A stepwise transformation: description and outcome of perioperative procedures in patients receiving a total knee arthroplasty

A DATA-DRIVEN 11-YEAR FOLLOW-UP STUDY

W. F. C. van Houtert,
D. O. Strijbos,
R. Bimmel,
W. P. Krijnen,
J. Jager,
N. L. U. van Meeteren,
G. van der Sluis

From Nij Smellinghe Hospital, Drachten, Netherlands

Aims

To investigate the impact of consecutive perioperative care transitions on in-hospital recovery of patients who had primary total knee arthroplasty (TKA) over an 11-year period.

Methods

This observational cohort study used electronic health record data from all patients undergoing preoperative screening for primary TKA at a Northern Netherlands hospital between 2009 and 2020. In this timeframe, three perioperative care transitions were divided into four periods: Baseline care (Joint Care, n = 171; May 2009 to August 2010), Function-tailored (n = 404; September 2010 to October 2013), Fast-track (n = 721; November 2013 to May 2018), and Prehabilitation (n = 601; June 2018 to December 2020). In-hospital recovery was measured using inpatient recovery of activities (IROA), length of stay (LOS), and discharge to preoperative living situation (PLS). Multivariable regression models were used to analyze the impact of each perioperative care transition on in-hospital recovery.

Results

The four periods analyzed involved 1,853 patients (65.9% female (1,221/1,853); mean age 70.1 years (SD 9.0)). IROA improved significantly with each transition: Function-tailored (0.9 days; $p < 0.001$ (95% confidence interval (CI) -0.32 to -0.15)), Fast-track (0.6 days; $p < 0.001$ (95% CI -0.25 to -0.16)), and Prehabilitation (0.4 days; $p < 0.001$ (95% CI -0.18 to -0.10)). LOS decreased significantly in Function-tailored (1.1 days; $p = 0.001$ (95% CI -0.30 to -0.06)), Fast-track (0.6 days; $p < 0.001$ (95% CI -0.21 to -0.05)), and Prehabilitation (0.6 days; $p < 0.001$ (95%CI -0.27 to -0.11)). Discharge to PLS increased in Function-tailored (77%), Fast-track (91.6%), and Prehabilitation (92.6%). Post-hoc analysis indicated a significant increase after the transition to the Fast-track period ($p < 0.001$ (95% CI 3.19 to 8.00)).

Conclusion

This study highlights the positive impact of different perioperative care procedures on in-hospital recovery of patients undergoing primary TKA. Assessing functional recovery, LOS, and discharge towards PLS consistently, provides hospitals with valuable insights into postoperative recovery. This can potentially aid planning and identifying areas for targeted improvements to optimize patient outcomes.

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Correspondence should be sent to W. F. C. van Houtert; email: w.houtert@nijsmellinghe.nl

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Introduction

The number of patients diagnosed with knee osteoarthritis is growing globally,[1] with the prediction for the next decade that a significant number will require arthroplasty surgery. In the Netherlands, the number of patients receiving total knee arthroplasty (TKA) due to osteoarthritis has increased by 44% over the past 13 years, with a projected annual increase of 4.5%.[2,3] TKA surgery has led to a 68% reduction in postoperative pain during activity (n = 30,046) and a 40% improvement in perceived health-related quality of life (n = 31,882).[4–6]

Surgery in general is considered to be a major physiological and psychosocial stressor, with potential risks of causing both reversible and

