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RISK FACTORS FOR VERY LONG ICU STAY AFTER CARDIAC SURGERY AND EFFECTS ON THE QUALITY OF LIFE

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Abstract

Risk factors for long stay in Intensive Care Unit (ICU) and the effect on the quality of life following cardiac surgery are of interest as the recourses for patient recuperation increase. The aim of the study was to assess risk factors inducing very long stay in a ICU after cardiac surgery and the quality of life a year later and more. This is a three years prospective and retrospective study at a university hospital ICU with 17 beds. Eighty out of 3619 patients undergoing cardiac surgery under extracorporal circulation and necessitating more than nine days ICU, are included in the study group. Patients with ICU stay more than 14 days out of same group – very long stay – are subject to additional risk factors study. Eighty-three of the operated patients with up to three days ICU stay represent the control group. Generic NHP questionnaire is used [1]. Multifactorial analysis determines as risk factor dopamine infusion > 13 days ($P < 0.001$) (ODD = 167.5). Patients who experienced sepsis have affected physical ability ($P = 0.014$), those with low cardiac output syndrome, social isolation ($P = 0.023$) and affected physical ability ($P = 0.011$) and emotional reaction ($P = 0.001$) Very long stay in ICU following cardiac surgery is caused by persistent heart failure complicated by respiratory and renal one, as well as need of massive blood transfusion. Patients with long ICU stay and surviving sepsis and/or LCOS experience long term effects on the quality of life.

Key words: very long ICU stay, cardiac surgery, risk factors, quality of life

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Introduction. The development of interventional cardiology has changed heart surgery patients profile [2]. Consequently, ICU stay following cardiac surgery is higher due to increased risks. New technologies and gained experience allow survival after long-term treatment. Risk factors for very long stay in ICU of patients after heart surgary continue to be studied due to increased costs for their survival [3]. Their effect on QoL is important in connection with the increased interest of relatives and patients [4]. In the literature the two problems are discussed separately [1, 5]. A lot of aspects of quality of life are not elucidated due to subjective questionnaires and different social status. Most of the studies deal with quality of life after uncomplicated cardiac surgery with beneficial issue. Seventy percent of ICU patients after cardiac surgery report good quality of life [4]. Patients with long ICU stay (and multi organs failure) [6] have low physical functionality and emotional reactions. A very small number of papers discuss very long ICU stay and related quality of life [2]. This motivates us for a new study based on our previous research [7–9]. We focused on the influence of risk factors on the very long stay in ICU. We studied the influence of additional factors on QoL and used new methodological approaches. Some additional conclusions can be drawn from the obtained results. The aim of the study was to assess risk factors inducing very long stay in an ICU after cardiac surgery and the quality of life a year later and more.

Materials and methods. The study population consists of 163 patients out of 3619 cardiac surgeries in a three year (2013–2015) period at University hospital "St. Ekaterina". Patents' age varies from 39 to 79 mean 67.18 ± 10.36. Male are 126 (77.3%), female 37 (22.7%) with M:F ratio 3.4:1. The study group consists of 80 patients undergoing more than nine days ICU stay. Initially patients are divided into study group and control group. In the study group two subgroups are considered: 41 patients with ICU stay ≥ 9 to ≤ 13 days and 39 – with ≥ 14. Eighty-three patients with ICU stay up to three days form the control group. Table 1 presents types of surgery in the study group and control group.

Methods. Patients data are collected from hospital information system, medical history and include filled out data of previous studies [7–9]. The same inclusion and exclusion criteria were used. Inclusion criteria: Survivors at one year or more after hospital discharge who spent nine or more days in the ICU following cardiac surgery with CPB. Exclusion criteria: Off-pump cardiac surgery procedures, heart transplant procedures, patients after ECMO, patients undergoing transcatheter aortic valve implantation (TAVI), patients with complications after an angiographic procedure and patients with acute myocardial infarction; prolonged ICU stay is defined to be nine or more days which is over the 90th percentile of the patient population in the ICU; very prolonged ICU stay – according literature data is ≥ 14 days [1,4,10,12] and mechanical ventilation more than 48 h is considered prolonged. Cardiac output lower than 2 $\mathrm{l/m^2}$ is considered LCOS (Low Cardiac Output Syndrome).

