

Effects of Endotracheal suction - do it right or close the lungs!

Birgitta Almgren, PhD, RN

Danderyd University Hospital, Karolinska Institutet

Department of Clinical Sciences

Division of Anaesthesia and Intensive Care

Stockholm, Sweden

Introduction

- **Ventilator induced lung injury**
- **Suction methods**
- **Side-effects of suction**
- **Post suction lung recruitment**

Mucus removal by suction

The endotracheal tube and the airways occasionally need to be cleared of mucus by suction

- normal coughing mechanism is disrupted
- mucus production is increased
- mucus clearance depressed
- leading to mucus accumulation

Repeated endotracheal suction is often needed to avoid tube occlusion

Negative effects of suction

- If the patient is disconnected from the ventilator during suction, there is a risk of lung volume loss
- Suction can negatively affect the patient
 - additionally lung volume loss
 - hypoxemia
 - arrhythmias
- The number and severity of negative effects resulting from suction is related to patient's conditions and suction method

Ventilator induced lung injury

- Mechanical ventilation can cause lung injury
- Responsible for ventilator-induced lung injury are
 - alveolar overdistention
 - repetitive derecruitment
 - reopening of unstable alveolar units
- Repeated de-recruitments, i.e. suction, might accentuate lung injury

Lung protective ventilation

- PEEP high enough to avoid de-recruitment
- Tidal volume small enough to avoid high airway pressures
- Recruitment manoeuvres in combination with lung protective ventilation

Suction catheter sizes

- Use a suction catheter with an outer diameter not exceeding half the ET tube inner diameter
- An example for ET tube 8 mm inner diameter requires a 12 French (Fr) suction catheter

Endotracheal tube narrowing

- Endotracheal tubes are markedly narrowed by the buildup of secretions, especially after closed-system suctioning
- Duration of intubation, but not endotracheal tube size or amount of secretions, are associated with the degree of narrowing

Glass et al. Endotracheal tube narrowing after closed-system suctioning: prevalence and risk factors. Am J Crit Care. 1999 Mar;8(2):93-100.

Suction methods

Different suction systems

- Open
- Quasi-closed
- Closed systems

Suction system

Open, disconnection from ventilator



Closed, no disconnection from the ventilator



Side effects of open/closed suction

Reference to the original publication is shown below for your information.

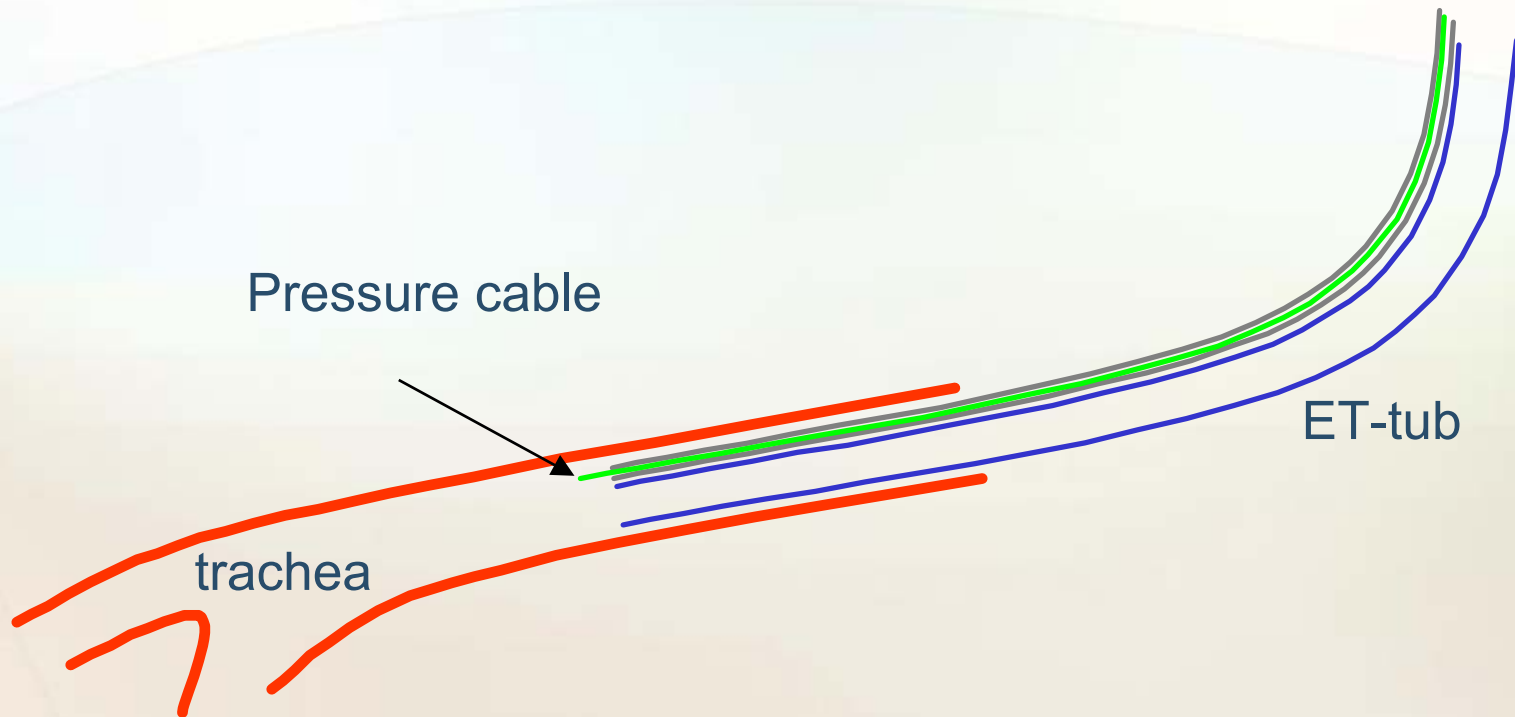
Figure not shown for copyright reasons (permission to reproduce is pending).

