

The practical role of the respiratory therapist in the standard apnea test procedure for declaration of death via neurologic criteria in adults

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ABSTRACT

Introduction: Respiratory therapists (RTs) in the intensive care unit can at times find themselves involved in and assisting during the performance of the apnea test (ApT). The ApT is a clinically complex procedure and is the last part of the clinical declaration of death by neurologic criteria (DNC) protocol and requires close collaboration between the physicians and the RTs. As such, the ApT should be performed with the upmost attention to detail.

Context and Aims: The RTs need to be versed on the intricacies of the ApT. Except in very large medical centers, the ApT is not a procedure performed with high enough frequency as to maintain high level of proficiency. For a successful ApT, structured knowledge and preparation are paramount. This publication attempts to fill that gap, for adult hospitalized patients not on ECMO (extracorporeal membrane oxygenation). To generate this report, we make use of the published guidelines, and our personal experience on performing ApTs in large medical centers.

Conclusion: We provide a structure by means of a checklist, from the RTs' perspective, to guide and help them lead on the efficient performance of the ApT.

Key words: brain; apnea; death; respiratory therapy; neurologic; timeout; criteria; critical; neurocritical.

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Contributions: AAJV, concepts generation, design, bibliographical research, analysis, and synthesis, drafting and writing, final approval; EBG, concepts generation, critical review, design, analysis, and synthesis, drafting manuscript and final approval; TJM, review, edits, critical revisions, and approval. All the authors have read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Conflict of interest: The authors declare that they have no competing interests, and all authors confirm accuracy.

Ethics approval: Not applicable.

Introduction

Patient death can be declared *via* 1 of 2 mechanisms: cardiopulmonary death or neurologic death [1]. The RTs are usually involved in both death declarations pathways, but the ApT has layers of complex, multistep and time-sensitive knowledge, timely collaborations and targeted skills [2,3].

More recently there has been a global attempt to standardize death by neurologic criteria (DNC) declaration through the World Brain Death Project (WBDP) [1]. As this effort continues to expand, the need for the RTs' knowledge and skills on the technique when participating in the performance of the ApT becomes even more relevant.

Background

The ApT procedure is a group effort, where the physically (or virtually) present attending physician is responsible for deciding the appropriateness and timing of the ApT. The goal of the ApT is to maximally stimulate the respiratory centers in the lower brain stem by acute hypercarbia and respiratory acidemia, when there is no restriction or limitation to being able to do so (i.e., no chemical paralysis, high cervical spine injury, chronic pCO₂ retention or severe obesity, among others). All while the patient remains perfused, normothermic and normoxic [1,4].

The ApT is the last key portion of the clinical declaration of death *via* neurologic criteria. Once a patient has been declared dead *via* neurologic criteria, then he/she has become a cadaver. If reconnected to the mechanical ventilator, then becomes an oxygenated and perfused cadaver.

Checklists have proven themselves to be useful in improving efficiency, efficacy, and safety. Checklists, when thoughtfully built and maintained, can be powerful tools for standardization of clinical care [5]. The declaration of DNC has evolved into a checklist that the licensed physician is responsible to follow [1,6]. To assist the RTs, a checklist is being provided here for the bedside navigation of the performance of the ApT procedure, from the RTs perspective, in a more smooth and seamless fashion.

The checklist provided (Table 1) is a general approximation, a set of reminders and guideposts for the RTs to have at-hand and in mind for more effective leadership and collaboration with the physician and clinical team during the ApT procedure.

Elements of DNC

The declaration of DNC requires meeting a sequence of clinical contexts and criteria [1,6]:

- In the context of a severe and irreversible neurological injury, in the absence of sedation and paralysis (chemical, anatomical or disease condition), and while the patient's systolic blood pressure (SBP) is >100 (MAP>60) mmHg and normothermic (>36°C):
 - 1) the presence of coma, Glasgow Coma Score (GCS) =3, and
 - 2) lack of brain stem reactivity: no pupillary, no corneal and no oculocephalic or oculovestibular reflexes, no extraocular movements, no gag/cough response, and no spontaneous respirations, and
 - 3) absence of respiratory effort during the ApT.
- The diagnosis of DNC is predominantly (>90% of the time) clinical. In less than 10% of cases paraclinical tests may be needed, such as transcranial Doppler, or electroencephalo-

gram, or nuclear medicine scans, and others). These are used when a component of the clinical exam is missing or cannot be obtained.

