Australian Critical Care 30 (2017) 260–265

Contents lists available at ScienceDirect

Australian Critical Care

journal homepage: www.elsevier.com/locate/aucc

Review Paper

Normal saline instillation before suctioning: A meta-analysis of randomized controlled trials

Chia-Hui Wang RN, PhD[a,b]
Jui-Chen Tsai RN, MSN[a,b]
Shu-Fen Chen RN, MSN[a,b]
Chien-Ling Su RT, MSc[c,d]
Lawrence Chen MS[e]
Chao-Chun Lin RN[e]
Ka-Wai Tam MD, PhD[e,f,g,h,*]

[a] Department of Nursing, Shuang Ho Hospital, Taipei Medical University, New Taipei City, Taiwan
[b] School of Nursing, College of Nursing, Taipei Medical University, Taipei, Taiwan
[c] School of Respiratory Therapy, College of Medicine, Taipei Medical University, Taipei, Taiwan
[d] Department of Thoracic Internal Medicine, Shuang Ho Hospital, Taipei Medical University, New Taipei City, Taiwan
[e] Center for Evidence-Based Health Care, Shuang Ho Hospital, Taipei Medical University, New Taipei City, Taiwan
[f] Division of General Surgery, Department of Surgery, Shuang Ho Hospital, Taipei Medical University, New Taipei City, Taiwan
[g] Department of Surgery, School of Medicine, College of Medicine, Taipei Medical University, Taiwan
[h] Cochrane Taiwan, Taipei Medical University, Taipei, Taiwan

ARTICLE INFORMATION

Article history:
Received 18 May 2016
Received in revised form 31 October 2016
Accepted 6 November 2016

Keywords:
Normal saline instillation
Suctioning
Oxygen saturation
Meta-analysis

ABSTRACT

Background: For airway management of intensive care unit (ICU) patients who are intubated, a 5–10-mL bolus of sterile normal saline (NS) solution is commonly instilled into an endotracheal or tracheostomy tube before suctioning. However, NS instillation has been associated with adverse events such as dyspnea, increasing heart rate, decreasing of oxygenation, blood pressure, and other vital parameters.
Objective: To conduct a systematic review and meta-analysis of randomized controlled trials (RCTs) to evaluate the necessity of NS instillation before suctioning in ICU patients.
Data sources: The PubMed, Embase, Cochrane Library, and Scopus databases and the ClinicalTrials.gov registry were searched for studies published before May 2016.
Review methods: RCTs evaluating the outcome of NS instillation before suctioning in ICU patients undergoing endotracheal intubation or tracheostomy were included. Individual effect sizes were standardised, and a meta-analysis was conducted to calculate the pooled effect size by using a random-effect model. The primary outcome was the oxygen saturation immediately and 2 and 5 min after suctioning. The secondary outcomes were the heart rate and blood pressure after suctioning.
Results: We reviewed 5 RCTs including 337 patients. Oxygen saturation was significantly higher in the non-NS group than in the NS group 5 min after suctioning. The pooled mean difference in oxygen saturation was −1.14 (95% confidence interval: −2.25 to −0.03). The heart rate and blood pressure did not differ significantly between the non-NS and NS groups.
Conclusion: NS instillation before suctioning does not benefit patients undergoing endotracheal intubation or tracheostomy. Moreover, it reduces oxygen saturation 5 min after suction. However, our reviewed studies had a low methodological quality. Thus, additional studies involving large-scale RCTs are warranted.

1. Introduction

Airway management is of particular importance when caring for critically ill patients. Critically ill patients often require endotracheal intubation or tracheostomy along with mechanical

* Corresponding author at: Center for Evidence-Based Health Care, Shuang Ho Hospital, Taipei Medical University, 291 Zhongzheng Road, Zhonghe District, New Taipei City 23561, Taiwan. Fax: +886 2 22490088.
E-mail address: kelvintam@h.tmu.edu.tw (K.-W. Tam).

http://dx.doi.org/10.1016/j.aucc.2016.11.001
1036-7314/

ventilation. Endotracheal or tracheostomy suctioning is one of the most common procedures used for removing respiratory secretions that may occlude the airway. In patients with pulmonary disease, infection, or dehydration, the ability to remove secretions through suctioning can prove difficult because of viscous mucus and deep infection site.[1]

A 5–10-mL bolus of sterile normal saline (NS) solution is commonly instilled into the endotracheal or tracheostomy tube before suctioning and in practice, is carried out according to the clinician's experience. The instillation of NS is purported to elicit coughing and to liquefy and mobilise secretions.[2–7] This is not supported by studies that have indicated mucus and water do not mix in vitro, even after vigorous shaking.[8,9] Of greater concern, suctioning is associated with potentially serious and life-threatening complications, such as hypoxemia, cardiac dysrhythmia, and increased intracranial pressure.[10–13] Despite these drawbacks, in one study 25% of health practitioners considered NS instillation not harmful to patients.[14]

As a routine procedure and perhaps a ritualistic practice, the necessity of NS instillation has been questioned in many studies. Several trials indicated that NS instillation before suctioning did not increase heart rate, and arterial oxygen saturation during endotracheal suctioning.[15,16] Previous systematic reviews were inconclusive and could not provide sufficient evidence regarding the efficacy of NS instillation before suctioning.[17,18] Moreover, several randomized controlled trials (RCTs) evaluating the practice of NS instillation have been published recently.[15,16] Therefore, the aim of our study was to conduct a systematic review and meta-analysis of the evidence available thus far and evaluated the necessity of NS instillation before suctioning in intensive care units (ICU) patients.

