ORIGINAL ARTICLE

The role of prehabilitation in reducing the incidence of postoperative pulmonary complications in patients undergoing elective cardiac surgery: Results from the Pre Surgery Check Team study

Dorota Sobczyk[1, 2], Jacek Osiewalski[3], Hubert Hymczak[4, 5], Dominika Batycka-Stachnik[2], Sylwia Wiśniowska-Śmiałek[2], Bogusław Kapelak[2], Krzysztof Bartuś[2]

[1]Department of Cardiovascular Diseases, Institute of Cardiology, Jagiellonian University Medical College, Kraków, Poland
[2]Department of Cardiovascular Surgery and Transplantology, Institute of Cardiology, Jagiellonian University Medical College, St. John Paul II Hospital, Kraków, Poland
[3]Cracow University of Economics, Kraków, Poland
[4]1st Department of Intensive Care, St. John Paul II Hospital, Kraków, Poland
[5]Faculty of Medicine and Health Sciences, Andrzej Frycz Modrzewski Krakow University, Kraków, Poland

Correspondence to:
Assoc. Prof. Dorota Sobczyk, MD, PhD,
Department of Cardiovascular Diseases,
Institute of Cardiology, Jagiellonian University Medical College,
St. John Paul II Hospital,
Prądnicka 80, 31–202 Kraków, Poland,
phone: +48 12 614 30 72,
e-mail: dorotasobczyk@yahoo.com

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ABSTRACT

Background: Despite its importance, prehabilitation has only been implemented in very few cardiac surgery centers.

Aims: The Pre Surgery Check (PreScheck) Team study was designed to evaluate the impact of comprehensive interdisciplinary assessment and implementation of the prehabilitation program on the incidence of postoperative pulmonary complications after elective cardiac surgery.

Material and methods: 725 adult patients (338 in the study group, 387 in the control group) were included in this single-center, prospective, observational study. Multimodal prehabilitation involves four elements: interdisciplinary medical assessment by a cardiologist, an anesthesiologist, and a cardiac surgeon, pulmonary assessment for patients at high risk of postoperative pulmonary complications, psychological assessment, and physiotherapeutic assessment and training. The primary endpoint was the occurrence of postoperative pulmonary complications, and the secondary outcomes were surgical site infection, rethoracotomy, length of stay in the intensive care unit, and length of hospital stay.

Results: Prehabilitation reduced the number of postoperative complications by 23%. Postoperative pneumonia was almost 3-fold less common (5.33% vs. 14.21%), and surgical site infection — 1.4 times less common in the PreScheck group (8.28 vs. 11.37%). In the logistic regression model, prehabilitation reduced the odds of postoperative pneumonia (by 0.346) and the odds of respiratory failure (by 0.479). Prehabilitation had no direct effect on the length of stay in the intensive care unit.

Conclusions: Prehabilitation, according to the Pre Surgery Check Team standard, reduces the incidence of postoperative pulmonary complications and the total number of postoperative complications in patients undergoing elective cardiac surgery. The main benefit of participating in the PreScheck Team program is the opportunity to receive supportive preoperative interventions.

Key words: elective cardiac surgery, postoperative pulmonary complications, prehabilitation, PreScheck Team study

WHAT'S NEW?

Pulmonary complications are common in patients undergoing open chest surgery and often affect the postoperative course. Comprehensive multimodal preoperative intervention (prehabilitation), consisting of the improvement of patients' physiological, nutritional, and psychological status before planned surgery, can significantly reduce the risk of postoperative pulmonary complications and, therefore, shorten the length of stay in the intensive care unit. The participation of the patient and his family in the multidimensional process of preparation for cardiac surgery significantly influences the immediate outcome of the operation. Considering the limited time available for prehabilitation, a combination of outpatient preoperative and prehabilitation clinics seems to be an optimal solution for cardiac surgery centers. The model implemented in our hospital for all patients awaiting elective cardiac surgery is safe and effective.

INTRODUCTION

Pulmonary complications, such as pneumonia, prolonged mechanical ventilation, and pleural effusions requiring drainage, are common in patients undergoing open chest surgery [1–3]. Postoperative pulmonary complications (PPCs) result in prolonged hospital stays and healthcare costs, as well as increased morbidity and mortality after cardiac surgery [2]. The population of patients with cardiovascular diseases listed for cardiac surgery has a high prevalence of individuals at advanced age, with frailty, low cardiac fitness, and severe extracardiac comorbidities [4]. All these factors have been identified as predisposing to the development of PPCs. Prehabilitation is the process of improving patients' physiological, nutritional, and psychological status [5]. It has recently been identified as a research priority in adult cardiac surgery [6]. The Pre Surgery Check (PreScheck) Team combined traditional preoperative assessment with an outpatient prehabilitation program [4, 5].

