

## CASE REPORT

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# Inotropic and Mechanical Support of Critically Ill Patient after Cardiac Surgery

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## ABSTRACT

**Introduction:** Cardiac surgery patients often need inotropic support to establish hemodynamic stability and adequate oxygen supply. The management of patients with coronary vascular disease can be challenging especially in patients with severe left ventricular dysfunction and critical left main or severe triple vessel disease. **Methods:** Article has descriptive character and presents a case report of 58 years old male patient who was admitted to our hospital due to planned coronary bypass surgery. **Results:** Applying inotropic support, IABP and adequate volume management during surgery and post surgery period in ICU has led to hemodynamic stability. Leading to the recovery of the patient and hospital discharge. **Discussion:** Given the availability of the treatment options, inotropic and mechanical support played a major role to produce the positive outcome in the presented case. Many factors were unfavourable, extreme hypotension, high lactate and creatinine levels, mechanical ventilation and related complications.

**Keywords:** coronary artery disease, inotropic drugs, intra-aortic balloon pump.

## 1. INTRODUCTION

Cardiac surgery patients often need inotropic support to establish hemodynamic stability and adequate oxygen supply. Catecholamines: Norepinephrine (noradrenaline), epinephrine (adrenaline), dopamine and dobutamine are still the backbone of inotropic support therapy. By acting on adrenoceptors, they allow vasoconstriction through the alpha receptors, and increased cardiac output via the beta 1 receptor. Combinations of different catecholamines with one another or with other drugs, such as phosphodiesterase inhibitors or nitrates, lead to a wide range of possible hemodynamic effects. Among them, phosphodiesterase inhibitors appear to be the most promising drugs introduced to clinical use to date. The management of patients with coronary vascular disease can be challenging especially in patients with severe left ventricular dysfunction and critical left main or severe triple vessel disease. Postoperative periods may also be characterised by low output cardiac state with attendant morbidity and mortality and thus action needs to be intensified to forestall these. Inotropes used in the perioperative or critical care periods to increase cardiac output can, in addition to increasing myocardial contractility, have other effects which may be detrimental on preload, after-load, heart rhythm, ventricular relaxation and myocardial oxygen demand (1). This may make the use of inotropes counterproductive and the need for mechanical devices like intra-aortic balloon pump (IABP) for circulatory assistance desirable. The intra-aortic balloon pump has been the most commonly used device for mechanical circulatory support in critically endangered patients. It requires a native beat and a stable rhythm as the balloon is synchronized with the heart. For more than four decades, IABP has been used to improve hemodynamic parameters in patients with cardiogenic shock. An IABP reduces afterload, increases cardiac output, optimizes coronary flow and decreases oxygen consumption. The IABP mechanism is based on its inflation of the balloon during the diastole of the cardiac cycle, at the root of the aorta, which results in an increase amount of blood and oxygen in the coronary arteries. Prophylactic and postoperative administration of IABP is recommended, which is commonly used in high-risk patients undergoing cardiac surgery or percutaneous coronary intervention. The IABP is the most readily available form of mechanical support and as such the

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indications for use are wide in the context of patients undergoing CABG: Cardiogenic shock, unstable angina, prophylactically, to facilitate weaning from CPB and for postoperative LCOS—low cardiac output syndrome (2).

The multitude of positive vasoactive agents enlisted alone or in combination for the management of LCOS include phosphodiesterase inhibitors (amrinone, milrinone), antidiuretic hormone analogues (vasopressin), pure alpha adrenergic agonists (phenylephrine), and both natural (epinephrine, dopamine) and synthetic (dobutamine, dopexamine) catecholamines. While individual physiological effects have been outlined, insufficient clinical data exist to guide general practice patterns for use of these agents following CABG (3).

