

Early postoperative complications in heart transplant patients hospitalised in the intensive care unit

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Key words: heart failure, transplantation, nursing care, intensive care, complications.

Abstract

Introduction: Heart transplantation remains the most effective therapy for end-stage heart failure. Despite medical and surgical progress, early complications remain a challenge.

Aim of research: To identify early postoperative complications and the factors that distinguish them.

Material and methods: The study employed the method of documentoscopy, utilising quantitative and descriptive analysis techniques. Data were collected using the author's questionnaire, which was based on the analysis of patients' medical records – completed by nurses and doctors – and direct observation of patients treated in the Department of Anaesthesiology and Intensive Care. The data collection covered the years 2019 to 2023. Analysed variables included demographic data, details of the surgical procedure, postoperative parameters, assessment methods, haemodynamic support, volume of transfused blood products and their components, pharmacotherapy and immunosuppressive treatment, length of hospitalisation, and complications.

Results: In the early postoperative period after heart transplantation (HTX), the most common complications were respiratory failure and cardiac arrhythmias. Patients with cardiac arrhythmias, infection, acute kidney injury (AKI), and respiratory failure were hospitalised for longer periods. Blood product transfusions are affected by haemoglobin values and the amount of drainage. Age over 50 years is associated with an increased risk of infection after surgery. The need for mechanical support of circulation before HTX reduces the risk of cardiac arrhythmias after surgery.

Conclusions: drainage volume, diuresis volume, central venous pressure, surgery time, cardiopulmonary bypass time, and clamping time of the recipient's aorta significantly affected postoperative complications.

Introduction

Heart failure is a condition in which the heart is unable to pump enough blood to the organs of the body, often caused by dilated cardiomyopathy or ischemic heart disease [1, 2]. It affects around 23 million people worldwide and 3.2% of the Polish population [3, 4]. Heart failure (HF) should be considered for heart transplantation if optimal medical therapy, as recommended by the ACC/AHA (American College of Cardiology/American Heart Association) guidelines, and cardiac resynchronisation therapy has failed to improve symptoms or halt progression of the underlying pathology. Transplantation significantly improves survival and quality of life in patients with advanced heart failure [3, 5, 6].

In Poland, 178 heart transplants were performed in 2023, with a total of 1286 since 2015. Advances in surgical techniques, immunosuppression, and patient selection have increased survival rates, although complications remain a key challenge, especially in the early postoperative period [7, 8]. The importance of continuous education and training for intensive

care unit (ICU) nurses is highlighted to maintain their competence in handling the unique challenges associated with heart transplant patients [9].

There are relatively few studies on heart transplant complications in patients after transplantation.

Aim of the research

The aim of this study was to present the complications that occurred in patients in the early postoperative period after heart transplantation and the factors that distinguish them.

Material and methods

Study design and sample

The retrospective study used the documentoscopy method, analysing medical records of adult heart transplant patients hospitalised in the ICU from 2019 to 2023. Records of patients undergoing other cardiac surgeries were excluded. Of 73 cases reviewed, 2 were excluded due to incomplete data, resulting in a final sample of 71 patients, including 62 men and 9 women.

Data collection

Data were collected using a questionnaire developed by the author from November 2023 to February 2024 at the medical archive of one of the six heart transplantation centres in Poland. Reviewed medical records included patient history, intensive care cards, surgical protocols, pain management, and immunosuppressive treatment documentation, as well as results from the New York Heart Association (NYHA), Numerical Rating Scale (NRS), and Behavioural Pain Scale (BPS).

The questionnaire covered demographic data, cause of transplantation, comorbidities, surgical details, and postoperative information such as vital signs, pharmacotherapy, haematotherapy, and complications. The tool was created based on a literature review.

Statistical analysis

The collected research material was subjected to quantitative and descriptive analysis. Descriptive statistics were applied to measurable variables, while categorical variables were presented as counts (*n*) and percentages (%). Normality was tested using the Shapiro-Wilk test. For non-normal distributions, the Wilcoxon rank-sum test was used. The Friedman test compared repeated measures, Pearson's correlation assessed linear relationships, and the χ^2 test examined associations between dichotomous categorical variables. The Kruskal-Wallis and Mann-Whitney tests compared independent groups. Analyses were conducted using IBM SPSS Statistics 22, with significance set at $p < 0.05$.

Results

In this study, women accounted for 12.7% of the study group, whereas men accounted for 87.3%. The patients studied were between 22 and 65 years of age. The mean age of the patients was 49.21 ± 12 years, with a median age of 53 years. The main cause of heart transplantation is heart failure, which is unspecified (40.8%, $N = 29$), congestive heart failure (23.9%, $N = 17$) or dilated cardiomyopathy (18.3%, $N = 13$). Smoking occurred in 22.5% ($N = 16$) of patients. The NYHA score before surgery was equal to 3 or 4 points. All patients received positive inotropic drugs prior to surgery. Preoperative mechanical cardiovascular support was implemented in 15.5% ($N = 11$) of patients. The average right atrial pressure was 6.87 ± 5.03 and was measured for 12 people.

