

Cardiopulmonary Bypass in Adult Cardiac Surgery Clinical Practice Guidelines (2019)

European Association for Cardio-Thoracic Surgery (EACTS)/European Association of Cardiothoracic Anaesthesiology (EACTA)/European Board of Cardiovascular Perfusion (EBCP)

This is a quick summary of the guidelines without analysis or commentary. For more information, go directly to the guidelines by clicking the link in the reference.

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The guidelines on cardiopulmonary bypass (CPB) in adult cardiac surgery were released on October 2, 2019, by the European Association for Cardio-Thoracic Surgery (EACTS), the European Association of Cardiothoracic Anaesthesiology (EACTA), and the European Board of Cardiovascular Perfusion (EBCP).^[1]

Choice of CPB Circuit

Minimally invasive extracorporeal circulation (MiECC) should be considered over standard conventional CPB systems to reduce blood loss and need for transfusion, as well as to increase the biocompatibility. A combination of MiECC features (eg, coating, centrifugal pump, separation of cardiectomy suction blood, and use of closed systems) should be considered to improve conventional CPB.

Use of Carbon Dioxide Flush

It is recommended that CO₂ flush of the CPB circuit before priming be established as the standard of care to reduce gaseous microemboli (GME). CO₂ flooding of the operative field may be considered to reduce GME.

Priming Volume in CPB Circuit

The use of modern low-molecular-weight starches in priming and nonpriming solutions to reduce bleeding and transfusions is not recommended.

Retrograde and antegrade autologous primings are recommended as part of a blood conservation strategy to reduce transfusions.

Periprocedural Anticoagulation Management

Activated clotting time (ACT) >480 s during CPB should be considered in CPB with uncoated equipment and cardiectomy suction. Required target ACT depends on the type of equipment used.

Individualized heparin and protamine management should be considered to reduce postoperative coagulation abnormalities and bleeding complications in cardiac surgery with CPB.

In the absence of individual heparin dosing tools, it is recommended that ACT tests be performed at regular intervals according to institutional protocols, and heparin doses have to be given accordingly.

Protamine overdosing should be avoided in order to reduce postoperative coagulation abnormalities and bleeding complications in cardiac surgery with CPB.

In patients with contraindications to heparin and/or protamine usage and in need of an operation requiring CPB, anticoagulation with bivalirudin should be considered. In such patients who have significant renal dysfunction, argatroban may be considered.

Acid-Base Balance and Electrolyte Management

Alpha-stat acid-base management should be applied in adult cardiac surgery with moderate-to-mild hypothermia to improve neurologic and neurocognitive outcomes.

Maintenance of a normal pH (7.35-7.45) and avoidance of hyperchloremic acidosis should be considered in order to reduce the risk of postoperative complications.

Magnesium sulfate may be considered perioperatively for prophylaxis of postoperative arrhythmias.

Control of Mean Arterial Pressure (MAP) During CPB

It is recommended to adjust the MAP during CPB with arterial vasodilators (if MAP >80 mm Hg) or vasoconstrictors (if MAP < 50 mm Hg), after checking and adjusting the depth of anesthesia and assuming sufficiently targeted pump flow. Use of vasopressors to force MAP during CPB at values higher than 80 mm Hg is not recommended.

It is recommended that vasoplegic syndrome during CPB be treated with alpha1-adrenergic agonist vasopressors. For vasoplegic syndrome refractory to such agents, alternative drugs (vasopressin, terlipressin, or methylene blue) should be used, alone or in combination with alpha1-agonists. Hydroxocobalamin may be used to treat vasoplegic syndrome during CPB.

Pump Flow Management During CPB

It is recommended that the pump flow rate be determined before initiation of CPB on the basis of body surface area and planned temperature.

The adequacy of the pump flow rate during CPB should be checked in accordance with oxygenation and metabolic parameters (mixed venous oxygen saturation [SvO₂], oxygen extraction ratio [O₂ER], near-infrared spectroscopy [NIRS], carbon dioxide production [VCO₂], lactates). The flow rate should be adjusted according to the arterial oxygen content to maintain a minimal threshold of oxygen delivery (DO₂) under moderate hypothermia.

Pump flow rates may be settled on the basis of lean mass in obese patients.

Type of CPB Pump Flow

Pulsatile perfusion may reduce postoperative pulmonary and renal complications and should be considered in patients at high risk for adverse lung and renal outcomes.

Perioperative Hemodynamic Management

Goal-directed hemodynamic therapy (GDT) is recommended to reduce the postoperative complication rate and length of hospital stay.

Use of Assisted Venous Drainage

It is recommended that an approved venous reservoir be used for assisted venous drainage.

It is recommended that the venous line pressure be monitored when using assisted venous drainage. Excessive negative venous pressures are not recommended.

Transfusion Management During CPB

It is recommended that packed red blood cells (PRBCs) be transfused during CPB if hemoglobin (Hb) < 6.0 g/dL.

