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**Provincial Death Determination by Neurologic Criteria (DNC) Policy Template**

**(Formerly known as the Neurological Determination of Death Policy)**

Approved by Ontario Health (TGLN) Clinical Operations Committee May 2023

Approved by Provincial Donation Steering September 2023

**Policy:**

In keeping with high-quality end-of-life care, every attempt should be made to assess for death determination by neurologic criteria (DNC) for all patients who have an established cause of a brain injury severe enough to cause death. DNC not only follows the standards for death determination in Canada, but it also provides families with relevant information to assist in making end-of-life care decisions.

Physicians performing clinical assessments for DNC must hold full and current licensure for independent (non-educational) medical practice in Ontario. The physicians must have skills and knowledge in the management of patients with severe brain injury, as well as in DNC for all relevant age groups within their care.

As per established clinical indicators/triggers, notification to Ontario Health (Trillium Gift of Life Network [TGLN]) is to occur for any patient where DNC is suspected. This notification is for the purpose of preliminary consultation to evaluate eligibility for organ donation and for DNC assessment recommendations (such as the use of ancillary tests when in the presence of confounding conditions that cannot be resolved).

 If the potential for organ donation exists, a physician performing DNC must not have any association or active involvement in transplant procedures, organ allocation, or care of the intended transplant recipient. The physician must also be cognizant of factors that might influence their judgment when performing DNC assessments.

**Definitions:**

For the purpose of this policy, the following definitions and terms will be applied:

**Ancillary Test** refers to a test of brain blood flow and perfusion used to corroborate the clinical assessment of DNC that otherwise, for any reason, cannot be conducted or is unreliable. For example, ancillary testing is required if confounding conditions cannot be resolved, or the full clinical assessment cannot be performed. Any ancillary test is considered supportive, not confirmatory of DNC, and therefore cannot be used independently to determine death.

**Computed Tomography-Angiography** or **CTA** refers to the use of iodinated contrast given through intravenous bolus injection with the purpose to visualize cerebral vasculature.

**Computed Tomography-Perfusion** or **CTP** refers to an imaging procedure where, after a bolus of contrast, the brain is scanned quickly many times to determine how fast the contrast percolates through the brain tissue. The slower the contrast travels, the more ischemic the brain tissue is.

**Core Body Temperature** refers to a body temperature measurement that is obtained through esophageal, rectal, bladder, or central venous, or arterial catheter monitoring.

**Death Determination by Neurologic Criteria (DNC)** refers to the process and procedure for determining the death of an individual based on neurologic criteria.

**Donation Support Physician** refers to an Ontario Health (Trillium Gift of Life Network [TGLN]) affiliated physician available 24/7 to support health care team members, in particular, the most responsible physician (MRP), with advice on leading practices in donation.

**Hospital** refers to (Insert Hospital Name).

**Patient(s)** refers to any person under the care of (Insert Hospital Name).

**Radionucleotide Brain Perfusion Study** sometimes known as Cerebral Perfusion Scan; refers to a scan of the brain that is performed utilizing a radioactive isotope to determine brain blood flow, or lack of brain blood flow, to the cerebral hemispheres.

**Transcranial Doppler** refers to a type of ultrasonography that is used to measure blood flow in the brain.

**Process**:

1. **Death Determination by Neurologic Criteria (DNC)**

***General***

* 1. DNC is primarily a clinical assessment that requires all three of the following:
		1. Absence of consciousness demonstrated by a lack of arousal and awareness in response to external stimuli; and
		2. Absence of brainstem function as demonstrated by cranial nerve testing; and
		3. Absence of the capacity to breathe demonstrated by formal apnea testing.
	2. DNC must be performed by a physician who holds licensure to practice medicine independently (non-educational) in the Province of Ontario.
	3. For legal determination of death:
* For patients greater than or equal to one year of age, one complete DNC clinical assessment is sufficient.
* For patients less than one year corrected gestational age, two complete DNC clinical assessments separated in time are required.