The average duration of operation was 318.55 ± 74.21 minutes. The mean duration of cardiopulmonary bypass was 154.30 ± 31.19 minutes. The mean aortic clamping time was 82.68 ± 21.16 minutes.

Clinical status of patients after heart transplantation

Table 1 shows vital signs during the first 7 days after heart transplant. The decreasing number of pa-

tients reflects ICU discharges due to clinical improvement or death.

Selected health factors of patients after heart transplantation and the occurrence of complications after heart transplantation

The most common complications in heart transplant patients were respiratory failure (47.9% $N = 34$), arrhythmias (43.7% $N = 31$), transplant rejection and AKI (both 33.8% $N = 24$), infections (31% $N = 22$), and cardiac tamponade (26.8% $N = 19$). Bleeding occurred in 12.7% and neurological issues in 4.2% of patients. ICU mortality affected 19 people, and 15 people were readmitted. Average length of ICU stay was 16.87 ± 14.8 days.

Infections were more frequent in patients over 50 years of age. Arrhythmias were significantly more common without pre-transplant mechanical circulatory support. Post-op hyperglycaemia on day 0 was seen in 74.1% of patients.

Postoperative bleeding was more common in patients with a heart rate > 120 bpm (beats per minute) on day 3 ($p = 0.05$) and active drainage > 100 ml/h on day "0" ($p < 0$), with a haemoglobin value in the range of 6–8 g/dl on day "0" ($p = 0.03$). AKI occurred more frequently in patients whose day-3 systolic blood pressure was between 80 and 100 mm Hg ($p = 0.02$), those on day 3 ($p < 0$) and day 7 ($p = 0$), diuresis less than 50 ml/h, a day-7 CVP greater than 10 ($p = 0$), and day-7 BPS or NRS values less than 5 ($p = 0.03$).

Respiratory failure or other respiratory complications occurred more frequently in patients whose day-3 systolic blood pressure was 80–100 mm Hg or 101–120 mm Hg and whose day 3 diuresis was less than 50 ml/h ($p < 0$), or day 7 diuresis of less than 50 ml/h ($p = 0$), day 7 had glycaemia of more than 10 mmol/l ($p = 0.04$), day 7 had a CVP of more than 10 ($p = 0.01$), and a day-7 BPS or NRS score of less than 5 ($p = 0$). Eight percent ($N = 3$) of patients with postoperative respiratory failure or other pulmonary complications were smokers. HFNO and BIPAP were each used in 55.9% ($N = 19$) of patients, and 30.1% ($N = 22$) of patients experienced respiratory failure.

Arrhythmias were linked to longer surgery, bypass, and aortic clamping times ($p = 0$). ICU stays were prolonged due to arrhythmia, infection, AKI, and respiratory failure ($p < 0$). All patients received cardiac monitoring; 59.2% had external pacemakers. Blood transfusions correlated with high drainage and low haemoglobin on day 0. In patients whose active drainage at day 0 exceeded 100 ml/h, PRBCs (packed red blood cells) were transfused significantly more often ($p = 0.03$).

The selected factors and variables related to the duration of medical procedures affecting the occurrence of postoperative complications are shown in Tables 2 and 3.

Table 1. Vital signs during the first 7 days after heart transplant surgery

Parameter	Day					
	Day "0"		Day "3"		Day "7"	
	N	%	N	%	N	%
Systolic blood pressure						
< 80 mm Hg	2	2.8	0	0.0	1	1.8
80–100 mm Hg	24	33.8	9	13.0	8	14.5
101–120 mm Hg	38	53.5	48	69.6	37	67.3
< 120 mm Hg	7	9.9	12	17.4	9	16.4
Heart rate						
< 60	1	1.4	0	0.0	0	0.0
60–80	36	50.7	31	44.9	20	36.4
81–100	22	31.0	24	34.8	22	40.0
101–120	11	15.5	12	17.4	8	14.5
> 120	1	1.4	2	2.9	5	9.1
Diuresis						
< 50 ml/h	5	7.0	15	21.7	18	32.1
50–100 ml/h	24	33.8	19	27.5	9	16.1
> 100 ml/h	42	59.2	35	50.7	29	51.8
Drainage						
> 100 ml/h	8	11.3	0	0.0	0	0.0
< 100 ml/h	63	88.7	69	100.0	44	100.0
Haemoglobin						
< 6.0 g/dl	0	0.0%	0	0.0	0	0.0
6.0–8.0 g/dl	2	2.8	0	0.0	0	0.0
8.1–10.0 g/dl	28	39.4	30	43.5	12	21.4
> 10 g/dl	41	57.7	39	56.5	44	78.6
Glycaemia						
< 3.9 mmol/l	0	0.0	0	0.0	0	0.0
3.9–5.5 mmol/l	0	0.0	1	1.4	0	0.0
5.6–10 mmol/l	17	23.9	64	92.8	50	89.3
> 10 mmol/l	54	76.1	4	5.8	6	10.7
CVP						
< 2	0	0.0	0	0.0	0	0.0
2–10	34	47.9	15	21.7	32	57.1
> 10	37	52.1	54	78.3	24	42.9
Pain						
0	0	0.0	2	2.8	15	21.2
< 5 BPS or < 5 NRS	71	100.0	69	97.2	56	78.9
5–7 BPS or 5–7 NRS	0	0.0	0	0.0	0	0.0
> 7 BPS or > 7 NRS	0	0.0	0	0.0	0	0.0

