

Anesthesiological organ protection during organ removal from adult "Donation after Brain Death (DBD)" donors

Version 4.0 — February 2026

CONTENT

1.0	Methodology	4
2.0	Preoperative measures	5
2.1	Premedication	5
2.1	Transfer from the intensive care unit to the operating theatre	5
3.0	Surgical measures	7
3.1	Risks and complications	7
3.2	Preparation of the patient in the operating theatre	7
3.1	Main side effects of brain death	8
3.1.1	Cardiovascular system	8
3.1.2	Respiratory system	10
3.1.3	Endocrine system	10
3.1.4	Blood and immune system	10
3.1.5	Nervous system	11
3.1.6	Urogenital system	11
4.0	Key points at a glance	Fehler! Textmarke nicht definiert.

1.0

Methodology

A detailed document analysis was carried out based on publications on PubMed and recommendations from European and North and South American organizations involved in organ transplantation.

The sources were reviewed by an editorial committee comprising doctors from the National Committee for Organ Donation (CNDO), the Swiss Association of Anesthesiologists, and Swisstransplant.

Given to the subject matter covered in this paper, laws, draft laws, decrees, ordinances, and resolutions were also considered as sources. The same applies to recommendations from organizations, foundations, and international associations.

The references were critically evaluated and divided into the following three categories based on the strength of the evidence and the recommendations formulated [6]:

Type of recommendation	Application modalities	Markings in the text
Strong consensus	Must be applied during treatment	+++
Weak consensus	Approach is strongly recommended	++
No or little consensus	Lack of reason: Decision of the team	+

2.0

Preoperative measures

2.1 Premedication

After brain death has been determined and after notification by the organ procurement coordinator, premedication is administered in the intensive care unit.

The following information must be provided by the intensive care unit and the donation coordinators for premedication so that it can be documented by the anesthesiologist:

- Medical and surgical history: Allergies and cardiovascular diseases that may influence organ preservation therapy
- Type of ventilation and any ventilation difficulties
- The patient's hemodynamic status and the vasoactive drugs required to maintain organ perfusion
- Up-to-date laboratory results
- Available or required blood products (erythrocyte concentrate, frozen fresh plasma, platelets)
- Times at which the various medications must be administered (antibiotics, corticosteroids, etc.)
- Complications and/or organ failure already identified (arrhythmias, dyscrasia, etc.)
- Existence of a death certificate duly completed and signed by the persons involved
- Procurement modalities (number of teams, organs to be removed, tissue to be removed, times etc.)
- Already initiated or planned monitoring

2.1 Transfer from the intensive care unit to the operating theatre

General recommendations:

- The patient is transferred either in the intensive care unit or in the operating area. The patient is presented by the responsible treatment team in accordance with the internal preoperative checklist.
- Ensure that blood products are available.
- Maintain protective ventilation to ensure that organs and tissues are adequately supplied with oxygen.

Recommended monitoring and medications to be prepared before transfer to the operating theatre:

- Electrocardiogram (ECG) – 5 leads
- End-tidal carbon dioxide (EtCO₂)
- Pulse oximetric oxygen saturation (SpO₂)
- Arterial catheter
- Central venous pressure (CVP)
- Measure cardiac output (CO), pulmonary artery catheter (CardioQ®, Flowtrac®, Pro-Act®, PiCCO®, etc. if indicated)
- Temperature
- Indwelling catheter
- Gastric tube

Essential medications (+++):

- Non-depolarising curare
- Morphinomimetics (morphine, fentanyl, sufentanil)
- Volatile or intravenous anesthetics (disoprivan, benzodiazepines, inhalation anesthetics)
- Vasoactive amines (noradrenaline, adrenaline, isoprenaline, dobutamine)
- Medications to lower blood pressure (nitroderivatives, sodium nitroprusside, alpha-1 blockers, urapidil (Mediatensyl®, Eupressyl®, Ebrantil®))
- Short-acting beta-blockers (Esmolol®)
- Lidocaine
- Electrolyte solutions (calcium, magnesium, potassium)
- Sodium heparin (300 IU/kg), to be used after surgical control of the major arterial and venous vessels
- Amiodarone

