ORIGINAL RESEARCH

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Effects of the cardiac rehabilitation program on the quality of life in patients after open-heart surgery

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Abstract

Objective: Cardiovascular disease (CVD) is a leading factor in global mortality and morbidity, but the use of effective cardiac rehabilitation tools improves the prognosis. The main benefits of cardiac rehabilitation include a 33% increase in metabolic equivalents and a 16% increase in maximal oxygen consumption. This improvement during exercise is associated with beneficial effects on quality of life (QoL) and cardiovascular outcomes. In this regard, it is important to determine the QoL of patients undergoing cardiac rehabilitation program.
The purpose of the study: to assess the quality of life of patients who underwent a cardiac rehabilitation program after open-heart surgery using the SF-36 questionnaire.

Methods: Overall, 104 patients admitted to the rehabilitation department through the state portal who underwent open -heart surgery were included in the study. The study design is a prospective clinical cohort analysis. The criteria for inclusion in the study are men and women who have undergone open-heart surgery over the age of 18 and exclusion criteria were specified. In patients, the SF-36 questionnaire was collected from the moment of admission to the day of discharge, as well as during the follow-up periods after 3-6 months, and the Wong-Baker scale was used to assess pain.

Results: As a result of the QoL and pain assessment, it was found that the intensity of pain decreased by 1.3 times by 20%, the quality of life increased by 1.2 times by 17%, and the psychological status improved by 1.2 times by 15%. The patient's training increased not only physically, but also emotionally, which has a positive effect on the patient's QoL and social adjustment.
The Wonga-Baker scale is used to track the presence of pain. Before cardiac rehabilitation, patients had 3-4-5-6 points on the Wonga-Baker scale, rarely 7-8-9-10 points, and after rehabilitation most often only 1-2-3 points, that is, the feeling of pain is much lower pressed.

Conclusion: Conducting a cardiac rehabilitation program in patients after open-heart surgery improves their quality of life, social status and postoperative pain.

Key words: cardiac rehabilitation, SF-36 questionnaire, Wong-Baker scale, exercise, open-heart surgery

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Introduction

Cardiovascular diseases (CVD) is a leading factor in global mortality and morbidity, but the use of effective cardiac rehabilitation (CR) program tools improves prognosis. The main benefits of CR include a 33% increase in metabolic equivalents and a 16% increase in maximal oxygen consumption. This improvement during exercise is associated with beneficial effects on quality of life (QoL) and cardiovascular outcomes (1, 2). Therefore, it is necessary to understand the risk factors and CR programs as an effective way to help patients with CVD. Different societies and associations recommend varies CR programs and all of them meet professional standards (3).

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Graphical abstract

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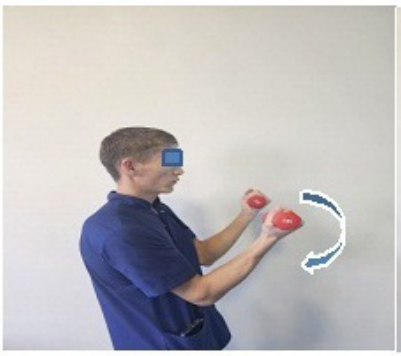

Types of surgery of 104 patients who underwent CR	
CABG, n(%)	44 (42.3)
RIMA, LIMA – CABG, n(%)	13 (12.5)
MVR, n(%)	28 (26.9)
AVR, n(%)	12 (11.5)
MVR + AVR, n(%)	5 (4.9)
CHD correction, n(%)	2 (1.9)

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CR is a comprehensive measure aimed at restoring the physical, psychological and social condition of people with CVD, stabilizing and preventing the further development of the atherosclerotic process, thereby reducing morbidity and mortality rates. CR is used as a secondary prophylaxis method (4). The main tasks of CR programs as a method of secondary prevention is decreasing the down-course of diseases related to the cardiovascular system; to improve a positive effect of treatment CVD; to increase the awareness of the impact of lifestyle on the QoL of patients with CVD. These tasks are organized on the basis of the "Health schools for patients who have experienced a myocardial infarction and their relatives" program. In addition, the tasks of CR include: involving patients in physical activity and rehabilitation programs; psychological support for patients with cardiovascular diseases in order to adapt to the presence of a chronic disease (5).

