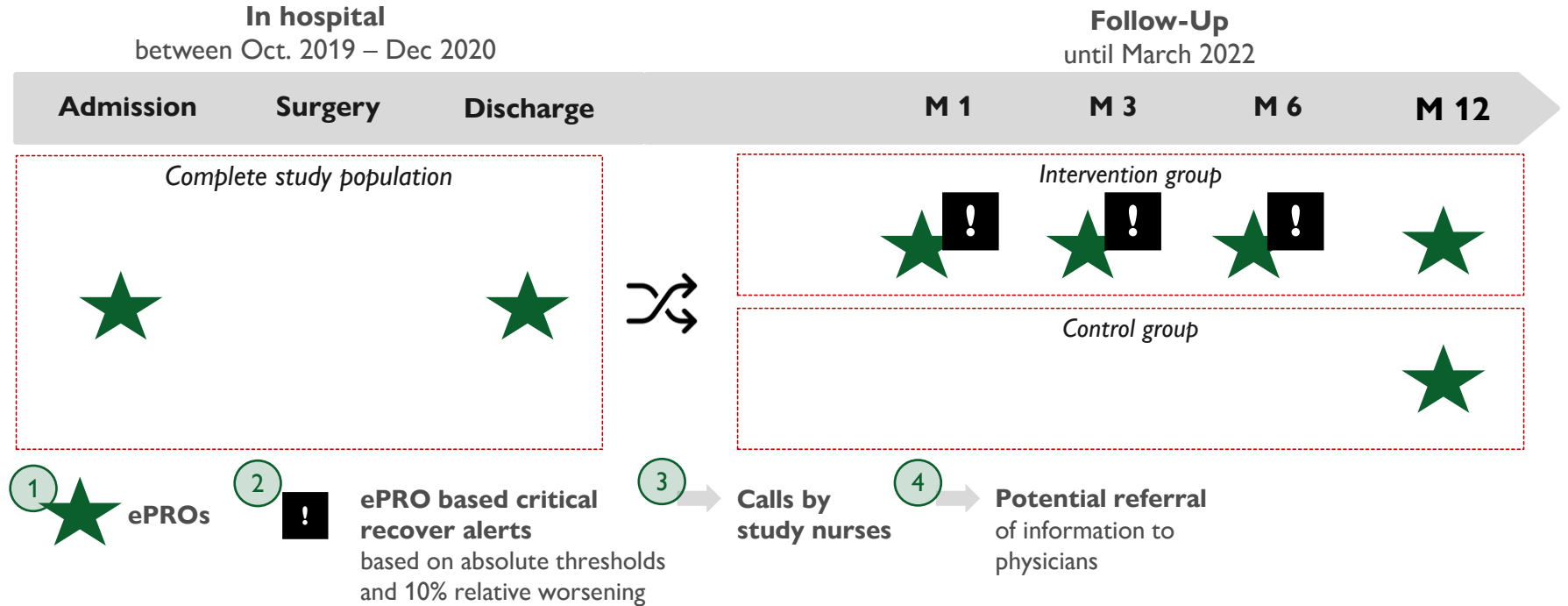
Our research aims at answering the following question:

**“Can a digital PROM monitoring and alert system for hip and knee replacement patients be used to decrease post-surgery health expenditures?”**