For hematocrit (Hct) values between 18% and 24%, PRBCs may be transfused based on an assessment of the adequacy of tissue oxygenation. PRBCs should not be transfused if Hct > 24%.

It is recommended that antithrombin concentrate be used instead of fresh frozen plasma (FFP) to treat antithrombin deficiency to improve heparin sensitivity. If antithrombin concentrate is unavailable, FFP should be considered.

FFP should not be used prophylactically during CPB to reduce perioperative blood loss.

Anesthesia and Pharmacologic Management

Volatile anesthetics should be considered during CPB. The oxygenator exhaust concentration of such an agent should be at least the same during CPB as before CPB (if used as sole anesthetic agent), except during rewarming, when it should be increased. Oxygenator exhaust concentrations should be monitored during CPB.

Doses of intravenous (IV) anesthetics and opioids, except remifentanyl, should be at least the same during CPB as before CPB (if used as the sole anesthetic agent). After 20-30 minutes from the initiation of CPB, the remifentanyl dose may be reduced by 30% at 32°C; hypothermia below 27°C requires immediate reduction by 60%.

Short-acting neuromuscular-blocking agents should be considered in cardiac anesthesia.

Routine use of prophylactic IV corticosteroids is not recommended during cardiac surgery.

Tight glycemic control may be considered during CPB.

Control of Ischemic Cardiac Arrest

It is recommended that patient-centered myocardial protective strategies be used on the basis of clinical condition and procedural complexity rather than the use of a fixed institutional cardioplegic solution.

Blood cardioplegia should be considered in selected patients to reduce hemodilution, bleeding complications, and transfusion requirements.

Lung Protection During CPB

Biocompatible modifications of circuits should be considered in order to protect the lungs from inflammatory responses and provide less oxidative stress.

Modified ultrafiltration (MUF) and selective pulmonary artery perfusion may be considered for improving postoperative respiratory function.

Leukocyte filtration and hyperoxia are not recommended for lung protection.

Positive end-expiratory pressure (PEEP) during CPB should be considered in order to protect the lungs. Ventilation during CPB may be considered for lung protection.

High-dose dexamethasone may be considered in order to protect the lungs in selected patients.

Use of Noninvasive Cerebral Monitoring

Routine use of processed electroencephalographic (EEG) monitoring to reduce the incidence of intraoperative awareness may be considered.

The use of NIRS-guided algorithms to improve clinical outcomes may be considered.

Management of Shed Blood

Discarding shed blood should be considered.

Processing and secondary filtration of red blood cells should be considered to decrease the deleterious effects of reinfused shed blood.

Minimally Invasive Surgery

Perfusionists should be adequately trained and educated in the different aspects of minimally invasive cardiac surgery techniques.

Minimally invasive heart valve surgery may be considered to reduce blood loss and the need for transfusion. Such surgery may be considered in experienced units with respect to the patient's preference.

Emergency Institution and Reinstitution of CPB

It is recommended that a set-up CPB circuit be available at all times for emergency procedures.

After the patient is weaned from CPB, it is recommended that the CPB circuit be kept functional until the patient's chest has been closed.

Hemodynamic Monitoring

A pulmonary artery catheter may be indicated in selected cases.

Cardiac output with pulse contour analysis may be indicated in selected cases.

Transesophageal echocardiography (TEE) should be considered in open-heart and thoracic aortic procedures unless there are contraindications.

Use of Positive Inotropes

Positive inotropic and/or vasopressor agents are recommended as a first-line treatment to reduce mortality in patients with hemodynamic instability.

The use of phosphodiesterase inhibitors should be considered to increase weaning success.

Prophylactic infusion of levosimendan to reduce adverse events and mortality is not recommended. Levosimendan as a therapeutic strategy in selected difficult-to-wean patients having CPB may be considered. In patients requiring hemodynamic support after cardiac surgery, adding levosimendan to other positive inotropes or vasopressors is not recommended.

Residual Blood Management

Retransfusion of the residual volume of the CPB circuit at the end of the procedure is recommended as part of a blood management program to minimize allogeneic blood transfusions.

Retransfusion of the processed residual volume of the CPB circuit at the end of the procedure should be considered for minimizing the risks of allogeneic blood transfusions.

For more information, please go to [Failure to Separate From Cardiopulmonary Bypass](#) and [Circulatory Arrest and Cardiopulmonary Bypass Hypothermia](#).

For more Clinical Practice Guidelines, please go to [Guidelines](#).

References

1. Puis L, Milojevic M, Boer C, De Somer FMJJ, Gudbjartsson T, van den Goor J, et al; EACTS/EACTA/EBCP Committee Reviewers. 2019 EACTS/EACTA/EBCP guidelines on cardiopulmonary bypass in adult cardiac surgery. *Interact Cardiovasc Thorac Surg*. 2019 Oct 2. Available at: <https://academic.oup.com/icvts/advance-article/doi/10.1093/icvts/ivz251/5579824>.

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