

# SAC 2012 Consensus Statement on Cardiovascular Recovery

## INTRODUCTION

In Argentina, different from other countries, Cardiovascular Recovery is a Cardiology subspecialty. Due to the complexity of the pathologies involved, it requires knowledge on several specialties as intensive care, anesthesiology, neurology, hematology and infectology. For this reason, the Area of Consensuses of the Argentine Society of Cardiology decided to develop a Guideline, with the participation of experts who evaluated the available bibliography, in order to establish evidence-based recommendations.

The recommendation class for each Consensus topic is expressed according to the following classification:

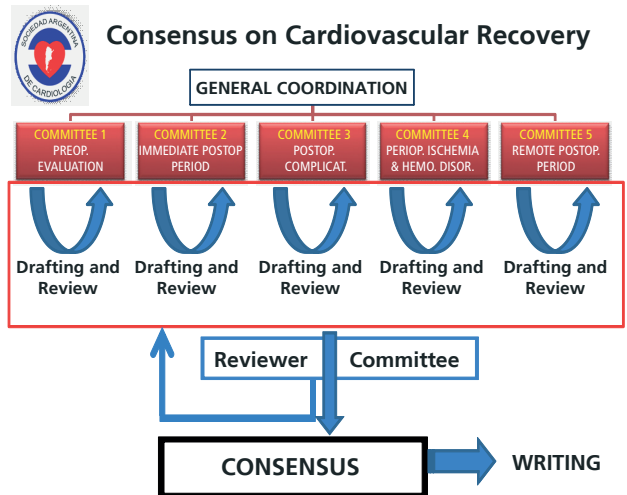
- **Class I:** conditions for which there is evidence and/or general agreement that the procedure or treatment is beneficial, useful and effective.
- **Class II:** conditions for which there is conflictive evidence and/or opinion disagreements regarding the usefulness/efficacy of the procedure or treatment.
  - **Class IIa:** the weight of evidence/opinion favors usefulness/efficacy.
  - **Class IIb:** the usefulness/efficacy is less well established by evidence/opinion.
- **Class III:** conditions for which there is evidence and/or general agreement that the procedure or treatment is not useful/effective and in some cases may be harmful.
  - **Level of evidence A:** solid evidence, arising from randomized clinical studies or meta-analyses.
  - **Level of evidence B:** evidence derived from a single, randomized clinical study or large non-randomized studies.
  - **Level of evidence C:** consensus or expert opinion and/or small studies, retrospective studies, registries.

The Consensus preparation was developed in stages as described in the figure:

The committees were coordinated by the following professionals:

**General coordinator:** Dr. Hernán Cohen Arazi<sup>MTSAC</sup>  
**Secretaries:** Dr. Jorge G. Allin<sup>MTSAC</sup> and Dr. Silvina Waldman

**Working committee I:** Preoperative evaluation  
 Coordinators: Dr. Pablo Heredia, Dr. Pablo Czerniuk



**Working committee II:** Immediate postoperative period  
 Coordinators: Dr. Sebastián Nani, Dr. Jorge Allin<sup>MTSAC</sup>

**Working committee III:** Postoperative complications  
 Coordinators: Dr. Mariano Benzádon<sup>MTSAC</sup>, Dr. Silvina Waldman

**Working committee IV:** Perioperative ischemia and hemodynamic disorders  
 Coordinators: Dr. Claudio Pensa<sup>MTSAC</sup>, Dr. Jorge Bilbao

**Working committee V:** Remote postoperative period  
 Coordinators: Dr. Ricardo Iglesias<sup>MTSAC</sup>, Dr. Nicolás Caturla

The Reviewer Committee was composed of the following professionals:

- Dr. Pablo Heredia
- Dr. Ricardo Iglesias<sup>MTSAC</sup>
- Dr. Claudio Pensa<sup>MTSAC</sup>
- Dr. Juan Krauss<sup>MTSAC</sup>
- Dr. Hernán Cohen Arazi<sup>MTSAC</sup>
- Dr. Jorge Bilbao

The following is a summary of the Consensus recommendations that may be seen in full edition in [www.sac.org.ar](http://www.sac.org.ar).

## PREOPERATIVE EVALUATION

DR. PABLO CZERNIUK

### INTRODUCTION

Adequate preoperative patient evaluation is a fundamental step to improve the procedure prognosis. The assessed strategies are summarized in the following recommendations:

Preoperative studies	Class	Level of evidence
- Thorax CT scan in aortic dissection, aortic aneurysms, ascending aorta evaluation in case of suspected dilation and in patients with pulmonary disease.	I	A
- Echo-Doppler of the neck vessels in patients > 60 years or > 55 years in case of DM. - Thorax CT scan in intracardiac masses and pericardial disease. - Aortogram in case CT cannot be performed to evaluate the aorta. - Intraoperative transesophageal echocardiography in patients with severe ventricular impairment, emergency/urgency surgery with myocardial ischemia and valve repair.	I	B
- Urine culture in patients with history of urinary infections and in patients who will undergo valve procedures. - Prostate study in men with history of prostate disease or > 60 years. - Dental study in patients who will undergo valve procedures. - Lab tests in all patients, including platelet count, prothrombin time, Quick test, APTT. - Chest X-ray in all patients. - HIV, hepatitis B and C, Chagas and VDRL serological tests in all patients.	I	C
- CA in men > 45 years (> 40 years with 2 or more risk factors) and women > 55 years. - Multislice CT scan to assess coronary anatomy may replace CA in young patients with adequate heart rate and no calcifications undergoing valve procedures. - Preoperative Swan-Ganz catheter in patients with severe LV function impairment, double valve surgery, combined surgery (CABG + valve surgery in patients with severe ventricular dysfunction, severe PHT).	IIa	B
- Pulmonary function tests in patients with history of pulmonary disease. - Lower-limb echo-Doppler in patients with severe peripheral vascular disease, especially in cases of programmed IABP implantation. - Acid-base assessment in patients with COPD undergoing thoracic surgery.	IIa	C
- Preoperative nutritional status assessment.	IIb	C
- CA in case of unmodified treatment strategy.	III	C

CT: Computed tomography. DM: Diabetes mellitus. APTT: Activated partial thromboplastin time. HIV: Human immunodeficiency virus. VDRL: Venereal Disease Research Laboratory. CA: Coronary angiography. LV: Left ventricular. CABG: Coronary artery bypass graft surgery. PHT: Pulmonary hypertension. IABP: Intra-aortic balloon pump. COPD: Chronic obstructive pulmonary disease.

Strategies to prevent complications	Class	Level of evidence
- Smoking cessation.	I	A
- Preoperative bath, preferably with chlorhexidine - ATB prophylaxis according to center (cefazolin, cephalotin). - Preoperative IABP in critical coronary disease (LMCA) and/or severe ventricular dysfunction, cardiogenic shock or AMI mechanical complications (IVC, heart failure) and in high risk patients to preserve hemodynamic stability during off-pump surgery.	I	B
- Amiodarone treatment (10 mg/kg/day, starting 6 days before surgery and over 6 days after surgery for AF prophylaxis.	IIa	A
- Nasal mupirocin twice daily, 3 to 5 days before surgery.	IIa	C
- ASA discontinuation in unstable patients.	III	A

ATB: Antibiotic. IABP: Intra-aortic balloon pump. AMI: Acute myocardial infarction. LMCA: Left main coronary artery. IVC: Interventricular communication. AF: Atrial fibrillation. ASA: Acetylsalicylic acid (aspirin).

**CARE DURING THE IMMEDIATE POSTOPERATIVE PERIOD**

DR. PABLO HEREDIA

DR. MARIANO BENZADÓN<sup>MTSAC</sup>

DRA. YANINA ARZANI

The immediate postoperative period after cardiac surgery is essential to define patient outcome. It requires a series of studies and differentiation of “expected” from pathological changes.