The purpose of the study: to assess the quality of life of patients who underwent a CR program after open heart surgery using the SF-36 questionnaire and to determine pain dynamics before and after CR according to the Wong-Baker scale.

Methods

Study design and population

The study design is a prospective cohort analysis.
Overall, 104 patients who underwent open-heart surgery and admitted to the rehabilitation department through the state portal were included in the study – and named Group 1R. Also as a control group, we added 94 patients, who did not follow CR program and were managed only medical drug treatment from previous years – named as Group 2C. The criteria for inclusion in the study Group 1R were men and women who have undergone open heart surgery over the age of 18; and exclusion criteria were patients whom rejected an informed consent and without open heart surgery.

The research was conducted at the CardioMed Clinic, Shymkent, Republic of Kazakhstan.

The study was performed in accordance with the relevant clinical practice standards (Good Clinical Practice) and the principles of the Declaration of Helsinki. The research protocol was approved by the Ethics committee of the CardioMed clinic. Written informed consent was obtained from all participants about the treatment procedure and possible complications before inclusion in the study.

Baseline variables

We assessed demographic variables as age, sex, risk factors of CVD – smoking, body mass index, hypertension, and diabetes, types of cardiac surgery and medical treatment.

Cardiac rehabilitation

Before the start of the rehabilitation measures, the patients were given instructions on the program, and each patient was given a methodical instruction with a complete description of the rehabilitation program and its structure (Fig. 1 and Fig. 2).

Before hospitalization, patients underwent all laboratory and instrumental tests according to the clinical protocol in a local clinic, and if any defects are detected, they are sent to a full re-examination or a profile specialist consultation without being referred to the rehabilitation department. For this reason, when assigning a CR program to a hospitalized patient, all additional conditions and diseases were accounted, and for this reason, individually directed exercises, types of physical therapy, and drug treatment were given. CR program is prescribed according to a specially designed structure for patients after open heart surgery with copyright. The program includes sitting and standing exercises (see description - Fig. 1 and 2.)

Figure 1. Exercise (sitting) up to 6 months after surgery

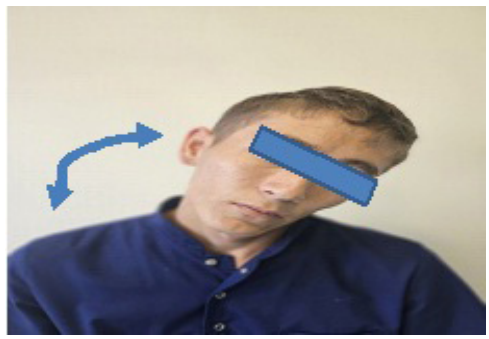
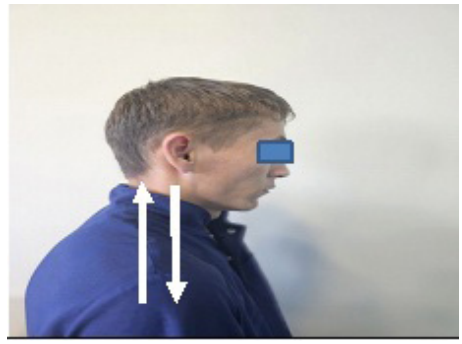
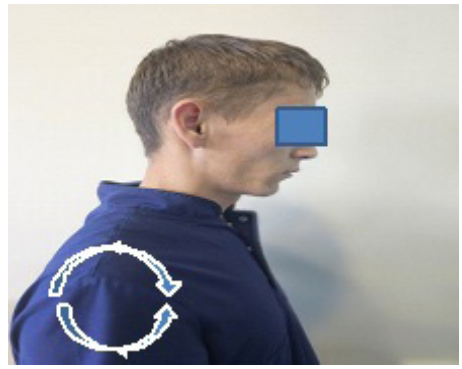
1. Sitting with good posture. Keeping the head straight, tilt to the right and left in turn. Repeat 4-5 times. Keep the face forward and tilt the ear to the right. Repeat to the left.	
2. Raise the shoulders to the ears, then lower the shoulders. Repeat 4-5 times.	
3. Sitting upright, roll the shoulders up, back and down in a circle. Repeat in reverse order 4-5 times.	
4. Chest rotation - slowly turning the chest to the right and left. Repeat 4-5 times.	

