

Gajos Małgorzata, Włoszczyk Patryk, Mioduska Monika, Wałęsa Grzegorz, Kujawska Agnieszka, Androsiuk Perkowska Joanna, Perkowski Radosław, Wnuk Zaparucha Agnieszka, Karczewska Katarzyna, Bieniek Daria, Husejko Jakub, Skierkowska Natalia, Topka Weronika, Missima Maurycy. Postoperative functioning of cardiac patients. Diagnostic methods of postoperative monitoring and risk of mortality. *Journal of Education, Health and Sport*. 2019;9(2):437-449. eISSN 2391-8306. DOI <http://dx.doi.org/10.5281/zenodo.2579657>  
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## Postoperative functioning of cardiac patients. Diagnostic methods of postoperative monitoring and risk of mortality

Małgorzata Gajos<sup>1</sup>, Patryk Włoszczyk<sup>2</sup>, Monika Mioduska<sup>2</sup>,  
Grzegorz Wałęsa<sup>2</sup>, Agnieszka Kujawska<sup>2,3</sup>, Joanna Androsiuk-Perkowska<sup>1</sup>,  
Radosław Perkowski<sup>1</sup>, Agnieszka Wnuk-Zaparucha<sup>2</sup>,  
Katarzyna Karczewska<sup>2</sup>, Daria Bieniek<sup>1</sup>, Jakub Husejko<sup>1</sup>,  
Natalia Skierkowska<sup>1</sup>, Weronika Topka<sup>1</sup>, Maurycy Missima<sup>2</sup>

*1. Department and Clinic of Geriatrics, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Poland.*

*2. Cardiology and Cardiosurgery Clinic, Military Clinical Hospital No. 10 with Policlinic in Bydgoszcz, Bydgoszcz, Poland*

*3. Department of Physiology, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Poland.*

### Abstract

**Introduction:** Cardiovascular diseases are the most common reason for deaths of people. Progress in cardiac surgery and cardiac diagnosis a significantly decreased the risk of surgery and postoperative mortality in patients. **The aim** of our study was to present methods for monitoring patients after cardiac surgery and to assess the risk of morality.

**Material and methods:** Articles in the EBSCO database have been analysed using keywords: postoperative functioning, cardiac surgery, risk of morality.

**Results:** Studies have shown that cardiac surgery patients are a large group with many co-existing health problems that affect the occurrence of problems in the postoperative period. Hemodynamic monitoring of patients is carried out using a variety of techniques, both invasive and non-invasive. There are also many tools to assess post operative cognitive dysfunction. Interesting are modern methods of hemodynamic monitoring, which can be used by patients at home, after leaving the hospital. It should be remembered that all methods of treatment and monitoring of cardiac surgery patients have an impact on their quality of life and functioning. Do not forget about non-pharmacological methods of affecting the functioning of postoperative patients included in the ERAS protocol.

**Conclusions:** Cardiac patients require a complex and interdisciplinary approach in the postoperative period. Many elements should be taken into account and prepared the patient for this situation. Progress in medicine more often reduces the risk of mortality cardiac patients. However, should remember about the impact of all our activities on the quality of life and functioning of patients.

**Keywords:** postoperative functioning, cardiac surgery, risk of mortality

## **Introduction**

Cardiovascular diseases are causing more than 17 million deaths worldwide, and according to the World Health Organization (WHO) mortality due to cardiovascular diseases will become the leading cause of deaths of up to 20 million people per year [1]. Progress achieved in cardiac surgery and cardiac diagnosis allows for a significant reduction in the risk of surgery and postoperative mortality in patients. However, the evaluation of the result of the operation should not focus only on the effectiveness of the surgery itself. Treatment of cardiac surgery patients should also take into account how will they function in everyday life situations after the surgery.

### **1.1. Problems and complications after operation in cardiac patients**

Cardiac patients undergoing surgical procedures constitute a special group of patients. It is a population with increased risk of complications at the time of operation and in the postoperative period. Age is an important factor affecting the functioning of the cardiac patient. Advanced age, usually defined as age 70 years old and older in the context of cardiac surgery, is one of the pre-eminent risk factors for mortality and major morbidity [2]. One of the problem in

patients undergoing cardiac surgery is the appearance of atrial fibrillation. New-onset post-operative atrial fibrillation (POAF) is a major cause of morbidity and mortality. It is associated with increased risk of stroke and death and constitutes a substantial use of healthcare resources, including increased duration of hospitalization and hospital costs [3]. Post-operative atrial fibrillation has also been shown to independently predict post-operative delirium and neurocognitive decline [4]. Also, obesity is a significant problem for a cardiac patient. A large group of patients undergoing surgery are patients with BMI > 30. Patients after surgery have difficulties with mobility and rehabilitation. Obesity significantly increases the risk of complications and death. After cardiac surgery, the patients often have cognitive impairment. Postoperative cognitive dysfunction (POCD) is a decline in cognitive dysfunction from preoperative levels, which has been frequently described after cardiac surgery [5]. POCD is characterised by impaired recent memory concentration, language comprehension and social integration [6]. The psychological condition of the patients before the surgery has a large impact on the patients' post-operative function. The main pre-operative risk factors for post-operative delirium after elective cardiac operations were subjective memory complaints, mild cognitive impairment, and type of cardiac surgery, such as valve procedures [7].

