Postoperative management of the patient undergoing coronary artery bypass grafting

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Postoperative care of the heart begins before surgery with a complete evaluation of the patient so that we can anticipate trans and postoperative complications. Comorbidities can be divided into two types, cardiological ones such as LVEF, pulmonary hypertension, concomitant heart valve diseases, presence of evolving coronary syndrome, etc., and non-cardiological ones such as COPD, diabetes, liver disease, neurological conditions and infections, among others. Some medications must be discontinued prior to surgery such as not applying insulin the night before, and others can be continued, such as antiplatelet agents, beta-blockers, and statins. Management in the Cardiological Intensive Care unit begins beforehand; we must be already prepared and know the type of patient and conditions; therefore, we must have the mechanical ventilator or supplemental oxygen support ready, as the case may be, the drugs and infusion pumps, invasive and non-invasive vital signs monitors as well as special devices such as intraaortic balloon pump, ECMO, etc. The following article shows a broad overview about the postoperative care of the patient undergoing coronary revascularization.

Key words: **Coronary artery bypass grafting; Postoperative care; Cardiological intensive care.**

Los cuidados postquirúrgicos de corazón comienzan desde antes de la cirugía con una evaluación completa del paciente de manera que podamos adelantarnos a las complicaciones en el trans y post quirúrgico. Las comorbilidades podemos dividirlas en dos, las cardiológicas como FEVI, hipertensión pulmonar, valvulopatía agregada, la presencia de síndrome coronario en evolución, etc y las no cardiológicas como EPOC, diabetes, hepatopatías, condiciones neurológicas e infecciones entre otras. Algunos medicamentos se deben de suspender previo a la cirugía, como la insulina no aplicarse desde la noche anterior, y otros se pueden continuar como los antiagregantes plaquetarios, los beta-bloqueoadores y las estatinas. El manejo en la unidad de Cuidados Intensivos Cardiológicos comienzan desde antes, debemos estar ya preparados y saber que tipo de pacientes recibimos y en que estado, de tal manera que debemos tener ya listo el ventilador mecánico ó el apoyo de oxigeno suplementario según sea el caso, las infusiones de medicamentos y bombas de infusión litas, los monitores de signos vitales invasivos y no invasivos así como los dispositivos especiales como el balón de contrapulso, ECMO, etc. En el siguiente articulo se presenta un panorama amplio sobre el mano del paciente postquirúrgico de revascularización coronaria.

***Palabras clave*: Revascularización coronaria; Cuidados postoperatorios; Cuidados intensivos cardiológicos.**

Cir Card Mex 2023; 8(1): 17-21.

Cardiological intensive care (CIC) is a relatively new concept. It was not until 1961 that Dr. Desmond Julian and Dr. Morris Wilburne, through a paper presented at the 1961 American Heart Association (AHA) meeting, demonstrated that patients who were attended in exclusive cardiology units had up to 25% less mortality compared to those who were cared for in general intensive care units [1,2].

Something very important in post-surgical management is to make a good pre-surgical evaluation, so that we know which patient we are going to find and be able to anticipate situations that can be complicated.

There are many risk scales to predict the morbidity and mortality of patients undergoing cardiac surgery. The most used currently is the Society of Thoracic Surgeons risk-score ("STS score" for its acronym in English). The common denominator is the idea of anticipating the problem. The 2021 guidelines of the American College of Cardiology (ACC) and the American Heart Association (AHA) classify it as a 1-B indication [3].

When we receive the patient in CIC unit, we are like the "battle of Waterloo", with fire from many fronts, on one hand

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the patient is recovering from his post-surgical situation, from the aggression that he was subjected to, recovering the hemodynamic state, the aggression of everything that is the surgery itself, and on the other hand the lack of control of all its situations, such as uncontrolled diabetes, kidney failure, etc.

All problems in CIC can be categorized into two types: cardiac ones, and non-cardiac ones. The latter ones more frequently alter the postoperative course are:

Chronic obstructive pulmonary disease (COPD).