Figure 1. Exercise (sitting) up to 6 months after surgery – continues from page 254

5. Chest tilt to the side - slowly tilt the chest to the right and left. Repeat 4-5 times.	
6. Sitting upright, raising the left hand with the thumb up. Raise your arms forward above your head. The elbow should be near the ear. Repeat with the other hand 4-5 times	
7. The arms are relaxed at the sides, the elbows are straight, the hands are stretched straight back. Repeat 4-5 times.	

Figure 2. Exercise (standing) after 6 months post-surgery

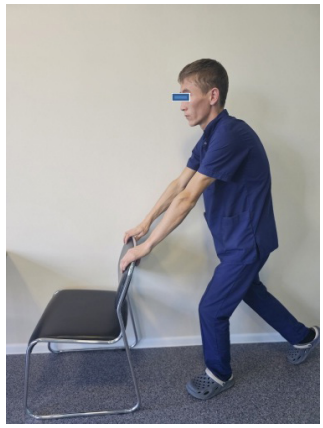
Exercise 1. Hold the chair with both hands and take a large step back with the right leg, then slightly bend the left leg for balance, hold the position for 8-10 seconds. Then return to the starting position. Next, take a large step back with the left leg, then bend the right leg slightly for balance, hold this position for 8-10 seconds. Return to the starting position.	

Figure 2. Exercise (standing) after 6 months post-surgery – continues from page 255

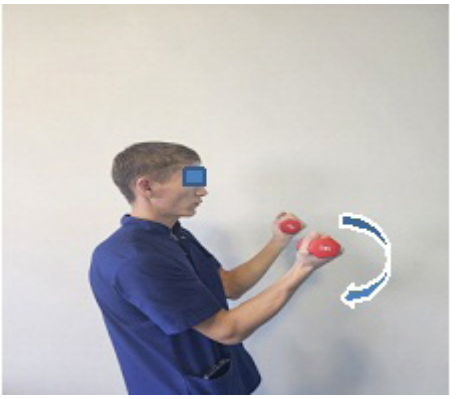
Exercise 2. Put the right leg to the right without bending the knee, and keep the left leg straight. Place the right leg without bending the knee, and keep the left leg straight. Put the left leg to the left without bending the knee, keep the right leg straight. Place the left leg without bending the knee, keep the right leg straight.	
Exercise 3. Double-arm curls with equipment (ball, dumbbell, etc.) toward the shoulders, then toward the knees at the same pace for 30 seconds.	
Exercise 4. Bend the body from one side to the other for 30 seconds. Hands should be on the hips. In some cases, you can hold onto the back of the chair for balance.	

Figure 2. Exercise (standing) after 6 months post-surgery – continues from page 255

Exercise 5. Reaching forward or grabbing the back of a chair. Gradually raise the right leg and left leg up to the knee.	
Exercise 6. While standing, turn to the right and left with a light equipment (ball, dumbbell, etc.) holding both arms straight.	
Step up on the STEP PLATFORM with your right leg, then step down with your left leg for 20-60 seconds. Regular repetition of the movement. Keep walking.	

Quality of life – SF-36 questionnaire

Patients' quality of life was assessed before and after CR using the SF-36 questionnaire (6). The SF-36 measures eight scales: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional state (RE), and mental health (MH).

Wong-Baker's pain scale

Wong-Baker's pain scale was used to assess the condition of adult patients (11): this scale consists of 6 points, from laughing (absence of pain) to crying (excruciating pain) - from 0 to 10 in the scoring system.

The pain evaluator explains to the patient which one should be chosen from the recommended pain level. Individual registration cards with clinical and functional examination data were created for each patient.

Data collection and follow-up

Data collection periods during the study are from the moment of hospitalization to the day of discharge, as well as the follow-up period after 3-6 months. The duration of CR lasts 14 days in the rehabilitation department.

Statistical analysis

Statistical analysis was carried out using Microsoft Excel 2007-2010 (Microsoft Corp., USA) and STATISTICA (StatSoft, USA) statistical software's. Qualitative indicators are presented as absolute frequencies and percentages. Continuous variables as arithmetic mean (standard error, SE).