- The presence of simple spinal cord reflexes or spontaneous muscle contractions is compatible with the diagnosis of DNC.
- The physician **is in the room** (physically or virtually) during the entire evaluation and clinical testing.
- Active monitoring during the ApT may include cardiac rhythm telemetry, continuous O₂ saturation, continuous or frequent (1-2 min) blood pressure, and waves and visual respiratory rate.
- **Apnea test** – beginning from normocarbia, no respirations are observed for around 10 minutes of disconnection of the endotracheal tube from the mechanical ventilator tubing, and documenting an increase from pre-disconnection arterial partial pressure of carbon dioxide (PaCO₂) 4.7-6.0 kPa (PaCO₂ 35-45 mmHg) to at least or greater than PaCO₂ ≥2.67 kPa (≥20 mmHg), or paCO₂ ≥8.0 kPa (≥60 mmHg).

In the United States of America (USA), there are 2 pathways to declare death:

- 1) cardiopulmonary criteria, or
- 2) neurologic criteria.

The apnea test is a key component of the declaration of DNC.

Generally, in the adult, only 1 ApT test is needed. If a second ApT is performed, then the same steps are followed. The patient is declared at the end of the last ApT, if criteria are met.

The ApT comes with some potential complications to be aware of, that include: hypotension, hypoxia, bradycardia, cardiac arrest, pneumothorax, among others, and can lead to aborting the procedure until adjustments and corrections can be implemented to decide if the ApT could be repeated [7].

After ApT, if the patient is declared dead, then the family will be approached by the organ procurement organization (OPO) about organ donation (in the USA [8], the clinical team does *NOT talk to family regarding organ donation*.) If the patient is NOT an organ donor, and the patient is reconnected to the mechanical ventilator, then a time is set to disconnect the patient from the critical care devices, including the mechanical ventilator. RTs will be notified, if not done already. If the patient is an organ donor, then the OPO will take over the case, and the healthcare team will assist, as needed, and requested.

Time-out!

Time-outs, as far as we know have not been studied, nor have been reported (in PubMed) as a component of the ApT procedure. But, time-outs have become an integral part of clinical practice to enhance patient safety. Time-outs are part of the Universal Protocol [9] from The Joint Commission, that aims to enhance patient safety. We believe that performing a time-out before performing the ApT should be considered part of the standard of care. RTs may play a leading role in implementing ApT time outs. Suggested statements and questions are itemized in Table 2.

Conclusions

A systematic, itemized, step-by-step approach is offered for the RTs, on how to confidently assist and lead during the performance of the complex multi-step standard ApT in adults, which is an integral part of the procedure for DNC. The ApT time-out is introduced.

Table 1. The RTs ApT itemized checklist, with comments - partially adapted from [1,4,7,9].