For the purposes of organ donation:

* In keeping with the *Gift of Life Act*, two full DNC clinical assessments must be performed for all patients, regardless of age.

**Note:** If two assessments for DNC are performed at different points in time, each physician must perform the entire DNC clinical assessment, including the apnea test.

* 1. Prior to the clinical assessment for DNC, the MRP should jointly complete the *Death Determination by Neurologic Criteria Confounding Factors Checklist* with the Ontario Health (TGLN) Coordinator.
	2. For patients with an isolated infratentorial brain injury (e.g., brainstem and/or cerebellar lesion due to infratentorial pathology such as ischemic or hemorrhagic stroke), a clinical assessment alone is not sufficient for DNC and ancillary testing is required to determine death. Alternatively, there can be a period of observation and reimaging to demonstrate the progression of the injury to include supratentorial involvement. If there is the demonstration of supratentorial involvement, a clinical assessment alone is sufficient to determine DNC (as per 1.3) and ancillary testing is only necessary as indicated in 1.8.
	3. Assessment for neurological function may be unreliable following a resuscitated cardio-respiratory event. To proceed with DNC post-cardiac arrest, clinical assessments should be delayed for a minimum of 48 hours from the time of the return of spontaneous circulation if there is no neuroimaging evidence of devastating brain injury. If a physician needs to complete DNC sooner than 48 hours, then imaging evidence of devastating brain injury must be present or an ancillary test must be performed (see 1.34 – 1.38). Consultation with the Ontario Health (TGLN) Donation Support Physician is recommended.
	4. The presence of therapeutic levels of anticonvulsants, sedatives, and analgesics do not constitute a contraindication to proceeding with DNC assessment.
	5. If instability of the patient precludes completion of the clinical assessment (including apnea testing), or if any portion of the clinical assessment for DNC cannot be completed, ancillary testing is required.
	6. The recommended sequence for DNC involves DNC clinical assessments performed to the fullest extent possible (with apnea testing as the final element of the clinical assessment) before the completion of any ancillary testing.
	7. The legal time of death is recorded as the time of completion of the last test required to fulfil DNC by the first determining physician.
		1. When DNC is established by clinical assessments only, the time of death is the time the blood sample was taken when the PaCO2 reached the apnea test thresholds.
		2. If ancillary testing is required, the time of death is documented as the time that the ancillary test was completed (not reported), with the understanding that results still need to be formally interpreted by neuroimaging experts and documented by the most responsible physician.
		3. If the assessment of DNC occurs out of the recommended sequence, the time of death is recorded as the time the last required test is performed, ensuring the clinical assessments are completed to the fullest extent possible and the ancillary testing is complete.
	8. For the purposes of organ donation, DNC is to be documented by both physicians who completed the DNC clinical assessments using the Ontario Health (TGLN) *Confirmation of Death Determination by Neurologic Criteria (DNC)* form or hospital-approved alternate. If an alternative to the Ontario Health (TGLN) form is used, this must be reviewed by the DSP.

***Minimum Criteria for Death Determination by Neurologic Criteria (DNC)***

* 1. The patient must have an established cause of devastating brain injury and this should be supported by documented neuroimaging evidence. In addition, confounding factors (see Appendix A) must be excluded to prevent the observation of neurological responses that may mimic death; including severe electrolyte abnormalities.
	2. The patient’s core body temperature should be greater than or equal to 36 degrees Celsius.
	3. The physicians involved in DNC must have the knowledge and ability associated with the management of patients who have severe brain injuries as well as in DNC for all relevant age groups within their care.

***Clinical Criteria for Death Determination by Neurologic Criteria (DNC) for Adults and Children greater than or equal to one year of age (must include all of the following)***

* 1. Bilateral absence of:
* Pupillary response, with pupils greater than or equal to 3mm;
* Corneal reflex;
* Oculovestibular response; and
* Motor response to central (painful) stimulation (e.g., supraorbital pressure), excluding spinal reflexes
	1. Absence of a cough and a gag response.
	2. A lack of respiratory effort as determined by apnea testing.
	3. Both clinical assessments may be performed concurrently.
	4. One apnea test may be performed in the presence of both physicians. However, if both physicians are not present, then a second clinical assessment and separate apnea test must be performed for organ donation purposes.