Supplementary medications (++)

- Diuretics (furosemide)
- Antibiotics, depending on the diagnosis and organs removed
- Corticosteroids: hydrocortisone (methylprednisolone for lung removal)
- Desmopressin (Minirin®) / arginine vasopressin (Empressin®)
- Other medications as required

Other materials:

- Ventilator with filter suitable for the patient
- System for administering inhalation anesthetics
- Device for warming infusions and heating mat
- Defibrillator, at hand
- Infusion solutions, preferably crystalloid solutions
- Erythrocyte concentrate (de-leukocyted), plasma (frozen fresh plasma) and, if necessary, platelet concentrate, prothrombin complex concentrate (Prothromplex®) if required

3.0

Surgical measures

3.1 Risks and complications

The risks and complications are comparable to those of other major surgical procedures: increasing hemodynamic instability due to positioning (often xiphopubic, position changes), hypovolemia, increased risk of bleeding, hepatic luxation, excessive blood loss, etc.

This can lead to significant blood loss. It is therefore necessary to perform transfusions on brain-dead patients during the removal phase in order to prevent prolonged reduced oxygen supply to the tissue. The target hemoglobin level is at least 70 g/l.

3.2 Preparation of the patient in the operating room

Preparation: Depending on which organs are to be harvested and the extent to which hemodynamics must be maintained, the following must be checked:

- Correct positioning
- At least two functional peripheral venous accesses of a suitable size
- Device for warming the infusions
- Positioning of the pulse oximeter
- Intubation tube and gastric tube in position
- Adequate hemodynamic monitoring

Adequate organ perfusion is indicated as follows (+++) [12–15]:

- Mean arterial pressure (MAP) between 60 and 70 mmHg
- Systolic blood pressure > 100 mmHg
- Heart rate (HR) 60–120/min
- Diuresis between 0.5 and 4 ml/kg/h
- Warm periphery
- SvO₂ > 65% or ScvO₂ > 70%
- Hemoglobin > 70g/l

During multi-organ procurement (MOP), specific hemodynamic problems associated with brain death may occur. These are discussed in the following sections.

3.1 Main side effects of brain death

3.1.1 Cardiovascular system		
Goals to be achieved	Side effects of brain death	Recommendations for organ protection (+++) [12]
Blood pressure = MAP 60–70 Systolic blood pressure > 100 HR 60–120/min. SvO ₂ > 65% or ScvO ₂ > 70% pH value: 7.35 – 7.45 PaO ₂ > 70 mmHg (++) PaCO ₂ normal Calcemia normal, treat if below 2.1 mEq/l (or < 1.1 mmol/l)	Reduction in contractility Reduced vascular resistance	Vasoactive amines Consider adjusting the depth of anesthesia
	Arrhythmias, "rhythm storm" Reflex bradycardia	Correct electrolyte imbalances, short antiarrhythmics, beta blockers Isuprel®: bolus of 10 µg, then 0.2–0.5 µg/kg/min, ESS if necessary Deepening of analgesia/sedation (morphine products)
	Hypovolemia due to Polyuria	Volume replacement, compensate for losses Consider Empressin®, desmopressin in cases of possible diabetes insipidus (sodium control)

Hypotension

- Exclude septic or obstructive shock such as pulmonary embolism, pneumothorax, tamponade
- Compensate for or prevent the volume deficit associated with vasoplegia using crystalloids, if necessary with gelatin preparations, fresh plasma, and/or albumin.
 - In case of hypovolemia (pulse pressure variation (PPV) > 13%, CVP < 8 mmHg / pulmonary artery occlusion pressure < 10 mmHg / Δ TA > 10%)
 - Crystalloids, 500 ml, repeat over 15–20 min (2nd choice: colloids, except in cases of lung removal)
 - For Hb < 70 g/l, transfusion of de leukocyt ed erythrocyte concentrate
 - In case of heart failure (marbled and pale extremities, cardiac index < 2.2 l/m² ↓, measured HMV < 1.5 l/min ↓, SvO₂ < 65%, ScvO₂ < 70%)
 - Dobutamine ≤ 5 µg/kg/min, then Empressin® due to its effect on maintaining euvolemia, then adrenaline, noradrenaline if necessary
 - If necessary, thyroid hormone T₃, unless already administered as a continuous IV infusion since the onset of brain death
- If points 1 and 2 have been ruled out or treated, it is probably distributive shock.
 - Noradrenaline in stages: 0.05 µg/kg/min, then 0.5–1 µg/kg/min up to a maximum of 2–3 µg/kg/min
 - Additional administration of epinephrine bolus/perfusor
- If diabetes insipidus is suspected:
 - Treatment with Minirin®: 1–4 µg directly IV, repeat every 4–8 hours depending on diuresis
 - Regular reevaluation of diuresis and sodium levels