## **1.2 Hemodynamic evaluation methods**

A very important part in the postoperative period in patients who underwent cardiac surgery is the monitoring of cardiac hemodynamic parameters. By analyzing these parameters, it is possible to establish further pharmacological treatment, evaluate the prognosis and the effect of surgery. The most commonly used method is the use of the Swan-Ganz catheter placed in the pulmonary artery and the vascular catheter placed in the radial or femoral artery. This allows to measure the blood pressure in the heart cavities and blood vessels, calculate cardiac output, total peripheral resistance, work index of both ventricles and many other parameters [8]. The introduction of the Swan-Ganz catheter through the internal or subclavian jugular vein carries the risk of complications such as dysrhythmia, air embolism, infection, pneumothorax, valve damage or pulmonary artery injury [9]. Non-invasive methods are becoming more and more popular. One of them is the Task Force Monitor system. The system uses a device for continuous and oscillometric measurement of blood pressure, electrocardiograph (ECG), impedance cardiograph (ICG) and pulseoximeter perform measurements and calculations completely non-invasively [10]. A similar device, which is mainly based on impedance cardiography, is PhysioFlow. The electrodes placed on the patient's neck and chest detect the

impedance changes that are used to calculate the hemodynamic parameters of the heart [11]. Both methods do not allow to measure parameters in the pulmonary circulation, therefore its application is restricted in conditions such as right ventricular failure, pulmonary hypertension or sepsis [9].

### **1.3 Cognitive Functions, assessment techniques**

POCD is a frequent and clinically important consequence of surgical procedures. Mostly, it concerns memory and executive functions [12]. In this context, it's important to diagnose patients cognitive functions before and after cardiac surgery.

In clinical practice were introduced, standardized tests evaluating various aspects of cognitive functioning, such as memory, concentration, attention, visual and spatial abilities, and psychomotor speed, which allowed for accurate observation of subtler and often difficult grasp changes in patients after surgery [13].

Compared with the pre-operative phase, in the postoperative phase, patients treated with cardiac surgery achieved significantly better results in several areas related to cognitive functioning, i.e. in the field of abstract thinking and semantic fluidity [14].

Assessment Techniques most often used in diagnostics, e.g. general intellectual efficiency: Adult Wechsler Intelligence Scale (WAIS -R) or the Raven test. The AVLT (Auditory-Verbal Learning Test) is a frequently used method in memory testing. Another method is CVLT (California Verbal Learning Test), in which words from the list can be further grouped into specific ones semantic categories, other options are the Wisconsin Card Sort Test (WCST), Number Memory Test, Tower of Hanoi Test, Tower of London Test, CogTest Battery, The Vienna Test System, Continuous Performance Test (CPT), Rey Auditory Verbal Learning Test, TYM Test, MoCA Montreal Cognitive Assessment test, Mini-Mental State Examination (MMSE), Clock Drawing Test, Stroop Test, Trail Making Test (TMT A and B), Verbal Fluency Test (VFT) [15]. Research and clinical practice indicates the use of these methods in predicting the quality of life after surgery and longer survival.

### **1.4 Modern methods of monitoring applied in cardiac patients**

Postoperative care of patients after cardiac procedures should develop in parallel to the development of technology and the resulting computerization and globalization of everyday life, which will allow more efficient monitoring of the patient's condition outside the hospital. At the same time, it is necessary to introduce such methods so that using them does not constitute too much financial burden for the patient who will not take up the principles of

modern care without economic opportunities. This is especially important when measuring basic determinants of health, such as heart rate or blood pressure. Observation of these parameters should be carried out in all patients after cardiac procedures, therefore the evolving telemedicine will have to provide fast and cheap ways to monitor these exponents.