***Clinical Criteria for Death Determination by Neurologic Criteria (DNC) for Infants aged two months to less than one year corrected gestational age (must include all of the following)***

* 1. Bilateral Absence of:
* Pupillary response, with pupils greater than or equal to 3mm;
* Corneal reflex;
* Oculovestibular response; and
* Motor response to central (painful) stimulation (e.g., supraorbital pressure), excluding spinal reflexes
	1. Absence of a cough and a gag response.
	2. A lack of respiratory effort as determined by apnea testing.
	3. The second required clinical assessment for DNC must occur separately and independently from the initial assessment, including apnea testing.
	4. There is no recommended time interval that must occur between the two assessments; however, each must be performed independently.

***Clinical Criteria for Determination of Death by Neurological Criteria (DNC) for Newborns aged 37 weeks corrected gestational age to less than two months (must include all of the following)***

* 1. Bilateral Absence of:
* Pupillary response, with pupils greater than or equal to 3mm;
* Corneal reflex;
* Oculovestibular response; and
* Motor response to central (painful) stimulation (e.g., supraorbital pressure), excluding spinal reflexes
	1. Absence of a cough and a gag response.
	2. Absence of sucking and rooting reflex.
	3. A lack of respiratory effort as determined by apnea testing.
	4. For this age group, there should be a minimum of 48 hours between birth and the first DNC clinical assessment.
	5. The second required clinical assessment for DNC should take place after a minimum interval of 24 hours after the first DNC clinical assessment. This interval may be extended based on physician judgment. Consultation with an Ontario Health (TGLN) DSP or another expert is recommended. Additional caution should be exercised in this age group.

***Apnea Testing***

* 1. Reasonable efforts to normalize the patient’s baseline arterial blood gas should be performed. In instances where the patient has an abnormal baseline arterial blood gas, expert consultation is required prior to apnea testing. In some circumstances, an ancillary test will be required (see Appendix B for Apnea Testing Guidelines).
	2. A period of pre-oxygenation with FiO2 of 1.0 is required for all apnea tests. Oxygen should be provided during the observation period for the apnea test (see Appendix B for apnea test guidelines).
	3. The following thresholds must be met to define an adequate apnea test (i.e. an adequate CO2 challenge of the brainstem):
* The final PaCO2 must rise to be greater than or equal to 60 mm Hg, and
* The PaCO2 must have a minimum increase of greater than or equal to 20 mm Hg above the baseline; and
* The final pH must be less than or equal to 7.28.

***Ancillary Testing***

* 1. For adults and children greater than or equal to one year of age, acceptable ancillary tests for DNC are, in order of recommendation, Radionucleotide Brain Perfusion Study (employing a lipophilic radiopharmaceutical), Computed Tomography-Angiography (CTA), Transcranial Doppler, and Computed Tomography-Perfusion (CTP). If ancillary testing is required, one of these tests must be used to confirm lack of blood flow and perfusion to the brain, consistent with DNC.
	2. For infants aged two months to less than one year corrected gestational age, the acceptable ancillary test for DNC is a Radionuclide Brain Perfusion Study, ideally using a lipophilic radiopharmaceutical with or without tomographic imaging.
	3. For newborns less than two months corrected age, ancillary testing is not recommended.
	4. The physician responsible for the review and analysis of the aforementioned ancillary tests must have the background and training necessary to make such conclusions.
	5. The physician(s) responsible for the final documentation and synthesis of all necessary clinical requirements for DNC, including ancillary testing documentation, is the patient’s most responsible physician and/or designate.

**Records:**

No records.

**References:**

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Canadian Council for Donation and Transplantation. (2007). *Brain blood flow in the neurological determination of death: Expert consensus meeting report. November 16, 2006.* Montreal, PQ.