Several meta-analyses of small clinical trials have shown that appropriately planned physical activity before cardiac surgery can reduce the risk of postoperative pulmonary complications and shorten the length of hospital stay [7–11]. A randomized controlled trial of exercise and inspiratory muscle training before cardiac surgery did not confirm the beneficial effect of physical training on exercise capacity or postoperative outcomes [12]. Physiotherapeutic assessment and implementation of respiratory exercises during the waiting period appear to be a crucial element of preoperative patient management in cardiac surgery. However, prehabilitation is a multimodal process that includes not only physical training but also other important aspects, such as optimization of comorbidity management, nutritional interventions, smoking cessation, and psychological support, whose effects will need to be investigated in future studies.

The main objective of this study was to evaluate the impact of comprehensive interdisciplinary assessment and the Pre Surgery Check Team's prehabilitation program on the incidence of postoperative pulmonary complications after elective cardiac surgery.

MATERIAL AND METHODS

This was a single-center, prospective, observational study conducted at the Department of Cardiac Surgery. The study population involved 725 adult patients (over 18 years of age) listed for elective cardiac surgery. The study group (PreScheck Team group) consisted of 338 consecutive patients (240 men, aged 29–81 years) who underwent surgery between January 1 and June 30, 2023 and comprehensive evaluation by the Pre Surgery Check Team 1-3 months before their planned cardiac surgery. The control group (No PreScheck Team group) consisted of 387 consecutive patients (275 men, aged 22–84 years) scheduled for elective cardiac surgery between March 1, 2022 and June 30, 2022, and January 1 and June 30, 2023, without preoperative multidisciplinary assessment. The exclusion criteria were 1) eligibility for emergent/urgent cardiac surgery, 2) exclusion from cardiac surgery after personal evaluation of the patient by the medical team, and 3) death in the operating room. The flowchart of the study and control groups is summarized in Figure 1.

The PreScheck Team started working in our hospital in October 2022, and all patients scheduled for elective cardiac surgery after January 1, 2023 were routinely referred for a pre-admission outpatient visit. All patients in the study group were thoroughly evaluated by the Pre Surgery Check Team during their 2-hour clinical appointments organized 1–3 months before their planned cardiac surgery. Patients in the control group were not seen by the multidisciplinary medical team before their planned surgery.

The PreScheck Team is an original concept that combines traditional preoperative evaluation and outpatient prehabilitation clinics [4, 5]. The PreScheck Team consists of the following components: 1) interdisciplinary personal medical assessment by a cardiologist, anesthesiologist, and a cardiac surgeon, who meet the patient and verify all data by physical examination; 2) pulmonary assessment (for patients with diagnosed chronic lung disease or high risk of postoperative pulmonary complications); 3) psychological assessment; 4) physiotherapeutic assessment and training [5].

Figure 2 summarizes the organizational scheme of the physiotherapy module. The data collected from interviews during physiotherapy visits included physical activity performed in the preceding period. For the majority of patients in the study group (301 patients, 89.05%), daily physical activity was low to moderate (PAL-physical activity