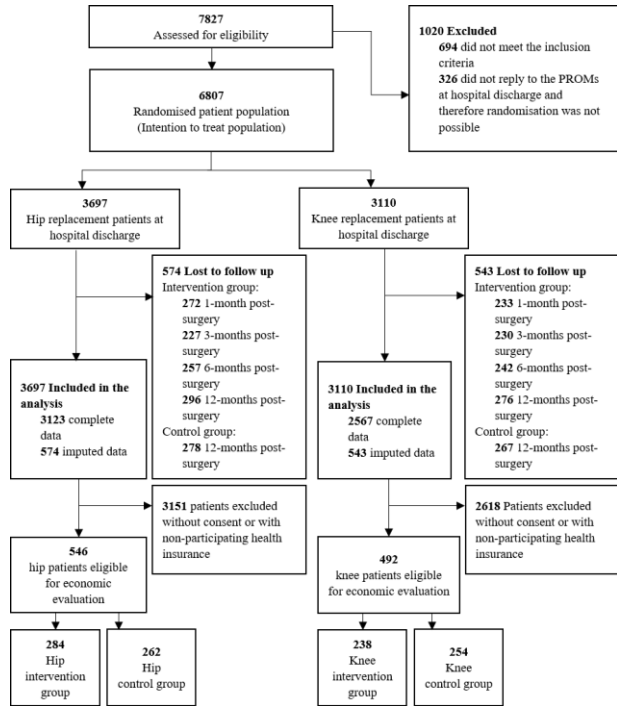


Secondary outcome of the PROMoting Quality trial

# Data & methods | The PROMoting Quality study design [9]



# Data & methods | Sample generation and data sources



- Between October 2019 and December 2020, 7827 patients were recruited from nine hospitals across Germany
- 3697 hip patients and 3110 knee patients were eligible and randomized
- Cost data available for 546 hip replacement patients and 492 knee replacement patients



Figure 1: Trial Profile  
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# PROMoting Quality | Results on outcomes already published

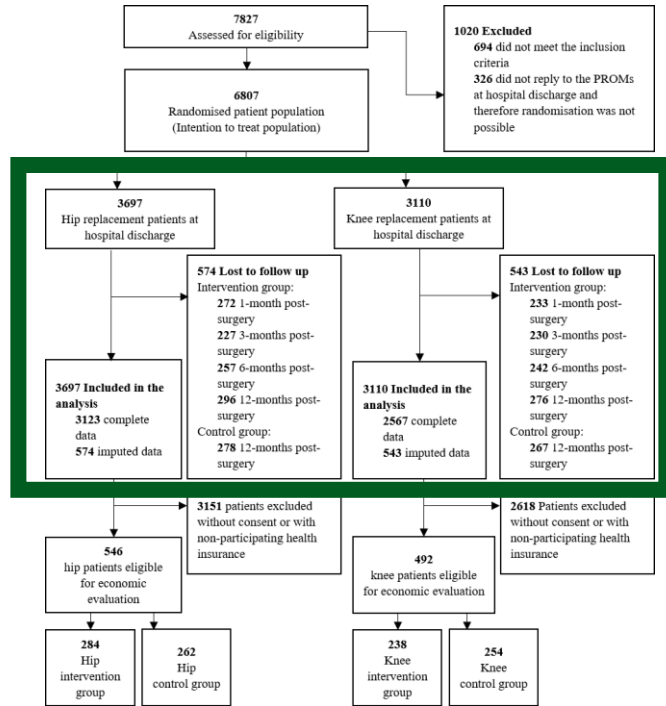



Figure 1: Trial Profile



**Original Investigation** | Orthopedics

September 1, 2023

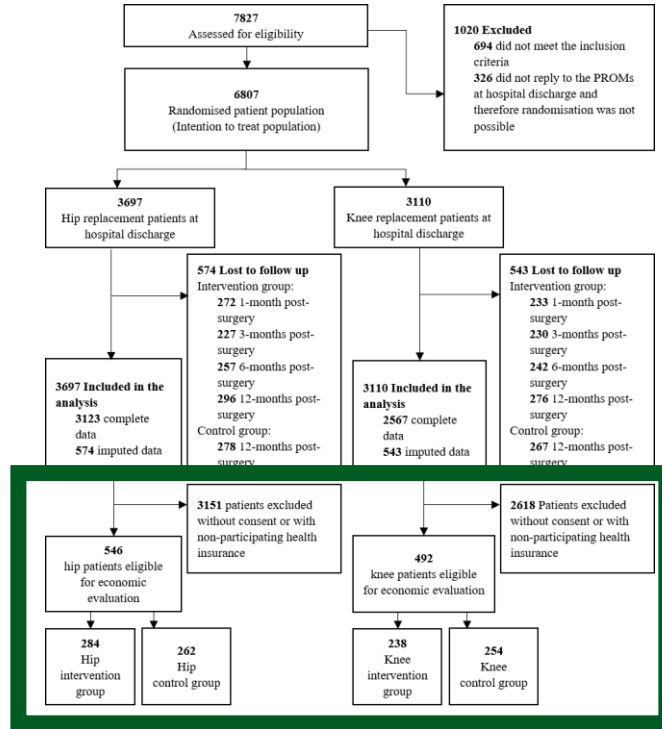
## Electronic Patient-Reported Outcome Monitoring to Improve Quality of Life After Joint Replacement Secondary Analysis of a Randomized Clinical Trial