If the above therapies prove to be insufficiently effective, the following treatment can be considered as a supportive/com bination therapy:

- 50 mg hydrocortisone every 6 hours, if not already administered in the intensive care unit
- Additional volume administration; at the same time, electrolyte imbalances and temperature must be corrected as far as possible

Hypertension

- Short-acting antihypertensive drugs (nitroderivatives, sodium nitroprusside) are used to treat the high blood pressure of brain-dead patients.
- Inhalation anesthetics such as flurane and opiates can be used in the operating theatre.

Bradycardia

Possible causes:

- Acute hypovolemia (mobilization, positioning, hemorrhage, etc.)
- Reflex vagal stimulation during incision or traction on the mesenteries, vessels, and joints [17]

Prevention:

- Use of opiates with peripheral effects [18–20].

Brain-dead patients hardly respond to atropine except in cases of parasympathetic stimulation (+) [21]. Therefore, the treatments of choice are:

1. Adrenaline (0.02–0.15 µg/kg/min)
2. Isoprenaline (if maximum chronotriphy is necessary) or ephedrine

There is a risk of arrhythmias, especially if electrolyte imbalances are present.

Note: External or, if necessary, transjugular pacing, if required.

Other arrhythmias

Consider correcting electrolyte imbalances

- Especially for calcium: $\text{Ca}^{++} = 2.3\text{--}2.54 \text{ mEq/l}$ (1.15–1.27 mmol/l), to be treated from 2.1 mEq/l (1.1 mmol/L) [10].
- Magnesium 4 g (16 mmol), administered intravenously over 15 minutes
- Aim for normokalemia

Antiarrhythmic drugs:

- Medications with a short half-life are preferable.
- If coronary heart disease and/or altered left ventricular function is present in the treatment of supraventricular tachycardia, or if slowed or reduced atrial fibrillation or atrial flutter occurs, amiodarone can be used.

3.1.2 Respiratory system		
Goals to be achieved	Side effects of brain death	Recommendations for organ protection (+++) [12]
Protective ventilation: 6–8 ml/kg of initial weight, PEEP 8–10 cm H ₂ O. FiO ₂ = 40%, plateau pressure < 35 mmHg, peak pressure < 40 mmHg Closed suction system, expansion before removal	Apnea Atelectasis Increased capillary permeability Pulmonary edema	Protective ventilation Screening (X-ray thorax) Restriction of fluid intake, CVP monitoring between 4 and 10 mmHg Monitor diuresis

3.1.3 Endocrine system		
Goals to be achieved	Side effects of brain death	Recommendations for organ protection (+++) [12]
Natriemia: < 150 mEq/L Normoglycemia: > 75 to < 150 mg/dl	Pituitary necrosis: Diabetes insipidus Hypernatremia > 150 mg/l	Desmopressin: 1–4 µg IV, then ½ dose every 6 hours or Vasopressin®, 1 bolus IV of 1 u, then 2.4 u/h
	Diabetes Hypothyroidism Adrenal insufficiency	Insulin infusion for blood sugar control < 150 mg/dl Continue hormone replacement therapy in the intensive care unit if indicated during removal.