For feedback and comments, feel free to contact author or editor, reader inquiries are always appreciated.

Cereda M, et al, Closed system endotracheal suctioning maintains lung volume during volume-controlled mechanical ventilation. Intensive Care Med. 2001 Apr;27(4):648-54.

Tracheal pressure

Pressure cable: PressureWire™, Radi Medical system, Sweden



Almgren, B. Endotracheal Suction a Reopened Problem.
Dissertation from the Faculty of Medicine, University of Uppsala,
Uppsala, Sweden 2005.

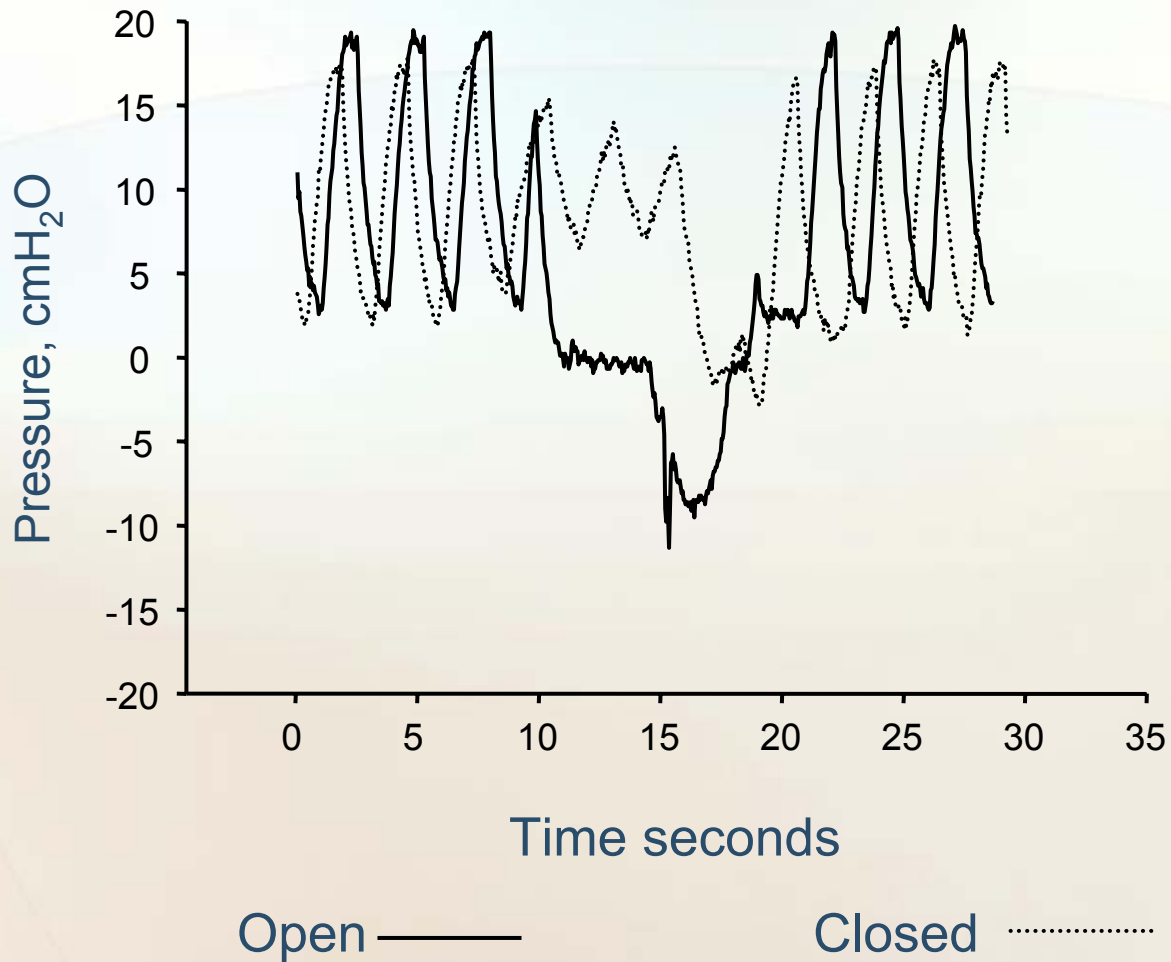
Tracheal pressure during suction

Catheter No	Open	Closed
12	$-11 \pm 1 \text{ cmH}_2\text{O}$ ($p < 0,001$)	$-5 \pm 1 \text{ cmH}_2\text{O}$
14	$-52 \pm 12 \text{ cmH}_2\text{O}$ (ns)	$-70 \pm 14 \text{ cmH}_2\text{O}$