In non-cardiac problems, COPD is one of the pathologies that most frequently give us problems in the post-surgical period, especially those who have an FEV-1 of less than 50%, which means that expiratory volume is less than half of a normal person. Obviously, these patients are more likely to have prolonged mechanical ventilation and intubation, in-hospital pneumonia, infections and sternal dehiscence caused by coughing and end up breaking the sternum. Thus, something important to be suggested is to stop smoking four weeks before surgical procedure. If smoking cessation just for a short time before, secretions will increase and even have delirium [4-6]. Personally, I always recommend using antibiotics, cough suppressants, bronchodilators, and even inhaled corticosteroids.It is often difficult to establish a real difference when COPD is the main decompensating agent or when dyspnea is mainly due to heart failure. For this purpose, natriuretic peptide (BNP) is of capital importance. A high BNP indicates to dyspnea due to heart failure; a low value orients towards dyspnea of pulmonary origin. However, it must be remembered that very frequently patients have both problems [4, 5].

Diabetes mellitus (DM).

Diabetes mellitus is an extensive disease, which is not exclusive to the coronary arteries. It causes a pro-thrombolytic and pro-inflammatory state that decreases the patency lasting of coronary grafts, and favors infection. Adequate metabolic control must be pursued [7-9]. The STS recommends that oral hypoglycemic agents be discontinued 24 hours prior to operation, and that insulin not be used the night before, as it can cause hypoglycemia in the trans-operative period. The objective should be to maintain glucose blood values between 120 and 180mg/dL [10, 11]. Aggressive condition from surgery per se cause hyperglycemia even in non-diabetic patients.

Hepatopathies.

Frequently, patients who have excessive alcohol consumption may have liver dysfunction and have alcohol withdrawal syndrome. This can be observed after surgery, when the effect of anesthetics is removed. Thus, they have state of delirium. There are many classifications and scores to measure the degree of liver involvement. As a general rule, patients with advanced alcoholic cirrhosis (class C) or a CTP (Child-Turcotte-Pugh) score ≥8 are generally not candidates for cardiac surgery. The operative mortality rate of patients with cirrhosis is generally very high: 9% for class A, 37.7% for class B, and 52% for class C. In addition, mortality rates at 1 year are very high at 27%, 66% and 78.9%, respectively [12]. Mortality in these patients (advanced liver cirrhosis) is above 50%; so, the operative management could only have very little impact on their quality of life and their lifespan.

Neurological conditions.

A history of stroke or transient ischemic attack, whether recent or old, is associated with a higher incidence of perioperative stroke. Approximately 10% to 15% of patients who require coronary revascularization surgery have significant carotid or peripheral vascular disease. Also, patients with active carotid disease very often have concomitant coronary artery disease. Chronic use of benzodiazepines is associated with a higher incidence of psychomotor agitation and dementia in the postoperative period [13,14], and upon awakening it is more difficult for the anesthesiologist. Patients usually develop dementia, delirium and/or hallucinations.

Peripheral vascular disease.

It is important to make a clinical evaluation of the health of the peripheral venous circulation of the pelvic limbs, since a good saphenous vein means good coronary grafts. Usually, during cardiac catheterization, a selective injection of the subclavian artery is performed to assess the internal mammary artery. If this was not done, great attention should be paid to differences in blood pressure between both arms, since a difference of more than 10mmHg can lead to obstruction of the subclavian. The arteries of the upper limbs are important since catheters can be placed through these vessels for invasive monitoring. Also, radial artery grafts can be harvested. An important contraindication for this would be Raynaud's syndrome [15,16].

Infections.

The two most common sites of infection are the upper respiratory tract and the urinary tract. Preoperative urinary tract infections must be completely eradicated. It is important to rule out major urinary tract obstructions such as prostate problems, as these can complicate Foley catheter placement immediately before operation [4]. The 2021 AHA and ACC recommendations to reduce sternal infections are: Nasal test for Staphylococcus aureus, use local ointments in the nose with 2% mupirocin to the patient and the surgical team (for many years it has been shown that the staphylococci colonizing the nose is the same staphylococci that causes infection of the wounds), use prophylactic antibiotics, glycosylated hemoglobin with a view to having a good preoperative metabolic control (this has been shown to reduce hospital infections and wound infections), stop smoking, use of topical vancomycin at the site of wounds (this is something relatively old but has been given greater support in these current guidelines), and not using prophylactic antibiotics longer than 48 hours prior to surgery [3].

Previous medication.

When they are going to undergo coronary revascularization surgery, all patients must continue taking their usual medications, especially anti-anginal drugs, including nitrates. We must pay especial interest in beta blockers and calcium channel blockers, since they have been shown to decrease ischemia due to the fact that they decrease myocardial oxygen consumption, decrease the incidence of postoperative atrial fibrillation and establish better blood pressure control [4].