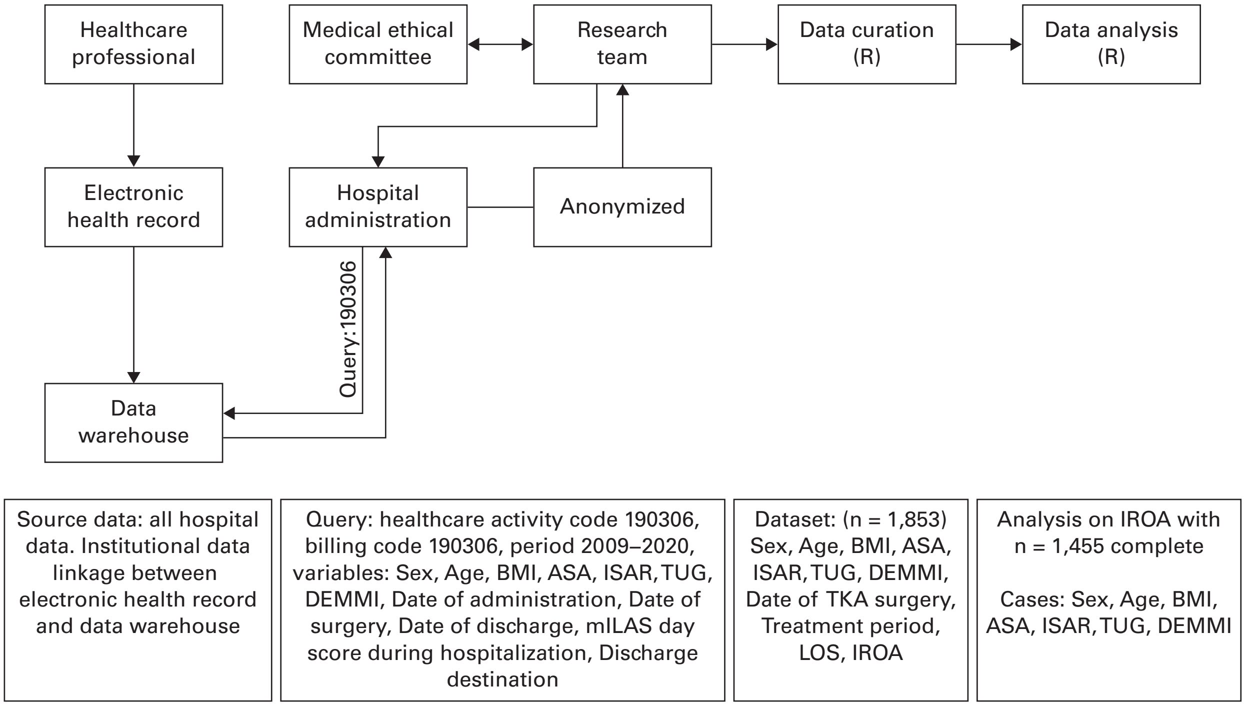

Fig. 1

Flowchart of data from source to final analysis on inpatient recovery of activities (IROA). ASA, American Society of Anesthesiologists grade; DEMMI, De Morton Mobility Index; ISAR, identification of seniors at risk; LOS, length of hospital stay; mILAS: modified Iowa Levels of Assistance Scale; TUG, Timed Up and Go test.

irreversible consequences.[7] People with a lower physiological reserve are at higher risk of responding inadequately to the demands of such a surgical stressor.[7,8] Hospital-associated disability remains prevalent, particularly among older adults, even with a shorter length of stay (LOS).[9] In this context, a drive for constant improvement of the perioperative programme has been observed, leading to the emergence of fast-track principles and prehabilitation programmes.[6,10,11]

The objective of this study was to investigate the impact of three stepwise improvements in perioperative care with patients undergoing TKA surgery. The first transition went from Joint Care to a Function-tailored model of care, which emphasizes physical, social, and mental activation of patients. Next, a medical Fast-track pathway was added. In the last period, Prehabilitation was introduced for at-risk patients who were selected based on validated screening.[12,13] The impact on in-hospital recovery of each of these care transitions was evaluated. We hypothesized that each of these transitions contributed to a faster inpatient recovery of activities (IROA), a shorter LOS, and a higher proportion of patients being discharged to their preoperative living situation (PLS).

Methods

This study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and Reporting of Studies Conducted using Observational Routinely-collected Data (RECORD) guidelines.[14] The checklist is available in the Supplementary Material.

Ethical approval. Ethical approval was obtained from Nij Smellinghe Hospital's Medical Ethical Committee (MEC). The MEC determined that a full review was not required under the Dutch Medical Research with Human Subjects Law (reference ID: 16-107/JS/AB, 3 December 2013 and BK/AB/ID 17568, 1 February 2021). Additionally, this study adheres to the Medical Treatment Agreement Act[15] and the General Data Protection Regulation Act.

Design, setting, and participants. An observational cohort study was chosen to evaluate the impact of each step of additive improvements in TKA care on IROA, LOS, and discharge towards PLS. Between May 2009 and December 2020, all 1,853 patients with symptomatic osteoarthritis of the knee requiring TKA were included. The patients had opted for TKA surgery in our district hospital and all received a preoperative functional screening from a dedicated physiotherapist. No exclusion criteria were used for this study. The dataset included only patients undergoing TKA, so no patients who underwent unicondylar knee or total knee revision surgery are included in the cohort. The preoperative functional screening with validated tools by a physiotherapist was standard care in our patients undergoing knee arthroplasty surgery.

Following approval from the MEC, the routinely collected medical data were obtained from the hospital's administration department. Population validation was conducted using all registries of healthcare activity code 190306 in conjunction with billing code 190306, representing TKA as defined by the Dutch Healthcare Authority.[16] Figure 1 illustrates the pathway

Table I. Content of intervention periods of total knee arthroplasty care given from 2009 until 2020 and stages of the patient journey.