## 2. CASE REPORT

A 58 year old man was admitted for planned surgical myocardial revascularization. Previous history showed, two vessel coronary artery disease, a 20 days old myocardial infarction. He received streptokinase after a heart attack. Pulmonary embolism 15 years ago, arterial hypertension, hyperlipoproteinemia. During preoperative preparation, an echocardiography is performed that describes neat left cavity dimensions. Mild wall and septum hypertrophy with hypokinesia anteroseptally. Ejection fraction estimated at 50% with diastolic dysfunction grade I. Aorta dimensions in the referent values . Minor functional mitral and tricuspid regurgitation. Pericardium without pathological fluid accumulation. Without absolute contraindications for surgery, the initial prepra-tion was done. Invasive hemodynamic monitoring line were placed, arterial line trough radial artery and central venous catheter trough internal jugular vein. Since the patient was not designated as a high-risk patient, the Swan Ganz catheter was not placed. The patient is given general anesthesia by intravenous anesthetics, midazolam, fentanyl, pancuronium in combination. Following the introduction and intubation, continuous infusion of these anesthetics was introduced to maintain the anesthesia, toghter with intermittent sevoulourane inhalation trough anesthesia machine The operative field is approached, with endoscopic harvesting of the venous graft from the saphen large vein and LIMA (Left Internal Mammary Artery). A bolus dose of heparine sulfate, 300 IU / kg, is administered. After reaching a targeted ACT of > 400 s the patient is connected to the cardio pulmonary bypass machine (CPB).The heart is stopped with cold cardioplegia and potassium chloride. During CPB time all hemodynamic parameters were regular. Anas-tamoses are made on three coronary vessels. After heating the patient, followed by a warm infusion of hot shot, with one defibrillation, cardiac rtiam is established and proximal anstamoses are grafted. After that, a gradual weining from the CPB is conducted. Due to lower systolic blood preassure, 80-90 mmHg, 5mcg of dobutamine is introduced and 4mcg of norepinephrine. Conversion dose of protamine is administered, followed by a drop in blood pressure. Decision to insert intra-aortic ballon pump (IABP) trough femoral artery was made. The dose of norepinephrine is raised to 6 mcg, IABP 1:1 ratio. The

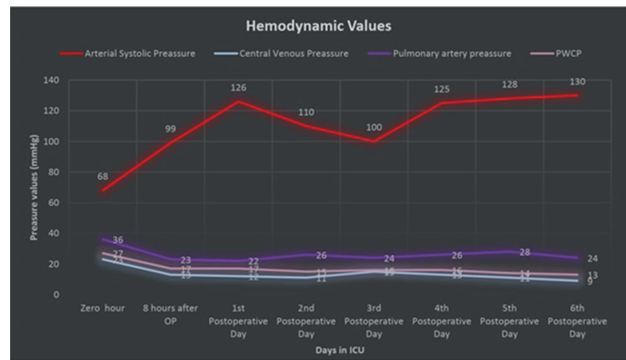


Figure 1. Presents the improvement of patient's hemodinamic parameters by days laying in ICU

patient develops grade II AV block, a temporary pacemaker is activated, hemodynamically stable, pacemaker depended. When the chest is being closed, ventricular tahycardia (VT) occurs, that spontaneously withdraws. The surgical team decides to open the chest and examine the graft anastamoses. Second attempt to close the chest resulted in another VT attack, that was resistant to therapy. Patient was without measurable blood pressure. An emergency resternotomy is performed, with manual heart massage and defibrillation, heart rythm is obtained, patient is pacemaker depended. Due to extreme hypotension patient underwente emergcy connection to CPB again. Infusion of adrenaline is introduced and doses od inotropic drugs are raised to 10 mcg. Time without blood pressure was 15 minutes. For the duration of the CPB, we administered brain protective drugs (tiopental 500 mg, pantroprazole 40 mg, dexamethason 8mg). The patient remains connected to the CPB for 45 minutes with gradual weaning from. Repeated tries to disconnect patient from the CPB wield no results. Even with triple inotropic support and IABP, blood pressure was 60/35 mmHg. It is decided, after the third attempt, to wean the patient from CPB and to close the operative field. Total CPB time was 3 hours and 45 minutes. After closure of the operative field, the patient is hemodynamically unstable; systolic blood pressure 56 to 68 mmHg. On admission in Intensive care unit (ICU), hemodynamic instability continues. Patient on maximum triple inotropic support (adrenaline 10 mcg, norepinephrine 10 mcg, dobutamine 10 mcg), IABP 1: 1, Cordarone infusion to prevent further arhythmias, pacemaker dependent for the next 12 hours. On admission hemodynamic parameters: Blood preassure (BP) 68/37 mmHg, Central venous preassure (CVP) 27 mmHg. After placement of the Swan Ganz catheter: Pulmonary artery preassure(PAP) 36/23 mmHg, Pulmonary capillary wedge preassure (PCWCP) 27 mmHG, Cardiac output (C.O.) 5.8 l/m, Cardiac index (C.I.) 2.7 l/min/m<sup>2</sup>, Systemic vascular resistance (SVR): 290 dyn.s/cm<sup>5</sup>. Laboratory analysis of arterial blood revealed: pH 7.15, pO<sub>2</sub> 7 kPa, pCO<sub>2</sub> 5.85 kPa, SO<sub>2</sub> 83%, Hco<sub>3</sub> 16 mmol/l, lactemia: 9.8 mmol/l. HTC 0.22, Hbg 72 g / l. Diuresis was regular. Increased drainage in the first hours, that seceded with two doses of fresh frozen plasma. Together with hematocrit correction with fresh blood dose. In the following hours, hyperlactatemia, extreme hypotension deepens. After