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*JAMA Netw Open.* 2023;6(9):e2331301. doi:10.1001/jamanetworkopen.2023.31301

# PROMoting Quality | Cost data for 546 hip and 492 knee replacement patients used



- Cost data available for 546 hip replacement patients and 492 knee replacement patients

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- Costs and utilization directly associated with medical treatment
- Health insurance claims data of 24 statutory health insurances (~22%)
- Patient-level longitudinal cost data 1 year pre- and 1 year post-surgery
- Data categorized in outpatient care (OC), inpatient care (IC), prescriptions (PRES), remedies (REM), medical aids (AIDS)

# Data & methods | Comparative analyses and mixed effect model used for statistical analysis



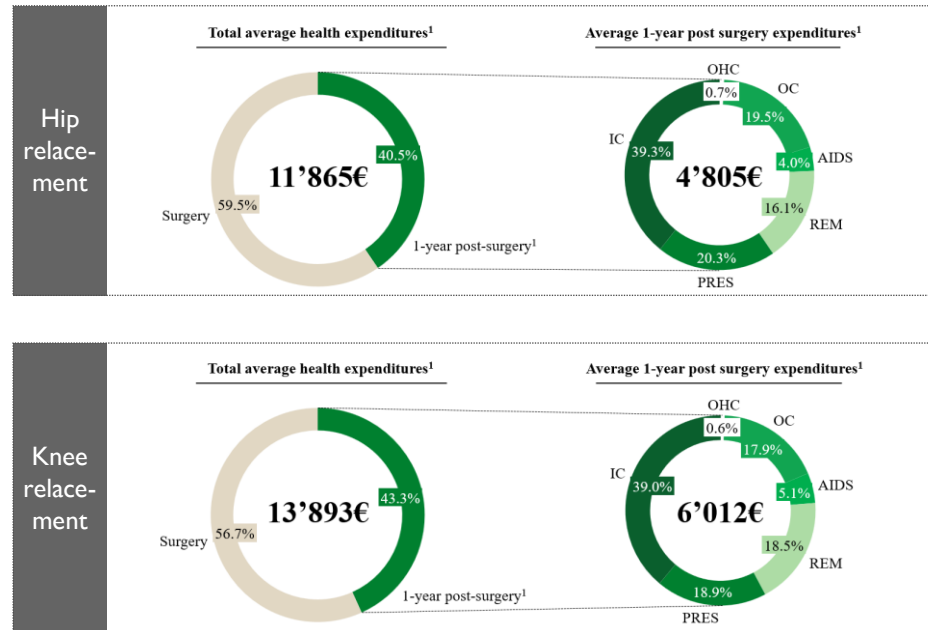
- **Comparative analysis:** use of t-tests and rank-sum tests to examine the intervention effect on post-surgery expenditures and utilization (e.g., physician visits)
- **Outliers:** To consider outliers and extreme costs we replaced the 5% extremest values in the dataset with values closest to the rest of the data by setting them to the minimum or maximum observed non-extreme values (winsorisation)
- **Cost data adjustments:** We adjusted the 1-year post-surgery cost data for pre-surgery differences between intervention and control group
- **Mixed effect model:** Testing for differences in the adjusted total post-surgery costs and utilization, as well as on the individual components outpatient care, outpatient hospital care, inpatient care, prescriptions, remedies, and medical aids
  - Controlling for age, gender, post-surgery mobilization and BMI

# Results | Patients majorly female, around 66 years old, and mostly overweight – knee replacement with higher expenditures

