	Providing Anesthesia for Neurologically Deceased Donors (NDD)	Doc. No.: ODHD-SRS.05.016
		Rev.: 4
		Rev. Date: 17-Jan-2023

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Providing anesthesia for neurologically deceased donors (NDDs) requires an understanding of the pathophysiology of cerebral herniation and brain death. Malignant intracranial hypertension and herniation is heralded by Cushing’s reflex with compromise of the pontine. With progressive loss of medullary function, patients often experience an “autonomic storm” with massive release of catecholamines and inflammatory mediators. The hemodynamic consequences of cerebral herniation are influenced by the rate of rise of intracranial pressure. The process of brain death may jeopardize end organ function and subsequent allograft procurement and performance. Priorities of care for NDDs are directed at resuscitating organs compromised by the evolution of brain death. Goals of anesthesia for organ procurement align with established ICU care of the NDD as well as abolishing spinal motor and hemodynamic reflexes.

Equipment, Drugs and Anesthetic technique:

- Neuromuscular blockade required to inhibit spinal motor reflexes
- Some advocate volatile anesthetics due to theoretical advantage of ischemic preconditioning
- Brain death may cause hemodynamic response to noxious stimuli; hypertension should be avoided


Below is a list of equipment and drugs that should be available for the procedure

Equipment

Intravenous infusion pumps	Bronchoscope	Gastric tube
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Drugs

Heparin 30,000 units	Long acting neuromuscular blocker
Vasopressin	Norepinephrine
Dobutamine	Milrinone
Nitroprusside	Labetalol
Mannitol	Esmolol
Furosemide	dDAVP
Balanced crystalloid	Insulin
Blood products	Albumin

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Monitoring & Venous Access:

- CAS monitors
- Urinary catheter
- Arterial & Central pressure monitors
- PA catheter, TEE or serial TEE for donors with reduced ventricular function (LVEF<40%)
- Two large bore peripheral IV catheters in upper extremities
- Hourly: arterial & venous blood gases, electrolytes, blood glucose, lactate

The ensuing section summarizes the clinical impact of brain death on major organ systems and includes recommendations for NDD management:

Cardiovascular

- Autonomic storm = catecholamine cardiotoxicity with reversible left ventricular dysfunction
- Cerebral herniation = loss of sympathetic tone & systemic vasodilation, increased venous capacitance, relative hypovolemia exacerbated by prior mannitol therapy and central diabetes insipidus

Management

- Restore intravascular volume with balanced crystalloids or albumin
- Data suggests restrictive fluid resuscitation strategy (CVP 4-8) may increase yield of lung allografts without jeopardizing kidney function
- Synthetic colloids should be avoided due to potential osmotic nephrotoxicity

Vasopressin is the vasopressor of choice (0.01-0.04 Units/min)

- Norepinephrine second line for hypotension. Dobutamine or milrinone as guided by cardiac function. Dopamine not recommended.

Standard hemodynamic goals include:

- MAP 65-90
- HR 60-120
- SBP 100-160
- SvO₂ ≥ 60%


Pulmonary

Common in NDD's

- Aspiration, neurogenic pulmonary edema and ALI/ARDS

Ventilation

- Avoid pulmonary derecruitment and ventilator induced lung injury
- Minimize disruption of breathing circuit and recruitment maneuvers post circuit disconnection
- Avoid high FiO₂
- Use low tidal volumes (4-8mls/kg *Predicted Body Weight*) with modest levels of PEEP (10cmH₂O)
- Recruitment maneuvers q4h
- Limit inspiratory pressures (<35cmH₂O).

