Letter to the Editor

To the Editor

Apnea test in the diagnosis of brain death

Guidelines for the diagnosis of brain death have been recently published by the Canadian Neurocritical Care Group in the *Journal*.[1] Apnea testing is an important component in the determination of brain death. In the recent guidelines it is suggested to insufflate 100% oxygen via a cannula inserted in the endotracheal tube to prevent hypoxemia during the apneic period. This is in agreement with the classic method of apnea testing. However, we would like to warn about serious complications of such a technique of apneic oxygenation. A few years ago we experienced a case of subcutaneous emphysema, tension pneumothorax followed by cardiac arrest during the performance of an apnea test with the classic method of inserting an oxygen catheter into the endotracheal tube. Subsequent investigation revealed that the oxygen catheter was wedged in the endotracheal tube. The 6 l/min flow of oxygen rapidly produce lung hyperinflation and major barotrauma. More recently, two very similar cases have been very well described by Bar-Joseph et al.[2] Brandsetter et al[3] have also reported a similar complication. The consequences of such complications can be catastrophic, especially when the patient is a candidate for organ donation. Moreover, they could be easily prevented by simple modification of the technique of apnea testing.

The first important step is to ensure a careful preoxygenation with 100% oxygen while maintaining normoventilation ($PaCO_2$ 40±5mmHg) during at least 10 minutes. Then the endotracheal tube can be connected either to a T-piece or to a high flow continuous positive airway pressure (CPAP) system.

If the patient required a FiO_2 less than 0.50 prior to apnea testing, a T-piece system delivering 100% oxygen will suffice to maintain an adequate arterial oxygenation throughout the apneic period. Alternatively, if prior to apnea testing the patient has hypoxic respiratory failure requiring a high FiO_2, the endotracheal tube can be connected to a high flow CPAP system of 5 to 10 cmH_2O delivering 100% oxygen. Practically, we use a PEEP valve (Vital Signs®, Totowa, N.J.) that we adapt to the distal extremity of the T-piece. A similar but more complex technique, the "bulk diffusion" technique, has also been described by Al Jumah et al.[4] With these techniques the risk of barotrauma and tension pneumothorax is minimal and probably entirely eliminated. Therefore, we suggest that the Guidelines for the Diagnosis of Brain Death should be amended to revise the technique of apnea testing.

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Response to Lessard et al.

Lessard and colleagues discuss possible risks of apnea testing using the standard protocol.[1] They draw attention to the extremely rare complication of pneumothorax related to the standard recommended therapy of oxygen delivery via a tracheal cannula inserted in the endotracheal tube. In over 20 years of performing apnea tests for brain death in adults and children, we have never encountered such a complication. The risk of a tracheal cannula becoming wedged in a small bore endotracheal tube, e.g., in a small child, must be greater than such a complication in an older child or adult. Such risks are minimized by ensuring that such catheters are of a caliber that will not become wedged in the endotracheal tube and that they are thin and flexible and do not protrude beyond the end of the endotracheal tube.

Their suggestion of using a technique involving continuous positive airway pressure (CPAP) is potentially problematic. An earlier report documented respiratory-like movements when apnea testing utilized CPAP in a patient who was apparently brain dead.[2] Rhythmic, thoracic, respiratory-like movements have been reported in brain death with earlier methods of testing and may arise from remaining cervical spinal cord function.[3]

Some centres utilize increased carbon dioxide concentration in the administered air during apnea testing. This also can also create problems. Too high a partial pressure of arterial carbon dioxide ($PaCO_2$), e.g. greater than 90 mm Hg, can depress any respiratory drive by inducing carbon dioxide narcosis.[4] Also, a very abrupt rise in $PaCO_2$ can cause a rapid rise in intracranial pressure in the patient who is not brain dead.[5]

We stress that the apnea test should be performed only after other criteria for brain death are met. It should not be used when exclusions apply or where it is deemed to be risky or the results uninterpretable.

Complications from the apnea test, such as that cited by Lessard et al., are rare. We suggest that the standard procedure, with precautions noted above, is still the best approach for the majority of cases. There may be special circumstances in which the methods suggested by Lessard et al. may be appropriate, but these too have their pitfalls. We look forward to hearing of other experiences with the apnea test in adults and children.

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for the Canadian Neurocritical Care Group
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