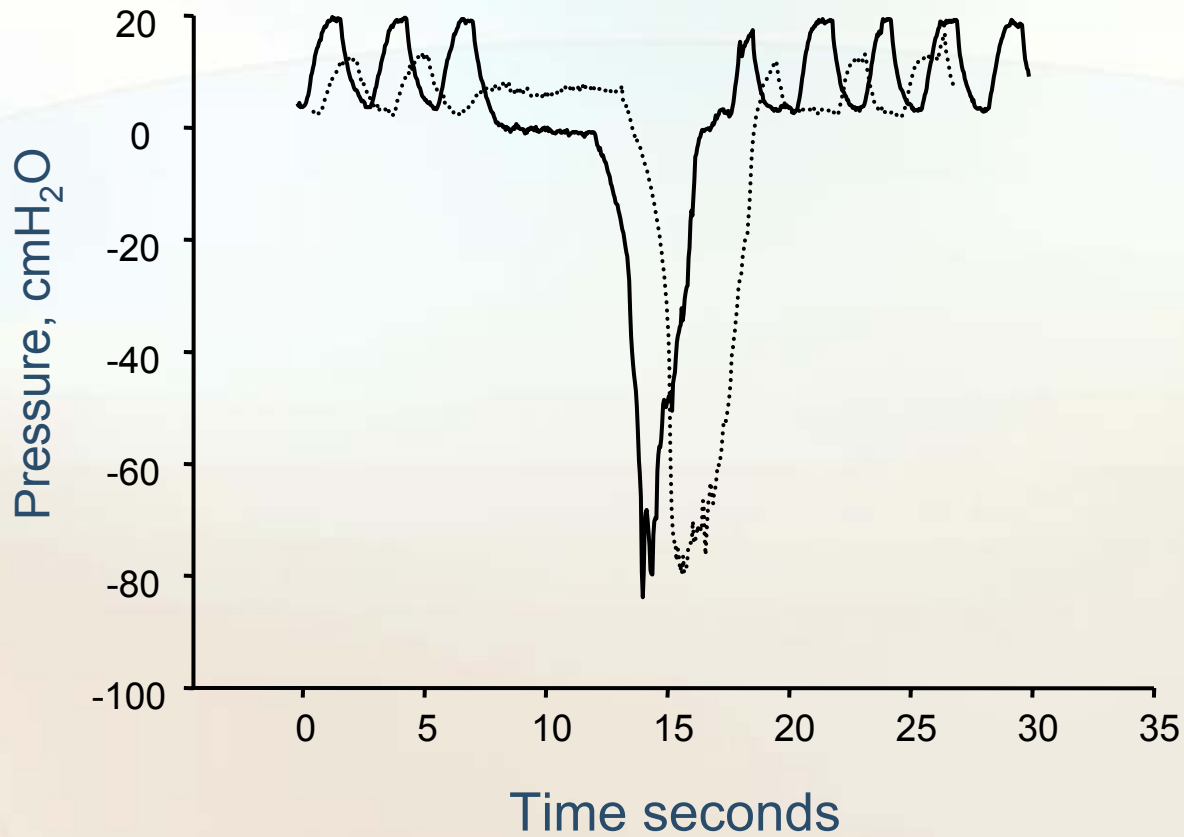
ET tube no 6

Mean \pm SEM

Tracheal pressure during suction 12 FR open/closed system