## Baseline characteristics

	Hip (N=546)	Knee (N=492)
Age		
mean (SD)	66.3 (10.4)	65.7 (9.3)
Sex (%)		
Female	357 (65.4)	304 (61.8)
Male	189 (34.6)	188 (38.2)
BMI (%)		
Underweight	4 (0.7)	0 (0.0)
Normal	166 (30.4)	64 (12.0)
Overweight	197 (36.1)	167 (33.9)
Obese	179 (32.8)	261 (53.1)
Comorbidities (%)		
None	203 (37.2)	130 (26.4)
PROM baseline score means (SD)		
EQ-5D-5L	0.581 (0.255)	0.610 (0.244)
EQ-VAS	54.5 (18.8)	57.3 (18.5)
HOOS-/KOOS-PS	49.0 (16.0)	43.0 (11.2)
PROMIS-F-SF	48.6 (10.2)	48.0 (9.9)
PROMIS-D-SF	49.9 (8.3)	49.6 (8.6)
Pain Score	2.9 (1.4)	2.8 (1.3)

## Expenditure distribution



Notes: OC – Outpatient care; OHC – Outpatient hospital care; IC – Inpatient care; PRES – Prescriptions; REM – Remedies; AIDS – medical aids; 1. Expenditures include all health care expenditures occurred within 1-year post surgery excluding rehabilitation cost