intensive treatment, fluid management, 8 hours after the surgery, there is an improvement in hemodynamic parameters: BP 99/39 mmHG, CVP 13 mmHG, PCW-PC: 17 mmHG, PAP 23/11 mmHg. The patient begins to react in a respiratory fashion and is switched from continuous mechanical ventilation (CMV) to synchronous intermittent ventilation (SIMV). At the first postoperative day, the Cardiac surgery patients often need inotropic support to establish hemodynamic stability and adequate oxygen supply. stabilize. BP 126/61 mmHG, Sinus rhythm 112 / min, CVP: 12 mmHg; PWCP: 17 mmHg, PAP 26 / 11 mmHg. (Figure 1). Other laboratory blood test results showed: BUN: 8.9  $\mu\text{mol} / \text{l}$ , Creatinine: 155  $\mu\text{mol} / \text{l}$ , Lactate 5.1 mmol/l, HTC 0.29, Hgb: 0.29 g/l, ALT: 648 mmol/l, AST: 465 mmol/l. Doses of inotropic drugs were gradually reduced, and adrenaline infusion was weaned from the therapy. An echocardiographic examination is performed which shows easily dilated left ventricle (LV), lowered EFLV to about 35-40%. Septum was hypoakinetic, significantly reduced LV cavity reduction in systole and diastole. TAPSE 8mm speaks in favor of depression right ventricle (RV). Minor functional mitral regurgitation of MR + 1 and smaller TR + 1. We tried to wean the patient from mechanical ventilation, but without results. Respiratory instability occurs with arterial gas disruption:  $\text{pO}_2$  7.5 kPA,  $\text{So}_2$ : 88%. Patient is relaxed and sedated in order to improve respiratory parameters. On the third postoperative day, sedation and relaxation cease, and the patient was gradually weaned from mechanical ventilation. On the sixth postoperative day he was extubated. Doses of inotropic drugs were gradually reduced; norepinephrine is excluded for support on the fourth postoperative day, dobutamine on the sixth postoperative day. Also, the IABP is taken out the same day. (Figure 1) During postoperative recovery psycho-motoric restlessness was present, a neurologist is consulted to establish a diagnosis of organically conditioned psychiatric disorder. Due to the unrest and disorientation, piracetam, haldol and b comlex was administered. With given drugs the patient's neurologic status improves.

Further postoperative recovery goes in the way to improve the general condition and hemodynamic stability. With the improvement of renal function, creatinine value reduced to 110  $\mu\text{mol} / \text{l}$ . Occasional control echocardiographs show an improvement in the ejection fraction, but also the presence of pleural effusion, which is evacuated repeatedly by pleural punction in quantities of 1000-1500 ml. After 28 days in the ICU and intensive treatment, the patient's condition improve, so can be transported to local rehabilitation facility. Follow-up examinations in the coming months show that the patient is cardio compromised, normotensive, eucardic.

### 3. METHODS

Article has descriptive character and presents case report. This case report includes 58 years old male patient who was admitted to our hospital due to planned coronary bypass surgery. He had a recent myoradial infarct,

pulmonary embolism 15 years ago and primary hypertension.