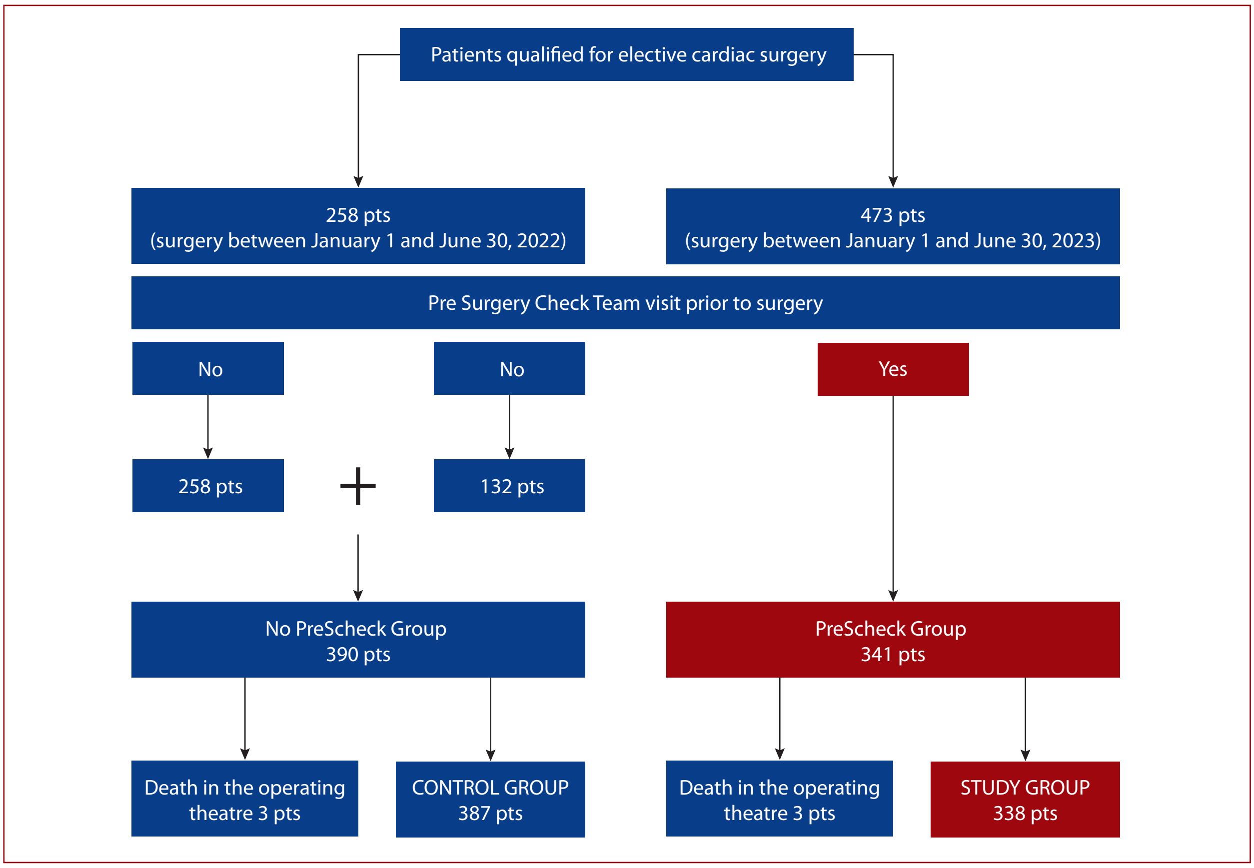

Figure 1. Flowchart of the study and control groups

Abbreviations: pts, patients

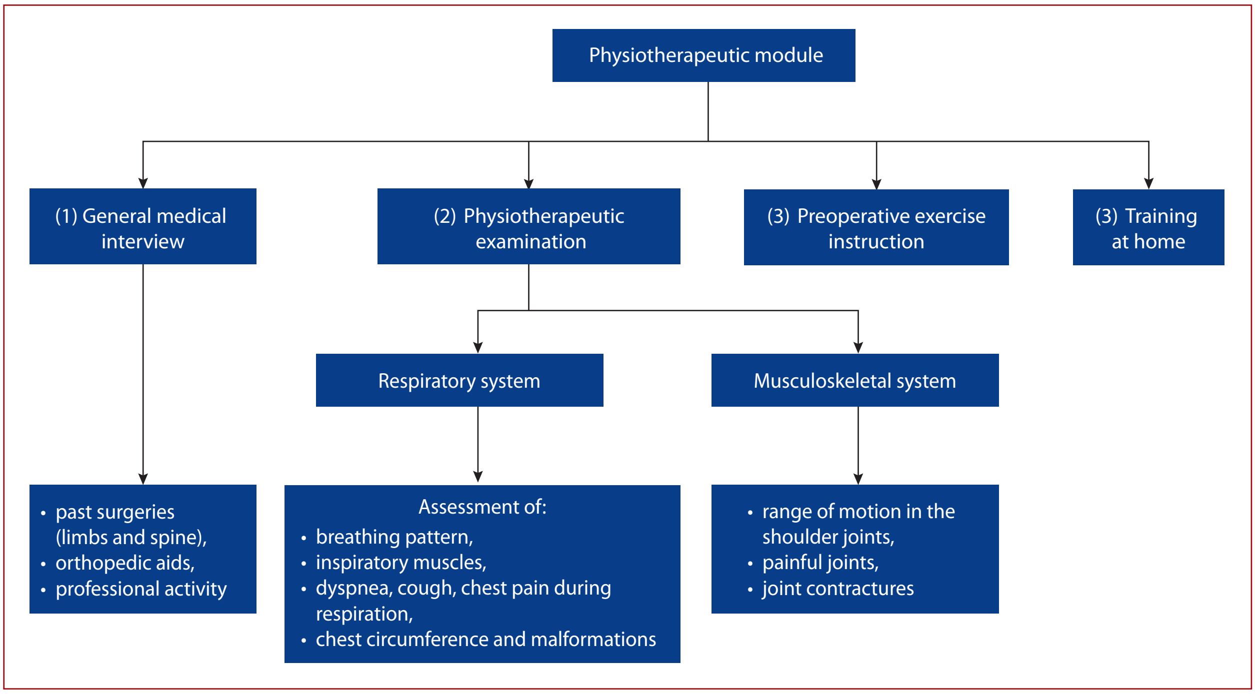

Figure 2. Organization scheme of the physiotherapy module

level 1.3–1.7) [13]. However, the most important element of the physiotherapy module was exercise instruction. The technique of performing the exercises was carefully explained to the patient and his relatives. Patients were given a booklet containing a series of general mobility and respiratory exercises (in the form of instructions with drawings). They were expected to perform seven exercises of their own choice at home for 20 minutes a day, without supervision, for 2 to 3 weeks before hospitalization. On admission to the hospital, patients were asked about their compliance with the recommendations, including the performance of the prescribed exercises, and all patients in the study group confirmed that they performed the exercises at home. An indirect way of verifying compliance with physiotherapy recommendations was that patients in the study group cooperated well with staff during postoperative rehabilitation, confirming their familiarity with the exercises. Tolerance of home exercises and the occurrence of possible adverse effects of preoperative rehabilitation were assessed on hospital admission.

The following preoperative parameters were collected: age, sex, smoking status, body mass index, chronic respiratory comorbidities, other comorbidities (arterial hypertension, diabetes, atrial fibrillation, extracardiac arteriopathy), EuroSCORE 2 grade, left ventricular ejection fraction, glomerular filtration rate, and arterial gases. Nutritional assessment with Nutritional Risk Screening 2002 questionnaire was performed on all patients [14]. Nutritional advice/intervention was given to all patients at risk of malnutrition in the study group (Nutritional Risk Screening 2002 >2). The type of surgery (coronary artery bypass grafting, valve surgery, other types of surgery, combined surgery) was