CVP – central venous pressure, BPS – Behavioural Pain Scale, NRS – Numerical Rating Scale.

Table 3. Selected variables of duration of medical procedures vs. complications after heart transplant surgery

Factors	Length of hospitalisation			Duration of procedure			Extracorporeal circulation time			Aortic cross-clamping time		
	M	SD	P	M	SD	P	M	SD	P	M	SD	P
Cardiac tamponade	No	14.96	13.96		314.15	77.08		154.42	30.92		81.42	22.54
	Yes	22.11	16.15	Z = -1.926; p = 0.054	330.58	66.12	Z = -1.260; p = 0.208	153.95	32.77	Z = -0.059; p = 0.953	86.11	16.90
Bleeding	No	16.61	14.22	Z = -0.113; p = 0.91	313.77	73.07	Z = -1.538; p = 0.124	154.92	31.95	Z = -0.346; p = 0.729	82.34	20.74
	Yes	18.67	19.27		351.44	77.98		150.00	26.58		85.00	25.15
Arrhythmia	No	11.45	9.90	Z = -4.425; p < 0	299.25	63.60	Z = -2.533; p = 0.011	144.45	27.91	Z = -2.966; p = 0.003	76.55	21.19
	Yes	23.87	17.15		343.45	80.33		167.00	31.00		90.58	18.63
Transplant rejection	No	18.19	16.09	Z = -0.463; p = 0.644	326.68	80.85	Z = -1.276; p = 0.202	156.66	32.32	Z = -0.87; p = 0.384	82.79	22.56
	Yes	14.29	11.78		302.63	57.33		149.67	28.94		82.46	18.59
Infection	No	11.00	5.18	Z = -4.671; p < 0	311.43	76.66	Z = -1.567; p = 0.117	152.35	30.25	Z = -0.703; p = 0.482	81.55	19.03
	Yes	29.95	20.23		334.41	67.39		158.64	33.49		85.18	25.61
Aki	No	12.57	10.76	Z = -4.469; p < 0	311.21	65.29	Z = -0.979; p = 0.328	154.62	29.74	Z = -0.17; p = 0.865	79.49	20.89
	Yes	25.29	17.99		332.92	88.93		153.67	34.51		88.92	20.71
Respiratory complications	No	10.32	6.49	Z = -5.096; p < 0	305.35	61.33	Z = -1.22; p = 0.222	151.68	29.54	Z = -0.657; p = 0.511	79.43	21.91
	Yes	24.00	17.84		332.91	84.67		157.15	33.10		86.21	20.04
Neurological complications	No	16.29	13.40	Z = 0.989; p = 0.989	316.13	73.98	Z = 0.13; p = 0.141	154.12	31.05	Z = 0.852; p = 0.861	82.59	18.93
	Yes	30.00	37.27		373.33	68.37		158.33	41.63		84.67	60.50

AKI – acute kidney injury; M – mean, SD – standard deviation, p – significance level, Z-test.

Discussion

The obtained results allow us to understand the importance the therapeutic team plays in the care of patients after heart transplantation. A nurse in the ICU should recognise worrying symptoms in heart transplant patients at an early stage and report them. This allows for the proper identification of postoperative complications and the implementation of appropriate treatment [10, 11].

According to studies by Neethling *et al.* in heart transplant patients, the main complications are AKI (72%), respiratory complications (34.7%), arrhythmias (41.8%), and postoperative bleeding (8.4%). Their studies revealed respiratory failure or other respiratory complications (47.9%), arrhythmias (43.7%), cardiac rejection (33.8%), and AKI (33.8%). Postoperative bleeding occurred in 12.7% of patients [12].