Table 1

Comparative analysis regarding types of surgery in the study group and control group

Surgery	Control group		Study group		P
	n	X	n	X	
Age	83	68.14 ± 8.89	80	65.45 ± 11.50	0.106
	n	%	n	%	
Male	65	78.3	61	76.3	
Female	18	21.7	19	23.7	
AVR	30	36.1	21	26.3	0.182
MVR	11	13.3	19	23.8	0.106
ABC					
0	23	27.7	30	37.5	n.s.
1	13	15.7	7	8.8	n.s
2	12	14.5	8	10.0	n.s
3	26	31.3	22	27.5	n.s
4	8	9.6	13	16.3	n.s
5	1	1.2	0	0	n.s
Pl.MV	19	22.9	12	15.0	0.234
Pl.TV	5	6.0	10	12.5	0.182
Resec.LV	6	6.0	5	4.3	1.000
Trombect LA	1	1.2	3	3.8	0.361
Sutura ASD	0	0	4	5.0	0.056
Open chest	0	0	1	1.3	0.491
Reoperatio	1	1.2	3	3.8	0.361

Quantitative evaluation of the significant factors for prolonged ICU stay was performed by means of logistic regression. Due to the irregular distribution ROC curve method was used. Internal regressive analysis in the study group regarding days on stay in ICU between group of patients with ICU stay from ≥ 9 to ≤ 13 days and with ICU stay ≥ 14 days is performed by means of logistic regression and the irregular distribution ROC curve method. Additionally, through a comparative analysis, we looked for differences in quality of life. A comparative analysis of the QoL was made within the studied group of patients with prolonged stay in ICU in relation to two additional factors; with and without sepsis and with and without the presence of LCOS. Sepsis is assessed according to [10].

Statistical analysis was performed by using the IBM SPSS Statistics 23.0 statistical package. For a significance level at which the null hypothesis is rejected, $P < 0.05$ was assumed. The following methods were applied: descriptive analysis, variation analysis, graphic analysis, alternative analysis, Fisher's exact test and χ^2 test, nonparametric test for Kolmogorov–Smirnov and Shapiro–Wilk, Student's t-test, non-parametric Mann–Whitney test. Binary logistic regression is used to

quantify the influence of the studied factors, ROC curve – to determine threshold values of quantitative characteristics in order to classify certain conditions.

Results. The results of the comparative and regressive analysis of factors for prolonged ICU stay between control group and study group are presented in Table 2.

In the regression analysis model only Mechanical Ventilation (MV) and Dopamine infusion persisted. One day of Mechanical Ventilation increases the risk of long ICU stay 36 times. Six or more days Dopamine infusion increases the risk

T a b l e 2

Comparative and regressive analysis of factors for prolonged ICU stay between control group and study group

Variable	Control group-83			Study group-80			P
	n	X	SD	n	X	SD	
Euro score%	81	9.11	7.38	72	13.07	10.90	0.005
EF% preoper.	83	51.72	9.34	79	44.46	12.27	< 0.001
EF% postoper.	83	44.98	6.76	78	39.96	10.78	0.001
ECC – min	59	92.47	30.65	73	111.74	34.93	0.001
Cross. clamp – min	59	50.31	20.24	70	59.00	23.83	0.035
Reperf – min	59	34.46	14.93	70	42.30	16.84	0.004
Bleeding	78	646.67	349.96	71	939.79	582.08	0.001
PaO_2–1 h	78	181.45	67.34	71	154.62	65.00	0.016
CPK – max	79	961.38	1398.86	70	1687.80	1849.86	< 0.001
Lactat – 1h	77	2.19	1.22	67	3.81	3.08	< 0.001
Creatinin – max	79	146.92	53.38	66	260.64	123.31	< 0.001
MV – days	83	0.66	0.25	80	5.49	729	< 0.001
Dopamin – days	83	1.78	1.89	80	14.09	8.99	< 0.001
IABP – days	83	0.07	0.66	80	3.69	5.30	< 0.001
HF – days	83	0.01	0.11	80	1.69	3.69	< 0.001
Stay ICU – days	83	2.87	1.55	80	15.69	7.95	< 0.001