3.1.4 Blood and immune system		
Goals to be achieved	Side effects of brain death	Recommendations for organ protection (+++) [12]
Hemostasis Prevent intravascular thrombosis of organs Control intraoperative hemorrhage or treat hemorrhagic syndrome	Thrombophilia, Consumption coagulopathy due to cytokine release Dilution of coagulation factors Dysfunction (congenital anomalies, hepatocellular insufficiency) Increased risk of thrombosis	Frozen fresh plasma Prothrombin complex preparations: 20 to 30 u/kg
Hematology Hemoglobin > 70 g/l or hematocrit > 30%	Anemia Hyperleukocytosis	Transfusion: Erythrocyte concentrate must be deleukocyted. Differential diagnosis Infection

Coagulation disorders

- The etiology of coagulation disorders is often multiple (hemorrhage, hypothermia, hemodilution).
- Routine diagnostic coagulation tests tend to be nonspecific and are often not very helpful in accurately explaining the etiology of coagulation disorders.
- In addition, patients experience an "inflammatory storm" before complete failure of cerebral circulation. Excessive consumption of coagulation factors and platelets leads to consumption coagulopathy, which results in self-sustaining disseminated intravascular coagulation. Treatment is therefore symptomatic and consists of correcting the cellular damage to the organs, replacing the consumed labile coagulation factors, and treating the underlying disease, if present.
- Congenital hemostasis defects (such as asymptomatic abnormalities of protein S, protein C, and factor IV Leiden) pose a high risk of thrombosis for organ recipients. The necessary products to prevent blood loss, thrombosis, and fibrinolysis should be transfused.

The therapeutic goals are:

- Restoration of the deficient factor level to at least 30%
- International Normalized Ratio (INR) < 2.0
- Thrombocytes > 150 G/l

3.1.5 Nervous system

Goals to be achieved	Side effects of brain death	Recommendations for organ protection (+++) [12]
Avoid spinal reflexes	Spinal somatic reflexes, increased parasympathetic reflex action	Curarization in the operating theatre Morphine treatment to mitigate parasympathetic reflexes
Body temperature 35–37°C	Impaired temperature regulation	Warm up if necessary (patient/fluids)

3.1.6 Urogenital system

Goals to be achieved	Side effects of brain death	Recommendations for organ protection (+++) [12]
Diuresis: 0.5 to 4 ml/kg/h	Polyuria	Vasopressin: 0.01–0.04 u/min or Desmopressin: 1–4 mcg / 6–8 h i.v. / s.c.

4.0

Key points in overview

By definition, brain-dead patients have neither consciousness nor pain perception. An autonomic sympathetic stress response with **tachycardia** and **hypertension** can affect the quality of donor organs. **Opiates** can suppress this stress response and stabilize heart rate and blood pressure (+++).

Curarisation is highly recommended for the interruption of spinal reflexes to facilitate the surgical procedure (+++).

The administration of **volatile anesthetics** has a protective effect against ischemic **reperfusion injury**, particularly to the heart [17–19]. Halogens have a positive effect on the liver [24], kidneys [25], and lungs [26] (caution should be exercised in cases of hypoxic liver damage).

For reflex arterial hypertension, the use of fluorinated inhalation anaesthetics is indicated, but this does not address the causes.

Other short-acting **antihypertensive** drugs (nitroderivatives, sodium nitroprusside) are used to treat **high blood pressure** in brain-dead patients.

For simultaneous tachycardia, beta-blockers with a short half-life (esmolol / Brevibloc®) are preferred.

Heparin therapy with 300 IU/kg heparin must be administered at least 2 minutes before cannulation (+++). This is done in consultation with the donation coordination team and the procurement team.

During **lung removal**, **anesthesiological measures** do not end with **aortic clamping**. In this case, the lung continues to be ventilated until tracheal clamping (**protective ventilation**). This is done in cases of hyperinflation so that the oxygen introduced is retained (+++) [8–10].

The following rules must be followed (+++) [8,26]:

- Restrict the supply of crystalloid fluids
- The ideal tidal volume is (4 –) 6 – 8 (– 10) ml/kg
- Maximum plateau pressure of 35 cmH₂ O
- Minimum PEEP of 5 cmH₂ O and maximum PEEP of 8 cmH₂ O
- FiO₂ of approx. 40%
- PaO₂: 100 mmHg (≈ 12 kPa);
- PaCO₂: 35–40 mmHg (4–5.5 kPa) If PaO₂ is low: it is better to increase PEEP than to increase FiO₂.
- Methylprednisolone 15 mg/kg (Solumedrol®)
- The use of volatile anesthetics has a positive effect on the lung [25].