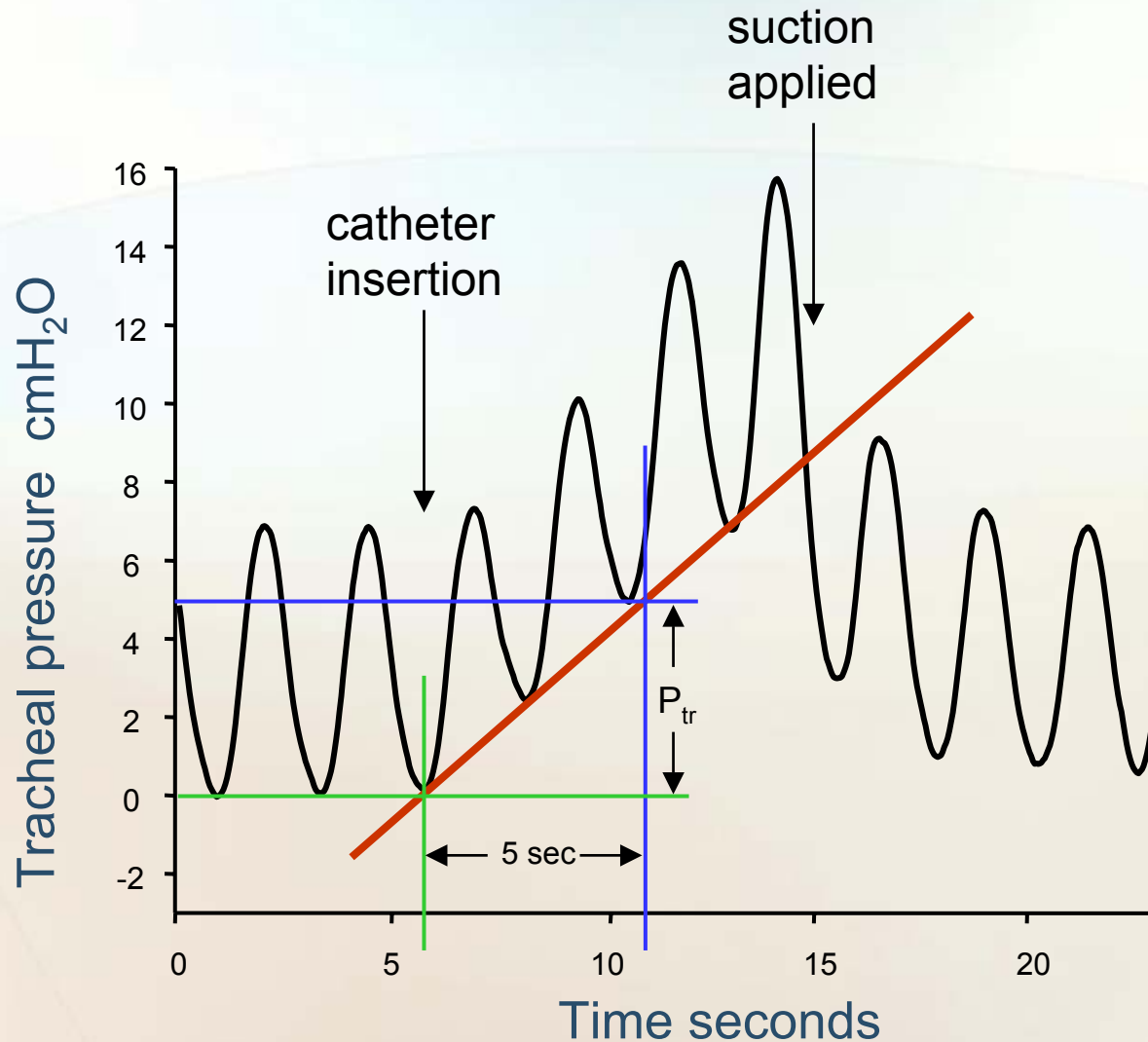
Tracheal pressure during suction 14 FR open/closed system