?	1) Agree on timing of the ApT procedure, and personnel.
?	2) Discuss if patient has contraindications such as being a chronic CO ₂ retainer, severe obesity, high cervical spine injury, hemodynamic instability, flail chest, ongoing severe cardiac arrhythmias, etcetera, and confirm ApT can proceed.
?	3) If available, consider ETCO ₂ or other non-invasive CO ₂ monitoring device, as it could help adjust breathing tidal volume and/or rate in preparation for disconnection.
?	4) Optimize patient: pulmonary recruitment maneuvers, and preoxygenate the patient with 100% FiO ₂ for ≥10 minutes to PaO ₂ ≥26.7 kPa (≥200 mmHg), with a PEEP of 0.49 kPa (5 cmH ₂ O).
?	5) Obtain pre-ApT ABG. Ventilator settings adjusted to reach normocarbica 4.7-6.0 kPa (PaCO ₂ 35–45 mmHg).
?	6) If PaCO ₂ out of range, then, note the difference between ETCO ₂ and the PaCO ₂ , and adjust ventilator (rate and/or volume), to reach target pre-ApT PaCO ₂ of 4.7-6.0 kPa (35-45 mmHg).
?	7) Confirm oxygen saturation sensor in place, and not in a limb with active blood pressure cuff. Ideally, listen to SpO ₂ signal, to auditorily monitor heart frequency, rhythm and oxygen saturations.
?	8) Gather ABG equipment: ideally a point-of-care ABG device, with 3-4 ABG kits, gloves, tape, cup with ice, and patient labels.
?	9) Gather apneic oxygenation/airway equipment: a) oxygen source, tubing, catheter for apneic oxygenation (endotracheal), or b) T-piece-CPAP, or c) resuscitation airway bag with PEEP valve, depending on your institutions practice preferences.
?	10) Confirm how and by who the ABGs will be obtained (direct arterial punctures, or via arterial line), and who is going to run the ABG test.
?	11) Determine who and how (such as with a stopwatch) is going to monitor and call-out every minute of the time from disconnection to reconnection.
?	12) Perform Time-Out (see Table 2).
?	13) Physician is in the room, supervising physically or virtually via telemedicine, from disconnection to reconnection of airway tubing.
?	14) Uncover the chest and upper abdomen, down to the gown, for direct visualization of potential respiratory movements.
?	15) Prepare for disconnection from the mechanical ventilator, generally for 8-12 minutes (duration at the discretion of the supervising physician).
?	16) During the ApT the patient's SBP ≥90 mmHg, is normothermic (>36°C), and normoxic.
?	17) Time tracking begins at disconnection and ends at reconnection. Note and document actual disconnection and reconnection times.
?	18) Apply agreed upon apneic oxygenation system.
?	19) Remind to minimize bed movements or touching the bed (this decreases the potential confounders, such as respiratory tracing deflections on the monitor, that may be interpreted as breathing motion).
?	20) Notify physician if the patient is noted to have cough, yawns, or breathes over the set rate of the mechanical ventilator or when disconnected from ventilator (any of these would prompt stopping the ApT procedure).
?	21) After minute-7 off the mechanical ventilator, be ready to draw ABG. As long as patient is hemodynamically stable, or the patient has not taken any breath, then the test can and may continue for several more minutes.
?	22) When physician gives order, draw ABG. Label the sample.
?	23) Run ABG test, and place the remaining and labeled blood sample in cup with ice.
?	24) Be ready to run another ABGs.
?	25) Positive test is an increase from pre-ApT values of: PaCO ₂ ≥8.0 kPa (PaCO ₂ ≥60 mmHg), or pCO ₂ rise of ≥2.67 kPa (≥20 mmHg).
?	26) The ApT may be aborted if, for example, there is presence of respiratory drive, SBP <90, hypoxia (O ₂ saturation <85% for >30 secs), unstable cardiac dysrhythmia, etc.). ApT may need to be repeated after necessary readjustments.
?	27) Reconnect patient to mechanical ventilator, using prior ApT settings, or as instructed by physician.
?	28) Stop stopwatch, note and document actual time. Calculate total procedure/apneic time (reconnection or final time – disconnection or initial time, in minutes).
?	29) Document procedure, including total duration, disconnection time, complications, or deviations.
?	30) Only the OPO will approach the family about organ donation.

Table 2. Ten suggested time-out statements and questions for before the ApT procedure.

- 1) Begin with: "We are going to perform a time-out"
- 2) "I am (your name), Respiratory Therapist, and I will be assisting with the ApT", then ask other members of the team to please introduce themselves and their roles, including the physician. If family present in the room, have them introduce themselves, too.
- 3) What procedure are we performing?
- 4) On what patient (name, room number and date of birth) is the ApT being performed on?
- 5) Has the physician (name) given the order, and is he/she physically or virtually in the room?
- 6) Is the necessary equipment in the room, including ABG equipment?
- 7) Who will collect, and from what site, are the ABG samples going to be collected?
- 8) Who will keep track of the time?
- 9) Announce: "please, do not touch or move the bed after disconnection, unless strictly necessary". (Movements of the bed may induce spontaneous muscle contractions or cause confounding artifacts on the monitoring equipment and waveforms.)
- 10) Ready to proceed?

Abbreviations

RTs, respiratory therapists;
ApT, apnea test;
DNC, death by neurologic criteria;
SBP, systolic blood pressure;
MAP, mean arterial blood pressure;
OPO, organ procurement organization.

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Received for publication: 27 February 2022. Accepted for publication: 7 April 2022.

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Multidisciplinary Respiratory Medicine 2022; 17:843

doi: 10.4081/mrm.2022.843

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