There are still controversies about whether or not to continue using ACE inhibitors in the preoperative period. Some studies mention that patients who use them for a long time

before operation have a higher incidence of vasoplegic syndrome after extracorporeal circulation [4].

Medications for diabetes should be stopped 24 hours before, and insulin should not be applied from one night before the surgical event.

Regarding acetylsalicylic acid (ASA), the ideal is to suspend it between 3 and 7 days before surgery [4]. However, new AHA and ACC guidelines no longer recommend this concept. Rather, all patients taking ASA should continue to take it. However, in patients who previously did not take it, ASA should not be started in the preoperative time [3]. It is recommended to suspend clopidogrel for 5 days. However, the new guidelines allow to be suspended only 3 days before the event [3]. Prasugrel should be discontinued 7 days before, and ticagrelor 3 to 5 days [3,4]. Other antiplatelet agents such as Glycoprotein (GP) IIb-IIIa inhibitors should be discontinued four hours before, and Abciximab 12 hours before the coronary artery bypass grafting. Vitamin K inhibitor anticoagulants such as warfarin and acenocoumarin should be discontinued for 3 to 5 days, and have an INR of less than 2.0 [3,4]. Unfractionated heparin with four hours of suspension is enough in order to avoid increasing the risk of bleeding in surgery. In contrast, low molecular weight heparins such as enoxaparin should be discontinued 24 hours before. The new oral anticoagulants such as Dabigatran, Rivaroxaban, and Apixaban have a much longer half-life, and should be discontinued for at least 48 hours [3].

Another aspect to consider is the clinical context of the patient. There is a great difference between the surgery on a patient with chronic coronary artery disease and another with acute coronary syndrome. The same is applicable for the patients with left ventricular dysfunction and those with normal ventricular function. Likewise, there is a great difference between stable left ventricular dysfunction and the state of acute decompensation. All the aforementioned above is of utmost importance, especially when there is involvement of other parts such as pulmonary edema, liver shock or concomitant valvular disease. All this increases the likelihood of death and postoperative complications.

Reception of the patient in the Cardiological Intensive Care Unit

Postoperative care begins even before the patient arrives at the CICU. At this stage, the preparation of the room where the operated patient will be received is in charge of the head of nursing and the intensivist doctor [17].

Before reception

The team in charge of receiving the patient must prepare the following implements:

Ventilator, invasive and non-invasive monitoring system, suction systems, drugs required by the patient, according to the information coming from the operating room, crash cart suitable for cardiopulmonary resuscitation, if required. The early postoperative course for most patients undergoing cardiac surgery using extracorporeal circulation is characterized by a typical pathophysiologic pattern. Cardiopulmonary bypass usage is associated with an inflammatory response that causes systemic vasodilation and capillary leak, along with hemodilution of a crystalloid solution, leading to a total body volume overload of 5%, in addition to causing dilutional and functional coagulopathy, with myocardial depression [4].

In the Mexican guidelines published in the journal Archivos de Cardiología de México [17], on the care of uncomplicated patients who underwent surgery, a table is presented that shows chronologically the times and actions to be carried out when receiving the patient [18]. Basically, from minute 0 to minute 5, the patient is received with connection to all ventilation devices, vital signs monitoring, drainage systems, starting with the airway, such as connecting the ventilator that was previously on and scheduled in the ICU or supplemental oxygen supply systems such as the bag-reservoir mask, continue to connect hemodynamic monitoring devices such as an arterial line for invasive blood pressure measurement, pulmonary flotation catheter, special devices such as the intraaortic balloon pump, or ECMO. Something also very important is to keep the patient in normothermia at 37°C, since hypothermia causes coagulopathies, lowers the myocardial threshold for cardiac arrhythmias. All this can be done simultaneously according to the number of qualified personnel available. From minute 5 to 20, laboratory tests are performed, which should ideally include arterial blood gases, blood counts, serum electrolytes (Na, K), coagulation times that lead us to possible coagulopathies that could cause mediastinal bleeding (for example, it is common for obese patients have heparin rebound despite the complete reversal of the effect after the extracorporeal circulation pump, this would be characterized by a prolonged PTT, other coagulopathies can also be detected even before it manifests with mediastinal bleeding, which that would allow us to get ahead by having the corresponding transfusion support ready, some centers still manage the thromboelastogram that more quickly allows detecting the quality of the clot and intuiting the present coagulopathy). Paraclinical tests are also performed at this time, including portable chest radiography (which allows us to detect unidentified problems in the operating room, such as pneumothorax. Let us remember that the invasion of the patient with subclavian central catheters is performed in the immediate pre-surgical period in the operating room and frequently there is no control x-ray, it also allows us to detect hemothorax and the correct position of the endotracheal tube). Also included in these paraclinical tests is the performance of an electrocardiogram that allows us to detect perioperative myocardial infarctions that are not always evident in the vital signs monitor, atrioventricular blocks, etc. After this time, other more sophisticated studies are also carried out, such as the transthoracic echocardiogram, a necessary tool in intensive care [17].