also taken into account. The primary endpoint was the occurrence of PPCs: postoperative respiratory failure, pneumonia, or pleural effusions requiring drainage. Postoperative pulmonary complications were defined according to the European guidelines for perioperative clinical outcome definitions [15]. Pleural effusion was assessed by chest X-ray or lung ultrasound [16], with cut-off volume of 300 ml as requiring drainage. Only PPCs meeting the objective criteria according to the guidelines were taken into account to eliminate bias. The following secondary outcomes were assessed: surgical site infection, rethoracotomy, length of stay in the intensive care unit (ICU), and length of hospital stay.

Ethics

The study protocol was approved by the local bioethics committee (decision number 1072.6120.78.2023). All study participants signed informed consent forms.

Statistical analysis

Descriptive statistics for all our variables were performed using the PS Imago Pro 9 package (Predictive Solutions). Categorical variables were expressed as numbers and percentages, when the assumption for the χ^2 test was not met, Fisher's exact test was used to compare the groups. Continuous variables were expressed as means (standard deviations) or medians (interquartile ranges) and compared using Student's t-test or Mann–Whitney U test when appropriate.

Our data set included information on 18 predictor variables and 35 explanatory variables. We chose to model and explain 7 variables: ICU length of stay, the presence of postoperative complications affecting at least 10% of patients, and the number of all postoperative complications considered for a given patient.

The initial statistical model for each of our 7 explained variables used the same 35 potential determinants. Logistic regression was used for zero-one variables, and Poisson regression for numeric variables [17]. In both types of models, we used maximum likelihood (ML) analysis as a tool for statistical inference [17]. All results were obtained using the Python module statsmodels.

