Heart & Lung 46 (2017) 452–457

Contents lists available at ScienceDirect

Heart & Lung

journal homepage: www.heartandlung.org

Care of Critically Ill Adults

Apnoeic oxygenation during intubation in the intensive care unit: A systematic review and meta-analysis

Matthew J. Binks, BMedSt, MD [a,b,*], Rhys S. Holyoak, BBiomedSci (Hons), MBBS [c], Thomas M. Melhuish, BMedSci, MBBS, GradDip (ClinUS) [a,b], Ruan Vlok, BMedSci, MBBS (Hons) [a,d], Anthony Hodge, BAppSci (med science), MBBS [e], Thomas Ryan, BPhty, MBBS (hons) [f], Leigh D. White, MBBS bsci, grad dip (clin us) [a,c]

[a] Wagga Wagga Rural Referral Hospital, NSW, Australia
[b] Faculty of Medicine, University of New South Wales, NSW, Australia
[c] School of Medicine, University of Wollongong, NSW, Australia
[d] University of Notre Dame Australia, School of Medicine Sydney, Australia
[e] Caboolture Hospital, QLD, Australia
[f] John Hunter Hospital, NSW, Australia

ARTICLE INFO

Article history:
Received 14 May 2017
Received in revised form
28 July 2017
Accepted 3 August 2017
Available online 12 September 2017

Keywords:
Apnoeic oxygenation
Intubation
Hypoxaemia
Critical desaturation
Intensive care
Critical care

ABSTRACT

Hypoxaemia increases the risk of cardiac arrest and mortality during intubation. The reduced physiological reserve and reduced efficacy of pre-oxygenation in intensive care patients makes their intubation particularly dangerous. Apnoeic oxygenation is a promising means of preventing hypoxaemia in this setting. We sought to ascertain whether apnoeic oxygenation reduces the incidence of hypoxaemia when used during endotracheal intubation in the intensive care unit (ICU). A systematic review of five databases for all relevant studies published up to November 2016 was performed. Eligible studies investigated apnoeic oxygenation during intubation in the ICU, irrespective of design. All studies were assessed for risk of bias and level of evidence. A meta-analysis was performed on all data using Revman 5.3. Six studies including 518 patients were retrieved. The study found level 1 evidence of a significant reduction in the incidence of critical desaturation (RR = 0.69, CI = 0.48–1.00, p = 0.05) and a significant increase in the lowest SpO2 value by 2.83% (CI = 2.28–3.38, p < 0.00001). There was a significant reduction in ICU stay (WMD = −2.89, 95%CI = −3.25 to −2.51, p < 0.00001). There was no significant difference between groups regarding mortality (RR = 0.77, 95%CI = 0.59–1.03, p = 0.08), first pass intubation success (RR = 1.17, 95% CI = 0.67 to 2.03, p = 0.58), arrhythmia during intubation (RR = 0.58, 95%CI = 0.08 to 4.29, p = 0.60), cardiac arrest during intubation (RR = 0.33, 95%CI = 0.01 to 7.84, p = 0.49) and duration of ventilation (WMD = −1.97, 95%CI = −5.89 to 1.95, p = 0.32). Apnoeic oxygenation reduces patient hypoxaemia during intubation performed in the ICU. This meta-analysis found evidence that apnoeic oxygenation may significantly reduce the incidence of critical desaturation and significantly raises the minimum recorded SpO2 in this setting. We recommend apnoeic oxygenation be incorporated into ICU intubation protocol.

Introduction

Apneic oxygenation uses cannulae to supply a constant stream of oxygen to the patient devoid of respiratory effort (Table 1).[1] First described in 1959,[2] the technique aims to prevent hypoxemic by delivering high volumes of oxygen to the pharynx, from where it can diffuse into the alveoli.[3,4] The process is effective so long as patients have a patent airway and are free of significant cardiopulmonary shunting.[3,4]

Endotracheal intubation is a life-saving treatment used in multiple hospital settings. The risk of intubation increases when performed outside of the operating theatre, where the clinical setting may be less controlled and the facilities and support staff less equipped.[1,5] The intensive care unit (ICU) patient's physiological reserve is often reduced due to acute and chronic illness, and up to 25–39% of intubations of critically ill patients result in complications.[6–9]

Hypoxemia is a particular risk during intubation, increasing the possibility of cardiac arrest and death.[1,10] Pre-oxygenation prior to

Conflicts of Interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.
Funding source: No funding was provided for this research.
Ethics: No ethics approval required.
* Corresponding author. Wagga Wagga Rural Referral Hospital, Wagga Wagga, NSW, Australia.
E-mail address: m.binks@unsw.edu.au (M.J. Binks).

0147-9563/$ – see front matter © 2017 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.hrtlng.2017.08.001

Table 1
Definitions of terms.