2. Materials and methods

2.1. Selection criteria

Our analysis included RCTs evaluating the outcome of NS instillation before suctioning in ICU patients undergoing endotracheal intubation or tracheostomy. These RCTs were required to clearly report the patient inclusion and exclusion criteria, the suctioning technique, the variables used to measure response, and the use of appropriate study controls. RCTs were excluded if (1) patients were not admitted to an ICU, (2) patients were younger than 18 years, or (3) duplicate reporting of patient cohorts had occurred.

2.2. Search strategy and study selection

A comprehensive literature search was conducted using several databases. These included PubMed, Embase, Scopus, and Cochrane Central Registers of Controlled Trials, as well as the ClinicalTrials.gov registry (http://clinicaltrials.gov/). The keywords used for the medical-subject-heading and free-text searches were *instilling* OR *instillation*, *saline* OR *normal saline*, *suctioning* OR *suction*, *endotracheal* OR *tracheal* OR *tracheostomy*. References of the similar articles reported by the Pubmed (displayed at right column of the search page) were also concerned as possible data to be analyzed. We reviewed all the retrieved abstracts, study reports, and related citations. No language restrictions were imposed. The final search was performed in May 2016. We also identified additional studies by reviewing the reference sections of relevant publications and by consulting pulmonary care experts.

2.3. Data extraction

Two reviewers independently extracted the baseline and outcome cardiorespiratory parameters from the included studies. Information of study designs, participant characteristics, inclusion, exclusion, and matching criteria, suctioning techniques, and complications were also retrieved. Inconsistencies between the findings of the 2 reviewers were resolved by a third reviewer.

2.4. Methodological quality assessment

Two reviewers independently assessed the methodological quality of each study by using the risk of bias method recommended by the Cochrane Collaboration. Several domains were assessed, including the adequacy of the randomization, allocation concealment, blinding of patients and outcome assessors, length of the follow-up period, reporting of study withdrawals, and performance of an intention-to-treat analysis.

2.5. Statistical analysis of RCT outcomes

The primary outcome was the oxygen saturation immediately and 2 and 5 min after suctioning. The secondary outcomes were the heart rate and blood pressure after suctioning. All data were analyzed using the Review Manager (version 5; Cochrane Collaboration, Oxford, England). Meta-analysis was performed according to the PRISMA guidelines.[19] Standard deviations were estimated when necessary from the confidence interval (CI) limits, standard errors, or range values provided in the previous studies. Effect sizes of continuous outcomes were reported as weighted mean differences (WMDs). The precision of the effect sizes was based on their 95% CIs. A pooled estimate of the WMDs was computed using the DerSimonian and Laird random-effect model.[20]

To evaluate the statistical heterogeneity and the inconsistency of treatment effects among the studies, the Cochrane Q and I^2 tests were used, respectively. Statistical significance was set at 0.10 for the Cochrane Q test. The proportion of the total outcome variability, attributable to the variability among the studies, was quantified as I^2.

3. Results

Fig. 1 illustrates the process used for RCT screening and selection. The initial search yielded 634 citations. On the basis of the screening criteria for titles and abstracts, 548 articles were excluded. We reviewed the full text of the remaining 86 articles, and 81 were excluded for the following reasons: 11 were retrospective or prospective studies; 4 included pediatric patients; 8 evaluated non-NS irrigation; and 58 addressed other aspects of endotracheal intubation. This left 5 RCTs meeting the selection criteria.[10,15,16,21,22] The characteristics of each are listed in Table 1.

The 5 RCTs were published between 1987 and 2014, with sample sizes of 29–150 patients. All RCTs compared the outcomes of NS instillation before suctioning with those of controls. One crossover study applied 3 NS instillation volumes (0, 2, and 5 mL) in each patient.[22] Two trials recruited patients undergoing cardiac surgeries.[10,15] Three trials[10,15,16] only included patients with endotracheal intubation, one only recruited patients with tracheostomy[22], and one included patients with both types of intubation (Table 1).[21] All RCTs instilled 5 mL of NS before suction; furthermore, 2 RCTs investigated the outcomes of 2-mL NS instillation and only one evaluated the efficacy of 10-mL NS instillation.[10] The assessment of the methodological quality of 5 RCTs is summarised in Table 2. No study specified its randomization methods. Schmollgruber et al. assigned every second patient to group 1 after assigning the first patient to group 2.[15] No study reported the methods of allocation concealment. Two studies reported the blinding of patients and outcome assessors.[16,21] All studies, except that of Ackerman and Mick[21] performed an intention-to-treat analysis. Only 1 patient withdrew during the follow-up among all five RCTs.[21]