Our main objective was to find the significant determinants (out of 35 initial explanatory variables) for each phenomenon to be modeled. The final statistical model for each explained variable was based on eliminating the "least significant" explanatory variables (and the intercept, if necessary) in several steps, where at each step, the reduction of the initial model was checked using the likelihood ratio (LR) test. Such a procedure is stopped when the reduced model contains only significantly non-zero coefficients (with individual *P*-values less than 0.05), and the validity of all zero restrictions leading from the initial to the final model is confirmed by a sufficiently high *P*-value associated with the LR statistic. Recall that the asymptotic distribution of such an LR statistic is χ^2, with degrees of freedom equal to the number of zero restrictions imposed on the parameters in the initial model.

The main research question was whether prehabilitation was one of the significant determinants (i.e., the explanatory variable remaining in the final model) and whether the sign of the estimated coefficient indicated that the effect of prehabilitation was negative.

In the Results section, we present some important statistics for inference in the final models. For each variable, we show the ML estimate not for the original parameter but for its functions, an odds ratio in the case of the logit model, and the incidence rate ratio in the Poisson regression model. These ML estimates of odds and incidence rate ratios were accompanied by the corresponding *P*-values and 95% confidence intervals.

RESULTS

No adverse events related to the implementation of prehabilitation training were reported in the study group. The characteristics of both groups are summarized in Table 1. Chronic lung disease was significantly more prevalent in the study group, but the proportion of patients with obesity was lower. Preliminary analysis indicated a different incidence of the 5 most common postoperative

Table 1. Demographic and clinical characteristics of the study and control groups

Characteristics	Study group (PreScheck Team group)	Control group (No PreScheck Team group)	*P*-value
Total number of patients, n	338	387	-
Male sex, n (%)	240 (71.01)	275 (71.01)	0.99
Cardiac surgery procedure, n (%)			
Coronary artery bypass grafting	146 (43.2)	159 (41.09)	0.57
Aortic valve surgery	140 (41.42)	166 (48.89)	0.69
Aortic procedure	29 (8.57)	36 (9.3)	0.73
Mitral valve surgery	46 (13.61)	48 (12.4)	0.63
Tricuspid valve surgery	16 (4.73)	23 (5.94)	0.47
Combined surgery	74 (21.89)	72 (18.6)	0.27
Other procedure	47 (13.91)	60 (15.5)	0.54
Age, years, mean (SD)	64.3 (9.67)	64.84 (10.99)	0.48
Age >65 years, n (%)	193 (57.1)	209 (54.01)	0.4
Age >70 years, n (%)	97 (28.7)	135 (34.88)	0.07
BMI, kg/m^2, median (IQR)	27.76 (25.1–30.8)	29 (25.86–31.97)	0.75
BMI >30 kg/m^2, n (%)	95 (28.11)	155 (40.05)	<0.001
LVEF, %, mean (SD)	54.88 (9.74)	55.16 (9.57)	0.7
LVEF ≤35%, n (%)	22 (6.51)	28 (7.24)	0.7
Prior cardiac surgery, n (%)	11 (3.25)	21 (5.41)	0.16
Smoking, n (%)	40 (11.83)	47 (12.14)	0.9
Coronary artery disease, n (%)	172 (50.89)	206 (53.23)	0.53
Arterial hypertension, n (%)	250 (73.96)	304 (78.55)	0.15
Chronic lung disease, n (%)	55 (16.27)	42 (10.85)	0.03
Diabetes, n (%)	139 (41.12)	147 (37.98)	0.39
Diabetes on insulin, n (%)	19 (5.62)	11 (2.84)	0.06
Extracardiac arteriopathy, n (%)	40 (11.83)	43 (11.11)	0.76
Atrial fibrillation, n (%)	62 (18.34)	77 (19.9)	0.6
EuroSCORE 2, median (IQR)	1.25 (0.89–1.85)	1.25 (0.87–2.06)	0.83
GFR, ml/kg/1.73 m^2, median (IQR)	85 (61–95)	83 (65.75–96)	0.65
pCO_2, mm Hg, mean (SD)	37.23 (4.12)	37.07 (3.57)	0.58
pO_2, mm Hg, mean (SD)	91.9 (15.3)	91.52 (15.32)	0.74

Abbreviations: BMI, body mass index; EuroSCORE 2, European System for Cardiac Operative Risk Evaluation 2; GFR, glomerular filtration rate; IQR, interquartile range; LVEF, left ventricular ejection fraction; pCO_2, partial pressure of CO_2; pO_2, partial pressure of O_2