Individual					
Variable	Comparison	OR	Low limit	Hight limit	P
Dopamin – days	$\geq 6/ < 6$	240.000	61.318	939.366	< 0.001
IABP – days	$\geq 2/ < 2$	54.667	7.238	412.910	< 0.001
HF	Yes/No	31.103	4.077	237.306	< 0.001
MV – days	$\geq 1/ < 1$	30.916	13.118	72.861	< 0.001
Creatinin max	$\geq 145/ < 145$	5.767	2.774	11.990	< 0.001
Lactat	$\geq 1.75/ < 1.75$	3.700	1.799	7.610	< 0.001
EURO score	$\geq 5/ < 5$	3.316	1.514	7.261	0.003
Bleeding	$\geq 500/ < 500$	3.195	1.533	6.659	0.002
CPB – min	$\geq 80/ < 80$	2.678	1.203	5.962	0.016
Cross clamp	$\geq 40/ < 40$	2.508	1.124	5.598	0.025
EF %	$\geq 55/ < 55$	2.115	1.039	4.303	0.039
Multifactorial					
MV – days	$\geq 1/ < 1$	36.117	4.203	310.398	0.001
Dopamin – days	$\geq 6/ < 6$	297.826	29.782	2978.364	< 0.001

Table 3

Comparative analysis of QL between the two subgroups

	Group of patients with ICU stay ≥ 9 to ≤ 13 days			Group of patients with ICU stay > 14 days			P
	n	X	SD	n	X	SD	
Dopamin/d	41	9.95	2.87	39	18.44	11.01	< 0.001
MV – days	41	3.11	2.51	39	8.00	9.55	< 0.013
IABP – days	41	2.51	3.47	39	4.92	6.54	0.144
CPB – min	39	110.95	34.40	34	112.65	36.03	0.803
HF	41	0.76	1.89	39	2.67	4.67	**0.036**
Blood all	26	1569.50	821.69	23	2817.22	1882.91	**0.006**
EL	41	28.18	30.65	39	36.41	34.84	0.262
PA	40	16.89	24.14	39	19.86	26.44	0.786
ER	41	18.34	22.14	39	25.17	28.51	0.339
S	41	33.34	35.03	39	42.03	35.27	0.428
SI	41	16.14	25.03	39	11.23	21.73	0.157
P	41	22.90	25.64	39	36.57	33.69	0.089

Legend: EL – energy level, PA – physical ability, ER– emotional reaction, S – sleep, SI – social isolation, P – pain

Variable	Compar	Individual				Groups			
			95% CI				95% CI		
		OR	Lower limit	Upper limit	P	OR	Lower limit	Upper limit	P
MV	$\geq 2/ < 2$	2.361	0.895	6.229	0.083				
Dop/day	$\geq 13/ < 13$	62.900	15.592	253.749	< 0.001	156.788	11.328	2170.046	< 0.001
All blood	> 100 ml	1.073	1.016	1.133	0.012	1.004	0.918	1.099	0.925

influence approximately 298 times. Table 3 presents the results of the internal comparative and regressive analysis between group of patients with ICU stay from ≥ 9 to ≤ 13 days and with ICU stay ≥ 14 days.

The group analysis showed that risk influence increased 157 times for Dopamin infusion ≥ 13 days and blood products infusion did not have statistical importance.