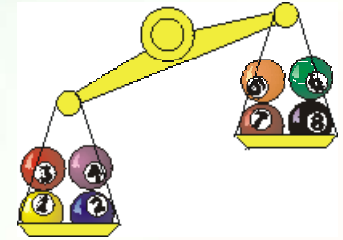
Open —————

Closed ·········

Closed suction during VCV

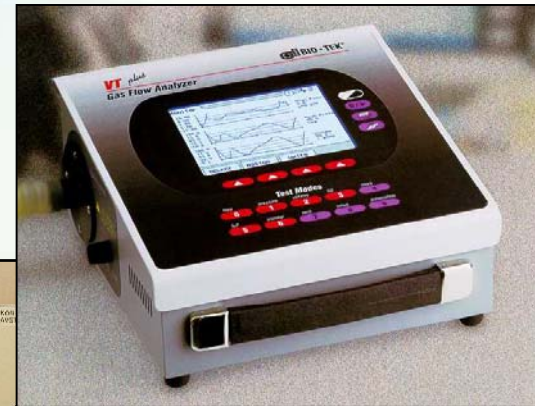


Measuring suction efficacy and mucus aspirated



Setup:

- Ventilator tester
- Plastic "trachea"
- Endotracheal tube
- Ventilator
- Gel
- Weight of gel measured



See article for "mucus aspirated" results: Lindgren s, et al Effectiveness and side effects of closed and open suctioning: an experimental evaluation. Intensive Care Med. 2004 Aug;30(8):1630-7. E-publication 2004 Feb 24.

Suction efficacy – comparing closed system (with two levels of suction pressure)

Suction pressure	Tracheal aspirate mass
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-200 cm _{H2O}	1.0 g
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-400 cm _{H2O}	1.7 g
------------------------	-------

p=0.02

Reference to the original publication is shown below for your information.

Figure not shown for copyright reasons (permission to reproduce is pending).

For feedback and comments, feel free to contact author or editor, reader inquiries are always appreciated.

Lasocki S, Lu, et al. Open and Closed-circuit Endotracheal Suctioning in Acute Lung Injury: Efficiency and Effects on Gas Exchange. *Anesthesiology*. 104(1):39-47, January 2006.

Tube colonization

- Closed endotracheal suction
 - results in increased colonization rates of ventilator tubing
- Compared with open endotracheal suction
 - do not increase the development of VAP

Leonardo MD, et al. Ventilator-associated pneumonia using a closed versus an open tracheal suction system. Critical Care Medicine. 33(1):115-119, January 2005.

Ventilator associated pneumonia (VAP)

- Closed system limits the incidence of nosocomial infection and exposure of personnel
- No significant differences in patients who develop VAP
- Closed suction do not provide any benefit on VAP incidence, mortality, or ICU stay of mechanical ventilated patients

Siempos II et al. Closed tracheal suction systems for prevention of ventilator-associated pneumonia. *Br J Anaesth.* 2008 Mar;100(3):299-306. Epub 2008 Feb 4.

Subirana M et al. Closed tracheal suction systems versus open tracheal suction systems for mechanically ventilated adult patients. *Cochrane Database Syst. Rev.* 2007 Oct 17;(4):CD004581.

Closed suction system

- Maintains connection with the ventilator during suctioning
- Suction-related lung volume loss avoided during volume control ventilation
- Less efficient
- Lower levels of environmental contamination
- Do not prevent VAP

Effects of open suction and recruitment – PVC and VCV compared

Almgren B et al.

Post-suction recruitment manoeuvre restores lung function in healthy, anaesthetized pigs.

Anaesth Intensive Care. 2004 Jun;32(3):339-45.

Sequential changes in PaO₂ control, derecruitment (disconnection) and recruitment maneuver groups

- control
- derecruitment
- △ recruitment

Reference to the original publication is shown below for your information.

Figure not shown for copyright reasons (permission to reproduce is pending).

For feedback and comments, feel free to contact author or editor, reader inquiries are always appreciated.

Koh, W. et.al. Recruitment maneuvers attenuate repeated derecruitment-associated lung injury. Critical Care Medicine. 33(5):1070-1076, May 2005.

Open suction caused a greater $\text{PaO}_2/\text{F}_1\text{O}_2$ decrease than closed, with both VC and PC

Caramez MP et al .