Patient journey	Joint Care (May 2009 to August 2010)	Function-tailored (September 2010 to October 2013)	Fast-track (November 2013 to May 2018)	Prehabilitation (June 2018 to December 2020)
Preoperative stage				
Screening and appointments	Functional screening,* medical screening, information meeting	Functional screening, medical screening, information module*	Functional screening, medical screening, information module	Functional screening, medical screening, information module, training period at home for patients at risk for delayed recovery*
Nutritional management	Fasted 12 hours before surgery	Fasted 12 hours before surgery	Preop 2 hours before surgery*	Preop 2 hours before surgery
Moment of surgery	According to hospital planning	According to hospital planning	According to hospital planning	According to patient's needs and preferences*
Preloading of pain medication	None	None	Gabapentin starting 3 days before surgery*	Gabapentin starting 3 days before surgery
Intraoperative stage				
Anaesthesia	Spinal (Bupivacaine 0.5%)	Spinal (Bupivacaine 0.5%)	Spinal (Bupivacaine 0.5%), local infiltration analgesia*	Spinal (Bupivacaine 0.5%), local infiltration analgesia
Surgical technique	Medial approach	Medial approach	Medial approach	Medial approach
Postoperative stage				
Postoperative pain medication	Patient-controlled analgesia, paracetamol, NSAIDs	Patient-controlled analgesia, paracetamol, NSAIDs	Gabapentin until 3 days after surgery,* paracetamol, NSAIDs, patient-controlled analgesia as rescue*	Gabapentin, paracetamol, NSAIDs, patient-controlled analgesia as rescue
Drain/catheter	Until 2 days postop	Removed in < 24 hours*	Removed in < 24 hours	Removed in < 24 hours
Start mobilization	After 24 hours	Within 4 hours*	Within 4 hours	Within 4 hours
Discharge planning	Time table and medical conditions	Functional and medical goal setting based on preop screening*	Functional and medical goal setting based on preop screening	Functional and medical goal setting based on preop screening
Projected discharge	5 days from day of surgery	mILAS score 0 achieved*	mILAS score 0 achieved	mILAS score 0 achieved

*Changes that were new in relation to baseline care.
mILAS, modified Iowa Levels of Assistance Scale; NSAIDs, non-steroidal anti-inflammatory drugs.

from accessing data in the healthcare process to its analysis, showcasing an example of final analysis on IROA.

Interventions. In 2009, baseline TKA care in our hospital was a programme called Joint Care, an in-hospital group-based rehabilitation programme with structured interventions based on postoperative days.[17] The first transition was from Joint Care towards Function-tailored care, a cultural change that involved collectively training all medical and allied health professional staff to preoperatively advocate patients staying active, emphasizing early mobilization and the high likelihood of discharge home. Staff were also trained to improve patients' postoperative functional recovery by achieving functional milestones. The second transition involved implementation of Fast-track principles with Function-tailored care, through tailored anaesthesia protocols to facilitate rapid emergence, proactive pain management strategies, and nutritional management adaptations to enhance early mobilization and rapid recovery. In the third transition, a validated risk stratification tool targeting inpatient functional recovery was used, followed by a prehabilitation programme aimed specifically at patients who are at risk of experiencing delayed physical functioning after surgery.[12,13] To improve clarity, we have named the transition periods according to the most important theme: Joint Care (May 2009 to August 2010), Function-tailored (September 2010 to October 2013), Fast-track (November 2013 to May 2018), and Prehabilitation (June 2018 to December 2020). An overview on the global content of each of these is presented in Table I. Further detailed information can be found in the Supplementary Material.

Measurements and variables. To evaluate each care period, we used routinely collected medical and functional data obtained from the hospital administration pertaining to all 1,853 patients who underwent TKA surgery, as depicted in Figure 1. All patients underwent preoperative functional screening conducted by a physiotherapist. Patients were screened for prospectively measured characteristics, including sex, age, BMI, American Society of Anesthesiologists (ASA) grade,[18] the identification of seniors at risk (ISAR) score,[19] Timed Up and Go test score (TUG), and de Morton mobility index (DEMMI) score.[20] These measures were used to account for the heterogeneity between patients in the different periods of care. Previous research has demonstrated that these measures have an independent influence on our outcome measures.[12,13,21]

To assess the impact of each period after transition, we used the same outcome measures as our previous publication in 2015,[17] including: 1) IROA, defined as the time in days from the day of surgery until the day when physical functioning was considered restored according to the modified Iowa Levels of Assistance Scale (mILAS) (score of ≤ 6); 2) LOS, defined as the number of days in hospital, including the day of surgery, until discharge; and 3) patients' discharge to PLS.[17,19]

Statistical analysis. Descriptive statistics were calculated for patient characteristics, performance measures, and dependent

Table II. Characteristics of all patients at preoperative screening and their postoperative recovery, separated over four periods of care.