Strategies in the immediate postoperative period	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Assess arterial oxygen saturation with continuous measurement.</li> <li>- Control blood glucose level on admission to the intensive care unit, every hour in case of continuous insulin infusion, every 2 hours when hyperglycemia is compensated with continuous insulin infusion and every 4 hours when corrections with bolus of insulin are administered.</li> <li>- Ensure adequate analgesia and comfort.</li> </ul>	I	A
<ul style="list-style-type: none"> <li>- Control serum magnesium in the presence of arrhythmias or difficult to correct hypokalemia. (When necessary: restore 2 g magnesium sulfate diluted in 100 ml dextrose or saline, always administered as slow IV infusion).</li> <li>- Insulin correction when blood glucose level is &gt; 180 mg/dL to maintain values between 140 and 180 mg/dL (5 IU of IV crystalline insulin per each 100 mg/dL exceeding 200 mg/dL blood glucose).</li> </ul>	I	B
<ul style="list-style-type: none"> <li>- Control serum potassium levels and electrolyte balance every 4 to 6 hours during the first postoperative day: (Hyperkalemia corrections: 15 to 30 mEq diluted in 100 ml dextrose in one hour).</li> <li>- Correct metabolic acidosis when pH is &lt; 7.30 or if bicarbonate is &lt; 15 mEq/L. (The correction is calculated according to the following equation: excess base (EB): kg × 0.3 = mEq of bicarbonate infusion. Half of the calculated bicarbonate will be infused at a fast rate and the rest at a slower infusion rate).</li> <li>- Control hematocrit every 6 hours during the first day and while there is blood output through the drainage tubes.</li> <li>- Control postoperative blood calcium levels and correct in case of severe hypocalcemia or associated with arterial hypotension [preferably 1 g calcium chloride (or eventually calcium gluconate) by slow IV infusion or drip diluted in 100 ml dextrose or saline].</li> <li>- Take 12-lead ECG, V3R, V4R and dorsal leads on admission to the intensive care unit and in case of arrhythmias, unexplained arterial hypotension or ischemic ST-T changes.</li> <li>- Thorax X-ray on admission to the intensive care unit and in case of hypoxemia or unexplained hemodynamic changes.</li> <li>- Early food intake and mobilization.</li> </ul>	I	C
<ul style="list-style-type: none"> <li>- Maintain serum potassium levels above 4 mEq/L.</li> <li>- TEE in case of hypotension of difficult management and uncertain etiology.</li> <li>- Initiate centripetal and centrifugal rewarming maneuvers on admission to the intensive care unit.</li> </ul>	IIa	B
<ul style="list-style-type: none"> <li>- Initiate continuous IV insulin administration at initial dose of 0.1 UI/kg/h with blood glucose above 300 mg/dL, after 1 or 2 insulin boluses.</li> <li>- Maintain a central venous access catheter for drug infusion.</li> </ul>	IIa	C
<ul style="list-style-type: none"> <li>- Correct metabolic acidosis with bicarbonate when base excess is greater than -8.</li> </ul>	IIb	B
<ul style="list-style-type: none"> <li>- Restore magnesium by infusion in case of high degree heart blockade.</li> </ul>	III	A

IV: Intravenous. ECG: Electrocardiogram. TEE: Transesophageal echocardiography

## MECHANICAL RESPIRATORY ASSISTANCE

Author: Dr. FERNANDO VILLAREJO

Adaptation: Dr. JORGE BILBAO

In patients undergoing cardiovascular surgery, intubation and mechanical respiratory assistance (MRA) are, in general, programmed and performed in the operating room by anesthesiologists trained in the best safety and aseptic conditions for the patient. Currently, early extubation is recommended, even before leaving the operating room. Maintenance of postoperative MRA is due to complications.

Strategies to prevent complications	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Minimize sedation and favor analgesia.</li> <li>- Extubate when the drainage tube output is &lt; 50 ml/h in the first 3 hours.</li> <li>- In case extubation is delayed, sedation should continue with propofol and/or midazolam, associated with fentanyl (50 to 200 µg/h) o remifentanyl.</li> </ul>	I	A
<ul style="list-style-type: none"> <li>- Mechanical ventilation parameters on admission to intensive care: TV from 8 to 10 ml/kg, FiO<sub>2</sub> allowing SaO<sub>2</sub> = 88-95%, RF = 10 to 12/min and PEEP: 5 cm H<sub>2</sub>O.</li> <li>- Normal body temperature should be ensured before extubation.</li> <li>- Adequate gasometry for extubation: PAFI &gt; 150 with FiO<sub>2</sub> ≤ 0.5, pCO<sub>2</sub> &lt; 50 and pH between 7.30 and 7.50.</li> </ul>	I	B
<ul style="list-style-type: none"> <li>- Tracheostomy: when the patient remains intubated after 15-20 days.</li> </ul>	Ila	A
<ul style="list-style-type: none"> <li>- If the patient is not extubated on admission to the intensive care unit, extubate immediately when clinical, hemodynamic, gasometric and mechanical parameters are adequate, the consciousness state is optimal, there is no presence of abundant secretions and/or there is an adequate cough management.</li> <li>- If the patient remains intubated, volume-controlled or pressure-regulated respiratory assistance is recommended if pulmonary distensibility and the generated pressure are normal, and pressure-regulated assistance is recommended if pulmonary distensibility is reduced.</li> <li>- Tolerance to T-tube tests during 30 minutes will be used to extubate.</li> <li>- In cases of pulmonary injury or ARDS: adjust PEEP according to the ARDS network PEEP/FiO<sub>2</sub> chart or titer PEEP according to measurement of pulmonary distensibility.</li> </ul>	Ila	B
<ul style="list-style-type: none"> <li>- Early extubation if clinical, hemodynamic, gasometric and mechanical parameters are not adequate, the consciousness state is not optimal, there is presence of abundant secretions and/or there is no adequate cough management.</li> </ul>	III	C

VT: Tidal volume. FiO<sub>2</sub>: Fraction of inspired oxygen. SaO<sub>2</sub>: Oxygen saturation in arterial blood. RF: Respiratory frequency. PEEP: Positive end-expiratory pressure. PAFI: partial pressure of arterial oxygen / fraction of inspired oxygen relationship. pCO<sub>2</sub>: Partial pressure of carbon dioxide. ARDS: Acute respiratory distress syndrome.

## ANALGESIA

Dr. SEBASTIÁN NANI

Dr. FERNANDO GUARDIANI<sup>MTSAC</sup>

Adequate analgesia prevents severe complications as arrhythmias, barotrauma and prolonged intubation. Different strategies are used.

Recommendation	Class	Level of evidence
- Ensure adequate analgesia during the whole postoperative period. - Remifentanyl or epidural analgesia with bupivacain, fentanyl, or morphine with clonidine in patients extubated when leaving the operating room.	I	A
- NSAID (naproxen, ketorolac, ibuprofen or paracetamol) in mild pain. - Compound analgesics combining paracetamol or ASA with opioids in moderate pain. - In ventilated patients: morphine as bolus or continuous infusion (0.02 mg/kg/h in patients < 65 years and 0.01 mg/kg/h in patients > 65 years), fentanyl 1 µg/kg/h or remifentanyl 0.05 mg/kg/min.	I	B
- Morphine 1 g in bolus, 0.3 mg/h infusion for intense pain in an extubated patient.	IIa	B
- Use hypnosedatives in patients without adequate analgesia with pain or psychomotor excitement during MRA. Diclofenac in patients with coronary disease undergoing CABG.	III	B

NSAID: Non-steroidal anti-inflammatory drugs. ASA: Acetyl salicylic acid (aspirin). RMA: Respiratory mechanical assistance. CABG: Coronary artery bypass graft surgery.

## MANAGEMENT OF BLEEDING IN CARDIAC SURGERY

Dr. MARCELO CASEY

Surgical hemorrhage is defined as loss of 20% blood volume. There are different strategies to avoid excessive bleeding and specific treatments in case of hemorrhage after cardiac surgery.

Antithrombotic therapy	Class	Level of evidence
- Resume ASA within 6 hours after CABG (when bleeding through the drainage tubes decreases) and maintain for an undefined period.	I	A
- Discontinue anticoagulants in programmed surgeries: <i>acenocoumarol</i> 3 days before and <i>warfarin</i> 5 days before surgery. - Subcutaneous <i>low molecular weight heparin</i> therapy as bridge to surgery in patients discontinuing oral anticoagulation. - <i>Aspirin</i> : 100-325 mg prior to surgery in all coronary patients. - <i>Clopidogrel</i> and <i>ticagrelor</i> : discontinue at least 5 days before programmed procedures. - Clopidogrel and ticagrelor should be discontinued at least 24 hours before surgery in patients referred for emergency procedures. - <i>Prasugrel</i> : should be discontinued at least 7 days in programmed procedures. - <i>Abciximab</i> : should be discontinued at least 12 hours before surgery and the rest of <i>GP IIb/IIIa inhibitors</i> should be discontinued at least 4 hours before surgery.	I	B
- Assess family history of coagulation disorders and/or <i>bleeding in previous surgeries</i> .	I	C
- <i>Clopidogrel</i> is an alternative in allergic or ASA-intolerant patients.	IIa	B

ASA: Acetylsalicylic acid (aspirin). CABG: Coronary artery bypass graft surgery. GP: Glycoprotein.

In case of excessive intraoperative or postoperative bleeding, the first step is to identify *local or systemic bleeding* and *surgical or hemostatic* bleeding origin. *Quantitatively*, “*surgical*” bleedings are defined as:

- Blood loss greater than 500 ml in the first hour, or
- Greater than 400 ml in the second hour, or
- Greater than 300 ml in the third hour, or
- Greater than 200 ml in the fourth hour, or
- Greater than 100 ml since the fifth hour, or

- Bleeding that does not stop despite transfusional and non-transfusional treatment, or
- Sudden massive bleeding.
- Red, bright blood (with “arterial” aspect) through the drainage tube.

*Qualitatively*, bleedings should be considered as “surgical” in:

- Patients with overt hemodynamic instability despite plasma volume expansion.
- Patients with clinical, hemodynamic and/or echocardiographic signs of cardiac tamponade.