Gas exchange impairment induced by open suctioning in acute respiratory distress syndrome: impact of permissive hypercapnia.

Crit Care Med. 2008 Feb;36(2):560-4.

Drop in end-expiratory lung volume

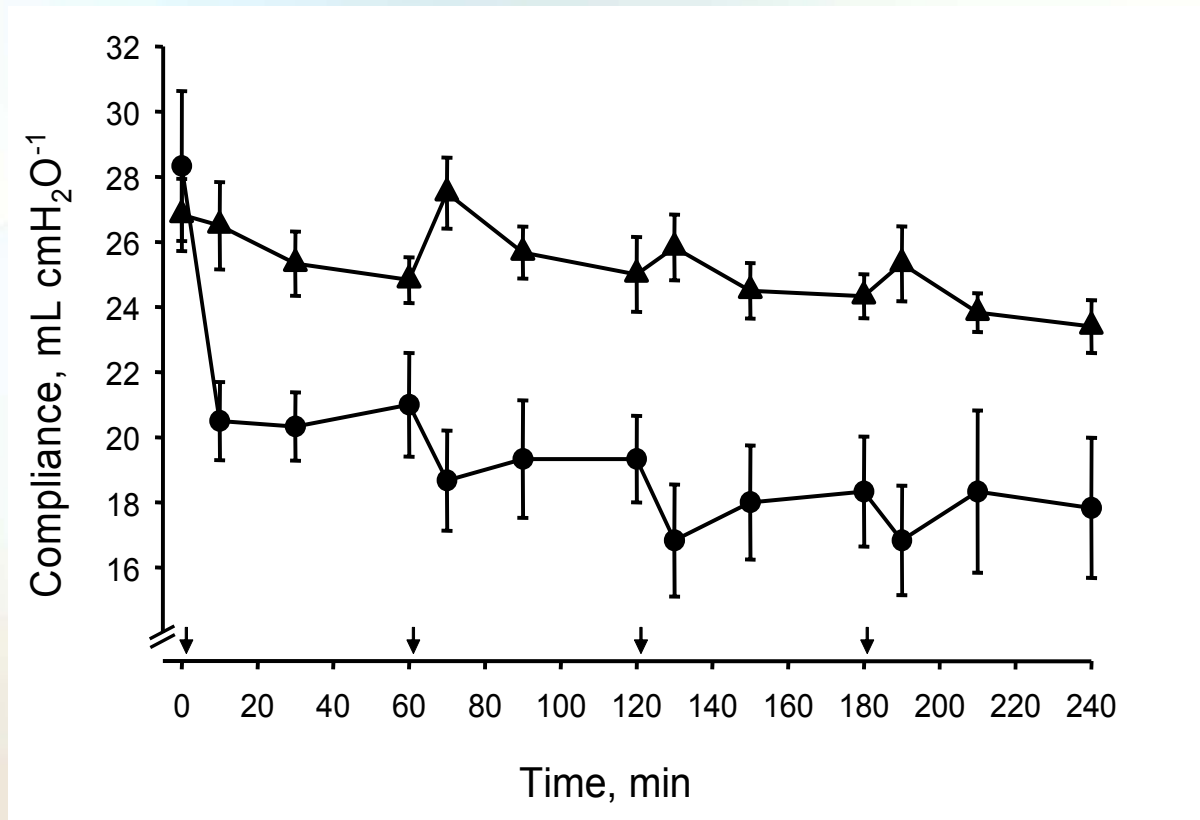
- **End-expiratory lung volume decrease after suction and increase after recruitment**

MAGGIORE S et al.

Prevention of endotracheal suctioning-induced alveolar derecruitment in acute lung injury.

Am J Respir Crit Care Med. 2003 May
1;167(9):1215-24. E-publication 2003 Feb 13.

Compliance decrease after repeated suction



▲ suction no recruitment ● suction and recruitment
↓ Arrows indicate timing of suction

Almgren, B. Endotracheal Suction a Reopened Problem. Dissertation from the Faculty of Medicine, University of Uppsala, Uppsala, Sweden 2005.

Summary

- Suction should only be performed when indicated
- Side-effects shall be observed and handled adequately
- Open suction systems are more effective to remove mucus compared to closed suction system
- Negative side-effects after suction can be avoided by a post-suction recruitment manoeuvre
- The post-suction recruitment manoeuvre should be applied directly after suction.
- There is no difference in VAP incidence between open and closed suction systems.