Table 2. Postoperative complications in the study and control groups

Complications, n (%)	Study group (PreScheck Team group) (n = 338)	Control group (No PreScheck Team group) (n = 387)	*P*-value
Rethoracotomy	32 (9.47)	39 (10.08)	0.78
Respiratory failure	26 (7.7)	60 (15.5)	0.001
Postoperative pneumonia	18 (5.33)	55 (14.21)	<0.001
Pleural effusion requiring drainage	39 (11.54)	54 (13.95)	0.33
Surgical site infection	28 (8.28)	44 (11.37)	0.17
Acute kidney injury requiring dialysis	12 (3.55)	14 (3.62)	0.96
Gastric bleeding	7 (2.07)	7 (1.81)	0.8
Neurological complications	9 (2.66)	6 (1.55)	0.29
Pacemaker implantation	15 (4.44)	15 (3.88)	0.7
Number of patients with *m* complications:			
$m = 0$	223 (65.98)	220 (56.85)	<0.001
$m = 1$	73 (21.6)	81 (20.93)	
$m \geq 2$	42 (12.43)	86 (22.22)	

complications in the study and control groups (Table 2). For example, postoperative pneumonia was almost 3-fold less common in the PreScheck group (5.33%) than in the control group (14.21%), and surgical site infection was 1.4 times less common in the PreScheck group (8.28 vs. 11.37%). Since the patients in both groups were very heterogeneous, we had to take into account all the available control variables to eliminate their influence and isolate the "true" effect of prehabilitation. The proportion of patients with postoperative complications occurring together (at least two for one patient) was lower, and the proportion of patients without complications was higher in the PreScheck group. Only the proportions of patients with one complication were similar in both groups (Table 2).

Table 3. Determinants of selected postoperative complications — results from final models

Explanatory variable	Estimated IRR/OR	*P*-value	95% CI	
			0.025	0.975
Number of complications (Poisson regression)				
Congenital heart defect	5.551	<0.001	2.686	11.484
Percutaneous intervention	2.038	0.001	1.323	3.139
Prior cardiac surgery	1.956	<0.001	1.398	2.735
Other type of surgery	2.164	0.007	1.230	3.811
Atrial septal defect plasty	1.902	0.005	1.218	2.971
Ablation	2.272	0.001	1.420	3.636
Tricuspid valvuloplasty	1.994	<0.001	1.504	2.643
Aortic surgery	2.907	<0.001	2.083	4.055
Mitral valve surgery	1.929	<0.001	1.480	2.512
Aortic valve surgery	1.598	<0.001	1.245	2.052
Minimally invasive CABG	2.633	<0.001	1.790	3.877
CABG	1.454	0.004	1.131	1.868
Prehabilitation	0.769	0.004	0.641	0.920
pCO_2	14.939	<0.001	3.861	57.858
pO_2	0.482	0.006	0.287	0.808
GFR	0.165	<0.001	0.112	0.243
Postoperative pneumonia (logit model)				
Aortic surgery	2.915	0.004	1.399	6.074
Other types of surgery	4.904	0.017	1.324	18.174
Ablation	6.437	0.005	1.775	23.313
Tricuspid valvuloplasty	3.238	0.005	1.419	7.396
Prehabilitation	0.346	<0.001	0.195	0.612
GFR	0.199	0.006	0.063	0.628
pCO_2	1520.812	0.030	2.058	1123.546
Postoperative respiratory failure (logit model)				
BMI	16.379	0.041	1.124	238.411
Congenital heart defect	10.392	0.012	1.674	64.521
Percutaneous intervention	4.229	0.007	1.477	12.097
Tricuspid valvuloplasty	3.248	0.006	1.412	7.470
Minimally invasive CABG	4.154	<0.001	1.986	8.689
Prehabilitation	0.479	0.007	0.282	0.815
EuroSCORE 2 result	1.271	0.001	1.099	1.469
GFR	0.261	0.028	0.079	0.862
Chronic lung disease	2.349	0.007	1.266	4.357

Abbreviations: CABG, coronary artery bypass grafting; CI, confidence interval; IRR, incidence rate ratio; OR, odds ratio; other — see Table 1

Determinants of postoperative complications

According to the final Poisson model, prehabilitation reduced the expected number of postoperative complications (Table 3) and was 1 of 16 determinants for the number of complications. Regarding particular postoperative complications, prehabilitation decreased the probability of postoperative pneumonia and respiratory failure. There were only 7 determinants for postoperative pneumonia and 9 determinants for respiratory failure (plus the significant intercept in both logit models), and prehabilitation was one of them in both cases (Table 4).