There are normal laboratory values and *hemostatic values*:

- *Platelet count*: normal value: 150.000-350.000/mm<sup>3</sup>. *Hemostatic value*: 50.000/mm<sup>3</sup>.
- *Coagulation factor levels*: normal value: 70%. *Hemostatic value*: 30%.
- *Fibrinogen*: normal value: 200-400 mg/dL. *Hemostatic value*: 100 mg/dL.

Treatment of bleeding	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Lysine analogues: useful in intraoperative and postoperative procedures using extracorporeal circulation. Tranexamic acid: total dose: 3-10 g (loading dose in anesthesia induction: 2-7 g, maintenance dose during surgery: 20-250 mg/h). Aminocaproic acid: loading dose in anesthesia induction: 1-15 g; maintenance dose during surgery: 1 to 2 g/h.</li> <li>- Deplasmatised <i>red blood cell transfusion</i> when the hematocrit is 22-24% in young asymptomatic patients and when it is &lt; 28% in elderly or coronary patients, or in case of major acute blood loss greater than 1500 ml or &gt; 30% blood volume or in hemodynamic decompensation.</li> <li>- <i>Platelet transfusion</i>: in case of bleeding with less than 50,000 platelet count or associated with clopidogrel or ticagrelor during the last 5 days prior to surgery or prasugrel 7 days before surgery.</li> </ul>	I	A
<ul style="list-style-type: none"> <li>- There should be an algorithm of transfusion and blood preservation (recovery) to avoid unnecessary transfusions.</li> <li>- <i>Platelet transfusion</i>: in case bleeding secondary to platelet dysfunction or bleeding associated with preoperative treatment with abx cimab is suspected.</li> <li>- <i>Fresh frozen plasma or prothrombin complex concentrates</i>: to restore coagulation factors and normalize prothrombin time.</li> <li>- Cryoprecipitates: to specifically restore factor VIII trying to achieve a level not less than 30% (1 U/10 kg of body weight to restore fibrinogen levels).</li> </ul>	I	B
<ul style="list-style-type: none"> <li>- Postpone surgery until hemostasia is restored in patients receiving fibrinolytic therapy.</li> </ul>	I	C
<ul style="list-style-type: none"> <li>- <i>Calcium chloride</i>: 0.5 to 1 g IV in case of hypocalcemia or repeated red blood cell transfusions.</li> <li>- Aminocaproic acid or factor VIIa: only in case of excessive bleeding with prior risk/benefit assessment.</li> </ul>	IIa	B
<ul style="list-style-type: none"> <li>- Consider off-pump procedures whenever possible.</li> </ul>	IIa	C
<ul style="list-style-type: none"> <li>- <i>Desmopressin</i>: for bleeding prophylaxis when there is evidence of von Willebrand disease.</li> </ul>	III	A

IV: Intravenous.

## DISCHARGE CRITERIA FROM CARDIAC INTENSIVE CARE UNIT

Dr. MARIANO GIORGI<sup>MTSAC</sup>

Dr. RODRIGO OVEJERO

The decision to transfer a postoperative cardiovascular surgery patient from the Cardiac Intensive Care Unit (CICU) to a less critical area has a subjective component associated with the experience of the medical team and the healthcare center, and another objective, defined by parameters indicating the “stability” and hence, the “safety” of this conduct.

Recommendation	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Transfer to a general ward: alert and collaborative patient, with no intravenous inotropic or vasoactive drug requirements, without arrhythmias or with already controlled arrhythmias, without drainage tube or drain exhibiting &lt; 50 ml/h in the last 2 hours, with hourly diuresis &gt; 0.5 ml/kg/h, extubated and without ventilatory insufficiency defined by the following parameters: PaO<sub>2</sub> &gt; 80 mm Hg, PaCO<sub>2</sub> &lt; 50 mm Hg, and SaO<sub>2</sub> &gt; 90% with FiO<sub>2</sub> ≤ 0.50.</li> <li>- Transfer to general ward: patients with postoperative neurologic event with clinical stability defined by imaging studies and neurology/neurointerventional specialist.</li> <li>- Transfer to general ward: patients without major surgical complications (pneumothorax, pleural effusion, infection associated with the vascular or urinary catheter or surgical wound involvement) or with resolved complications, clinically stable and with established appropriate treatment.</li> </ul>	I	B
<ul style="list-style-type: none"> <li>- Transfer to telemetry ward: patient with supraventricular arrhythmia without hemodynamic decompensation, in arrhythmia reversion plan, with intravenous antiarrhythmic treatment, or non-reversible supraventricular arrhythmia without hemodynamic decompensation, with frequency control treatment.</li> <li>- Transfer to the intermediate care unit in patients requiring intravenous insulin infusion.</li> <li>- Transfer to general ward: clinically stable patients with resolving pneumothorax, with chest drainage tube.</li> </ul>	I	C
<ul style="list-style-type: none"> <li>- Transfer to hospital room: clinically stable patients with resolving pneumothorax, with chest drainage tube.</li> </ul>	IIa	C
<ul style="list-style-type: none"> <li>- Transfer to hospital room: ischemic or transient ischemic attack and/or acute stroke (ischemic or hemorrhagic) or seizures.</li> </ul>	III	A

PaO<sub>2</sub>: Partial oxygen pressure in arterial blood. FiO<sub>2</sub>: Fraction of inspired oxygen. SaO<sub>2</sub>: Oxygen saturation in arterial blood. PaCO<sub>2</sub>: Partial pressure of carbon dioxide in arterial blood.

## SYSTEMIC INFLAMMATORY RESPONSE SYNDROME

Dra. SILVINA WALDMAN

Dr. HERNÁN COHEN ARAZI<sup>MTSAC</sup>

The Society of Critical Care Medicine and the American College of Chest Physicians define systemic inflammatory response syndrome (SIRS) as the presence of two or more of the following factors:

- Temperature > 38 °C or < 36 °C.
- Heart rate > 90 bpm.
- Respiratory frequency > 20/min with hypocapnia (PaCO<sub>2</sub> < 32 mm Hg).
- Changes in leucocyte count (leucocytes > 12.000/mm<sup>3</sup> or < 4.000/mm<sup>3</sup> or > 10% immature forms).

However, in cardiovascular surgery, almost all the patients fulfill these criteria. To improve the specificity of this diagnosis some authors postulate including vasopressor drugs as an additional requirement (intravenous noradrenaline infusion at doses > 0.5 µg/kg/min).

### Prophylaxis

Some strategies to avoid SIRS may in turn lead from 8% to 12% vasoplegic shock, which is associated with high risk of death.

Prophylaxis recommendation	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Minimize surgical times, especially with ECC.</li> <li>- Use membrane oxygenators.</li> </ul>	IIa	B
<ul style="list-style-type: none"> <li>- Preoperative corticoid treatment.</li> </ul>	IIb	B
<ul style="list-style-type: none"> <li>- Surgery in deep hypothermic circulatory arrest.</li> </ul>	III	B

ECC: Extracorporeal circulation.

### Treatment

The aim of treatment is to restore adequate levels of tissue perfusion.

Recommendation	Class	Level of evidence
- Optimize loads with plasma volume expanders and/or vasodilators.	I	A
- Epinephrine treatment in patients who remain in shock after 500 ml crystalloids or 250 ml colloids.	I	B
- Add vasopressin in patients with refractory vasoplegic shock to high vasopressor doses (doses: 0.01-0.04 IU/min during 24 hours).		
- Methylene blue: 1.5-3 mg/kg in 20-60 min, or continuous infusion.		
- In patients with pulmonary hypertension or severe functional impairment, hemodynamic monitoring with pulmonary artery catheter is suggested when high doses of vasopressors or methylene blue are administered.		
- Counterregulate with nitroglycerin, dopamine (< 3 g/kg/min), dobutamine (2-4 g/kg/min) or milrinone (0.25 g/kg/min) to improve splanchnic perfusion.	IIa	B
- Plasma volume expansion preferably with colloids.	IIb	B
- Plasma volume expansion with blood derivatives.	III	B
- Vasopressor treatment without optimizing loads. (CVP/PCP).		

CVP: Central venous pressure. PCP: Pulmonary capillary pressure.

### POSTOPERATIVE RESPIRATORY COMPLICATIONS

Dr. RAFAEL PORCILE<sup>MTSAC</sup>

Up to 70% of patients present with some degree of respiratory deficit during the postoperative period of cardiovascular surgery. However, less than 10% require mechanical ventilatory assistance for more than 48 hours.

The most frequent complications are:

*Atelectases*: their incidence is 80%, involving mostly the inferior lobes.

*Pleural effusions*: with an incidence of 70%, they occur mostly in the left pleura in patients with mammary artery bridge and only in 10% of cases if effusion is bilateral.

*Infections*: are associated with nearly 24% mortality and are considered a predisposing factor of mediastinitis.

