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Early postoperative complications in open heart surgery patients: A review

Georgi Bachvarov *

Department of cardiovascular surgery, Medical University "prof. d-r Paraskev Stoyanov", Varna, Bulgaria.

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Abstract

Over the past few decades, open heart surgery has undergone significant progress in terms of technologies used, operative techniques and resuscitation care. This has led to a significant increase in patient survival and quality of life after discharge. However, there are still a number of challenges to be addressed, one of which is reducing the incidence of early postoperative complications. They are directly and primarily determined by patients' demographic and clinical characteristics, as well as by the characteristics of the surgical intervention itself and are a major factor in the outcome of the surgery performed. This review presents the most important and frequent early complications, their epidemiological and clinical features. Their good knowledge is the key to achieving an optimal treatment approach and seeking effective opportunities for their prediction and incidence reduction.

Keywords: Open heart surgery; Early complications; Review; Technologies

1. Introduction

Over the years, open heart surgery has undergone significant transformations, from innovative operative techniques and new technologies, through cardiopulmonary bypass and off-pump bypass, to advances in anesthesiology, resuscitation care and perfusion technology and a look into the future to the promising results of regenerative medicine, personalized medicine and artificial intelligence [1]. Quite naturally, the incidence of open cardiovascular surgery has increased significantly over the past three decades, while showing significant variations resulting from a number of factors, namely demographic, geographic, economic, etc. [2]. Despite the significant development, open heart surgery faces a number of challenges. One of the most important among them are postoperative complications, still a major determinant of success and outcome of open heart surgery [3]. Therefore, good knowledge of postoperative complications (risk factors directly related to the appearance, epidemiological and clinical characteristics of complications) are a key to achieving an optimal treatment approach and searching for effective prediction possibilities.

2. Research methods

We reviewed epidemiological and clinical studies on early postoperative complications after open heart surgery indexed in MEDLINE/PubMed databases. Papers from the period 2000-present were analyzed where material and methods were clearly presented to match the topic of the presented review.

3. Early complications after open heart surgery: types, frequency and characteristics

Open heart surgery postoperative complications are not rare and, depending on severity, can present a serious health and social problem for the patient and healthcare system by prolonging hospital stay, increasing costs and altering patient's quality of life in the short or long term [4].

* Corresponding author: Georgi Bachvarov

Early postoperative complications (up to the 30th day after surgery) are characterized by great diversity, which stems from the multiple pathophysiological mechanisms associated with their manifestation [5]. There is no uniform system for their classification, but they are most commonly grouped according to affected organs and systems, namely: cardiovascular, pulmonary, renal, neurological, gastrointestinal and hepatic. Last but not least, bleeding is also added to the list [6].

3.1. Early postoperative cardiovascular complications

3.1.1. Rhythm and conduction disorders

The most common cardiovascular complications in the early postoperative period of open heart surgery are rhythm and conduction disturbances.

Atrial fibrillation (AF) has been reported in 15% to 40% of patients undergoing coronary artery bypass graft (CABG) surgery; in 37% to 50% after valve surgery and up to 60% in combined surgery (bypass and valve intervention). Most often it occurs < 3 days after operation. In patients with no prior AF history, sinus rhythm was restored in 15% to 30% of cases within 2 hours, and in 80% within the first 24 hours [7]. According to other authors such as Maisel et al., the rhythm disturbance occurred in a much more significant proportion, up to 65% of cardiac surgery patients, usually on the 2nd or 3rd postoperative day. In most patients, sinus rhythm was restored within 6 weeks [8].

Ventricular tachyarrhythmias, including ventricular tachycardia and ventricular fibrillation are uncommon after cardiac surgery. Reported rates are between 0.41% to 1.4% [7].

Bradyarrhythmias, mainly involving sick sinus syndrome and varying degrees of atrioventricular block, are more common in valvular surgery and are associated with direct surgical injury or cardiac tissue edema. The need for a permanent pacemaker after CABG surgery is between 0.8% and 3.4% of cases, and in combined valve and bypass surgery from 2% to 4%. In some specific surgeries, such as tricuspid prosthetics and severely calcified aortic valves, the need for a permanent pacemaker can reach 20%-24% [9,10, 11].