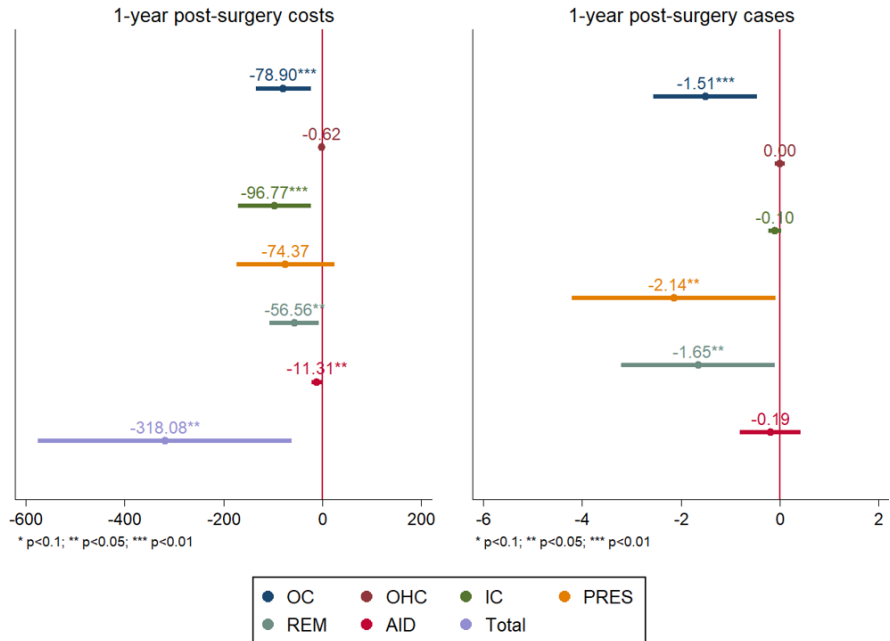


# Results – hip replacement | Comparative analyses shows differences for OC, IC, PRES and REM

		Intervention (n=284)				Control (n=262)				Comparative statistic <sup>a</sup>		
		mean	SD	median	IQR	mean	SD	median	IQR	Delta	p (t)	p (w)
OC	Utilisation n (%) <sup>b</sup>	284 (100.00%)				261 (99.62%)					0.298	0.298
	Cases <sup>c</sup>	11.91	5.96	11	7	13.51	6.83	13	9	-1.60	0.004	0.007
	Raw in € <sup>d</sup>	852.27	856.52	658.70	626.52	1026.72	1075.65	807.92	767.95	-174.45	0.036	0.003
	Adjusted in € <sup>e</sup>	816.43	329.89	740.13	422.10	907.01	360.41	817.18	539.86	-90.58	0.002	0.002
OHC	Utilisation n (%) <sup>b</sup>	21 (7.39%)				21 (8.02%)					0.786	0.786
	Cases <sup>c</sup>	0.15	0.63	0	0	0.15	0.61	0	0	0.01	0.853	0.823
	Raw in € <sup>d</sup>	32.00	145.72	0.00	0.00	40.29	217.47	0	0	-8.29	0.598	0.784
	Adjusted in € <sup>e</sup>	13.85	6.58	11.60	5.43	14.67	7.47	12.39	6.19	-0.82	0.174	0.240
IC	Utilisation n (%) <sup>b</sup>	74 (26.06%)				77 (29.39%)					0.385	0.385
	Cases <sup>c</sup>	0.36	0.71	0	1	0.46	0.84	0	1	-0.10	0.122	0.261
	Raw in € <sup>d</sup>	1735.18	4404.33	0.00	437.48	2055.79	4548.14	0.00	211.16	-320.61	0.403	0.352
	Adjusted in € <sup>e</sup>	1438.52	440.01	1332.25	541.30	1551.83	476.87	1403.10	714.14	-113.31	0.004	0.003
PRES	Utilisation n (%) <sup>b</sup>	272 (95.77%)				250 (95.42%)					0.840	0.840
	Cases <sup>c</sup>	14.05	12.69	11	14	16.52	14.20	14	16	-2.47	0.032	0.022
	Raw in € <sup>d</sup>	745.82	1775.37	280.56	649.58	1223.32	5054.07	364.97	690.06	-477.50	0.135	0.031
	Adjusted in € <sup>e</sup>	560.32	586.21	331.51	444.96	654.50	641.81	404.54	570.68	-94.18	0.074	0.023
REM	Utilisation n (%) <sup>b</sup>	239 (84.15%)				227 (86.64%)					0.413	0.412
	Cases <sup>c</sup>	8.36	8.58	6	8	10.09	10.01	8	11	-1.73	0.031	0.041
	Raw in € <sup>d</sup>	689.03	903.64	463.89	652.65	867.40	1217.52	563.37	843.16	-178.37	0.051	0.019
	Adjusted in € <sup>e</sup>	658.19	294.63	560.95	334.55	722.09	318.29	622.61	437.48	-63.90	0.015	0.010
AIDS	Utilisation n (%) <sup>b</sup>	175 (61.62%)				172 (65.65%)					0.329	0.329
	Cases <sup>c</sup>	2.36	3.64	1	3	2.66	4.01	1	3	-0.30	0.352	0.388
	Raw in € <sup>d</sup>	171.96	408.35	56.31	173.90	218.69	661.61	61.19	200.77	-46.73	0.317	0.320
	Adjusted in € <sup>e</sup>	132.82	64.35	112.75	63.71	146.47	67.95	124.89	80.65	-13.64	0.016	0.005
<b>Total</b>	Raw in € <sup>d</sup>	<b>4226.26</b>	<b>5575.47</b>	<b>2146.55</b>	<b>3946.5</b>	<b>5432.22</b>	<b>7604.43</b>	<b>2614.23</b>	<b>5918.04</b>	<b>-1205.96</b>	<b>0.034</b>	<b>0.019</b>
	Adjusted in € <sup>e</sup>	<b>3620.12</b>	<b>1544.80</b>	<b>3218.23</b>	<b>1619.8</b>	<b>3996.55</b>	<b>1656.16</b>	<b>3508.19</b>	<b>2312.27</b>	<b>-376.43</b>	<b>0.006</b>	<b>0.004</b>