Recommendation	Class	Level of evidence
- MRA in pressure control mode ensuring TV of 8 ml/kg.	I	B
- PEEP ≥ 5 cm H <sub>2</sub> O.		
- In ARDS associated with PHT: nitric oxide treatment (inhalatory administration at doses of 5 to 40 ppm), especially if it leads to right ventricular dysfunction.		
- Early nutritional support		
- Optimize oxygen transport improving all its components (BP, CI, Ht).	I	C
- Pressure catheter in the pulmonary artery when ARDS is refractory to initial treatment.		
Subacute respiratory insufficiency requires permanent kinetic respiratory assistance.		
- Perform tracheostomy after 15 to 20 days MRA.	IIa	A
- In ARDS, PEEP should be adjusted according to the ARDS network PEEP/FiO <sub>2</sub> chart or titer according to pulmonary distensibility.	IIa	B
- In subacute respiratory insufficiency, set PEEP 2 cm H <sub>2</sub> O above the lower inflection point of the pressure-volume curve, with TV not greater than 8 ml/kg and stable plateau pressure for zero flow, with airway peak pressure less than 35 cm H <sub>2</sub> O.		
- Extracorporeal membrane oxygenation (ECMO) as a last resource in refractory ARDS.		
- ARDS treatment with antiendotoxins (HA-1A), prostaglandins (PGE1 and PGI2), antioxidants, corticosteroids and anti-prostaglandin agents (ibuprofen).	III	B

MRA: Mechanical respiratory assistance. TV: Tidal volume. PEEP: Positive end-expiratory pressure. ARDS: Adult respiratory distress syndrome. BP: Blood pressure. PHT: Pulmonary hypertension. CI: Cardiac index. Ht: Hematocrit. FiO<sub>2</sub>: Fraction of inspired oxygen.

**CARDIAC ARRHYTHMIAS**Dr. ADRIÁN LESCANO<sup>MTSAC</sup>

Dr. GASTÓN GÓMEZ

Dr. GABRIEL DIONISIO

Arrhythmias vary from conditions which have low clinical impact (isolated atrial extrasystoles) to processes affecting patient morbidity and/or mortality (atrial fibrillation, atrial flutter, ventricular tachycardias).

The greatest incidence of atrial fibrillation (AF) is present in the second postoperative day, and the highest risk period extends from the first to the fifth day.

Recommendation for atrial fibrillation prophylaxis	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Preoperative betablockers, except when contraindicated.</li> <li>- Betablockers within the first 24 postoperative hours, except when contraindicated.</li> <li>- Maintain adequate analgesia and sedation.</li> </ul>	I	A
<ul style="list-style-type: none"> <li>- Preoperative prophylaxis with amiodarone in patients at high risk of developing AF and/or with contraindications to betablockers.</li> <li>- Postoperative amiodarone in patients at high risk of developing AF and/or with betablocker contraindications.</li> <li>- Maintain potassium and magnesium levels within normal values.</li> <li>- Postoperative biatrial pacing.</li> </ul>	IIa	A
<ul style="list-style-type: none"> <li>- Postoperative sotalol in patients with normal LVSF.</li> <li>- Statins.</li> </ul>	IIa	B
<ul style="list-style-type: none"> <li>- Postoperative single atrial pacing.</li> </ul>	IIb	A
<ul style="list-style-type: none"> <li>- Preoperative sotalol.</li> <li>- Calcium blockers in patients presenting tachycardia, with normal LVSF and contraindications to betablockers.</li> <li>- Corticoids in patients with elevated inflammatory response.</li> </ul>	IIb	B
<ul style="list-style-type: none"> <li>- Digoxin.</li> </ul>	III	B

LVSF: Left ventricular systolic function.

Recommendation for atrial fibrillation treatment	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Heart rate control with AV nodal blocking drugs in case AF does not produce ischemia or hemodynamic decompensation, especially when there are potentially triggering and modifiable causes.</li> <li>- Reversal to sinus rhythm with IV amiodarone</li> <li>- Initiate anticoagulation after 48-hour persistent AF (initiate with UFH using 1.5-2 times APPT reference value, followed by oral anticoagulation (INR 2-3) for 3 to 4 weeks).</li> <li>- After 48-hour AF persistence or recurrence, 3 weeks of effective anticoagulation are required prior to electrical or pharmacological cardioversion.</li> <li>- TEE is an alternative to anticoagulation after 48 hours of AF.</li> <li>- Patients presenting thrombi should be treated with oral anticoagulation (INR 2-3) for at least 3 to 4 weeks and a new TEE should be performed to ensure thrombi removal. Anticoagulation should be continued for 3-4 weeks after sinus rhythm has been reestablished.</li> </ul>	I	B
<ul style="list-style-type: none"> <li>- Electrical cardioversion for high response AF or AF associated with myocardial ischemia or hemodynamic decompensation.</li> <li>- Assess decompensating factors associated with AF triggering.</li> <li>- Restore sinus rhythm when AF persists beyond 24 hours despite treatment with AV nodal blocking drugs and potential causes triggering recurrence have been corrected.</li> <li>- In AF persisting for more than 48 hours requiring urgent electrical cardioversion due to hemodynamic instability, heparin will be administered simultaneously (except when contraindicated) as IV load followed by continuous infusion, to attain 1.5 to 2 times APTT reference value.</li> </ul>	I	C
<ul style="list-style-type: none"> <li>- It is reasonable to restore sinus rhythm through pharmacological or electrical cardioversion, independently of hemodynamic involvement, once secondary causes within the first 48 hours have been ruled out.</li> <li>- Treatment with antiarrhythmic agents to maintain sinus rhythm in patients with recurrent AF.</li> <li>- Atrial flutter should be treated in the same way as AF.</li> </ul>	IIa	B

AV: Atrioventricular. AF: Atrial fibrillation. IV: Intravenous. UFH: Unfractionated heparin. APTT: Activated partial thromboplastin time. INR: International normalized ratio. TEE: Transesophageal echocardiography.

#### Recommendations for paroxysmal supraventricular tachycardias

Recommendation	Class	Level of evidence
- Electrical cardioversion when it generates hemodynamic involvement.	I	A
- Adenosine: 6 mg quick IV bolus through central catheter, with option of a repeat dose of 12 mg 2 minutes later.	I	B
- Perform ECG with epicardial leads to certify diagnosis.	I	C
- Rapid atrial pacing for reversion of PSVT.	I	C
- Diltiazem: 0.25 mg/kg in 2 minutes followed by 0.35 mg 15 minutes later.	IIa	B
- Digitalis (0.5 mg every 5 minutes up to 15 mg) in nodal reentrant PSVT to control heart rate (rule out WPW).	IIa	B
- Betablockers in nodal reentrant PSVT to control heart rate.	IIa	B
- Vagal stimulation inhibiting AV conduction and carotid sinus massage should be applied with caution.	IIa	C
- Verapamil: 5 mg in 2-minute IV infusion.	IIa	C

IV: Intravenous. ECG: Electrocardiogram. PSVT: Paroxysmal supraventricular tachycardia. WPW: Wolff-Parkinson-White. AV: Atrioventricular.

#### Ventricular tachycardia and ventricular fibrillation

They have an incidence of 1-3% in patients undergoing cardiovascular surgery, with 20-30% mortality rate. Both ischemia/infarction as reperfusion of ischemic areas may trigger arrhythmias.

Recommendation for ventricular tachycardia	Class	Level of evidence
- Electrical cardioversion when it generates hemodynamic involvement. - In torsade de pointes initiate ventricular pacing at 90-100 bpm or isoproterenol at 1-4 µg/min.	I	A
- It may be treated with IV lidocaine, amiodarone or betablockers when it is present in patients with normal LVSF. - Amiodarone 150 mg in 15 minutes followed by 1 mg/min (60 mg/h) during 6 hours, and then 0.5 mg/min (30 mg/h) for 18 hours. - Torsade de pointes requires treatment with potassium chloride (except when associated with hyperkalemia) and magnesium choride.	I	B
- It may be treated with ventricular pacing to inhibit reentry. - In case of polymorphic VT, ischemia/infarction should be ruled out immediately and assess the need of emergency CA.	I	C
- Betablockers.	Ila	B

IV: Intravenous. LVSF: Left ventricular systolic function. VT: Ventricular tachycardia. CA: Coronary angiography.

## NEUROLOGICAL COMPLICATIONS IN CARDIAC SURGERY

Dr. ALEJANDRO HLAVNIKA

Dr. FERNANDA DÍAZ

Cardiac surgery is associated with risk of numerous neurological events, from cognitive impairment to stroke, which are associated with decreased quality of life and increased morbidity and mortality.