3.1.2. Pump function disturbances

After rhythm and conduction disorders, the second most frequent cardiovascular complications are cardiac pump function disturbances. Acute cardiovascular failure occurs perioperatively in more than 20% of cardiac surgical patients [12, 13, 14]. It presents clinically as a transient, reversible postoperative deterioration of contractility, requiring inotropic support to prevent tissue hypoperfusion and organ dysfunction, as well as left-sided, right-sided or total congestive heart failure, pulmonary edema, cardiogenic shock. 25% of patients after CABG surgery require inotropic support for postoperative myocardial dysfunction. About 40% of patients, who develop shock, show sonographic evidence of right ventricular dysfunction [15]. Postoperative cardiovascular dysfunction may be characterized by unexpectedly low systemic vascular resistance.

Deterioration of cardiac function in the perioperative period according to the time of occurrence can be defined as precardiotomic, inability to exit mechanical support, and postcardiotomic. It can also be classified according to its degree and severity as critical, rapidly worsening, or stable but dependent on inotropic support. In postcardiotomy heart failure, where balloon counterpulsation is required, survival is between 40% and 60% [16].

3.1.3. Postoperative myocardial infarction

Cardiovascular complications are caused by myocardial damage. Factors that may lead to a postoperative rise in troponin after coronary artery bypass grafting, the laboratory marker of myocardial injury, are suboptimal myocardial protection, direct myocardial injury, as well as ischemic myocardial injury. Depending on whether surgery was off-pump or on-pump, myocardial damage was observed in 32-44% of coronary LGE-CMR patients, with cardiac troponin and CK-MB also providing satisfactory similarity to LGE-CMR results. It is important to note that laboratory data should be accompanied by ECG and imaging data for new myocardial ischemia/new loss of viable myocardium [17].

Depending on the definition used, perioperative myocardial infarction ranges from 5 to 30% after CABG surgery. Despite the widely accepted definition of myocardial infarction published in 2018, distinguishing expected postoperative changes from acute periprocedural myocardial infarction remains a challenge. Subclinical myocardial injury may occur in up to a quarter of patients due to direct cardiac manipulation, microembolization, suboptimal myocardial protection, and other reasons [18].

3.1.4. Graft failure

A rare, but dramatic complication in coronary surgery, often necessitating reintervention in the early postoperative period, is graft failure, which varies in frequency in different sources and can even reach 4% [19]. In a study by Rasmussen et al., suspicion of compromised graft during isolated CABG occurred in 3.5% of a total of over 2000 patients. These patients were divided into two groups: hemodynamically stable, in which re-angiography was performed (n=59) and those with severely compromised hemodynamics, who were directly transferred to the operating room for emergency re-operation. In the first group, coronary angiography showed an occluded vein graft in 32% of cases, poor distal blood flow of the bypassed coronary artery in 17%, LIMA stenosis in approximately 7%, LIMA occlusion in 5%, vein graft stenosis in 5% of cases. 27 patients were subsequently reoperated. In the second group, graft occlusion was found in 92% [20]. In a study by Laflamme et al. of 5598 CABG patients, 39 patients underwent coronary angiography postoperatively because of suspected myocardial ischemia [21]. The graft was compromised in 32 patients. The reasons were divided into two main groups: internal reasons – most often connected to graft and target artery morphology (diameter, degree of atherosclerotic changes, previous endovascular procedures) and technical reasons – harvesting method, dilation protocol, graft storage, anastomosis execution [22].

3.2. Bleeding

Open heart surgery, especially performed in conditions of extracorporeal blood circulation, is associated with one very serious complication in the early postoperative period, significant bleeding. It occurs due to changes in the coagulation and anticoagulation systems in the perioperative period. Risk factors for postoperative mediastinal bleeding are divided into three groups. The first group includes patient-related factors: advanced age, female sex, small body surface area, preoperative anemia, advanced heart disease, comorbid conditions, coagulopathies, etc. The second group includes medications that affect coagulation, such as antiplatelet agents and anticoagulants, whose intake is not discontinued in accordance with the time of exhaustion of their effect, as well as fibrinolytics before emergency surgery. The third group includes factors related to the surgical intervention itself: complex valve-bypass surgery, deep hypothermia interventions, reoperations, emergency operations [23]. Most often, in daily practice, the amount of blood separated from the drains for a certain time is taken as bleeding marker in the postoperative period. In a study by Dyke et al., this criterion was considered insufficient [6]. According to the complex of criteria that they introduced (delayed closure of the sternum due to bleeding, amount separated from drains in 12 hours, units of erythrocyte mass flown, units of fresh frozen plasma flown, units of platelet concentrate flown, use of prothrombin complex concentrate, recombinant factor VII, reexploration due to bleeding or tamponade) patients were grouped into five groups: with insignificant bleeding - 51.4%, mild bleeding - 14.9%, moderate bleeding - 24%, significant bleeding - 8.2%, massive bleeding - 1.6%.