Determinants of the length of ICU stay

Table 4 summarizes important postoperative data for both groups. Length of hospital and ICU stay were not different between groups. However, the rates of in-hospital death, ICU stay, and hospital readmission were lower in the study group.

Since the length of ICU stay is at least one day, to use the standard Poisson regression model, our explanatory variable was defined as the number of days spent in the ICU minus one. The initial Poisson regression included all 35 preoperative explanatory variables. The direct role of prehabilitation in reducing the length of ICU stay was not confirmed because the final model did not include our crucial variable (Table 5). There were 23 determinants of the length of ICU stay (plus the significant intercept), and prehabilitation was not one of them.

DISCUSSION

The PreScheck Team study is the first clinical trial of this size to evaluate the impact of a multimodal 4-component structured prehabilitation program on the incidence of postoperative pulmonary complications in patients undergoing elective cardiac surgery. The total study population involved 725 patients (338 in the study group and 387 in the control group). The model implemented in our hospital

Table 4. Postoperative hospitalization data from the study and the control groups evaluated by regression

Variable	Study group (PreScheck Team group) (n = 338)	Control group (No PreScheck Team group) (n = 387)	*P*-value
Period between PreScheck Team visit and surgery, days, median (IQR)	50 (23–79)	Not applicable	–
Length of ICU stay, days, median (IQR)	1 (1–3)	1 (1–4)	0.8
Length of hospital stay, days, median (IQR)	9 (7–14)	8 (7–14)	0.82
ICU readmission, n (%)	7 (2.07)	27 (6.96)	0.001
Hospital readmission within 30 days after discharge, n (%)	13 (3.81)	27 (6.96)	0.07
In-hospital death, n (%)	6 (1.78)	18 (4.65)	0.03

Abbreviations: ICU, intensive care unit; other — see Table 1

Table 5. Determinants of the number of additional days (above 1 day) spent in the , intensive care unit, assessed by Poisson regression

Explanatory variable	Estimated IRR	*P*-value	95% CI	
			0.025	0.025
Age	12.317	<0.001	4.855	31.249
Age >65 years	0.614	<0.001	0.524	0.720
Chronic lung disease	1.183	0.012	1.038	1.350
Diabetes	1.251	<0.001	1.130	1.387
Diabetes on insulin	0.624	<0.001	0.480	0.811
Coronary artery disease	1.247	0.005	1.068	1.455
pCO_2	241.773	<0.001	78.649	742.483
BMI >30 kg/m^2	1.242	<0.001	1.124	1.373
LVEF ≤35%	1.197	0.023	1.025	1.399
GFR	0.270	<0.001	0.209	0.348
EuroSCORE 2 result	1.058	<0.001	1.030	1.084
CABG	1.280	0.016	1.047	1.564
Minimally invasive CABG	2.547	<0.001	1.982	3.274
Aortic valve surgery	1.530	<0.001	1.311	1.784
Mitral valve surgery	1.244	0.020	1.036	1.493
Aortic surgery	3.089	<0.001	2.521	3.785
Tricuspid valvuloplasty	2.886	<0.001	2.447	3.401
Ablation	2.447	<0.001	1.937	3.089
Other surgery	3.725	<0.001	2.832	4.899
Combined surgery	1.573	<0.001	1.347	1.839
Percutaneous intervention	1.507	0.004	1.142	1.989
Congenital heart defect	8.298	<0.001	5.652	12.170
Prior cardiac surgery	2.319	<0.001	1.840	2.921

Abbreviations: see Tables 1 and 3

from October 1, 2022 assumes that all patients awaiting elective cardiac surgery will eventually be included in the prehabilitation program [4, 5]. Currently, approximately 100 patients per month are evaluated by the PreScheck Team before hospital admission. Due to the large number of patients and logistical constraints (e.g., the need to use ward staff), an unsupervised home training model was used in the first phase of introducing prehabilitation as a standard of care (Figure 2). Despite these limitations, the results of the study are very encouraging. All postoperative pulmonary complications (respiratory failure, pneumonia, pleural effusion requiring drainage) were less frequent in the PreScheck group (Table 2). According to the logit model, the positive effect of prehabilitation was significant in the case of postoperative respiratory failure and pneumonia (Table 3). For the latter, prehabilitation reduced the odds of postoperative pneumonia by a factor of about 0.346 (all other characteristics held constant). Similarly, prehabilitation decreased the odds of postoperative respiratory failure by a factor of about 0.479.

