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Discussion

Pro-con debate on preoxygenation: Pros
We provide optimum oxygen storage before induction of anaesthesia to facilitate airway management minimizing the risk of critical hypoxia

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Preoxygenation consists of replacing the nitrogen (N_2) from Functional Residual Capacity (FRC) in the lungs, by oxygen (O_2), before the induction of general anaesthesia to extend the duration of safe apnea, defined as the time until a patient reaches a $SpO_2 < 92\%$ to allow for placement of a definitive airway. Time earned depends principally on how a patient's characteristics influence oxygen consumption and FRC. In a healthy, adult patient, this manoeuvre entails safe oxygenation between 6 and 10 minutes during apnoea [1,2].

Maintaining haemoglobin oxygen saturation during airway management is critical to patient safety. Desaturation to below 70% exposes patients at risk for dysrhythmia, hemodynamic decompensation, hypoxic brain injury, and death [3].

Preoxygenation allows a safety buffer during periods of hypoventilation and apnoea. It extends the duration of safe apnoea, defined as the time until a patient reaches a saturation level of 88%–90%, to allow for placement of a definitive airway. When patients desaturate below this level, which is the steepest portion of the oxyhaemoglobin dissociation curve, decrease to critical levels of oxygen saturation (<70%) may appear in seconds [4].

The safe apnoea period as part of induction of general anaesthesia, facilitates the airway management for a secure control of ventilation. In healthy individuals breathing room air, a drop in PaO_2 leading to loss of consciousness is observed after 90 sec of apnoea. This time is related to O_2 consumption (200 ml/min) from body stores (approximately lungs 450 ml in FRC and blood 850 ml linked to haemoglobin), driving in 5–6 min to a life threatening hypoxia [5,6]. During apnoea (in room air) an equilibrium between alveolar gas and mixed venous blood is produced, which represents a decrease in O_2 alveolar pressure from 105 to 40 mmHg in 60 sec that corresponds to an O_2 consumption of 230 ml (2/3rds of total FRC).

Preoxygenation was introduced in the 1950s when anaesthesiologists realized that administration of 100% oxygen rather than room air before tracheal intubation markedly increased time to desaturation [7].

Today, monitoring gas exchange provides safety information to prevent hypoxemia during the management of patient at risk: anticipated difficult airway, rapid sequence induction in an emergency when positive pressure O_2 insufflation can facilitate regurgitation and aspiration, reduction of FRC in obese, pregnancy, elderly, infants, increased O_2 demand in pregnancy, hyperthermia and for patients where maintaining SaO_2 is crucial (coronary artery disease, acute fetal distress, severe anaemia) [8].

Preoxygenation is performed by the administration of 100% O_2 for a few minutes prior to induction of anaesthesia. This is accomplished by different techniques of different duration, tidal volume and respiratory rate, to increase the reserve of O_2 mainly in FRC [9–11]. It is the safest manoeuvre to reduce the risk of critical hypoxemia during this phase of anaesthesia [12,13].

As the "can't intubate can't oxygenate" scenario remains unpredictable even in apparently easy to manage patients, should we consider more efficient preoxygenation in every patient?

We may have an overview of a difficult airway scenario to answer this question.

Airway assessment must go beyond carrying out a series of bedside tests. Difficulty can be related not only to anatomic but also to procedural or conceptual factors [14]. Patients evaluated as *low difficulty* by predictors, can be of actual *high difficulty* in cases of emergency surgery causing impairment in practitioner performance. This unexpected new situation may worsen in cases of inadequate or poor equipment and limited expertise or training.

The ability to perform bag mask ventilation (MV) is a relevant factor in the scale of difficulty as the first rescue manoeuvre after

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failed endotracheal intubation. Langeron et al. in a prospective study of 1502 patients, found a 5% incidence of difficult mask ventilation (DMV): It was defined as the inability of an unassisted anaesthesiologist to maintain the measured oxygen saturation as measured by pulse oximetry > 92% or to prevent or reverse signs of inadequate ventilation during positive-pressure mask ventilation under general anaesthesia [15]. In the same line Ketherpal et al. in 22,660 attempts of MV found an incidence of 1,4% of DMV defined by inadequate, unstable, or requiring two providers to maintain oxygenation [16,17].

It is clear that accurate prediction of difficult airway management may reduce potential complications by allowing the allocation of experienced personnel and the use of relevant equipment [18]. But, how does the prediction work to anticipate difficulties?

The assessment recommended preoperatively by the American Society of Anaesthesiologists [19] is unspecified as it is the NAP4 project in United Kingdom [18], while the choice of assessment is at the discretion of the anaesthesiologist in charge.

No single predictor of difficult intubation is sufficiently reliable, whereas referenced meta-analysis have found either none or only sparse evidence, because of the low sensitivity and specificity of available tests. This situation associated with difficult mask ventilation is potentially life threatening.

Norskov et al. retrieved a cohort of 188,064 cases from the Danish Anaesthesia Database, investigating the diagnostic accuracy of the predictions of the anaesthesiologists regarding difficult tracheal intubation and difficult mask ventilation [20]. Of 3391 found difficult intubations, 3154 (93%) were unanticipated. When difficult intubation was anticipated, 229 of 929 (25%) had an actual difficult intubation. In the same way difficult mask ventilation was unanticipated in 808 of 857 (94%) cases, while when anticipated (218 cases), difficult mask ventilation occurred only in 49 (22%) cases. This results of anaesthesiologist's daily practice, shows that prediction of airway difficulties remains a challenging task, underlining the importance of being constantly prepared for unexpected difficulties in airway management.

Hundred percent oxygen concentration during induction of anaesthesia causes a greater number of atelectasis and intrapulmonary shunt when compared with administration of oxygen 60%–80%. However, a FiO_2 60%–80% reduces the time of secure apnoea, which is a major risk in cases of unanticipated difficult airway. In addition, atelectasis can be easily prevented applying CPAP during preoxygenation or treated applying recruiting manoeuvres and PEEP after intubation during controlled ventilation. This way FRC is easily maintained and/or restored [21].

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