An attempt to develop a technology that meets this type of conditions was taken, among others, by Zhao et al., who described the technique of uncovering the temporal dynamics of the heartbeat, thanks to the transformation of delay and the analysis of the component images of a single channel. According to the research results, it is a sensitive and specific method, and relatively cheap, which will facilitate its introduction into clinical practice [16]. Promising results were also obtained in the measurement of heart rate using the time-lapse image acquired from a CCD camera. In a study conducted by Takano and Ohta, 40 healthy women aged 22-27 were involved in this method and were simultaneously measured with pulse oximeter and respiratory rate using thermistor placed at the external naris. According to the results of the study, the technique is non-invasive, non-contact and effective [17], which may work well in clinical practice based on telemedicine.

The problem faced by older patients after cardiac procedures is the risk of falling. Death caused by the loss of balance is the second most common cause of death due to unintentional trauma in every age group and the main cause in people over 79, which is why it is important to effectively implement techniques to reduce mortality due to falls. Therefore, it was suggested that using telemedicine quickly register the fall and speed up the start of rescue operations. A perfect solution turned out to be automatic detectors responding to the fall and placed in the floor and on the elements of senior apartment equipment, for which it can fall. This technique has been widely accepted and many different detection methods have been developed to date [18]. Elements of the person's protection after cardiac surgery against falls were also included in the so-called smart home technologies. It differs from the previously described possibility of patient communication using not only the detectors, but also using directly connection between the patient and the person coordinating his health condition, using the Internet. These techniques also give the option of contacting qualified health professionals with the patient. This comprehensive solution provides a greater range of care for seniors and protects to a large extent against accidents at home, including falls [19].

### **1.5. Post-operative quality of life and daily life functioning**

In patients with an implantable cardioverter-defibrillator (ICD), intra-cardiac discharges protect patients from life-threatening arrhythmia. Nevertheless, the quality of life of ICD patients may

be worse due to fear of the discharges, reduced daily activity or the occurrence of symptoms of anxiety and depression [20]. Feeling of internal ambivalence between the fear of shock and a sense of dependence on ICD, and a sense of security guaranteed by the device, may lead to formation of anxiety disorders, post-traumatic stress disorder, loss of meaning in life, feelings of unhappiness or hopelessness [21].

Even if the methods used during treatment do not cause any long-term unpleasant side effects like in ICD, the patient's quality of life after cardiac surgery may not be completely satisfactory. It is believed that patients after pacemaker implantation should feel at ease, and their well-being should improve after surgery due to restoration of normal myocardial function. However, the results of some studies indicate that patients up to 6 months after the implantation surgery may feel exhausted, and their social functioning may be significantly impeded by physical or emotional problems, may have a lowered mood and feel worried about their health situation [22].

A slightly different group of patients are patients after surgical correction of congenital heart defects. Atrial septal defect dislocation (ASD II) is the most common congenital heart defect in adults, representing 20-30% of all congenital heart anomalies in this group. People after ASD II surgical correction are considered to be completely cured [23]. The surgery itself is a safe procedure (perioperative mortality is close to zero) and gives good long-term results (5- and 10-year survival is 98% and 94% respectively) [24]. Despite good long-term results of the operation, some studies indicate a significantly worse self-assessment of the quality of life made by patients compared to healthy population. In particular, subjectively low assessment of physical capabilities and limitations of functioning and fulfilling everyday life functions. An equally important factor influencing the overall quality of life in this group of patients is the fact that despite good results of surgery, a large number of patients may have problems with finding an employment. Employers in many cases may be reluctant to employ people after cardiac surgery due to fear of their presumed morbidity and absenteeism at work [23]. In addition, in many works it has been shown that patients, despite seemingly normal life in the family and professional aspects, can have large emotional problems [25]. Low self-esteem and uncertainty about the future can lead to emotional disorders or even more suicides in this group of patients [26].

Having considered all of the above-discussed facts, it seems necessary to continue rehabilitation (both physical and psychological) in the group of patients after cardiac procedures. This may allow to get rid of the anxiety, improve the self-assessment of patients in terms of their health status and perceiving their own future, and consequently improve the quality of the patient's

functioning. The need to continue the patient care after cardiac surgery is often emphasized in the literature [26-30].

### **1.6 Interventions aimed to improvement functioning of cardiac patients**

Cardiac rehabilitation (CRP) programs are essential for improving quality of life, reducing cardiovascular diseases (CVD), reducing CVD risk factors, and premature death [31]. However, only 10% - 25% of patients who qualified for the program take part in it [32]. One of the problems of these programs is about limiting place of its application to big cities only. Therefore, patients from suburban and rural areas encounter geographical barriers, poor transport, low rates for referral [31]. Easily accessible internet and the use of technology has become a potential solution for reaching patients from a distance [32].