Pulmonary complications are common after heart transplantation and may result from heart failure duration, extracorporeal circulation, immunosuppressants, or comorbidities [13, 14]. According to Fischer MO, for example, pulmonary complications such as dyspnoea, pneumonia, pleural effusion, and respiratory failure occur in 1 in 2 patients after cardiac surgery. This leads to an increase in the length of hospitalisation in the intensive care unit and in the hospital [13]. In our own studies, 47.9% of patients who underwent heart transplantation developed respiratory failure or other respiratory complications, which significantly increased the duration of hospitalisation in the ICU.

Non-invasive ventilation (NIV) is effective in managing respiratory failure post HTX. Bozbaş *et al.* applied NIV in 3 of 9 patients with respiratory failure at 1-week post-transplant [14]. In our cohort, 47.1% of patients with respiratory failure received NIV. Although 8.8% of smokers developed respiratory failure, the association was not statistically significant.

According to Kourek *et al.*, postoperative hyperglycaemia, i.e. a glycaemic value > 10 mmol/l, affects 30% of patients after cardiac surgery and increases the risk of AKI [15]. In in-house studies, 76.1% of patients had postoperative hyperglycaemia on day 0. Glycaemia values > 10 mmol/l on day 0 have not been shown to significantly increase the incidence of AKI in patients.

The literature indicates that prolonged cardiopulmonary bypass increases the risk of AKI, which extends the ICU stay. Elevated CVP is also associated with postoperative AKI [8, 16]. Our study confirmed that AKI prolongs ICU hospitalisation, but cardiopulmonary bypass time had no significant effect on AKI incidence. Those requiring continuous renal replacement therapy (CRRT) stayed in the intensive care unit for an average of 25 ± 19 days, compared with 12 ± 10 days for those without AKI [17]. Our data also showed a statistically significant association between AKI and elevated CVP.

Postoperative haemorrhage treatment after heart transplantation is rarely addressed in the literature; however, the use of four-factor prothrombin complex concentrates, platelet concentrates, and irradiated leukocyte-poor packed red blood cells is recommended [8, 15]. In our study, most transfusions of PRBCs occurred in patients with drainage > 100 ml/h on day 0 and were more frequent in those with lower haemoglobin levels.

Infections most often occur within the first month posttransplant. Therefore, after HTX, the patient is placed under protective isolation. Standard infection control measures include protective isolation, hand hygiene, equipment disinfection, and daily linen changes [7]. In our cohort, infections affected 31% of patients. According to Carrillo-Gómez *et al.*, bacterial infections are predominant in the first month posttransplant, accounting for 21.05% of cases [18]. Another study identified diabetes and recent antibiotic use as key infection risk factors within the first year post transplant, underscoring the importance of stringent infection control measures immediately after transplantation [19]. A review of early postoperative management strategies after heart transplantation included the prevention of infections due to immunosuppression [20].

Studies have shown that older age increases the risk of infection after heart transplantation. Sponga *et al.* reported more frequent infections in patients over 40 years of age [21], while Pons *et al.* found a significant association between age over 60 years and early bacterial or fungal infections [22]. Our data confirmed that infections occurred significantly more often in patients over 50 years of age. Other studies also linked age > 60 years with higher rates of graft dysfunction, infections, and complications [23, 24].

Our study showed a link between the occurrence of cardiac arrhythmias and the duration of surgery, cardiopulmonary bypass, and aortic cross-clamping – the longer these times, the higher the arrhythmia risk. While similar findings are scarce in the literature, one study did report a significant association between prolonged cross-clamp time and arrhythmias within 48 h after surgery [25]. Other recent studies have confirmed these durations as key risk factors [26]. The literature indicates that pre-transplant mechanical circulatory support (MCS) does not significantly affect postoperative mortality [23, 27], which is consistent with our findings. However, in our study, arrhythmias were more common in patients without prior MCS. This finding is supported by studies indicating that pre-transplant MCS may reduce the risk of severe arrhythmias and improve clinical outcomes [28–30], whereas its absence is linked to higher rates of complications and mortality [31, 32].

No comparison of mortality rates with data from other countries was made due to the lack of access to

sufficiently accurate and comparable data, which prevented a reliable international analysis.

Conclusions

In the early postoperative period after heart transplantation, respiratory failure and arrhythmias were the most common complications. Incidence of complications was influenced by drainage volume, diuresis, CVP, surgery duration, extracorporeal circulation time, and aortic implantation time. Older patients had more infections, and arrhythmias were more frequent in those without prior mechanical circulatory support.

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Ethical approval

The study was approved by the director of the hospital, the head of the department, the Dean of the Faculty of Health Sciences at the Jagiellonian University Medical College.

Conflict of interest

The authors declare no conflict of interest.

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