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Intubation using apnoeic oxygenation to prevent desaturation: A systematic review and meta-analysis

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ABSTRACT

Purpose: To determine whether or not apnoeic oxygenation reduces the incidence of hypoxaemia during endotracheal intubation.
Materials and methods: A systematic search of six databases for all relevant studies until November 2016 was performed. All study designs using apnoeic oxygenation during intubation were eligible for inclusion. All studies were assessed for level of evidence and risk of bias. A meta-analysis was performed on all data using Revman 5.3.
Results: Seventeen studies including 2422 patients were retrieved. Overall there was a significant reduction in the incidence of desaturation (RR = 0.65; $p < 0.00001$), critical desaturation (RR = 0.61, $p = 0.002$) and safe apnoea time (WMD = 1.73 min, $p < 0.00001$). There was no significant difference in mortality (RR = 0.77, $p = 0.08$).
Conclusions: In patients whom are being intubated for any indication other than respiratory failure, apnoeic oxygenation at any flow rate 15 L or greater is likely to reduce their incidence of desaturation (<90%) and critical desaturation (<80%). However, further high quality RCTs are required given the high degree of heterogeneity in many of the outcomes and subgroup analyses.

Contents

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1. Introduction

Endotracheal intubation, a life-saving intervention, is a commonly used procedure in the operating theatre (OT), emergency department (ED), and the intensive care unit (ICU) [1]. Whilst endotracheal intubation is seen as a regular intervention, in certain circumstances the procedure can potentially be high-risk, especially if performed outside of an OT [1,2].

Hypoxaemia is often seen to be one of the most significant complications that can arise during endotracheal intubation [1,3], and has been strongly associated with cardiac arrest and death in critically ill patients [3]. Hypoxaemia can be ameliorated by providing pre-oxygenation prior to or during endotracheal intubation. This has been established to result in a prolonged 'safe apnoea time' – a term used to describe a period of time before a patient undergoes critical arterial desaturation [1]. However, this has been shown to be significantly less effective when applied to a critically ill population [4].

Apnoeic oxygenation, a technique first devised in 1959 [5], aims to prevent hypoxaemia from occurring during endotracheal intubation. The technique involves providing a constant stream of oxygen via nasal cannulae during intubation or any period of apnoea. If a patent upper airway is present, and there is an absence of pulmonary shunting, this prolonged oxygenation is theorised to facilitate mass diffusion of gas from the pharynx to the alveoli, thereby providing an increased volume of oxygen to diffuse into the arterial circulation and delay hypoxaemia [6,7].

Current literature provides numerous studies regarding the use of apnoeic oxygenation during intubation, including several level one randomised controlled trials (RCTs). Despite this, there are currently no systematic reviews or meta-analyses on the topic. We hypothesise that apnoeic oxygenation will reduce the incidence of desaturation during intubation. The primary aim of this systematic review and meta-analysis was to investigate whether or not apnoeic oxygenation is shown to reduce the incidence of hypoxaemia (incidence of desaturation, lowest SpO_2 and critical desaturation) during endotracheal intubation. The secondary aims included determining the effect of apnoeic oxygenation during intubation on safe apnoea times, adverse outcomes during intubation and longer term outcomes such as duration of ventilation and mortality.

2. Methods

2.1. Search strategy

Five databases (CINAHL, SCOPUS, PubMed, Medline and Web of Science) were systematically searched up to and including 19th November 2016. Search terms were determined using the key words included in several of the large studies on this topic. Two independent reviewers (RH, LW) searched the databases using the terms (1) (apnoeic oxygenation) AND (endotracheal intubation); (2) (apneic oxygenation) AND (endotracheal intubation). A manual reference check of recent papers was then performed to identify any additional studies. There were no language restrictions.

2.2. Inclusion criteria

For a study to be included, the study was required to compare apnoeic oxygenation during intubation to a control group included. Two reviewers (RH, LW) assessed each study for inclusion in this systematic review. All study designs were eligible for inclusion.

2.3. Data extraction

Data from studies that met the inclusion criteria were extracted. This included the indication for intubation, apnoeic oxygenation intervention and clinical outcome results. The data collected by each reviewer was then assessed for homogeneity.

2.4. Outcome measures

Data extracted from each included paper was grouped into outcomes for analysis. This included both short and medium-to-long-term outcome measures. The short term outcomes included measures of desaturation during intubation, lowest measured SpO_2 during intubation, critical desaturation during intubation, time to desaturation and resaturation, first pass intubation success, intra-procedural arrhythmias and cardiac arrest. The medium-to-long-term outcomes included duration of ventilation, length of ICU stay and mortality.

2.5. Definition(s)

Low Flow Apnoeic Oxygenation: oxygen delivered via nasal cannulae at flow rates of 15 L/min or less during the period of intubation.

High Flow Apnoeic Oxygenation: oxygen delivered via nasal cannulae at flow rates of 50 to 60 L/min during the period of intubation.

Desaturation: a decrease in oxygen saturation (SpO_2) during intubation to <93–95%.

Critical Desaturation: a decrease in oxygen saturation (SpO_2) during intubation to <80%.

Safe Apnoea Time: duration of apnoea without desaturation.

Mortality: death during ICU admission or within 28 days of intubation.

2.6. Sensitivity analysis

Where possible data was subdivided into indication for intubation; respiratory failure and other indications. Within these two indications, where possible, data was grouped into low flow and high flow apnoeic oxygenation.