Furthermore, in the parsimonious Poisson regression model, prehabilitation significantly reduced the expected number of postoperative complications for a given patient (Table 3). In our case, the expected number of postoperative complications for a given patient was approximately 23% lower if the patient had undergone prehabilitation (compared to a patient with exactly the same characteristics who did not undergo this procedure).

Several small single-center trials with different types of prehabilitation before cardiac surgery have reported up to a 50% reduction in postoperative pulmonary complications, reduced readmission rates, and, in the elderly, reduced length of hospital stay [7–11]. Only two randomized controlled trials have focused on physical exercise and inspiratory muscle training [12, 18]. Patients eligible for coronary artery bypass grafting (CABG) were included in the study by Hulzebos et al. [18]. Preoperative, tailored, individualized inspiratory muscle training (IMT) reduced the incidence of PPCs and length of hospital stay in patients at high risk of developing pulmonary complications after CABG. In the study by Akowuah et al. [12], a combination of exercise and IMT before cardiac surgery was not superior to standard care in improving functional exercise capacity as measured by a 6-minute walk test preoperatively. The authors reported no significant differences in postoperative surgical and pulmonary complications. Despite the conflicting results, both meta-analyses of small trials and sub-analyses of randomized trials show that the greatest benefit of prehabilitation is seen in the highest-risk patients, i.e., older, less fit, very frail patients [8, 12, 19]. Another randomized multicenter controlled trial (PRECOVERY) was designed to evaluate the effectiveness of 2 weeks of inpatient multimodal prehabilitation for patients aged 75 years or older undergoing elective cardiac surgery [20].

Prehabilitation seems to be one of the main preoperative interventions to improve recovery after cardiac surgery. Unfortunately, despite strong interest, it has only been implemented in very few cardiac surgery centers [21]. This is most likely due to two reasons: 1) concerns about the safety of physical training in patients awaiting cardiac surgery, and 2) the waiting time for surgery is too short to allow for prehabilitation. Several studies have shown that prehabilitation in the form of physical exercise and/or IMT is feasible and safe in cardiac surgery patients [12, 18, 19]. In our study, we also reported no adverse events related to the implementation of prehabilitation training. Considering the limited time available for prehabilitation, the PreScheck program implemented in our center seems to be an optimal solution because it combines both the pre-admission outpatient and prehabilitation clinics. It allows the multidisciplinary team to simultaneously assess and confirm the patient's eligibility for surgery and perform prehabilitation to ensure optimal preparation for surgery.

In the study by Akowuah et al. [12], about half of the patients declined to participate in exercise training due to travel constraints, and only 71% of the recruited patients attended at least half of the supervised exercise sessions. In our study, 72.09% of patients listed for surgery from January 2023 attended at least one PreScheck Team visit. However, the percentage of patients attending an outpatient clinic is currently approximately 90% of all patients awaiting elective cardiac surgery. Feedback from the PreScheck Team staff indicated that both patients and their families were enthusiastic about participating in prehabilitation. Patients and their relatives, who are always encouraged to accompany the patient during PreScheck Team visits, particularly appreciate the opportunity to discuss their risk stratification data and treatment strategies with the multidisciplinary medical team. A visit to the prehabilitation clinic makes the patient aware that he or she is not just a subject but also an equal partner in the treatment process. The main benefit of attending these visits is undoubtedly the opportunity to perform supportive preoperative interventions. Reducing the patient's surgical risk is not only related to improving physical fitness and inspiratory muscle strength. There are other important elements, such as optimizing the management of comorbidities, nutritional interventions, smoking cessation, or reducing anxiety levels through psychological support.

The study has several limitations. First, the impact of disqualifying extremely high-risk patients during preoperative visits should also be considered. The main reason for permanent exclusion from cardiac surgery was unacceptably high operative risk associated mainly with advanced age, frailty, morbid obesity, and pulmonary status. Second, only patients who were eligible for elective cardiac surgery were included in the study. Third, regardless of individual risk, all patients in the study group underwent the same prehabilitation model. The PreScheck Team prehabilitation model can be described as "interventional" prehabilitation because it involves a single outpatient clinic visit for most patients before surgery. Future research should focus on the effects of individualized prehabilitation over several weeks in the highest-risk group of patients.

Prehabilitation, according to the PreScheck Team model, reduces the incidence of some postoperative pulmonary complications in patients undergoing elective cardiac surgery. The significant effect of prehabilitation on other postoperative data (like in-hospital deaths or ICU and hospital readmission rates) could also be expected; however, this is left to future research.

Article information

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