Recommendation	Class	Level of evidence
- Before surgery, evaluate preoperative and intraoperative factors associated with stroke risk. - Use membrane oxygenator and filters < 40 µm during ECC. - Perform brain CT scans or MRI in the presence of suggestive symptoms of stroke if there are no contraindications. - MRI can be performed post-CABG after removal of epicardial leads.	I	A
- Perform epi-aortic echo during surgery in patients with history of aortic atherosclerosis. - Avoid body temperature > 37 ° C	I	B
- In patients at risk of ischemic stroke prioritize surgery without ECC. - Use the alpha stat method to maintain pH during cardiopulmonary bypass. - Maintain blood glucose level between 140 and 180 mg/dL during surgery.	Ila	A
- Prioritize a simple technique with single aortic clamping. - Maintain MAP > 70 mm Hg during ECC. - Control with transcranial Doppler ultrasound during surgery in high risk patients.	Ila	B
- Maintain blood glucose level < 140 mg/dL during surgery. - Maintain Hb > 9 mg/dL.	Ila	C
- Intravenous thrombolysis in ischemic stroke within 3 months after surgery. - Treatment with neuroprotective agents. - MRI in prosthetic valves with ferromagnetic material. - MRI in the presence of epicardial pacing with preserved conduction.	III	A
- Filters to reduce microemboli.	III	C

ECC: Extracorporeal circulation. CT: Computed tomography. MRI: Magnetic resonance imaging. CABG: Coronary artery bypass graft surgery. MAP: Mean arterial pressure. Hb: Hemoglobin

## POSTOPERATIVE RENAL FAILURE IN CARDIAC SURGERY

Dr. SILVINA WALDMAN

Dr. HERNÁN COHEN ARAZI<sup>MTSAC</sup>

### Definition / diagnostic criteria

The best definition for postoperative renal failure after cardiovascular surgery is the one using the AKIN criteria (Acute Kidney Injury Network):

- Sudden decrease (within 48 hours) of renal function with absolute increase of serum creatinine  $> 0.3$  mg/dL or more than 150% of preoperative values; or
- Reduction in urine output  $< 0.5$  ml/kg/h for more than 6 hours.

It is subdivided into three stages:

1. Serum creatinine increase  $> 0.3$  mg/dL or 150% increase of baseline values; or urine output  $< 0.5$  ml/kg/h in 6 hours.
2. Creatinine increase of 200 to 300% baseline value; or urine output  $< 0.5$  ml/kg/h in 12 hours.
3. Creatinine increase  $> 300\%$  of preoperative values, or absolute creatinine  $> 4$  mg/dL; or urine output  $< 0.3$  ml/kg/h in 24 hours or anuria in 12 hours.

Creatinine clearance (normal values:  $120 \pm 25$  ml/min in males and  $95 \pm 20$  ml/min in females) is calculated with the Cockcroft-Gault formula, based on patient age, body weight and serum creatinine. However, its use in the postoperative period has limited usefulness. Serum creatinine is the main biomarker to evaluate the clinical outcome of patients with renal failure; however, it is not sensitive enough to determine renal function in acute renal failure (ARF) because it only rises above the high normal range when glomerular filtration rate has decreased more than 50%.

In cardiac surgery it is important to assess the preoperative individual risk of each patient for the development of postoperative ARF considering age, ejection fraction, prior renal function impairment, urgent surgery, use of contrast within the previous 24 hours, diabetes mellitus, hypertension, treatment with intra-aortic balloon pump, peripheral vascular disease, whether it is a reoperation and clamping and cardiopulmonary bypass times.

Neutrophil gelatinase-associated lipocalin (N-GAL) is one of the most studied biomarkers as ARF predictor. However, its low availability limits its application.

Similarly, the determination of cystatin C preoperative values and their derived equations have prognostic value for the development of postoperative renal failure; however, there is no consensus for its use.

Recommendations for acute renal failure prophylaxis	Class	Level of evidence
- Ensure an appropriate renal perfusion level with intravascular volume and MAP adjustment.	I	A
- Statin therapy in patients with moderate or high risk.	IIa	A
- Systematic treatment with low dose dopamine (3 g/kg/min), mannitol or furosemide.	IIb	B
- Systematic treatment with N-acetylcysteine.	III	B

MAP: Mean arterial pressure.

Recommendations for acute renal failure prophylaxis	Class	Level of evidence
- Start RRT according to hemodynamic or metabolic parameters, regardless of the diuretic rate.	I	A
- In hemodynamically unstable patients, continuous RRT is suggested, when available.	I	C
- In hemodynamically stable patients intermittent hemodialysis will be employed.		
- There are no specific drugs for treatment.	IIa	B
- Nesiritide may be indicated in individual cases with LVEF impairment.		
- Dopamine treatment with doses $\leq 3$ g/kg/min.	IIa	C
- Treatment with theophylline.	III	B
- Treatment with calcium channel blockers.		

RRT: Renal replacement therapy. LVEF: Left ventricular ejection fraction.

**PREVENTION, DIAGNOSIS AND TREATMENT OF INFECTIONS IN CARDIAC SURGERY**

Dr. FRANCISCO NACINOVICH

Dr. PABLO FERNÁNDEZ OSES

Recommendations for infection prophylaxis	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Chlorhexidine baths or with another antiseptic before surgery.</li> <li>- Avoid shaving, or otherwise perform it immediately before surgery, with type "zero" machines.</li> <li>- Antibiotic prophylaxis at anesthesia induction, before surgery, usually with IV administration of first-generation cephalosporins.</li> <li>- In patients allergic to cephalosporins, IV vancomycin, 2 hours before surgery (infused in 60 minutes).</li> <li>- Keep antibiotics only for 24-48 hours postoperatively, regardless of central venous catheter or drainage persistence.</li> <li>- Hand washing and use of gloves for surgery.</li> <li>- Use of sterile surgical drapes.</li> <li>- Use of facial mask and surgical gown by the operating-room staff.</li> </ul>	I	A
<ul style="list-style-type: none"> <li>- Bacterial decolonization with nasal mupirocin 3-5 days before surgery.</li> <li>- Skin preparation before sternotomy with 2% chlorhexidine alcohol solution.</li> <li>- Add a dose of intraoperative antibiotic if surgery lasts more than 4 hours.</li> <li>- Early extubation.</li> <li>- Avoid unnecessary hemoderivative transfusions.</li> <li>- Start early, preferably enteral, feeding.</li> <li>- Antimicrobial treatment only after sampling for the respective cultures (wound, blood cultures).</li> </ul>	I	B
<ul style="list-style-type: none"> <li>- Use chlorhexidine gluconate 0.12% oral rinse 3-5 days before the procedure.</li> <li>- Minimize preoperative hospital stay.</li> <li>- In patients receiving vancomycin prophylaxis, add a second antibiotic against gram-negative bacilli.</li> <li>- Early removal of central catheters and other devices.</li> </ul>	I	C
<ul style="list-style-type: none"> <li>- Maintain perioperative blood glucose &lt; 180 mg/dL.</li> <li>- VAC (vacuum-assisted closure) to accelerate sternum healing in severe mediastinitis treatment.</li> </ul>	Ila	A
<ul style="list-style-type: none"> <li>- Add another drug to antibiotic prophylaxis if there are documented resistant germs to first choice antibiotics at the institution.</li> </ul>	Ila	C

IV: Intravenous.

**POSTOPERATIVE ISCHEMIC SYNDROMES**Dr. CHRISTIAN CAROLI<sup>MTSAC</sup>Dr. CLAUDIO PENSA<sup>MTSAC</sup>

Myocardial infarction associated with coronary artery bypass graft surgery is defined by increased myocardial markers with troponin 10 times higher than the 99th percentile upper reference limit during the first 48 hours of the postoperative period, associated with one or more of the following findings: new pathological Q wave in the electrocardiogram (ECG), new complete left bundle branch block (LBBB), angiographically documented new bridge or native coronary artery occlusion or evidence of new loss of viable myocardium in an imaging study.

Recommendations	Class	Level of evidence
- Order CK-MB or troponin T or I markers in all patients in the first 72 hours of postoperative cardiovascular surgery.	I	A
- 12-lead ECG, V3R, V4R and posterior leads (V7, 8 and 9) within the first 10 minutes of patient admission in the cardiac intensive care unit. - 12-lead ECG every 6-8 hours during the first 72 hours and then daily until discharge. - In all patients with suspected myocardial infarction presenting ST-segment alterations, start intravenous nitroglycerin. In case it fails to normalize in the next 15 minutes or there is evidence of hemodynamic involvement, the need to implement a reperfusion strategy will be evaluated. - Echocardiogram to evaluate motility disorders when there is doubt in the diagnosis of infarction. In case of inadequate acoustic window, a transesophageal study is advised. - In the presence of perioperative ischemia with hemodynamic decompensation, initiation of hemodynamic support therapy with inotropic drugs and eventually circulatory support with intra-aortic balloon pump counterpulsation is recommended, without delaying reperfusion therapy. - A coronary angiography is indicated to evaluate the culprit vessel, the condition of myocardial bridges and the pathophysiological mechanism of the ischemic event. - The presence of persistent ST-segment elevation will require mechanical reperfusion strategy; angioplasty or cardiac reoperation, in case it involves an extensive myocardial territory or generate hemodynamic involvement. The decision should be taken by clinical cardiology and cardiovascular surgery consensus. - Angioplasty is superior to reoperation in postoperative myocardial infarction. - The initial goal is to reestablish patency of the native artery. - Reoperation is only indicated in cases of specific surgical defects with simple resolution when angioplasty is not possible due to an extensive territory or hemodynamic decompensation.	I	B
- The standard goal of maximum time to reperfusion will be equal or less than 60 minutes from the onset of ST-segment alterations. - In patients with vein graft occlusion by fresh thrombus, reoperation is preferable to angioplasty in the following cases: native artery not suitable for angioplasty or occlusion of several important bridges.	I	C
- In perioperative ischemia without hemodynamic decompensation, circulatory support with intra-aortic balloon pump counterpulsation is recommended, without delaying the reperfusion strategy.	IIb	B
- The presence of persistent ST-segment elevation requires angioplasty reperfusion strategy in case of a non-extensive myocardial territory or without hemodynamic involvement.	IIb	C
- New coronary artery bypass graft surgery in the presence of perioperative myocardial infarction without assessment from a new coronary angiography. -Local intracoronary/intrabridge or systemic thrombolytic therapy and use of IIb / IIIa inhibitors as reperfusion strategy.	III	B
- Wait for serological marker results to indicate a reperfusion strategy in patients with ST-segment elevation and suspected ischemic event. - Treatment with intravenous nitroglycerin in patients with systolic blood pressure below 90 mm Hg or suspected right ventricular infarction. - Reoperation in high-risk patients who present with persistent ST-segment elevation in a non-extensive myocardial territory or without hemodynamic involvement.	III	C