Patient characteristic	Joint Care (2009 to 2010)		Function-tailored (2010 to 2013)		Fast-track (2013 to 2018)		Prehabilitation (2018 to 2020)	
	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
Age, yrs	127	71.1 (8.4)	404	69.4 (9.6)	721	70.2 (8.9)	601	70.1 (8.8)
BMI, kg/m^2	127	29.9 (5.4)	399*	30.1 (5.0)	721	29.4 (4.6)	598*	29.1 (4.8)
ASA grade, I to IV	112*	2.0 (0.4)	403*	1.9 (0.5)	714*	2.1 (0.5)	600*	2.1 (0.5)
ISAR, 0 to 6 points	112*	1.2 (1.3)	397*	0.9 (1.0)	673*	0.7 (0.9)	508*	0.7 (0.8)
TUG, seconds	126*	12.4 (7.4)	397*	11.4 (5.8)	689*	9.3 (5.2)	539*	9.5 (5.2)
DEMMI, 0 to 100 points	111*	76.2 (17.6)	388*	76.5 (16.6)	682*	82.6 (14.6)	542*	83.6 (14.3)
IROA, days	85†	4.4 (0.9)	334†	3.5 (0.9)	663†	2.9 (1.0)	575†	2.5 (1.0)
LOS, days	127	5.2 (1.8)	382*	4.1 (1.1)	714*	3.5 (1.3)	601	2.9 (1.6)
Discharge destination, % PLS	127	69.0	382*	77.7	720*	91.6	598*	92.6

*Missing cases due to no traceable data in the patients' medical records.
†Missing cases due to patients who were not fully recovered, who were referred to a rehabilitation centre.
ASA, American Society of Anesthesiologists; DEMMI, de Morton Mobility Index; IROA, time to inpatient recovery of activities; ISAR, identification of seniors at risk; LOS, length of hospital stay; PLS, preoperative living situation; SD, standard deviation; TUG, Timed Up and Go test.

Table III. Tobit regression analysis of inpatient recovery of activities, including correcting covariates and the periods Joint Care, Function-tailored, Fast-track, and Prehabilitation.

Variables	Estimate (95% CI)*	p-value
Sex	0.003 (-0.025 to 0.031)	0.825
Age	0.005 (0.003 to 0.007)	< 0.001
BMI	0.000 (-0.003 to 0.003)	0.955
ASA grade	0.024 (-0.006 to 0.054)	0.117
ISAR	0.030 (0.013 to 0.048)	< 0.001
TUG	0.009 (0.004 to 0.013)	< 0.001
DEMMI	-0.002 (-0.003 to -0.001)	0.005
Treatment period		
Function-tailored	-0.235 (-0.301 to -0.168)	< 0.001
Fast-track	-0.443 (-0.506 to -0.379)	< 0.001
Prehabilitation	-0.581 (-0.646 to -0.517)	< 0.001
Linear hypotheses†		
Function-tailored vs Joint Care	-0.235 (-0.315 to -0.154)	< 0.001
Fast-track vs Function-tailored	-0.208 (-0.252 to -0.164)	< 0.001
Prehabilitation vs Fast-track	-0.139 (-0.176 to -0.101)	< 0.001

*Multivariable Tobit regression model with the variables sex, age, BMI, ASA grade, ISAR score, TUG time, and DEMMI score (n = 1,455, 398 observations deleted due to missing data, 12 observations were Right-censored to 7 days).
†Post-hoc paired comparison analysis.
ASA, American Society of Anesthesiologists; CI, confidence interval; DEMMI, de Morton Mobility Index; IROA, time to inpatient recovery of activities; ISAR, identification of seniors at risk; LOS, length of hospital stay; TUG, Timed Up and Go test.

variables. In the regression analysis of the outcomes, the diversity between patients related to age, BMI, ASA grade, TUG, and DEMMI was controlled for by using these variables. To test if the additively implemented changes in care actually improved outcomes, we applied post-hoc pairwise multiple comparisons to the consecutive periods.

The relation between each transition in care on IROA was analyzed with a Tobit regression model. The patients with incomplete functional recovery were discharged to a rehabilitation clinic or nursing home. They did not receive functional independence during hospital stay (mILAS < 6), and hence had missing values on IROA. These patients were of interest to us, because they were at risk of a delayed recovery of physical function after surgery.[21] To keep these patients in the analysis, the missing values were treated as right-censored, set at seven days.

The relation between each transition in care and LOS was analyzed by a multivariable Poisson regression model. To find models that are optimal in predicting LOS, those that had minimum Akaike's Information Criterium (AIC) values were selected.[22] Additionally, a sensitivity analysis using Cook's distance was conducted to assess the potential influence of extreme outlying cases on model outcomes. To further validate the robustness of conclusions from the model, bootstrapping with $R = 2,000$ replicates was conducted to verify the validity of the confidence intervals (CIs) for the estimated parameters of the multivariable model.

The relation between each transition and the proportion of patients returning to their PLS after hospital discharge was analyzed with univariable and multivariable logistical regression analysis. A multivariable analysis followed by minimum AIC model selection was performed to find the best predictive model for testing our expectations by multiple pairwise comparisons.[22] To assess the sensitivity and robustness of our multivariable logistic regression model, Cook's distances were calculated for each patient. This enabled an examination of influential observations while validating the internal consistency and predictive strength of the multivariable model via bootstrapping with $R = 2,000$ replicates.