Authors

Contributing medical professionals from the first edition (in alphabetical order)

- Prof. Sylvie Bachy
- Nicole Baehler
- Prof. Dr. med. Balthasar Eberle
- Dr. med. Catherine Blanc
- Dr. med. Christian Brunner
- Dr. med. Sabine Camenisch
- Dr. med. Peter Christen
- Dr. med. François Clergue
- Dr. med. Nicolas Dufresne
- Dr. med. Raphaël Giraud
- Frédéric Guibert
- Dr. med. Olivier Huot
- PD Dr. med. Franz Immer
- Prof. Dr. med. Christian Kern
- Dr. med. Nathalie Krügel
- Dr. med. Andreas Lüthi
- François Marguet
- Prof. Dr. med. Hans Peter Marti
- Dr. med. Maurice Matter
- Dr. med. Yannick Mercier
- Diane Moretti
- Bernard Mugnier
- Dr. med. Mathias Nebiker
- Dr. med. Bruno Regli
- Dr. med. Heinz Rieder
- Dr. med. Eduardo Schiffer
- Prof. Dr. med. Frank Stüber
- PD Dr. med. Andreas Vogt
- Dr. med. Jean-Luc Waeber

References

- [1] Souter, M.J., Eidbo E., Findlay J.Y. et al. Organ donor management: part 1. Toward a consensus to guide anesthesia services during donation after brain death. *Semin. Cardiothorac. Vasc. Anesth.* 2018; 22: 211 – 222
- [2] Eurotransplant. Annual Report 2019. <https://www.eurotransplant.org/wp-content/uploads/2020/06/Annual-Report-2019.pdf>
- [3] Manara, A.R., Thomas I. Current status of organ donation after brain death in the UK. *Anaesthesia* (im Druck)
- [4] Gelb, A.W., Robertson K.M. Anaesthetic management of the brain dead for organ donation. *Can J Anaesth* 1990; 37: 806 – 812
- [5] Patel, M.S., Abt P.L. Current practices in deceased organ donor management. *Curr Opin Organ Transplant* 2019; 24: 343 – 350
- [6] Westphal, G. A., Garcia, V. D., Souza, R. L., et al. Guidelines for the assessment and acceptance of potential brain-dead organ donors. *Rev. Bras. Ter. Intensiva* 2016; 28: 220 – 255
- [7] Lechaux, D., Dupont-Bierre, É., Karam, et al. Technique des prélèvements multi-organes. EMC (Elsevier SAS, Paris) 2005 ; 40ff.
- [8] Raikhelkar, J. K., Blum, J. M. Intraoperative lung-protective ventilation. *Int. Anesthesiol. Clin.* 2018; 56: 80 – 87
- [9] Futier, E., Constantin, J. M., Jaber, S. Protective lung ventilation in operating room: a systematic review. *Minerva Anesthesiol.* 2014; 80: 726 – 735
- [10] Powner D.J., O'Connor K.J. A clinician's guide to donation and transplantation. NATCO 2018. <https://www.natco1.org/professional-development/publications/clinicians-guide/>
- [11] Petignat P.A. Les guidelines sont-ils des standards à suivre? *Rev. Med. Suisse* 2009; 5, 2271 – 2275
- [12] Anderson, T.A., Bekker P., Vagefi P.A. Anesthetic considerations in organ procurement surgery: a narrative review. *Can. J. Anaesth.* 2015; 62: 529 – 539
- [13] McKeown, D.W., Bonser R.S., Kellum J.A. Management of the heartbeating brain-dead organ donor. *Br. J. Anaesth.* 2012; 108 Suppl. 1: 96 – 107
- [14] Lipsett, P.A., Organ Donation. In: *Essentials of Neurosurgical Anesthesia & Critical Care*. Brambrink A.M. and Kirsch J.R., Editors. 2020, Springer International Publishing, Cham, Switzerland: 641 – 646
- [15] Maciel, C.B., Hwang D.Y., Greer D.M. Organ donation protocols. In: *Critical Care Neurology Part I*. Wijdicks E.F.M. and Kramer A.H., Editors. 2017, Elsevier: 409 – 439
- [16] Anwar, A., Lee J.M. Medical Management of Brain-Dead Organ Donors. *Acute Crit. Care* 2019; 34: 14 – 29