Examination of pre- and post-treatment defects in quantitative terms for comparison or normal distribution was performed for unrelated groups (Student's t-test analysis). In the case of non-observance of the law of normal distribution, the numerical separation of two different groups was carried out according to the Mann-Whitney U-test. Comparison of two different groups according to qualitative characteristics was carried out by Pearson Chi-square test. If treatment was performed for multiple treatments or post-test, normal-function analysis of variance (ANOVA) was performed on quantifications performed at multiple stages, which was also used for continuous testing, and γ-squared analysis of categorical means was used. All adjustment values at $p< 0.05$ were considered significant.

Results

Clinical characteristics

As can be seen Table1 there were no any statistically significant differences in the demographic characteristics of the patients and risk factors for CVD and types of surgery, though mitral calve replacement had tendency to be higher in Group 1R. Also, among all the operations performed, only 11% surgeries were emergent, all the other surgeries were performed as planned after preliminary preparation. Therefore, heart failure circulatory disorders as NYHA IV were observed only in 5% of operated patients in main Group 1R.

Table 1. Patient's characteristics

Variables	Group 1R (n=104)	Group 2C (n=92)	p
Age, years	51.96 (1.13)	52.3 (1.04)	0.36
Men, n(%)	68 (65.4)	61(66.3)	0.064
Women, n(%)	36 (34.6)	31(33.6)	0.45
Risk factors			
Smoking, n(%)	21 (20.2)	14 (15.2)	0.08
Body mass index, kg/m2	29.8 (0.47)	28.5 (0.6)	0.096
Arterial hypertension, n(%)	70 (67.3)	65(70.6)	0.163
Diabetes type 2, n(%)	23 (22.1)	19(20.6)	0.174
Surgery			
CABG (2 or more vessels), n(%)	44 (42.3)	39(42.4)	0.097
Only mammaro-coronary shunting n(%)	13 (12.5)	19(20.6)	0.326
Mitral valve replacement, n(%)	28 (26.9)	13 (14.1)	0.069
Aortic valve replacement, n(%)	12 (11.5)	11(11.9)	0.47
Mitral - aortic prosthesis, n(%)	5 (4.9)	7(7.6)	0.128
Correction of CHD, n(%)	2 (1.9)	3(3.4)	0.169

Data are presented and mean (SD) and n(%)
CABG – coronary bypass surgery, CHD – congenital heart disease

Patients received standard medical therapy, including beta-blockers, ACE inhibitor inhibitors, acetylsalicylic acid, lipid-lowering therapy, diuretics or other antithrombotic drugs, proton pump inhibitors, and others as shown in Table 2. There were no differences between groups in treatment they received, although there was tendency but not significant to higher use of warfarin in Group 1R, that may be explained by also tendency to higher number of mitral replacement therapy.

Table 2. Medical drug therapy			
Medical drug	**Group 1R (n=104)**	**Group 2C (n=92)**	**p**
Warfarin n(%)	26(25)	21(22.8)	0.09
Clopidrogel, n(%)	38(36.5)	28(30.4)	0.145
Ticagrelor, n(%)	38(36.5)	29(31.5)	0.123
Acetylsalicylic acid, n(%)	76(73.1)	70(76)	0.174
B-blockers	83(79.8)	78(84.7)	0.369
ACE inhibitors, n(%)	64(61.5)	55(59.7)	0.1
Calcium channel blockers, n(%)	17(16.3)	14(15.2)	0.255
Diuretics, n(%)	73(70.2)	64(69.5)	0.33
Digoxin, n(%)	13(12.5)	9(9.8)	0.14
Pantaprasol, n(%)	18(17.3)	11(11.9)	0.651
Data are presented as n (%) ACE inhibitor – angiotensin-converting enzyme inhibitor			

Effects of CR on quality of life (Table 3)

An assessment of the QoL after cardiac rehabilitation was carried out in patients only in Group 1R, since in the control Group 2C the patients had already been discharged, it was difficult to carry out the survey and it was not possible. However, in the future, all patients will be called for re-treatment and then a survey will be conducted to assess the QoL after drug treatment.