Table 4 presents the comparative analysis in the study group of patients with prolonged ICU stay with and without sepsis and with and without presence of LCOS regarding the QoL.

The analysis shows a significant difference in energy levels in patients with sepsis as compared to those without. In patients with LCOS emotional responses, energy levels, and social isolation were statistically significantly different from those without extensive LCOS.

Discussion. This study is oriented towards late results. We focus on survivors and how they manage life after severe critical care. Low quality of life is of social importance and concerns patient's family and relatives. The aim of the study is to look for risk factors associated with very long ICU stay and QoL one

Table 4

Comparative analysis in the study group of patients with prolonged ICU stay with and without sepsis and with and without presence of LCOS regarding the QoL

	No sepsis			Sepsis			P
	n	X	SD	n	X	SD	
EL	58	28.75	32.08	13	40.26	34.58	0.236
P	58	16.81	22.31	13	20.22	27.79	0.710
ER	58	19.00	23.32	13	25.70	27.15	0.274
S	58	33.62	35.10	13	54.85	33.61	0.058
SI	58	13.09	22.04	13	13.85	28.64	0.798
PA	58	22.93	26.57	13	46.91	35.39	0.014
	No LCOS			LCOS			
	n	X	SD	n	X	SD	
EL	21	17.43	23.40	24	27.00	32.60	0.355
P	21	13.17	20.71	24	12.40	21.35	0.7832
ER	21	7.83	17.14	24	23.59	24.46	0.001
S	21	40.22	33.14	24	35.64	40.68	0.707
SI	21	1.99	6.32	24	14.87	24.83	0.023
PA	21	13.21	13.04	24	34.93	31.55	0.011

Legend: EL – energy level, P – pain, ER – emotional reaction, S – sleep, SI – social isolation, PA – physical ability

year after hospital discharge. We used multifactorial analyses providing variables which allow to predict higher risk for a certain result. Regarding the analysis of the long stay between the studied group and the representatives (83) of the general population (163) dopamine (> 6 days), (OR $= 297.826$), ($P = 0.001$) and MV (> 1 day) (OR $= 36.117$), ($P = 0.001$) are the main risk factors (Table 2). They are related to respiratory and heart failure (HF). Hein et al. [5] describe as independent factor for ICU stay > 14 days respiratory and renal failure. Heart failure during the first days is a factor associated with post cardiotomy syndrome. Dalén et al. [11] describe postoperative HF in patients with preserved EF as a major cause of poor early and late outcomes. Our results in relation to the duration of stay are similar. QoL in the study group is worse in terms of Pain, Emotional Reaction, Sleep, and Physical Abilities as demonstrated in our previous studies [7]. The interest towards detailing the study is based on the broad spectrum of patients conditions in the group (80), wide ICU stay range (9–50 days), elderly patients with a longer stay in the ICU report a better quality of life compared to young people with a shorter stay, patients who experienced sepsis and LCOS only in the study group: 39% are above 70 years old, 39 (49%) of the patients have more than 14 days ICU stay.

We divided the study group into two subgroups: patients with ICU stay < 9 to 13 days and > 14 days. In comparative analysis the subgroup > 14 days demonstrates significant difference regarding PMV, dopamine infusion (HF), massive