All statistical analysis was performed using the programming language R v. 4.1.1, along with the main R packages (R Foundation for Statistical Computing, Austria): foreign version 0.8-86, car version 3.1-2, multcomp version 1.4-25, MASS version 7.3-60, and AER version 1.2-10.[23–26] Statistical significance was set throughout at $p \leq 0.05$.

Results

Baseline characteristics of the patients are provided in Table II. There were no statistically significant differences between the patient populations visiting our hospital during the four periods with regard to age (F(3, 1,849) = 1.468; p = 0.222). There were significant differences for BMI (F(3, 1,841) = 3.519; p = 0.015), ASA grade (F(3, 1,825) = 15.19; p < 0.001), TUG score (F(3,

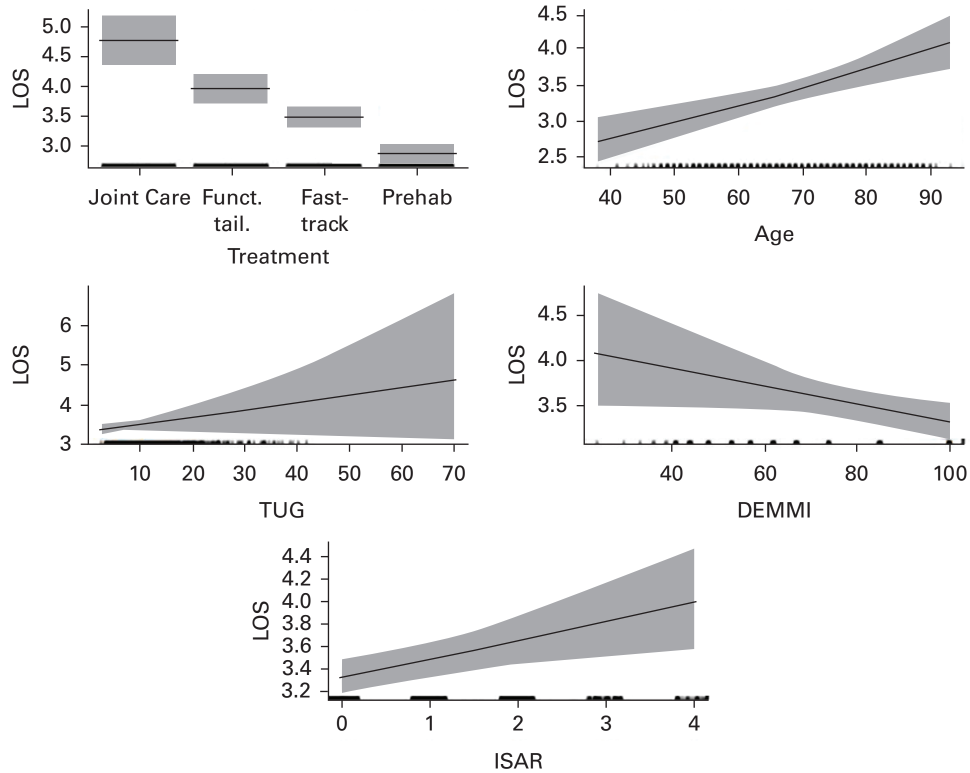

Fig. 2

Visualization of the effects of the variables: treatment period, age, Timed Up and Go test (TUG), de Morton Mobility Index (DEMMI), and identification of seniors at risk (ISAR) in the multivariable Poisson regression model and their influence on length of stay (LOS) in days.

1,748) = 20.43; $p < 0.001$), and DEMMI score ($F(3, 1,719) = 22.79$; $p < 0.001$).

The relationship between the implemented changes in care and IROA was investigated with a Tobit regression analysis using the explanatory variables sex, age, BMI, ASA grade, ISAR, TUG, and DEMMI. The results are presented in Table III.

Post-hoc paired comparison showed that IROA (in days) decreased significantly after each transition by 0.9 days in the Function-tailored period ($p < 0.001$ (95% CI -0.32 to -0.15)), by 0.6 days in the Fast-track period ($p < 0.001$ (95% CI -0.25 to -0.16)), and by 0.4 days in the Prehabilitation period ($p < 0.001$ (95% CI -0.18 to -0.10)).

The relationship between the implemented changes in care and LOS was analyzed with a univariable and multivariable Poisson regression analysis. We used a minimum AIC model (Δ AIC = AIC total model: 5,496 – min. AIC model: 5,492.2 = 3.8), in which the minimum AIC model is 3.8 points better at explaining the variability in the data compared to the total model, with the variables age, ASA grade, ISAR, TUG, and DEMMI. Visualization of the effects of the variables in the multivariable model with minimum AIC is presented in Figure 2. The Cook's distance revealed that the maximum influence exerted by any single data point on the model's coefficients or predictions for LOS was 0.058, signifying minimal influence on the model's outcomes. The results of these analyses are presented in Table IV.