According to the Table 3, as a result of the assessment of the QoL, it was found that the intensity of pain decreased by more than 20%, the lifestyle increased by up to 17%, and the psychological status improved by 15%. The patient's training increased not only physically, but also emotionally, which has a positive effect on the patient's QoL and social adjustment. There were significant improvements in the physical functioning ($p<0.05$), vitality ($p<0.05$) and mental health ($p<0.05$) and increase in role limitations ($p>0.05$) throughout CR during hospital stay, 3 months and 6 months follow –up as compared to before start of CR.

Table 3. Results of quality of life assessment					
SF-36	**The day of admission to rehabilitation**	**On the day of discharge from the hospital**	**After 3 months**	**After 6 months**	**p**
Physical functioning	61.61(1.15) (23.7; 87,39)	65.3(1.09) (29.51; 89.65	68.01 (1.04) (35.25; 89.88)	70.39 (1.04) (36.72; 89.98)	<0.05
Role limitations	50.65(1.24) (5.01; 71.35)	55.43(1.26) (10.03; 81.65)	58.05 (1.22) (15.05; 82.54)	60.64(1.2) (16.73; 83.56)	<0.05
Pain	54.44(1.21) (30.62; 81.20	38.03(1.24) (34.07; 49.56)	50.81 (1.18) (37.52; 59.98)	43.23(1.11) (38.55; 50.1)	>0.05
General health	53.99(0.94) (35.48; 77.63)	57.3(0.95) (41.16; 81.05)	59.68 (0.90) (45.02; 82.05)	52.17(0.86) (46.71; 83.45)	>0.05
Vitality	53.95(0.97) (31.85; 73.78)	57.58(0.98) (36; 77.81)	60.17 (0.96) (38.73; 79.46)	62.56(0.93) (40.12; 80.05)	<0.05
Social functioning	54.6(0.90) (36.2; 78.23)	58.09(0.90 (39.1; 80.1)	54.68 (0.85) (42.06; 81.05)	53.05(0.81) (45.03; 82.56)	>0.05
Role limitations due to emotional problems	48.71(0.97) (6; 69.43)	52.29(0.92 (16.82; 72.33)	51.03 (0.85) (26.37; 74.13)	51.43(0.84) (28.76; 76.46)	>0.05
Mental health	52.06(0.97) (33.67; 78.34)	55.34(0.99) (37.99; 81.29)	57.8(0.95) (40.01; 82.77)	60.28(0.90) (44.05; 83.41)	<0.05

Effect of CR on Wonga-Baker scale of pain

As can be seen form Table 4, in Group 1R the patients had 3-4-5-6 points on the Wonga-Baker scale before CR, rarely 7-8-9-10 points, and after rehabilitation most often had only 1-2-3 points, that is, the feeling of pain is more significantly reduced (p=0.0012). In Group 2C, we revealed that 3-4 points increased but -5-6-7 points did not change results in overall less significant differences (p-0.02), and mostly the subjective improvement may be due to waiting for the treatment and self-esteem.

Table 4. Wonga-Baker scale analysis

Pain scale		**n**	**%**
Group 1R. Before rehabilitation			
Points	3.00	3	2.9
	4.00	31	29.8
	5.00	44	42.3
	6.00	15	14.4
	7.00	2	1.9
	8.00	4	3.8
	9.00	2	1.9
	10.00	3	2.9
	Total	104	100.0
Group 1R. After rehabilitation			
Points	1.00	10	9.6
	2.00	58	55.8
	3.00	36	34.6
	Total	104	100.0
*p- before/after = 0.0012			
Group 2C. Before treatment			
Points	3.0	5	4.8
	4.0	22	25.9
	5.0	31	34.6
	6.0	24	23.3
	7.0	8	10.5
	8.0	1	0.9
	Total	92	100
Group 2C. After treatment			
Points	3.0	21	23
	4.0	33	34.7
	5.0	21	25.9
	6.0	13	14.5
	7.0	2	1.9
	Total	92	100
*p-value before/after = 0.0245			

Discussion

The key finding of our study is that a CR program with properly exercises improves the QoL and social adaptation, which in turn improves the patient's vitality; in addition, a decrease in the pain threshold during exercise shows the possibility of the patient returning to the daily routine of life.