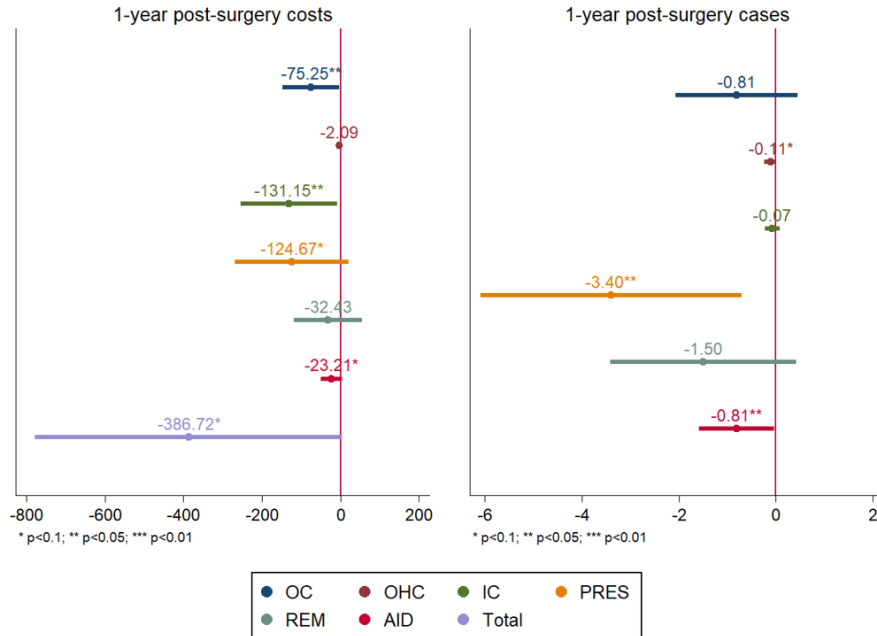
OC – Outpatient care; OHC – Outpatient hospital care; IC – Inpatient care; PRES – Prescriptions; REM – Remedies; AIDS – medical aids; a: Comparative Analysis conducted at 5% level with two-sided t-tests (p(t)) and, in case of non-normality, with wilcoxon rank-sum tests (p(w)); b: if a service in the corresponding category was used at least once in the 1-year post-surgery period; c: number of cases per category in the 1-year post-surgery period; d: unadj. occurred costs the 1-year post-surgery period; e: 1-year post-surgery period costs adjusted for the baseline differences with winsorised linear regression

# Results – hip replacement | Mixed effect model results only slightly different – OC with most significant difference



- Total 1-year post-surgery expenditures are 318€ lower in the intervention than in the control group
- Significant effects wrt expenditures seen for OC, IC, REM, and AID
- Patients in the intervention group have 1,5 fewer outpatient physician visits than those in the control group
- Differences stem from GP visits (*ongoing analyses*)
- Differences in utilization and expenditures for remedies originate from physiotherapy sessions

# Results – knee replacement: Effects of the intervention on expenditures and utilization weaker for knee than hip replacements



- Total 1-year post-surgery expenditures are 387€ lower in the intervention than in the control group (10% significance level)
- Significant effects wrt expenditures seen for OC, IC, PRES, and AID
- Only small and weakly significant effects on utilization (IC, AID)



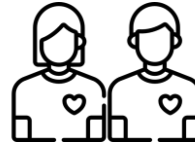
## Take aways



### “Can a digital PROM monitoring and alert system for hip and knee replacement patients be used to decrease post-surgery health expenditures?”

- Evidence that remotely monitoring hip and knee replacement 1-year post-surgery decreases healthcare utilization and expenditures (Hip: -318€<sup>\*\*</sup>; Knee: -386€<sup>\*</sup>)
- For hip replacement the intervention has significant positive effects on expenditures for nearly all cost categories – with strongest effects for OC (-78€<sup>\*\*\*</sup>), IC (-97€<sup>\*\*\*</sup>) and REM (-57€<sup>\*\*</sup>)
- Regarding utilization, we observe fewer OC physician visits (-1.51<sup>\*\*\*</sup>), prescriptions (-2.14<sup>\*\*</sup>), and remedies, esp. physiotherapy (-1.65<sup>\*\*\*</sup>)
- For knee replacement, effects are primarily for expenditures and less significant
- If implemented efficiently digital PROM applications could unburden the health systems budgets and counteract workforce shortages

# Acknowledgements



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**aQua**  
ZUKUNFT DURCH QUALITÄT

**heartbeat** 

# Sources – detailed

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