Bootstrap analysis (R = 2,000) confirmed the validity of model implications. Post-hoc paired comparison revealed that LOS decreased significantly after each phase of implementation: by 1.1 days in the Function-tailored period ($p = 0.001$ (95% CI -0.30 to -0.06)), by 0.6 days in the Fast-track period ($p < 0.001$ (95% CI -0.21 to -0.05)), and by 0.6 days in the Prehabilitation period ($p < 0.001$ (95% CI -0.27 to -0.11)).

The relation between the implemented changes in care and discharge towards PLS was analyzed with a univariable and multivariable logistical regression analysis. The results of these analyses are presented in Table V.

There was a univariable relationship between the periods in care and the percentage of patients discharged towards their PLS out of 1,852. After each transition, the percentage of patients with a referral towards their PLS increased from 69% (88/127) to 77% (297/387) in the Function-tailored period, 91.6% (660/720) in the Fast-track period, and 92.6% (554/598) in the Prehabilitation period. Further investigating the relationship between the periods of care and the percentage of people discharged towards their PLS, a logistic regression analysis and a multivariable model with a minimum AIC (Δ AIC = total model: 832.69 – min. AIC model: 829.18 = 3.51) with the (significant) variables age, ISAR, TUG, and DEMMI was used.[22] Visualization of the effects of the variables in the multivariable model with minimum AIC is presented in Figure 3. Bootstrapping (R = 2,000) confirmed the results of the model.

Table IV. Univariable and multivariable Poisson regression analysis of length of stay, including correcting covariates and the periods Joint Care, Function-tailored, Fast-track, and Prehabilitation.

Variables	Univariable relationship*		Multivariable model†	
	Estimate (95% CI)	p-value	Estimate (95% CI)	p-value
Sex	0.96 (0.91 to 1.01)	0.081		
Age	1.01 (1.01 to 1.02)	< 0.001	0.01 (0.00 to 0.01)	< 0.001
BMI	1.00 (1.00 to 1.01)	0.192		
ASA grade	1.15 (1.09 to 1.21)	< 0.001	0.05 (-0.01 to 0.11)	0.091
ISAR	1.14 (1.11 to 1.17)	< 0.001	0.05 (0.02 to 0.08)	0.004
TUG	1.02 (1.02 to 1.03)	< 0.001	0.00 (0.00 to 0.01)	0.149
DEMMI	1.00 (0.99 to 0.99)	< 0.001	0.00 (-0.01 to 0.00)	0.034
Treatment period				
Function-tailored			-0.18 (-0.28 to -0.08)	< 0.001
Fast-track			-0.31 (-0.40 to -0.21)	< 0.001
Prehabilitation			-0.50 (-0.60 to -0.40)	< 0.001
Linear hypotheses‡				
Function-tailored vs Joint Care	-0.25	< 0.001	-0.18 (-0.30 to -0.06)	0.001
Fast-track vs Function-tailored	-0.16	< 0.001	-0.13 (-0.21 to -0.05)	< 0.001
Prehabilitation vs Fast-track	-0.18	< 0.001	-0.19 (-0.27 to -0.11)	< 0.001

*Univariable relationship between the variables and LOS.
†Multivariable Poisson regression model (n = 1,601, 252 observations deleted due to missing data) with the variables age, ASA grade, ISAR score, TUG time, and DEMMI score. A minimum AIC model is used (Δ AIC = AIC total model – minimum AIC model = 5496–5492.2 = 3.8).[22]
‡Post-hoc paired comparison analysis.
ASA, American Society of Anesthesiologists; CI, confidence interval; DEMMI, de Morton Mobility Index; IROA, time to inpatient recovery of activities; ISAR, identification of seniors at risk; LOS, length of hospital stay; TUG, Timed Up and Go test.

Table V. Univariable and multivariable logistic regression analysis of return to preoperative living situation using correcting covariates and the periods Joint Care, Function-tailored, Fast-track, and Prehabilitation.

Variables	Univariable model*			Multivariable model†		
	Estimate	OR (95% CI)	p-value	Estimate	OR (95% CI)	p-value
Sex	0.69	1.99 (1.44 to 2.77)	< 0.001			
Age	-0.13	0.88 (0.86 to 0.90)	< 0.001	-0.10	0.90 (0.88 to 0.93)	< 0.001
BMI	-0.00	1.00 (0.97 to 1.02)	0.738			
ASA	-0.92	0.40 (0.30 to 0.53)	< 0.001			
ISAR	-0.84	0.43 (0.37 to 0.50)	< 0.001	-0.23	0.79 (0.66 to 0.96)	0.017
TUG	-0.19	0.83 (0.81 to 0.85)	< 0.001	-0.07	0.93 (0.89 to 0.97)	< 0.001
DEMMI	0.08	1.09 (1.07 to 1.10)	< 0.001	0.03	1.03 (1.01 to 1.05)	< 0.001
Treatment period						
Function-tailored	0.47	3.48 (1.03 to 2.49)	0.036	0.58	1.79 (1.00 to 3.18)	0.049
Fast-track	1.62	11.02 (3.19 to 8.00)	< 0.001	1.60	4.97 (2.73 to 9.01)	< 0.001
Prehabilitation	1.76	12.66 (3.58 to 9.46)	< 0.001	1.90	6.68 (3.51 to 12.80)	< 0.001
Linear hypotheses‡						
Function-tailored vs Joint Care	0.47		0.098	0.58		0.134
Fast-track vs Function-tailored	1.15		< 0.001	1.02		< 0.001
Prehabilitation vs Fast-track	0.14		0.855	0.30		0.571

