Australian Critical Care (2009) **22**, 155—162

ACCCN
Australian College of Critical Care Nurses
www.elsevier.com/locate/aucc

RESEARCH PAPER

Lung recruitment—A guide for clinicians

Jacqui I. Jauncey-Cooke RN, MNRS, Grad Dip Crit Care, PhD Candidate[a,b,*], **Fiona Bogossian RN, RM, PhD, Assoc. Professor**[a], **Christine E. East RN, RM, PhD, Research Consultant, Senior Lecturer**[a,c]

[a] *The University of Queensland, School of Nursing and Midwifery, Herston, Australia*
[b] *Clinical Nurse, PICU Mater Children's Hospital, Brisbane, Queensland, Australia*
[c] *Dept of Perinatal Medicine and Dept of Obstetrics & Gynaecology, The University of Melbourne, Royal Women's Hospital, Australia*

Received 2 February 2009; received in revised form 12 May 2009; accepted 4 June 2009

KEYWORDS
Mechanical ventilation;
Recruitment;
Positive end expiratory pressure;
Sustained inflation;
Paediatric;
Lung protective ventilation

Summary Recruitment manoeuvres play an important role in minimising ventilator associated lung injury (VALI) particularly when lung protective ventilation strategies are employed and as such clinicians should consider their application. This paper provides evidence-based recommendations for clinical practice with regard to alveolar recruitment. It includes recommendations for timing of recruitment, strategies of recruitment and methods of measuring the efficacy of recruitment manoeuvres and contributes to knowledge about the risks associated with recruitment manoeuvres.

There are a range of methods for recruiting alveoli, most notably by manipulating positive end expiratory pressure (PEEP) and peak inspiratory pressure (PIP) with consensus as to the most effective not yet determined. A number of studies have demonstrated that improvement in oxygenation is rarely sustained following a recruitment manoeuvre and it is questionable whether improved oxygenation should be the clinician's goal. Transient haemodynamic compromise has been noted in a number of studies with a few studies reporting persistent, harmful sequelae to recruitment manoeuvres. No studies have been located that assess the impact of recruitment manoeuvres on length of ventilation, length of stay, morbidity or mortality. Recruitment manoeuvres restore end expiratory lung volume by overcoming threshold opening pressures and are most effective when applied after circuit disconnection and airway suction. Whether this ultimately improves outcomes in adult or paediatric populations is unknown.

* Corresponding author. Tel.: +61 0418335634.
E-mail addresses: jacqui.jauncey-cooke@mater.org.au, j.jauncey-cooke@uqconnect.edu.au (J.I. Jauncey-Cooke).

1036-7314/ $ — see front matter
doi:10.1016/j.aucc.2009.06.004

Introduction

The concept of lung recruitment has evolved as a consequence of the conceptual shift towards lung protective ventilation strategies.[1,2] Low tidal volume and higher positive end expiratory pressure (PEEP) benefit the patient by minimising parenchymal injury. This reduces the incidence of ventilator associated lung injury (VALI).[3,4] A well documented iatrogenic phenomenon caused by high transpulmonary pressures at the end of inspiration and inadequate alveolar recruitment at end expiration.[3,5–10] The occurrence of VALI is significant as it impacts on length of ventilation, length of stay and may lead to chronic pulmonary impairment.[8,11] An experimental study by Kornecki et al. compared adult, adolescent and infant rats' lungs both in vivo and ex vivo to their susceptibility to lung injury via positive pressure ventilation.[12] Both hyperinflation and cytokine release were greater in adult lungs compared to infant lungs.[12] However, in humans Wolf et al. demonstrated similar end expiratory lung volume (EELV) loss in children as in adults.[13] This may suggest that the prevalence of VALI in both adult and paediatric populations is clinically significant.

As a consequence of using lung protective ventilation strategies the chronic derecruitment of distal and dependant regions of the lung occurs.[1–5,8,12] The need to periodically and deliberately re-recruit alveoli becomes apparent, more so following disconnection from the circuit and the application of suction.[7] Hence, the concept and practice of recruitment manoeuvres has evolved. This review aims to compare the most common methods of recruiting alveoli — by manipulating PEEP, sustained inflation, or a combination of these strategies — and discusses their application in the clinical setting along with potential harmful sequelae. Searches were undertaken using the following databases: Medline via Ovid; Embase; Cinahl; Joanna Briggs; and the Cochrane Central Register of Controlled Trials from their inception to July 2008. The following keywords were used: mechanical ventilation; alveolar ventilation; recruitment; recruitment manoeuvres; overdistension; hyperinflation; ventilator induced lung injury; acute respiratory distress syndrome; paediatrics; mechanotransduction; airway suction; acute lung injury; positive end-expiratory pressure. Further to this electronic search, citation tracking was undertaken. Randomised controlled trials, quasi randomised controlled trials and observational studies of both clinical and experimental studies were included. These methods yielded 189 papers of which 120 were excluded as they were beyond the scope of this paper. A total of 29 experimental and 40 clinical studies were utilised.

Timing of recruitment

Derecruitment of alveoli occurs rapidly within seconds of airway pressure release in addition to chronic derecruitment secondary to low tidal volume ventilation.[15,16] This is not homogenous; there are significant regional differences in the degree of derecruitment with distal and dependant regions being the first to rapidly collapse.[2,3,7,13,14,17] The application of sub-atmospheric pressure via suction to the airways further attenuates this derecruitment and results in alveolar injury.[3,13] Fig. 1 illustrates the reduction in relative impedance reflecting the drop in EELV secondary to disconnection and suction and the subsequent period of time required to restore previous impedance levels.

Secretion clearance is essential in the care of any intubated patient and those patients with a primary acute lung injury (ALI) commonly have an increased need for secretion elimination. With each disconnection and suctioning, alveolar derecruitment occurs, exacerbating the ALI and contributing to VALI.[4,13] Additionally, the instillation of saline increases threshold opening pressures and worsens derecruitment.[18] A study by Heinze et al. reported that irrespective of the mode of ventilation used

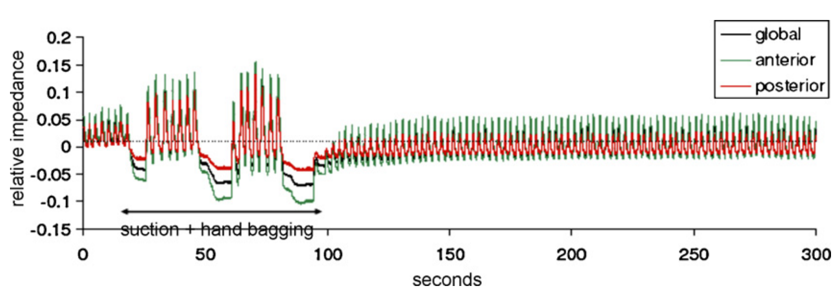

Fig. 1 Global and regional impedance change demonstrating disconnection from circuit, hand ventilation, suction and reconnection to circuit with no recruitment.