Recent years and with them huge technological progress have shown that telerehabilitation is a good way to overcome many barriers. Interactive "virtual" CRP (vCRP) allows you to maintain constant contact with the patient. The patient is constantly monitored from a distance and receives frequent information about his health. It is possible to monitor the patient with the use of many specialized devices, for example a sphygmomanometer, motion sensor, ECG recording and even cardiac rhythm recording, etc. After registration, all health information is transmitted to specialists via the Internet and a mobile phone [33].

Amber Zutz et. al. conducted a pilot study on the safety and feasibility of using the internet for "virtual" CRP (vCRP). 15 patients were divided into two groups: VCRP and control group. The VCRP group started from online admission forms, they also had individual chat sessions with a nurse, dietitian and physiotherapist. Heart rate, blood pressure, body weight and glucose were also monitored. All patients were evaluated in terms of risk factors, lifestyle, physical performance at the beginning and at the end of the study after 12 weeks. Patients from the Internet-using group logged in on average 4.2 times a week. Researchers have noticed improvement in HDL-C, triglycerides, total cholesterol, exercise self-assessment, physical fitness assessed in metabolic equivalents, and physical activity. All patients from the VCRP group were satisfied and saw improved health and physical performance. Acceptance of patients using VCRP shows that this method can potentially positively manage rehabilitation in comparison to the control group [32].

Munro et. al. showed that cardiac CR rehabilitation at home is just as effective as CR in the hospital. Telemedicine gives more patients the opportunity to benefit from help and rehabilitation. Nine studies covering 830 people were analyzed. Data were collected taking into account four subgroups: psychosocial results, compliance, clinical results, physical activity

results. Indicators of physical activity, psychosocial results and clinical results have declined, and the results of compliance have improved significantly but have dropped over time. According to the patients' opinion and the analysis of the results, the new rehabilitation method was positively treated [34].

### **1.7 Diet in patients after cardiac surgery**

According to the guidelines of the ERAS protocol, patients prepared for surgical procedures may take permanent meals up to 6 hours before the planned procedure and clear liquids for 2 hours before anesthesia [35]. After the surgery, the diet is gradually expanded, from the pasty to the easily digestible diet. The period after cardiac surgery is a good time to change eating habits in order to reduce body mass and correct any irregularities. American Heart Association recommends base patient' diet on vegetables and fruits, both fresh and frozen, or from a can, but without the addition of sugar, salt and high-calorie sauces. The same organization recommends whole grain mill products, poultry and skinless fish. Particular attention is paid in the recommendations on the amount of consumed table salt. When recommending products with low sodium content, limiting the daily intake of sodium to 1500 mg is a desirable habit and helps lower blood pressure [36].

The most similar diet to the correct nutritional recommendations turns out to be the Mediterranean diet. In the Seven Countries Study, it has been proven that the longest life time and the lowest frequency of cardiovascular disease are found in the inhabitants of areas located on the Mediterranean Basin. However, the highest percentage of ischemic heart disease related to the population from Finland, the Netherlands and the United States, what is more, in these countries the highest consumption of animal fats rich in saturated fatty acids was observed [37]. In Poland in the 1990s, mortality due to cardiovascular diseases decreased by 32% on average in both sexes, which is largely associated with the improvement of the dietary habits of Poles. Consumption of fruit increased by 75%, vegetable fat by 100% (which means increased consumption of mono- and polyunsaturated fatty acids, vitamins and flavonoids), and butter consumption decreased by 47%, while other animal fats - by 16% (which means decrease in consumption of saturated fatty acids) [38].

In addition to the basic principles of rational nutrition, it is worth mentioning individual vitamins and minerals. Noteworthy is vitamin B12 and folic acid, whose metabolism is associated with the reduction in the body of homocysteine. The increased concentration of this amino acid contributes to atherosclerosis of the coronary and peripheral arteries, and increases the risk of stroke [39].

Another vitamin worth attention is vitamin E, whose increased intake reduces the risk of heart attack by as much as 77% [40]. Researchers also pay attention to the intake of dietary fiber. It is the basis of a diet in obesity, diabetes, and cardiovascular diseases. Epidemiological studies have shown a relationship between increased dietary fiber and the risk of ischemic heart disease [41,42]

**Conclusions:**

Cardiac surgery patients have many co-existing health problems that make them require special monitoring during the postoperative period. The development of cardiac surgery methods reduces the risk of mortality in these time. Currently, advanced invasive and non-invasive techniques are used in postoperative monitoring patients. They have an impact on the quality of life and functioning of patients, just like the operation itself. Non-pharmacological postoperative care is part of the ERAS protocol, which should be implemented in all patients. Therefore the care of a cardiac surgery patient should be exercised by a team that will be interdisciplinary and take into account all the areas discussed.

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