### LOW CARDIAC OUTPUT SYNDROME

Dr. PABLO COMIGNANI<sup>MTSAC</sup>

Dr. JULIO GIORGINI<sup>MTSAC</sup>

Low cardiac output syndrome (LCOS) is defined by the presence of arterial hypotension (SAP < 90 mm Hg lasting more than 30 minutes), cardiac index (CI) less than 2.2 L/min/m<sup>2</sup> and pulmonary capillary pressure (PCP) higher than 15 mm Hg and/or increased systemic vascular resistance greater than 1.200 dynes/sec-5. Blood lab tests show arteriovenous O<sub>2</sub> difference greater than 5.5 ml/dl, lactic acidosis and venous oxygen saturation (SvO<sub>2</sub>) below 60%.

Recommendations for the diagnosis of low cardiac output syndrome	Class	Level of evidence
- 12-lead ECG + dorsal and right leads. - Transesophageal echocardiography.	I	B
- Chest x-ray. - Lab tests: serum electrolytes, internal environment, lactate, glucose, hematocrit, blood gases.	I	C
- Swan-Ganz catheter.	IIa	C

### Treatment

The purpose is to ensure adequate tissue perfusion, so it is essential to optimize perfusion pressure. The strategy may include:

Recommendations for the treatment of low cardiac output syndrome	Class	Level of evidence
- ECV in LCOS associated with AF with rapid ventricular response or VT.	I	A
- MRA in LCOS refractory to inotropic drugs. - IABP in LCOS refractory to inotropic drugs. - SNP in LCOS with HT and aortic dissection.	I	B
- Optimize preload with controlled volume expansions. - Temporary pacemaker in LCOS with bradyarrhythmia.	I	C
In RV dysfunction - Treatment with milrinone, dobutamine and isoproterenol.	IIa	A
- Treatment with inotropic drugs ( <i>dopamine, dobutamine, epinephrine, milrinone, levosimendan, noradrenaline</i> ). - NTG in LCOS with HT. - SNP in LCOS with HT or high peripheral resistance and normal blood pressure. - Ventricular assistance in LCOS refractory to MRA and IABP.	IIa	B
- Metaraminol. - Inotropic drugs to treat bradycardia. - Calcium channel blockers.	III	A

ECV: Electrical cardioversion. LCOS: Low cardiac output syndrome. AF: Atrial fibrillation. VT: Ventricular tachycardia. MRA: Mechanical respiratory assistance. IABP: Intra-aortic balloon pump. SNP: Sodium nitroprusside. HT: Hypertension. RV: Right ventricular. NTG: Nitroglycerin.

## POSTSURGICAL RIGHT VENTRICULAR FAILURE

Dr. FLAVIO SALVAGGIO

Severe acute right ventricular (RV) failure after cardiac surgery occurs in about 0.1% of patients after cardiovascular surgery, in 2-3% of patients undergoing cardiac transplantation and in 20-30 % of patients who receive a left ventricular assist device.

Right ventricular failure is associated with high in-hospital mortality; however, it has decreased significantly since the eighties due to better myocardial protection (antegrade and retrograde cardioplegia), less hypothermia and improved surgical techniques.

Nevertheless, it remains a major cause of postoperative low cardiac output, especially when there is pulmonary hypertension.

Recommendations for the diagnosis of right ventricular dysfunction	Class	Level of evidence
- Hemodynamic monitoring: to identify the hemodynamic pattern of right ventricular failure and monitor the effect of drugs on pulmonary pressure and cardiac output.	I	C
- Two-dimensional and Doppler echocardiography for right ventricular function, tricuspid insufficiency and pulmonary pressure assessment.	IIa	C
- Transesophageal echocardiography in case of poor transthoracic window.	IIb	C

Treatment of right ventricular dysfunction may require drugs or mechanical assistance.

Recommendations for the treatment of right ventricular dysfunction	Class	Level of evidence
- Nitric oxide (20-40 ppm) when associated with severe PHT.	I	A
- Adjust ventilation for optimal oxygenation, avoid hyperinflation, and use low PEEP (5 cm H <sub>2</sub> O). In PHT: use high O <sub>2</sub> concentrations, moderate tidal volumes, hypocapnia and PEEP (5-10 cm H <sub>2</sub> O). - Correct hypothermia, hypoxemia, hypercapnia and acidosis. Optimize preload: observe response with 200 ml of colloids or 600 ml of crystalloids. (Objective: increase CVP by 2 mm Hg and improve CO. Ideal CVP = 10 mm Hg.). - Dobutamine or milrinone in patients with signs of RV failure and SAP over 100 mm Hg. - Noradrenaline in patients with signs of right ventricular failure and hypotension.	I	B
- Treatment of tachyarrhythmias: Supraventricular: Amiodarone: 5-6 mg/kg loading dose; maintenance: 10 mg/kg. Ventricular: Lidocaine: 1-2 mg/kg loading dose; maintenance 2-4 mg/min. Amiodarone: 5-10 mg/kg. - Treatment of bradyarrhythmias: AV pacing. - Reduce RV afterload with: NTG: 0.1-10 µg /kg/min. SNP: 0.1- 10 µg /kg/min. - Inotropes: milrinone in patients with RV failure, SAP higher than 100 mm Hg and prior use of beta-blockers.	I	C
- Noradrenaline or phenylephrine in patients with RV failure who develop hypotension with inodilator agents (dobutamine, milrinone or levosimendan). - In severe RV dysfunction with severe PHT: IV prostacyclins: (0.03 a 0.2 µg/kg/min). Iloprost nebulization.	IIa	A
- Levosimendan in patients with RV failure secondary to LV failure. - Dopamine or epinephrine in patients with RV failure, hypotension, and bradycardia.	IIb	B
- Dobutamine, milrinone or levosimendan in patients with SAP < 100 mm Hg.	III	A

PHT: Pulmonary hypertension. PEEP: Positive end-expiratory pressure. CVP: Central venous pressure. CO: Cardiac output. RV: Right ventricular. SAP: Systolic arterial pressure. NTG: Nitroglycerin. SNP: Sodium nitroprusside. IV: Intravenous

### POSTSURGICAL RIGHT VENTRICULAR FAILURE

Dr. RICARDO LEVIN<sup>MTSAC</sup>

Use of circulatory assistance as “support” consists in the replacement or maintenance of partial or total, left, right or biventricular ventricular function. The intra-aortic balloon pump (IABP) is the most common form of assistance used in cardiac surgery.

Intra-aortic balloon pump recommendations	Class	Level of evidence
- Preoperative in unstable patients with ischemia refractory to medical treatment. - Preoperative in stable but high risk patients.	I	B
- Intraoperative with difficult ECC recovery. - Postoperative in LCOS or myocardial ischemia unresponsive to vasodilators.	I	C
- Preoperative in stable patients who do not meet with high-risk characteristics. - Moderate to severe aortic valve failure, aortic dissection. - Active bleeding diathesis.	III	B

ECC: Extracorporeal circulation. LCOS: Low cardiac output syndrome.

The need for complex circulatory support in postoperative cardiac surgery is 1% and is associated with high mortality. It may be indicated as bridge to myocardial recovery, seeking circulatory support for a limited period of time until functional recovery or development of irreversible complications (neurological, respiratory, renal, etc.), or it may be a therapeutic option as bridge to decision.

Ventricular assistance recommendations	Class	Level of evidence
- Centrifugal pump as left, right or biventricular support in case of potentially reversible ventricular failure in potentially recoverable patients, under maximum inotropic support and IABP at institutions with availability and personnel (medical and paramedical) experienced in its management. - Postoperative ECMO in case of potentially reversible postoperative ventricular and respiratory failure in recoverable patients, under maximum inotropic support and IABP at institutions with availability and personnel experienced in its management.	I	C
- Complex circulatory assistance in patients with uncertain possibilities of recovery or noble organ failure not clearly secondary to heart failure at institutions with availability and personnel experienced in circulatory assistance.	IIa	C
- Circulatory assistance in elderly patients or with parenchymal failure with uncertain possibilities of recovery.	IIb	B
- Circulatory assistance in patients with no chance of myocardial function recovery or at institutions without experience in its management.	III	B

IABP: Intra-aortic balloon pump. ECMO: Extracorporeal membrane oxygenation.