Ventilation

After most cardiac procedures, the patient arrives fully anesthetized and sedated, requiring mechanical ventilation for several hours. Patients with spontaneous ventilation and pulse oximetry saturation >90% can leave the operating room extubated. Early extubation is usually defined as withdrawal of mechanical ventilation within six hours of surgery, and many protocols are designed to achieve extubation within a few hours.

Warming from hypothermia to 37 °C

Hypothermia (<36°C) on ICU admission has been associated with adverse outcomes. Namely, 1) it predisposes to

atrial and ventricular arrhythmias, and lowers the threshold for ventricular fibrillation, 2) It produces peripheral vasoconstriction, increasing systemic vascular resistance. (SVR). This will raise filling pressures, mask hypovolemia, increase afterload, increasing myocardial oxygen demand, and often cause hypertension, potentially increased mediastinal bleeding, 3) shivering increases peripheral O2 consumption and CO2 production, 4) produces platelet dysfunction and generalized deterioration of the coagulation cascade, 5) prolongs the duration of action of anesthetic drugs and prolongs extubation time, 6) increases the risk of wound infection [4,18].

Intravenous solutions:

Crystalloid solutions should be administered in order to maintain adequate intravascular volume. Parameters frequently used to make this decision are central venous pressure, pulmonary wedge pressure, or invasive blood pressure variation, all of them having their own limitations [4,17].

Electrolytes

They must be maintained within normal limits and their contribution is determined according to the losses and needs of the patient, in particular potassium and magnesium. (Recommendation Class I, Level of Evidence A). Crystalloid solutions should contain potassium so that serum concentrations of 3.7 to 5.5 mEq/L are maintained to prevent ventricular arrhythmias. The addition of low doses of magnesium to crystalloid solutions is useful to prevent supraventricular and ventricular arrhythmias (doses of 2-6 g/day) (Recommendation Class IIa, Level of Evidence B) [17].

Control of mediastinal bleeding:

Generally, an arbitrary bleeding rate of >200 mL/h is cause for concern. Unless anemia occurs with a hematocrit <22-24% or there is evidence of hemodynamic compromise or organ dysfunction, transfusion should not be necessary. A major bleeding rate without evidence of a decrease requires evaluation and treatment, which is frequently surgical re-exploration [4]. The etiologies of bleeding are so many that it can range from surgical problems such as coronary graft anastomoses, to medical causes. These generally occur when we still have effects of some medications that we do not stop properly. Occasionally, due to hasting situation, clopidogrel was not discontinued on time and the patient may present platelet dysfunction, for which platelet apheresis is indicated. Heparin rebound can occur in obese people, which can be detected by the TTP laboratory result, and treatment consists of protamine sulfate. Thus, the causes of mediastinal bleeding can be quite numerous.

Important drugs in the early postoperative period.

Antiplatelet therapy

ASA at doses of 100 to 325mg/day. Early administration of antiplatelet drug (antiaggregant) has improved the graft patency and reduced mortality in patients undergoing in coronary artery bypass grafting [17].

Analgesic drugs

By inducing adequate analgesia early in the postoperative period minimizes anxiety, pain, and hemodynamic stress, all of them contributing to hypertension and ischemia. Careful monitoring of the patient's mental status and respiratory effort after extubation is imperative, as the patient is still in an early phase of recovery from anesthesia.

Ketorolac is a COX-1 inhibitor that inhibits platelet aggregation, so in addition to providing analgesia, it has also been shown to improve graft patency and reduce mortality after CABG [4,17]. Beta-blockers are recommended and should be started as soon as possible to reduce postoperative ventricular arrhythmias and atrial fibrillation.

Fortunately, personnel specialized in postoperative heart care are becoming more frequent, thus improving performance in the CIC unit and reducing mortality and complications. All this has resulted in a greater possibility of offering cardiac surgery in general.

FUNDING: None

DISCLOSURE: The author has no conflicts of interest to disclose.

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