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Renal


- Central diabetes insipidus common, contributes to hypovolemia
 - Treat with vasopressin (0.01-0.04Units/min or dDAVP (1-4 mcg q6-8hrs iv/sc) when urine output >4mLs/kg/hr)
 - will assist in fluid management and avoid severe hypernatremia that can contribute to hepatic allograft dysfunction
- Urine output goal = maintain >0.5ml/kg/hr

Hematologic

- Disseminated intravascular coagulation may complicate brain death
- Correct coagulopathy only in actively bleeding donors
- Optimal hemoglobin concentration is unknown but likely between 70-100g/dL
- DIC is a contraindication to antifibrinolytics

Endocrine

- Poikilothermia: results with brain death due to disruption of hypothalamic thermoregulation
- Pituitary function compromised (posterior>anterior) causing vasopressin deficiency with DI and reduced vasomotor tone
- No routine thyroid hormone supplementation. May consider its use in donors with hemodynamic instability or cardiac dysfunction (L-thyroxine 100 µg IV bolus followed by 50 µg IV q12h (administer only when serum K+ > 3.5))
- Suggest IV Hydrocortisone for donors requiring vasopressor support (50mg IV q6h)
- Glycemic control: blood glucose levels <10
- Goal temperature – 34-35 degrees C for all donors who will be donating kidneys. In the event that kidneys are not being donated, normothermia is appropriate.

 BC TRANSPLANT <small>Provincial Health Services Authority</small>	Providing Anesthesia for Neurologically Deceased Donors (NDD)	Doc. No.: ODHD-SRS.05.016
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References

- Kutsogiannis DJ, Pagliarello G, Doig C, Ross H, Shemie SD. Medical Management to Optimize Donor Organ Potential: Review of the Literature. *Can J Anesth* 2006; 53(8): 820-830.
- Minambres E, Rodrigo E, Ballesteros MA, Llorca J, Ruiz JC, Fernandez-Fresnedo G, Vallejo A, Gonzalez-Cotorruelo J, Arias M. Impact of Restrictive Fluid Balance Focused to Increase Lung Procurement on Renal Function after Kidney Transplantation. *Nephrol Dial Transplant* 2010; 25: 2353-2356.
- Abdelnour T, Rieke S. Relationship of Hormonal Resuscitation Therapy and Central Venous Pressure on Increasing Organs for Transplant. *J Heart Lung Transplant* 2009; 28(5): 480-5.
- Mascia L, Mastromauro I, Viberti S, Vincenzi M, Zanello M. *Minerva Anesthesiol* 2009; 75: 125-33.
- Bugge JF. Brain Death and its Implications for Management of the Potential Organ Donor. *Acta Anaesthesiol Scand* 2009; 53: 1239-1250.
- Nath DS, Basha HI, Liu MH, Moazami, Ewald GA. Letter: Increased Recovery of Thoracic Organs Following Hormonal Resuscitation Therapy. *J Heart Lung Transplant* 2010; 29(5): 594-5.
- McKeown DW, Bonser RS, Kellum JA. Management of the Heartbeating Brain-Dead Organ Donor. *Br J Anaesth* 2012; 108(S1): i96-i107.
- Shemie SD, Ross H, Pagliarello J, Baker AJ, Greig PD, Brand T, Cockfield S, Keshavjee S, Nickerson P, Rao V, Guest C, Young K, Doig C. Organ Donor Management in Canada: Recommendations of the Forum on Medical Management to Optimize Donor Organ Potential. *CMAJ* 2006; 176(6): s13-30.
- Lucangelo U, Del Sorbo L, Boffini M, Ranieri VM. Protective Ventilation for Lung Transplantation. *Curr Opin Anesthesiol* 2012; 25(2): 170-4.
- Dictus C, Vienenkoetter B, Esmaeilzadeh M, Unterberg A, Ahmadi R. Critical Care Management of Potential Organ Donors: Our Current Standard. *Clin Transplant* 2009; 23(Suppl. 21): 2-9.
- Novitzky D, Cooper DKC, Rosendale JD, Kauffman HM. Hormonal Therapy of the Brain-Dead Organ Donor: Experimental and Clinical Studies. *Transplantation* 2006; 82: 1396-1401.
- Rosendale JD, Kauffman HM, McBride MA, Chabalewski FL, Zaroff JG, Garrity ER, Delmonico FL, Rosengard BR. Hormonal Resuscitation Yields More Transplanted Hearts, With Improved Early Function. *Transplantation* 2003; 75(8): 1336-41.
- Ball I, Hornby L, Rochweg B, Weiss M et al. Management of the Neurologically Deceased Organ Donor: A Canadian Clinical Practice Guideline. *CMAJ* 2020; 192:E361-9.