### INDICATIONS FOR PERMANENT PACEMAKER IN POSTOPERATIVE CARDIAC SURGERY

Dr. MAURICIO ABELLO<sup>MTSAC</sup>

Dr. JULIÁN OLMEDO

The incidence of atrioventricular (AV) block in coronary artery bypass graft surgery (CABG) is from 6% to 19% and up to 23% in valve surgeries. This percentage rises considerably with a preexisting conduction disorder.

## Preoperative risk score

Variables	Class
Preoperative electrocardiogram:	
Complete right bundle branch block.	2
Complete left bundle branch block.	1
PR > 200 ms.	1
Multivalvular surgery:	
Including tricuspid valve.	2
Not including tricuspid valve.	1
Others:	
Age ≥ 70 years.	1
Previous valve surgery.	1

Maximal score: 7 points. Low risk: 0 to 1. Moderate risk: 2 to 3. High risk: 4 or more.

Permanent pacemaker recommendations	Class	Level of evidence
- Third-degree or advanced second-degree AV block without expected recovery or persisting more than 7 days in children and patients with congenital heart disease surgeries.	I	B
- Third-degree or advanced second-degree AV block at any anatomic level without expected postoperative recovery. - Symptomatic bradyarrhythmias caused by sinus node dysfunction or AV block 3 weeks after heart transplantation. - Symptomatic or inappropriate sinus bradycardia without expected spontaneous resolution in heart transplantation.	I	C
- Chronotropic incompetence seriously affecting quality of life in the late postoperative period of heart transplantation.	IIa	C
- New onset of persistent bundle branch block after aortic valve replacement.	IIb	B
- Asymptomatic sinus bradycardia after biventricular repair of congenital heart disease when resting heart rate is below 40 bpm or in the presence of pauses lasting more than 3 seconds. - Transient postoperative third-degree AV block with residual bifascicular block in children and patients with congenital heart disease. - Prolonged or recurrent bradycardia limiting rehabilitation or discharge after the postoperative course of heart transplantation. - Syncope after heart transplantation, even in the absence of documented bradyarrhythmias and symptomatic bradyarrhythmias between the first and third week of transplantation.	IIb	C
- Transient asymptomatic AV block in the postoperative period of congenital heart disease surgical repair with recovery of normal AV conduction in 7 days.	III	B
- Asymptomatic bifascicular block with or without first-degree AV block after reconstructive surgery of congenital heart disease in the absence of transient complete AV block. - Asymptomatic bradyarrhythmias and well tolerated chronotropic incompetence, and bradyarrhythmias during the first week of heart transplantation.	III	C

AV: Atrioventricular.

**CARDIOVASCULAR REHABILITATION**Dr. ROBERTO PEIDRO<sup>MTSAC</sup>

Dr. ENRIQUE GONZÁLEZ NAYA

The main objectives of cardiac rehabilitation are the reintegration of the patient to an active lifestyle and the prevention of bridge reocclusion and progression of cardiovascular disease.

Discharge Recommendations	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Initiate early mobilization during hospitalization, standing and walking with and without assistance in the room and the corridor between 3-5 times per day, as tolerated, up to the moment of discharge.</li> <li>- Perform aerobic exercise 3-5 times per day with increasing intensity and according to physical capacity and sternotomy evolution after discharge.</li> <li>- High risk patients should enter a cardiac rehabilitation plan at least during the first three months of initiating physical activity.</li> <li>- Sexual activity may be resumed with regular partners and more passive positions if there is sternal stability and physical daily life activities develop without symptoms of pain or dyspnea.</li> </ul>	I	A
<ul style="list-style-type: none"> <li>- Exercises for patients with a history of coronary artery bypass graft surgery do not differ from those programmed for patients without previous surgery.</li> <li>- Exercise programming can take place according to the results of a submaximal or maximal stress test depending on patient condition.</li> <li>- During the exercises of the cardiac rehabilitation program, presence of symptoms, heart rate (self-monitoring, sensors or monitors, as required) and blood pressure will be monitored. In diabetic patients blood glucose level assessment is necessary.</li> <li>- High risk patients (functional capacity &lt; 7 MET, residual ischemia or malignant ventricular arrhythmias during stress testing or ventricular dysfunction on echocardiography) should be monitored and supervised more closely.</li> <li>- Subsequent sports practice can be evaluated according to sports history, personal tastes, and sport and patient personality characteristics.</li> <li>- Exercise intensity to start programmed exercise plans must be between 50% and 80% of maximum VO<sub>2</sub> at stress test</li> <li>- In patients with low physical fitness, level limits are set at 3-4 of the "1-10" Borg scale or at 11-13 of the "6-20" Borg scale, corresponding to mild and "fairly heavy" efforts .</li> <li>- The time allotted to these exercises should be 20 to 60 minutes.</li> <li>- Work tasks involving intellectual activity with low intensity physical activity can be started early.</li> </ul>	I	B
<ul style="list-style-type: none"> <li>- Dynamic exercises generally employing large muscle groups can be chosen.</li> <li>- About 15-20% of the session should include strength / muscular endurance exercises.</li> <li>- Several daily sessions of shorter duration (10-15 minutes) can be done.</li> <li>- Stronger physical activities require functional testing (30-45 days after surgery) before returning to work.</li> </ul>	I	C
<ul style="list-style-type: none"> <li>- Exercises with ample arm stretching before 3 months after surgery.</li> </ul>	III	C

VO<sub>2</sub>: oxygen consumption

## CARDIOVASCULAR REHABILITATION

Dr. RICARDO IGLESIAS<sup>MTSAC</sup>

Dr. MATÍAS TINETTI<sup>MTSAC</sup>

Recommendations after discharge	Class	Level of evidence
<ul style="list-style-type: none"> <li>- Indefinite 100-325 mg/day ASA therapy after CABG, especially in patients with venous bridge revascularization.</li> <li>- Start statin therapy during hospitalization and continue indefinitely. The aim is to achieve an LDL-C &lt; 100 mg/dL, preferably &lt; 70 mg/dL.</li> <li>- Treatment with clopidogrel, for at least one year, in patients with ASA allergy.</li> <li>- Start beta-blocker therapy as early as possible when there are no contraindications and the patient is hemodynamically stable, especially in case of history of myocardial infarction, impaired LVSF and heart failure.</li> <li>- ACEI therapy during hospitalization if not contraindicated, in patients with impaired LVSF, diabetes, hypertension, or chronic renal disease.</li> <li>- Ischemia evocative tests (stress echo/perfusion scan) 5 years post-CABG in asymptomatic patients.</li> <li>- Ischemia evocative tests (stress echo/perfusion scan) before 5 years post-CABG in symptomatic patients with ischemic pattern on the ECG or LVSF impairment.</li> <li>- Doppler echocardiography if valvular defects are suspected at any postoperative time.</li> </ul>	I	A
<ul style="list-style-type: none"> <li>- Restart clopidogrel/ticagrelor for 3-12 months if the patient received it prior to urgent CABG.</li> <li>- Initiate beta-blocker therapy, if there are no contraindications, as early as possible for AF prophylaxis.</li> </ul>	I	B
<ul style="list-style-type: none"> <li>- Postoperative treatment with ACEI in all patients if there are no contraindications.</li> </ul>	IIa	B
<ul style="list-style-type: none"> <li>- Doppler echocardiography during the postoperative period before discharge or within the first month.</li> <li>- Annual Doppler echocardiography in the patient presenting uneventful initial outcome during the first year after valve surgery.</li> </ul>	IIa	C
<ul style="list-style-type: none"> <li>- Beta-blocker therapy in patients with hemodynamic instability or high degree AV block.</li> </ul>	III	A

ASA: Acetylsalicylic acid (aspirin). CABG: Coronary artery bypass graft surgery. LDL-C: Low-density lipoprotein cholesterol. LVSF: Left ventricular systolic function. ACEI: Angiotensin-converting enzyme inhibitors. ECG: Electrocardiogram. AF: Atrial fibrillation

## BIBLIOGRAPHY

- Shanewise JS, Cheung AT, Aronson S, Stewart WJ, Weiss RL, Mark JB, et al. ASE/SCA guidelines for performing a comprehensive intraoperative multiplane transesophageal echocardiography examination. *Anesth Analg* 1999; 89:870-4.
- Hillis LD, Smith PK, Anderson JL, Bittl JA, Bridges CR, Byrne JG, et al. 2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation* 2011; 124:e652-735.
- Society of Thoracic Surgeons Blood Conservation Guideline Task Force, Ferraris VA, Ferraris SP, Saha SP, Hessel EA 2nd, Haan CK, Royston BD, et al; Society of Cardiovascular Anesthesiologists Special Task Force on Blood Transfusion, Spiess BD, Shore-Lesserson L, Stafford-Smith M, Mazer CD, Bennett-Guerrero E, Hill SE, et al. Perioperative blood transfusion and blood conservation in cardiac surgery: the Society of Thoracic Surgeons and The Society of Cardiovascular Anesthesiologists clinical practice guideline. *Ann Thorac Surg* 2007; 83(5 Suppl):S27-86.
- Rassias AJ. Intraoperative management of hyperglycemia in the cardiac surgical patient. *Semin Thorac Cardiovasc Surg* 2006; 18:330-8.
- Murphy GJ, Angelini GD. Indications for blood transfusion in

cardiac surgery. *Ann Thorac Surg* 2006; 82:2323-34.