*Univariable logistic regression model (n = 1,852), relationship between each implemented change and discharge towards home in comparison with the Joint Care period.
†Multivariable logistic regression model (n = 1,622, 230 observations deleted due to missing data) with the variables age, ISAR score, TUG time, and DEMMI score. A minimum AIC model is used (Δ AIC = AIC total model: 832.69 – min AIC model: 829.18 = 3.51).[22]
‡Post-hoc paired comparison analysis.
ASA, American Society of Anesthesiologists; CI, confidence interval; DEMMI, de Morton Mobility Index; IROA, time to inpatient recovery of activities; ISAR, identification of seniors at risk; LOS, length of hospital stay; OR, odds ratio; TUG, Timed Up and Go test.

To ensure model robustness, Cook's distance was performed, revealing a maximum value of 0.029 over all patients. Post-hoc paired comparison revealed that the percentage of patients discharged towards their PLS changed significantly (p < 0.001 (95% CI 3.19 to 8.00)) from the Function-tailored (77.7%) to the Fast-track period (91.6%). From the Joint Care (69%) to the Function-tailored period (p = 0.172 (95% CI -0.16 to 1.25)) and the Fast-track to the Prehabilitation period (92.6%) (p = 0.460 (95% CI -0.29 to 0.98)), no significant changes were found.

Discussion

This study presents the first investigation into the impact of three different care transitions on in-hospital recovery in patients undergoing TKA surgery over an 11-year period in

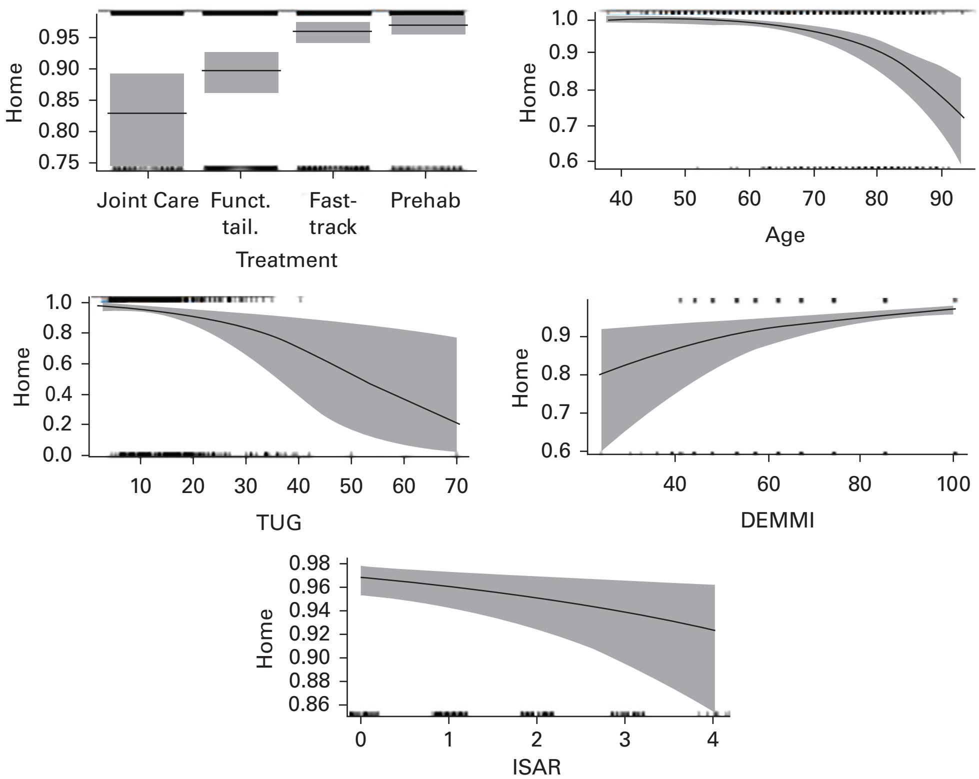

Fig. 3

Visualization of the effects of the variables: treatment period, age, Timed Up and Go test (TUG), de Morton Mobility Index (DEMMI), and identification of seniors at risk (ISAR) in the multivariable logistic regression model and their influence on discharge to preoperative living situation.

our institution. Our study takes a comprehensive approach by examining multiple care transitions over an extended duration while focusing on various aspects of in-hospital recovery. The results demonstrate consistent improvements in IROA and LOS and increased discharge towards PLS.