Jain, S., & DeGeorgia, M. (2005). Brain Death-Associated Reflexes and Automatisms. *Neurocritical Care, 3*(2): 122-126.

Levesque, S., Lessard, M.R., Nicole, P.C., Langevin, S., LeBlanc, F., & Lauzier, F. et al. (2006). Efficacy of a t-piece system and a continuous positive airway pressure system for apnea testing in the diagnosis of brain death. *Critical Care Medicine, 34*(8), 2213-2216.

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Wijdicks, E.F.M., Varelas, P.N., Gronseth, G.S., & Greer, D.M. (2010). Evidence-based guideline update: Determining brain death in adults. *Neurology, 74*, 1911-1918.

**Appendix A: Confounding Factors**

**Include but are not limited to:**

1. Less than 48 hours from return of spontaneous circulation following cardiac arrest
2. Unresuscitated shock
3. Hypothermia
4. Drug intoxications
5. Administration of cycloplegic or muscle relaxant drugs
6. Neuromuscular pathology
7. Recent decompressive craniectomy
8. Spinal cord injury
9. Isolated brainstem or infratentorial brain injury
10. Severe metabolic disorders such as:
	* Hypoglycaemia
	* Sever hypophosphatemia
	* Hypernatremia
11. Severe liver or renal dysfunction

Prior to the clinical assessment for DNC, the MRP should jointly complete the *Death Determination by Neurologic Criteria Confounding Factors Checklist* with the Ontario Health (TGLN) Coordinator.  For every case, the MRP should obtain the most up-to-date *Death Determination by Neurologic Criteria Confounding Factors Checklist* and *Confirmation of Death Determination by Neurologic Criteria (DNC)* form from the Ontario Health (TGLN) Coordinator.

**Sources:**

Canadian Council for Donation and Transplantation. (2003). *Severe brain injury to neurological determination of death: A Canadian forum: Report and recommendations.* April 9-11, 2003, Vancouver, British Columbia.

Shemie, S.D., Wilson, L.C., Hornby, L. *et al.* A brain-based definition of death and criteria for its determination after arrest of circulation or neurologic function in Canada: a 2023 clinical practice guideline. *Can J Anesth/J Can Anesth* (2023). https://doi.org/10.1007/s12630-023-02431-4.

Ontario Health (Trillium Gift of Life Network). (2021). *CSF-9-5* *Guidelines for the death determination by neurologic criteria (DNC) for the purposes of organ donation in Ontario: Adult and pediatric patients 1 year and older.*

Ontario Health (Trillium Gift of Life Network). (2021). *CSF-9-201* *Death determination by neurologic criteria confounding factors checklist.*

**Appendix B: Apnea Testing Guidelines**

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| **Prerequisites:** |
| The apnea test should be the final element of the clinical assessment |
| Arterial line insitu for frequent arterial blood gas draws |
| * 1. Attempt to normalize arterial blood gases (ABG) PaCO2 35-45 mmHg
	2. pH 7.35-7.45