- Gommers D, Bakker J. Medications for analgesia and sedation in the intensive care unit: an overview. *Crit Care* 2008; 12(Suppl 3) S4.
- MacIntyre N. Evidence Based Guidelines for Weaning and Discontinuing Ventilatory Support. *Chest* 2001; 120:375s-95s.
- Mangano DT. Aspirin and mortality from coronary bypass surgery. *N Engl J Med* 2002; 347:1309-17.
- Nakasugi M, Matsushita M, Asada A. Risk factors for prolonged ICU stay in patients following coronary artery bypass grafting with a long duration of cardiopulmonary bypass. *J Anesth* 2005; 19:118-23.
- Loubani M, Mediratta N, Hickey M, Galiñanes M. Early discharge following coronary bypass surgery: is it safe? *Eur J Cardiothorac Surg* 2000; 18:22-6.
- Wan G, Arifi AA, Wan IY, Ng CS, Lee TW, Yim AP. Inflammatory responses to cardiopulmonary bypass: mechanisms involved and possible therapeutic strategies. *Chest* 1997; 112:676-92.
- Leyh RG, Kofidis T, Strüber M, Fischer S, Knobloch K, Wachsmann B, et al. The drug choice for catecholamine refractory vasoplegia after cardio-pulmonary bypass. *J Thorac Cardiovasc Surg* 2003; 125:1426-31.
- Litmathe J, Kurt M, Feindt P, Gams E, Boeken U. Predictors and outcome of ICU readmission after cardiac surgery. *Thorac Cardiovasc Surg* 2009; 57:391-4.
- Ng CS, Wan S, Yim APC, Arifi AA. Pulmonary Dysfunction after Cardiac Surgery. *Chest* 2002; 121:1269-77.

- Mathew JP, Fontes ML, Tudor IC, Ramsay J, Duke P, Mazer CD, et al. A multicenter risk index for atrial fibrillation after cardiac surgery. *JAMA* 2004;291:1720-9.
- European Heart Rhythm Association; European Association for Cardio-Thoracic Surgery, Camm AJ, Kirchhof P, Lip GY, Schotten U, Savelieva I, Ernst S, Van Gelder IC, Al-Attar N, Hindricks G, Prendergast B, Heidbuchel H, Alfieri O, Angelini A, Atar D, Colonna P, De Caterina R, De Sutter J, Goette A, Gorennek B, Haldal M, Hohloser SH, Kolh P, Le Heuzey JY, Ponikowski P, Rutten FH; ESC Committee for Practice Guidelines. *Europace* 2010; 12:1360-420.
- Zabala JA. Neurological complications of cardiac surgery. *Rev Esp Cardiol* 2005; 58:1003-6.
- Bagshaw SM, George C, Bellomo R, ANZICS Database Management Committee. A Comparison of the RIFLE and AKI criteria for acute kidney injury in critically ill patients. *Nephrol Dial Transplant* 2008; 23:1569-74.
- Brochard L, Abroug F, Brenner M. An Official ATS/ERS/ESICM/SCCM/SRLF Statement: Prevention and Management of Acute Renal Failure in the ICU Patient An International Consensus Conference in Intensive Care Medicine. *Am J Respir Crit Care Med* 2010; 181:1128-55.
- Demirkiliç U, Kuralay E, Yenicesu M, Çağlar K, Oz BS, Cingöz F, et al. Timing of replacement therapy for acute renal failure after cardiac surgery. *J Card Surg* 2004; 19:17-20.
- Calmaggi AR, Guerrini GM, González Arzac M del R. Prevención de infecciones del sitio quirúrgico y profilaxis antibiótica en cirugía. En: Stamboulian D. *Infectología para la práctica diaria III*. Buenos Aires, Argentina: FUNCEI; 1998:85-119.
- Cimochoowski GE, Harostock MD, Brown R, Bernardi M, Alonzo N, Coyle K. Intranasal mupirocin reduces sternal wound infection after open heart surgery in diabetics and nondiabetics. *Ann Thorac Surg* 2001; 71:1572-9.
- Salehi Omran A, Karimi A, Ahmadi SH, Davoodi S, Marzban M, Movahedi N, et al. Superficial and deep sternal wound infection after more than 9000 coronary artery bypass graft: incidence, risk factors and mortality. *BMC Infect Dis* 2007;7:112.
- Fowler VG, O'Brien SM, Muhlbauer LH, Corey GR, Ferguson B, Peterson ED, et al. Clinical Predictors of Major Infections After Cardiac Surgery. *Circulation* 2005; 112; 358-65.
- Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD, et al. Third universal definition of myocardial infarction. *Eur Heart J* 2012; 60:1581-98.
- Costa MA, Carere RG, Lichtenstein SV, Foley DP, de Valk V, Lindenboom W, et al. Incidence, Predictors, and Significance of Abnormal Cardiac Enzyme Rise in Patients Treated With Bypass Surgery in the Arterial Revascularization Therapies Study (ARTS). *Circulation* 2001; 104:2689-93.
- The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). *Eur Heart J* 2010; 31:2501-55.
- Zhao DX, Leacche M, Balaguer JM, Boudoulas KD, Damp JA, Greelish JP, et al. Anesthesiology, and Interventional Cardiology Groups at the Vanderbilt Heart and Vascular Institute. Routine Intraoperative Completion Angiography After Coronary Artery Bypass Grafting and 1-Stop Hybrid Revascularization. *J Am Coll Cardiol* 2009; 53:232-41.
- Henquin R, Bozovich G, Aranda G, Ciruzzi M, Nadinic B, Fabrikant F y cols; por Investigadores de CONAREC III. Predictores independientes de bajo gasto cardíaco en el preoperatorio de cirugía de revascularización miocárdica. *Rev Argent Cardiol* 1996; 64:179-86.
- Dickstein K, Cohen-Solal A, Filippatos G, McMurray JJ, Ponikowski P, Poole-Wilson PA, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2008: the Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2008 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association of the ESC (HFA) and endorsed by the European Society of Intensive Care Medicine (ESICM). *Eur Heart J* 2008; 29:2388-442.
- Costachescu T, Denault A, Guimond JG, Couture P, Carignan S, Sheridan P, et al. The hemodynamically unstable patient in the intensive care unit: Hemodynamic vs. transesophageal echocardiographic monitoring. *Crit Care Med* 2002; 30:1214-23.
- Kaul TK, Fields BL. Postoperative acute refractory right ventricular failure: incidence, pathogenesis, management and prognosis. *Cardiovasc Surg* 2000; 8:1-9.
- Haddad F, Couture P, Tousignant C, Denault AY. The right ventricle in cardiac surgery, a perioperative perspective: II pathophysiology, clinical importance and management. *Anesth Analg* 2009; 108:422-33.
- Comité Organizador Comisión de Normatizaciones y Consensos (SAC). Consenso de Asistencia Circulatoria Mecánica. *Rev Argent Cardiol* 2004; 72:37-51.
- Miceli A, Duggan SM, Capoun R, Romeo F, Caputo M, Angelini GD. A Clinical Score to Predict the Need for Intraaortic Balloon Pump in Patients Undergoing Coronary Artery Bypass Grafting. *Ann Thorac Surg* 2010; 90:522-6.
- Nakatani T. Japanese registry for the clinical use of ventricular assist devices. En: *Third Annual meeting of Japanese Society for Clinical Use of Ventricular Assist Devices, 1997, Yokohama, Japan*.
- Gordon RS, Ivanov J, Cohen G, Ralph-Edwards AL. Permanent Cardiac Pacing After a Cardiac Operation: Predicting the Use of Permanent Pacemakers. *Ann Thorac Surg* 1998; 66:1698-704.
- Patrono C, Collier B, Fitzgerald G, Hirsh J, Roth G. Platelet active drugs: the relationship among dose, effectiveness and side effects: the seventh ACCP conference on antithrombotic and thrombolytic therapy. *Chest* 2004; 126(Suppl):234S-64S.
- Goyal A, Alexander J, Hafley GE, Graham SH, Mehta RH, Mack MJ, et al. Outcomes associated with the use of secondary prevention medications after CABG. *Ann Thorac Surg* 2007; 83:993-1001.
- Edmunds LH Jr, Clark RE, Cohn LH, Grunkemeier GL, Miller DC, Weisel RD. Guidelines for reporting morbidity and mortality after cardiac valvular operations: Ad Hoc Liaison Committee for Standardizing Definitions of Prosthetic Heart Valve Morbidity of the American Association for Thoracic Surgery and The Society of Thoracic Surgeons. *J Thorac Cardiovasc Surg* 1996; 112:708-11.