- [17] Ullah, S., Zabala, L., Watkins, B., Schmitz, M. L. Cardiac organ donor management. *Perfusion* 2006; 21: 93 – 98
- [18] Young, P. J., Matta, B. F. Anesthesia for organ donation in the brainstem dead – why bother? *Anesthesia* 2000, 55 pages, 105 – 106
- [19] Poulton, B., Garfield, M. The implications of anaesthetising the brainstem dead. *Anesthesia* 2000: 55: 695 – 696
- [20] Song SY, Son SH, Kim SO, Roh WS. Intravenous fentanyl during shoulder arthroscopic surgery in the sitting position after interscalene block increases the incidence of episodes of bradycardia hypotension. *Korean J. Anesthesiol.* 2011; 60: 344 – 350
- [21] Vaghadia, H. Atropine resistance in brain-dead organ donors. *Anesthesiology* 1986, 65: 711 – 712
- [22] Schielke A., Conti F., Gourmard C., et al. Liver transplantation using grafts with rare metabolic disorders. *Dig. Liver Dis.* 2015; 47: 261 – 270
- [23] Agence Régionale de Sante (ARS) Centre-Val de Loire, Observatoire des Médicaments, Dispositifs médicaux, Innovations Thérapeutiques (OMéDIT). OMéDIT Centre-Val de Loire: Guide des antidotes d'urgence de la région Centre-Val de Loire 2 / 32.
[https:// www.omedit-centre.fr](https://www.omedit-centre.fr)
- [24] Tao, K.M., Yang L.Q., Liu Y.T., et al. Volatile anesthetics might be more beneficial than propofol for postoperative liver function in cirrhotic patients receiving hepatectomy. *Med. Hypotheses* 2010; 75: 555 – 557
- [25] Beck-Schimmer, B., Schadde, E., Schläpfer, M. Volatile anaesthetics and organ protection in kidney transplantation: finally, a randomized controlled trial. *Br. J. Anaesth.* 2017; 118: 643 – 644
- [26] O'Gara B., Talmor D. Lung protective properties of the volatile anesthetics. *Intensive Care Med.* 2016; 42: 1487 – 1489
- [27] Mazon, M. C., Alain, S., Leruez-Ville, M., Schnepf, N. Infections à cytomégalovirus. *Encyclopédie médico-chirurgicale. EMC – Maladies infectieuses* 2015 ; 12:1 – 16

Changes

Date	Version	Changes
February 2026	4.0	<p>Entire module:</p> <ul style="list-style-type: none"> - Title shortened - Changes/corrections to improve readability. - New chapter structure introduced, removing the former chapters "Introduction," "Surgical Procedure," and "Further Reading." <p>Chapter 1.0 "Methodology": Only the evidence level system actually used in the Module is mentioned (evidence level system from CH removed).</p> <p>Chapter 3.2 "Preparation of the patient in the operating theatre": Duration of skin discoloration after pressure and core temperature removed.</p> <p>Chapter 3.1.4 "Blood and Immune System / Coagulation Disorders": Information on organ exclusion removed (organ evaluation is not the responsibility of anesthesia).</p> <p>Attachment 1 (Anesthesia decision tree) removed as no longer current.</p>
February 2023	3.1	Correction
December	3.0	Revision, layout
May 2014	2.1	Layout and title adjustment
August 2011	2.0	Text update
August 2009	1.0	Original version

Swisstransplant

Effingerstrasse 1

3011 Bern

T: +41 58 123 80 00

info@Swisstransplant.org

www.swisstransplant.org

CNDO

Nationaler Ausschuss für Organspende
Comité National du don d'organes