### 4. DISCUSSION

In the presented case report, we showed how unpredictable outcome of the CABG surgery can be. Inotropic or mechanical support is commonly administered for high risk patients. Those with lower ejection fraction, below 50%, chronic heart failure and etc. While weaning from CPB machine can be difficult, inotropic support can help facilitate the weaning period. In this case, patient underwent regular elective surgery of CABG with the use of CPB machine. After grafting three grafts, weaning from CPB was bridged with dobutamine and norepinephrine afterwards. Protamine conversion can usually produce mild hypotension, in this case it was the indication for IABP insertion, in order to preserve the myocardium from oxidative stress. Grafts inspection was the only available method at the moment after ventricular tachycardia attack. The only option left after administration of full doses of inotropes and IABP was to return to CPB, without cardioplegia. This could lower preload to the heart and made it more prepared to weaning from CPB. It didn't give any major results regarding hemodynamic status. Decision to close the patient that had extreme hypotension and pacing rhythm was the difficult one, after eight hours of surgery, knowing that all this led to the unfavourable outcome. First hours in the ICU turned the tide to the positive outcome resulting in patient discharge after 28 days in ICU. Several clinical studies have examined the factors associated with the development of LCOS and the subsequent need for inotropic support. While some clinicians/institutions routinely administer inotropic agents to all patients undergoing CABG, others administer these agents selectively to patients with either authentic or anticipated LCOS. LCOS is commonly defined as as low cardiac output (confidence interval [CI] <2.5) with evidence of end-organ dysfunction such as low urine output (<0.5mL/kg/hr), LCOS is associated with increased morbidity and mortality following CABG and is known to increase length of stay, resource use, and overall costs. Data is lacking with regards to inotrope and vasopressor use for treatment of low cardiac output syndrome (LCOS) in the early postoperative period following CABG. According to the German-Austrian CSMI guideline, dobutamine should be preferred as an inotrope option, norepinephrine as a vasopressor option, and levosimendan over phosphodiesterase III inhibitors in case of refractiveness to catecholamines. In the current IABPSHOCK II trial, 74% of the patients with CSMI were treated with norepinephrine, 53% of them with dobutamine, 26% of them with epinephrine, 4% of them with levosimendan, and 4% of them with dopamine (4).

Mechanical circulatory support devices are being used to an increasing extent. The use of these devices as an adjunct to cardiac surgery to support ventricular function has contributed to improved outcomes for the highest risk patients. In the context of patients undergoing coronary artery bypass grafting, there are several po-



tential indications for mechanical circulatory support: preoperatively in the setting of acute cardiogenic shock, or in patients with intractable angina with or without haemodynamic compromise; at induction of anaesthesia prophylactically in patients with critical coronary anatomy and/or severely impaired left ventricular function; intraoperatively in the setting

of failure to wean from cardiopulmonary bypass; or postoperatively in patients who develop an intractable low cardiac output state. The use of the intra-aortic balloon pump, veno arterial extracorporeal membrane oxygenation, TandemHeart, Impella and central ventricular assist devices will be considered in the setting of high-risk patients undergoing coronary artery bypass grafting. The IABP is the commonest form of mechanical support utilised in cardiothoracic practice. Its first use was in the 1960s following the work of Kantrowitz who identified that 'diastolic augmentation' could be utilised to improve myocardial oxygenation. The IABP is the most readily available form of mechanical support and as such the indications for use are wide in the context of patients undergoing CABG (2). In one study the outcome after insertion IABP was followed by measuring renal function. Increase in creatinine levels after the insertion of IABP was an important prognostic factor that depict poor outcome. The study observed an increase in creatinine levels of  $> 132$   $\mu\text{mol/L}$  as a marker of poor prognosis (5). Patients with preoperative use of IABP had improved convalescence as shown by a significantly shorter postoperative length of hospital stay for AMI patients without CS undergoing CABG. However, the preoperative IABP insertion was not associated with a reduction of 30-day postoperative mortality (6). Weaning from IABP can be difficult and there are many hemodynamic and physiologic criteria, which should be kept in mind before deciding to remove IABP. The weaning time may be simply predicted by measuring serum lactate levels early after CABG surgery. Based on the results from one study, 97.8% of the patients ( $n = 46$ ) were successfully weaned from IABP support and 95.7% ( $n = 45$ ) survived to discharge from the hospital. Two patients with persistent serum lactate levels  $> 15$   $\text{mmol/L}$  in the first 12 hours of IABP support had the worst prognosis. A significant association was found between the mean serum lactate levels  $\geq 6$   $\text{mmol/L}$  in the first 12 hours after the surgery and  $\geq 48$  hours dependency on IABP (7).

Given the availability of the treatment options, inotropic and mechanical support played a major role to produce the positive outcome in the presented case. Many factors were unfavourable, extreme hypotension, high lactate and creatinine levels, mechanical ventilation and

related complications. The perioperative use of mechanical and inotropic support was introduced as indicated, since this was not a high risk patient.

## 5. CONCLUSION

Applying inotropic support, IABP and adequate volume management during surgery and post surgery period in ICU has led to hemodynamic stability. Leading to the recovery of the patient and hospital discharge. The outcome of cardiac surgery in the patients with coronary artery disease depends of high-quality preoperative preparation, the type of operation, and postoperative treatment that requires adequate hemodynamic and respiratory management.

- **Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms
- **Author's contribution:** EM, AK, ZB and AM gave substantial contribution to the conception or design of the work and in the acquisition, analysis and interpretation of data for the work. AK had role in drafting the work and revising it critically for important intellectual content. Each author gave final approval of the version to be published and they agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
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