A strength of this study is the use of three independent outcome variables to measure in-hospital recovery, unlike previous studies that focused solely on the influence of a single care transition.[27–30] This comprehensive approach allowed assessment of multiple aspects of patients' recovery, including the reduction in hospitalization time, improvements in the speed of achieving functional capability for returning home, and the progress in patients' discharge towards their PLS. By adopting this patient-centred perspective, our study focused on the impact of perioperative care transitions from the patient's point of view. Another strength of the study is that it included data from all patients who underwent primary TKA surgery and received a preoperative functional screening from a physiotherapist. Our patient population closely matches the demographics of patients who underwent TKA included in the National Arthroplasty Registries, with similar characteristics in terms of sex, age, ASA grade, and BMI.[4]

There are some limitations to consider. Despite our methodological focus on discrete care transitions, necessitating timestamped periods to monitor the changes implemented in perioperative care, our study encountered limitations in exploring temporality due to episodic data collection. The current design makes time-series analyses impossible. Nevertheless, our approach yielded significant insights into the direct impact of the care transitions on inpatient recovery. While acknowledging that transitions in perioperative care constitute continuous learning processes, characterized by iterative cycles with anticipated gradual improvements, our data show a consistent improvement in the speed of IROA and reduction in LOS in each period of implemented care.[31] Another area of potential improvement is the measurement of LOS in days. LOS following TKA procedures is decreasing, it might be more appropriate to consider measuring LOS in hours, as suggested by some studies.[32,33] This approach to improvements in LOS would be potentially more accurate and give a stronger statistical result. Furthermore, although our patient characteristics demonstrate similarities to the general population of TKA patients in the Netherlands, we observed that in the later periods our patients had better TUG and DEMMI scores.[4] Functional preoperative status has been shown to influence in-hospital recovery.[6] Even small improvements in TUG score correlate with an improved speed of IROA.[12] In our multivariable analysis, we included TUG and DEMMI as controlling variables in our models for in-hospital recovery. Regarding the differences observed in BMI and ASA grade, their values in the four time periods in Table II indicate these were very small.

Based on the findings of our study, we advocate for the continuous monitoring of in-hospital recovery across various outcomes, including IROA, LOS, and discharge towards PLS. Our study's transitions demonstrated significant improvements in these outcomes. Over an 11-year period, the mean IROA went from 4.4 days to 2.5 days, the mean LOS went from 5.2 days to 2.9 days, and discharge towards PLS increased from 69% to 92.6%. Routine measurement of these outcomes enables hospitals to identify areas for improvement and implement targeted interventions to optimize patient outcomes. Safe and validated patient discharge can be based on the medical situation and IROA. If LOS, IROA, and discharge towards PLS can be predicted for the majority of patients, it provides a logistical advantage in planning. This predictive capability may assist hospitals in effectively using their limited resources in the future. Finally, we recommend hospitals take into account the functional perioperative status of patients and use appropriate controlling variables when analyzing in-hospital recovery.

Take home message

- This study highlights the positive impact of different perioperative care procedures on in-hospital recovery of patients undergoing primary total knee arthroplasty surgery.
- Assessing functional recovery, length of stay, and discharge towards preoperative living situation consistently provides hospitals with valuable insights into postoperative recovery, aiding in planning and identifying areas for targeted improvements to optimize patient outcomes.

Supplementary material

The supplementary material provides additional information on specific parts of the implemented interventions in preoperative total knee arthroplasty care, and provides the RECORD statement table.

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Author information:
W. F. C. van Houtert, BSc, Physiotherapist
D. O. Strijbos, MSc, Physiotherapist
Department of Physiotherapy, Nij Smellinghe Hospital, Drachten, Netherlands.

R. Bimmel, MD, Orthopaedic Surgeon, Department of Orthopaedics, Nij Smellinghe Hospital, Drachten, Netherlands.

W. P. Krijnen, PhD, Lecturer, Hanze University of Applied Sciences Groningen, Groningen, Netherlands.

J. Jager, MSc, Lecturer, Faculty of Health, University of Applied Sciences Leiden, Leiden, Netherlands.

N. L. U. van Meeteren, Prof. Dr., Professor, Department of Anaesthesiology, Erasmus Medical Centre, Rotterdam, Netherlands.

G. van der Sluis, PhD, Program Manager, Department of Health Innovation, Nij Smellinghe Hospital, Drachten, Netherlands.

Author contributions:
W. F. C. van Houtert: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.
D. O. Strijbos: Conceptualization, Investigation, Methodology, Software, Validation, Writing – original draft, Writing – review & editing.
R. Bimmel: Conceptualization, Investigation, Methodology, Resources, Writing – review & editing.
W. P. Krijnen: Conceptualization, Data curation, Formal analysis, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing.
J. Jager: Conceptualization, Validation, Writing – original draft, Writing – review & editing.
N. L. U. van Meeteren: Conceptualization, Methodology, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing.
G. van der Sluis: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing.

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