The main problem of CR programs is the discrepancy between their proven clinical effectiveness and the low percentage of patient participation. In the USA, the frequency of participation of patients in rehabilitation after cardiac surgery is 10-20%, in Europe - about 35% (7-9), also in Kazakhstan the data's in same level, but in last 1-2 years, it is become more popular among patients.

Cowie et al (10) showed that the improvement of indicators of CR is influenced by regular physical activity and the relationship between good exercise and tolerance. We also revealed that 'the rest' significantly reduces cardiovascular resistance to exercise and contributes to physical weakness.

Perrotti et al. (11) found that cardiac surgery has a lasting and positive impact on both the physical and mental components of QoL based on the results of a study that included 272 patients (213 men, 59 women); the mean age at inclusion was 65 (10) years. Ten years after the operation, 81 patients (29.7%) died. The composite physical component score (PCS) was significantly higher at 5 years postoperatively than at baseline ($p < 0.01$) and significantly lower at 10 years than at 5 years ($p < 0.01$), although there was a significant difference between 10-year PCS and baseline score ($p = 0.004$). The total mental component score was significantly higher at 5 years than at the time of surgery ($p < 0.001$) and remained significantly higher compared to baseline at 10 years after surgery ($p = 0.010$) (11). In the second stage of CR in the hospital, drug therapy in the cardiac surgery hospital always continues. In additions, changes and substitutions are carried out depending on the patient's drug tolerance and his clinical condition. Work at this stage is aimed at continuing the treatment of postoperative complications, trying to achieve a stable index of international normalized ratio, arterial pressure, heart rate, and increasing physical activity of patients, lifestyle and providing recommendations to outpatient doctors (12). However, in our study we did not find any significant difference in Wonga-Baker scale even after optimal medical therapy in comparison to performed CR program, where Wonga-Baker scale became better.

Based on the results of the meta-analysis (14 randomized controlled studies including 1739 participants) the CR resulted in statistically significant and clinically significant improvements in physical performance and overall health (SF-36) at 6 months, and in physical functioning at 12 months (13). In another meta-analysis consisting of 24 studies (n=4890): of these, 15 short-term and 9 medium-term studies with 36-item short-term questionnaires (SF-36), EuroQol-5D (EQ-5D) and MacNew. Six short-term and five medium-term domains of the SF-36 questionnaire statistically favoured exercise-based cardiac rehabilitation. For only two SF-36 short-term outcomes, "physical function" and "role physical", the benefit was significant. A meta-analysis of short-term measures of the physical and mental components of EQ-5D and MacNew, as well as medium-term measures of the physical component of SF-36, showed no statistically significant benefits. As a result, there is some evidence of a short-term positive impact of modern exercise-based CR on the QoL of people with coronary artery disease (14). Statistically significant and sustained improvements were also found in our study in social and physical functioning, but our exercise program is different.

In an era in which adherence to clinical practice guidelines has improved survival, CR continues to provide clinically meaningful improvements in physical performance, overall health, and physical functioning in the short and long term in today's patients.

Secondary prevention is very important for people who have undergone coronary bypass surgery. The development of atherosclerosis in local coronary arteries continues even after coronary bypass grafting, and the risk of complications in the vein remains. It is necessary to regulate this process in patients with ischemic heart disease using traditional medicines and non-medicinal methods, as exercise-based CR (15).

Study limitations

We did not include data on the results of left ventricular ejection fraction, as well as the relationship with the level of heart failure and the complexity of the operation by EuroScore with the ongoing CR program, since they were already indicated in another article.

Conclusion

Conducting a CR program in patients after open-heart surgery improves their quality of life, social status, and postoperative pain. Exercises performed during CR are easy and effective, and it would be an additional advantage to determine the quality of life.

Ethics: Informed consent was obtained from patients before all procedures, and study protocol was approved CardioMed Clinic Ethic`s Committee.

Peer-review: External and internal

Conflict of interest: None to declare

Authorship: M. B., B. A.B., K.S.T., K.S.K., Z. S. B., B.Y. equally contributed to the study, preparation of manuscript and fulfilled authorship criteria

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Statement on A.I. - assisted technologies: None to declare

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