Term	Definition
Apneic oxygenation	Oxygen administered via nasal cannulae to the patient devoid of respiratory effort.
Low-flow apneic oxygenation	Apneic oxygenation with oxygen flow rates of 15 L/min or less.
High-flow apneic oxygenation	Apneic oxygenation with oxygen flow rates of 50–60 L/min.
Critical desaturation	Fall in oxygen saturation (SpO2) to below 80% during intubation.
Mortality	Death in ICU or within 28 days of intubation.

intubation is a well-established technique used to ameliorate the risk of hypoxemia and prolong the 'safe apnea time' – the window of time following induction before desaturation occurs.[1] However in the critically-ill population, pre-oxygenation is significantly less efficacious.[11] Apneic oxygenation is commonly employed to improve oxygen saturations during intubation, including in the ICU. The technique uses high-flow nasal prongs, which supply concentrated oxygen to the nasopharynx at flow rates of between 15 L and 60 L per minute, whilst intubation is taking place.

Trials have assessed the use of apneic oxygenation during intubation in a broad variety of settings. These studies are difficult to compare given the vastly different protocols used and patient groups studied. In an attempt to produce a clinically meaningful analysis for intensive care professionals, only studies carried out in the ICU were included in this meta-analysis. The primary aim of this systematic review and meta-analysis was to evaluate the efficacy of apneic oxygenation in reducing hypoxemia (lowest SpO2 and incidence of critical desaturation) during intubation performed in the ICU. The secondary aims were to assess the impact of apneic oxygenation on post-apnoea oxygen saturation and on the incidence of adverse outcomes both during and after intubation such as duration of ventilation and mortality.

Methods

Search strategy

Commencing on 1st November 2016, a systematic search of five databases (SCOPUS, Web of Science, CINAHL, Medline and PubMed) was performed by two independent reviewers (RH, LW) and included articles published up to and including the 19th November 2016. Search terms used were: ((apneic OR apneic) oxygenation) AND ((endotracheal OR tracheal) intubation). The reference lists of recent papers were then manually checked for additional studies.

Inclusion criteria

Papers were included in our study if they compared apneic oxygenation during intubation with a control group in adult patients. Only studies carried out in the intensive care setting were eligible for inclusion in this analysis. Assessment for inclusion was made by two reviewers (RH, LW). There was no limitation on study design. Published abstracts were included.

Exclusion criteria

Studies performed outside the ICU setting or without a control group were excluded. Papers unavailable in English and unpublished studies were excluded.

Quality assessment

The Centre for Evidence Based Medicine (CEBM) levels of evidence (introductory document) was used to evaluate each study.[12] These studies were subsequently evaluated for methodological quality and risk of bias using the Cochrane Collaboration's tool for assessing the risk of bias.[13]

Data extraction

Extracted data included indication for intubation, apneic oxygenation intervention and patient outcomes. Data was independently extracted by two reviewers (RH, LW). Collected data collected was subsequently assessed for homogeneity.

Outcome measures

The pooled data was analyzed for short, intermediate and long-term outcomes. Short-term outcomes included lowest measured SpO2 during intubation, critical desaturation during intubation, timing of desaturation, successful first-pass intubation, cardiac arrest, arrhythmias during the procedure and mortality (Table 1). Intermediate measures included duration of ventilation and ICU stay. The long-outcome of all-cause mortality was included.

Statistical analyses

RevMan 5.3 software (The Nordic Cochrane Centre, Copenhagen, Denmark) was used to interrogate the combined data. Relative risk (RR) with 95% confidence interval (CI) was calculated for dichotomous outcomes and the weighted mean difference (WMD) with 95% CI was found for continuous results.

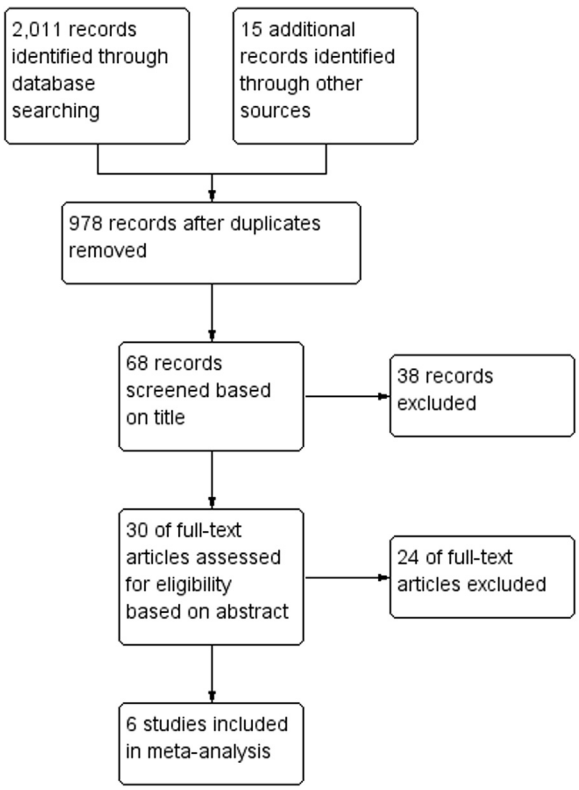

Fig. 1. Systematic database search strategy.