blood transfusion and hemofiltration. These observations come from our previous studies [9]. The new element is that we use binary logistic regression analysis. We had to apply the method of ROC curves to establish their threshold values. Only dopamine remained in significant values ($P = 0.001$), (OR = 156.788), respective HF. Regarding the QoL there was no significant difference between the two subgroups (Table 3). Our results differ from those stated in the literature. Most authors do not report heart failure as a reason for very long stay in the intensive care unit after cardiac surgery. Hein et al. [5] consider it a factor only in the early stage of ICU stay. In our studies dopamine (HF) is a factor that is present in both group analyses. We assume that HF is the main factor responsible for long ICU stay. Cardiac surgery aims at treating HF patients surgically. Postoperative management is connected to treating HF. Mebazaa et al.. [12] find that acute heart failure perioperatively occurs in 20% in heart surgery patients. The probable success in such patients is high due to curability of myocardium postoperatively [13]. We can summarize that the successful and rapid treatment of HF in patients with long stay in ICU leads to shorter stay. The different length of stay is due to accompanying complications – LCOS with respiratory failure, renal failure and massive blood transfusion. de Oliveira Sa et al. [14] show that LCOS causes longer ICU stay, need of mechanical ventilation a renal complications. Later sepsis develops. Murthy et al. [15] demonstrate that hemodynamical status at the moment of admittance in ICU (LCOS, use of vasopressors, pulmonary hypertension) and early postoperative events (stroke, bacteriaemia) are of greater importance than pre- and intra operative variable for mechanical ventilation. We hypothesize that part of patients with persistent HF were temporarily curable with the intensive medicine tools. Later with resumption of heart failure in combination with the consequences or complications led to a longer stay. Patients surviving HF and respiratory failure with sepsis and LCOS have longer problems with QoL after discharge from hospital – one year and more (Table 4). This is a very small group, but requires serious management and greater financial and human resources [3]. Probably reducing the percentage of this population will be a good criterion for long term success of our work. Patients surviving LCOS have more impairments. In long term plan we hypothesize that impaired QoL is a mirror of persistent HF and the consequences related to sepsis and/or LCOS reduce physical activities, which limit social contacts and impaired emotional stability (Table 4). It is difficult to define whether this result is associated with the surgical intervention and the prolonged stay or is due to biological processes of accelerated ageing after critical suffering [4], but the consequences are a fact. The study group is heterogeneous and very small [9] but ICU does not possess strictly profiled beds and cardiac surgeries are not performed on selected heart disease patients. The resources needed for these patients are enormous – about 550 bed days. All of them have long stay and the associated need for recourses and methods for treating cardiac failure, respiratory failure, massive haemotrans-

fusion and haemofiltration. We can respond to the sceptics of this hypothesis that finally surgical treatment of heart disease makes the patient "less" heart diseased. Early good results do not guarantee long term success [16]. Furthermore we could suggest that such patients survived more than a year to be assessed in terms of level of independency, emotional status, ejection fraction, physical capacity, heart failure therapy, renal failure. This may help us gather more knowledge regarding the criteria for treatment success and indications for surgery. What motivated us to perform this study? In the efforts to achieve remarkable results regarding survival rate in certain patient group we forget the most important aspect of our profession – the social impact. The euphoria among the relatives of the patient's discharge after a long stay in the ICU is replaced by disappointment and painful expectation due to the lack or very slow recovery. There is a lack of information in this respect. Studies in this field will contribute significantly to collect important data for the relatives of the patients and to justify resources spent on treatment. Our study is novel with no similar one in the scientific literature. We covered a non selected population of operated patients with long ICU stay and survivors one year after hospital discharge (70%). This is the way we analyzed short term and long term results. By means of different statistical analyses we looked for relationships between long ICU stay, risk factors and QoL. In fact a complete model of the research has been done. The focus of further investigations has to be directed to improving the preoperative health condition of the patient, as well as discussion with the relatives regarding the duration and complexity of the treatment, timely discussion for the possible need of postoperative health care and financial recourses needed. The limitations of this study are one-time estimation of quality of life, lack of data on QoL before operation which affects dehospitalization [17], relatively small group of patients and lack of data about dehospitalization [18].

Conclusion. Very long stay in ICU following cardiac surgery is mainly caused by persistent or badly managed heart failure complicated by respiratory and renal failure, as well need of massive blood transfusion. Survived patients with long ICU stay after cardiac surgery who experienced sepsis and/or LCOS have lower QoL a year or more later.

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