3.3. Neurological complications

With improvements in operative techniques, some patients, previously considered high-risk or inoperable, now undergo routine surgery. Expansion of indications for surgery leads to a constant age increase in cardiac surgery patients. This also increases the risk of postoperative neurological complications.

Very often, for research purposes, stroke is defined as a specialist-confirmed neurological deficit persisting for more than 24 hours. The risk of perioperative stroke varies in most publications between 1% and 5% [24, 25, 26]. Most important risk factors include: patient age, aortic atheroma, symptomatic cerebrovascular diseases, diabetes [27].

Stroke rate for valve surgery is even higher - in a study of 16,000 patients followed up for an average of 11.7 days, stroke occurred in 4.8% after isolated aortic valve replacement, in 8.8% after isolated mitral valve replacement, and in 9.7% after combined valve surgery. Postoperative delirium and cognitive deficits occur in the early postoperative period and may affect more than half of cardiac surgery patients, but resolve spontaneously in 50% of them. Efforts to overcome these complications include: arterial pressure optimization, intraoperative brain monitoring, temperature management during surgery, overcoming hemodilution, strict glycemic control [28].

3.4. Renal failure

Renal failure is very often defined as a three-fold increase in baseline creatinine or a new need for dialysis. According to literature, acute renal injury after cardiac surgery varies between 3% and 30%, and, in its most severe forms, the need for renal replacement therapy is between 1% and 5%. Prognosis in the latter is significantly worse, with a multiple increase in mortality (over 60%) [28]. Although there are predictive models for the risk of acute renal failure after cardiac surgery, there is currently no valid consensus [29, 30]. Patients with end-stage renal disease preoperatively are known to be at high risk in terms of morbidity and mortality [31]. Even mild degrees of renal injury are characterized by an increased risk of complications after cardiac surgery, therefore it is important to include preoperative renal function in risk prediction models [32, 33].

3.5. Pulmonary complications

Continuous ventilation is defined as any ventilation lasting >24 hours. Cardiac surgery patients often have underlying primary pulmonary disease such as chronic obstructive pulmonary disease or secondary pulmonary dysfunction related to the cardiac disease such as chronic heart failure. This, together with interruption of normal ventilation in conditions of extracorporeal circulation leads to pulmonary complications in the early postoperative period [34]. They range from 3% to 6% after coronary operations and from 5% to 7% after valvular operations [35]. They are characterized by atelectatic changes, postoperative pneumonia, in rarer cases ARDS, pneumothorax. Among the risk factors for pulmonary complications are advanced age (>60 years), preoperative heart failure, preoperative pulmonary hypertension, prolonged CPB (>120 min.), phrenic nerve injury. Prolonged ICU stay, greater need for blood products and re-exploration are among the main risk factors [36, 37].

3.6. Gastrointestinal disorders

Gastrointestinal complications are not common after open heart surgery. Published rates are between 0.3% and 5.5%, with an average incidence of 1.2% and associated mortality varies between 0.3 and 87%, with an average of 32% [38]. Most common are gastrointestinal bleeding, with an average incidence of 35%. They results from gastrointestinal complications, mesenteric ischemia, pancreatitis, cholecystitis and ileus. Those with a lower incidence (<2.5%) include acute liver failure, pseudomembranous colitis, peritonitis, and iatrogenic abdominal organ injury [39]. Diagnosis remains difficult because the symptoms are not always sufficiently expressed or are non-specific, and this often leads to delay in their diagnosis and treatment. Currently, prevention strategies are aimed at optimizing hemodynamic and respiratory parameters, metabolic status, and minimizing vasoconstrictive therapy. In future studies, we should address questions related to hemodynamic management (pressure or blood flow as more important), hemoglobin and hematocrit target values. Early diagnosis and definitive treatment are critical for improving the outcome. It is believed that development of more sensitive and specific diagnostic methods, such as gastrointestinal ischemia biomarkers, will have great application [40].

4. Conclusion

Open heart surgery still poses a high risk for postoperative complications. Cardiovascular complications, particularly rhythm-conduction disorders, remain the most common. Graft failure complications, major bleeding, stroke and prolonged ventilation are associated with the highest risk of death.

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