Note: In instances where the patient has an abnormal baseline blood gas, expert consultation is required prior to apnea testing. In some circumstances, an ancillary test will be required. (e.g., chronic respiratory insufficiency with chronic CO2 retention) |
| Obtain baseline arterial blood gas (within 1 to 2 hours prior to death determination) |
| **Diagnostic Criteria for Apnea Testing** |
| No respiratory efforts are observed after a maximal respiratory stimulus defined by an arterial blood gas with all of the following:1. pH less than or equal to 7.282. pCO2 greater than or equal to 60 mmHg3. An acute rise in pCO2 greater than or equal to 20 mmHg relative to the starting PCO2 value on the initial ABG |
| **Apnea Testing Process** |
| **Preoxygenation:** Patients should always be pre-oxygenated with 100% O2 for 10-20 min. |
| **Continuous observation:** Patients are observed continuously for respiratory effort and stability. If the patient becomes unstable, they should be re-connected to the ventilator and appropriate ventilator settings reinstituted. |
| **Sequential arterial sampling:** * During the exam, ABG is done at 5-minute intervals to assure targets are met.
* Point-of-Care testing is recommended if available.
* A baseline ABG (within 1-2 hours prior to determination) is required to ensure pH and PCO2 are within target range. After starting the apnea test the first ABG is usually drawn after 5 minutes then every 5 minutes until targets are met.
* If Point-of-Care ABG is not available then drawing one ABG prior to reconnecting to the ventilator is prudent if final results are not yet known. Usually 10-15 minutes of apnea produces respiratory acidosis and hypercarbia within thresholds.
 |
| **Three (3) Methods for Apnea Testing:** |
| 1. ***Passive Oxygenation with Suction Catheter (off ventilator)***
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| *This method does not require any specialized equipment but may allow more atelectasis and thus is not optimal for potential lung donors.** Disconnect patient from ventilator and supply 4-6 litres per minute of oxygen through the ETT via a catheter positioned above the carina. Observe the time; this is the beginning of the test.
 |
| 1. ***Positive Airway Pressure***
 |
| 1. Positive Airway Pressure with PEEP Valve (off ventilator)

*This method provides CPAP during the apnea test (which is best practice for potential lung donors) but may provide inconsistent levels of CPAP due to leaks in the system.** Insert and seal a suction catheter through a swivel ETT adapter. Sealing can be done using occlusive tape.
* Disconnect patient from ventilator and attach resuscitator bag with PEEP valve set at 10-15 mmH2O via the above swivel setup.
* Supply 4-6 Liters of oxygen via the suction catheter which should be positioned above carina.
* Give patient one breath via resuscitator bag to generate positive airway pressure. Observe the time; this is the beginning of the test.
 |
| 1. Positive Airway Pressure While Remaining on the Ventilator

*This method does not require any disconnects and maintains recruitment and CPAP during apnea testing. Some ventilators may not allow apnea ventilation to be disabled which may interfere with observation of respiratory efforts.* * Turn apnea ventilation off and widen alarm values. The alarms will go off during the test and will need to be silenced.
* Change the ventilator mode to CPAP/spontaneous mode with CPAP set to prior PEEP level and pressure support to zero. Observe the time; this is the beginning of the test.
 |
| 1. Positive Airway Pressure with Intentional Hypoventilation

*This method often allows completion of apnea testing in patients with significant cardio-respiratory instability and in whom other apnea testing is unsuccessful. It may require longer to reach the target ABG criteria due to the minimal ventilation provided.** Change ventilator mode to SIMV with 2-4 breaths a minute at low tidal volumes (e.g., less than 50% baseline minute ventilation, or 200cc) and no pressure support; or change to Assist Control 2-4 breaths with apnea ventilation turned off. Observe the time; this is the beginning of the test.
* After arterial blood gases confirm that target pH and PCO2 have been reached, ventilator is disconnected or set to standby and the patient is observed for any respiratory efforts for a period of 60 seconds.
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| 1. ***Carbogen Ventilation***
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| *Carbogen ventilation ensures a consistent and rapid rise in pCO2. It does require access to a carbogen tank and a regulator to allow connection to the patient mechanical ventilator.** Disconnect the oxygen supply hose from the wall and connect it to the carbogen regulator. This will allow the ventilator to deliver a mixture of 97% oxygen and 3% carbon dioxide.
* Change ventilator mode to SIMV with 2-4 breaths a minute and no pressure support; or change to Assist Control 2-4 breaths with apnea ventilation turned off. Observe the time; this is the beginning of the test
* After arterial blood gases confirm that target pH and PCO2 have been reached, ventilator is disconnected or set to standby and the patient observed for any respiratory efforts for a period of 60 seconds.
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| **Time of Death and Documentation** |
| The time of death is the time the blood sample was taken when the PaCO2 reached the apnea test thresholds. Documentation of the time of death is completed on the *Confirmation of Death Determination by Neurologic Criteria (DNC)* form. When death is determined independently by two physicians, the legal time of death is the time of completion of the first physician’s assessment. |