Cuff pressure management

This bibliography is a literature reference for users and represents selected relevant publications, without any claim to completeness.

Table of Contents

20 Strategies to prevent ventilator-associated pneumonia in acute care hospitals 16
21 Evidence on measures for the prevention of ventilator-associated pneumonia 17

Evaluation of an automated endotracheal tube cuff controller during simulated mechanical ventilation

Chenelle CT, Oto J, Sulemanji D, Fisher D, Kacmarek RM
Respir Care. 2015 Feb;60(2):183-90
PMID 25425705, **http://www.ncbi.nlm.nih.gov/pubmed/25425705**

Design	Bench study: manual regulation versus Intellicuff
Patients	Mannikin with head movement and trachea model
Objectives	Compare Pcuff regulation with Intellicuff and manual technique during 2 hours with head movement and 8 hours using static model
Main Results	During 2 hours with head movement the change in Pcuff from before (25 cm) to after (15 cm) ventilation was important for the manual technique (-39.6%,) but not for IntelliCuff (3.5%). In the static model, the change in Pcuff from before to after ventilation was important for the manual technique (-14.39%) but not for the IntelliCuff (5.65%).
Conclusion	Pcuff decreases during mechanical ventilation with manual regulation, whereas it remains stable with Intellicuff
Comment	With manual regulation, Pcuff decrease was small but clinically important after 8 hours. This result is not consistent with patient studies showing larger and faster drops in cuff pressure, probably because the model was too static.

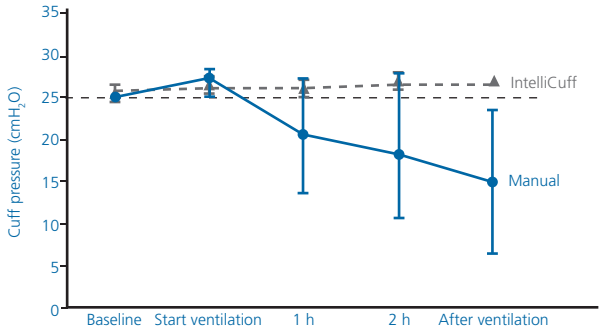

Figure 1: Pcuff measurements during 2 hours of ventilation with head movement. Intellicuff maintains a more stable Pcuff in narrow ranges.

Continuous endotracheal tube cuff pressure control system protects against ventilator-associated pneumonia

Lorente L, Lecuona M, Jiménez A, Lorenzo L, Roca I, Cabrera J, Llanos C, Mora ML
Crit Care. 2014 Apr 21;18(2):R77
PMID 24751286, **http://www.ncbi.nlm.nih.gov/pubmed/24751286**

Design	Prospective observational study of continuous versus intermittent Pcuff control
Patients	284 ICU patients with mechanical ventilation for longer than 48 h
Objectives	Compare the incidence of VAP
Main Results	The incidence of VAP was lower with the continuous (n=150) than with the intermittent (n=134) pressure control system (22.0% versus 11.2%; p=0.02)
Conclusion	Continuous control of Pcuff is associated with a decrease of VAP

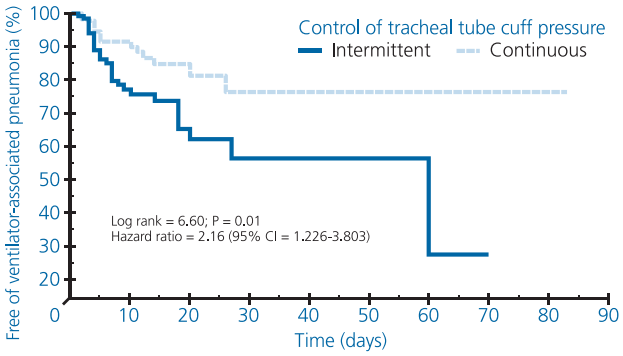

Figure 2: The continuous control of Pcuff allowed patients to remain free of VAP during the 90 study days

Evaluation of an intervention to maintain endotracheal tube cuff pressure within therapeutic range

Sole ML, Su X, Talbert S, Penoyer DA, Kalita S, Jimenez E, Ludy JE, Bennett M
Am J Crit Care. 2011 Mar;20(2):109-17
PMID 21362715, **http://www.ncbi.nlm.nih.gov/pubmed/21362715**

Design	Prospective crossover randomized study: continuous monitoring and alarm or routine care of Pcuff
Patients	32 intubated patients for 12 h
Objectives	Test the effect of an intervention on the proportion of time that Pcuff was between 20 and 30 cmH2O and evaluate changes in Pcuff over time
Main Results	During the control condition, 52% of Pcuff were out of range compared with 11% during the intervention condition. During the intervention, a mean of 8 adjustments were required, mostly to add air to the endotracheal tube cuff. During the control condition, cuff pressure decreased over time.
Conclusion	The monitoring was effective in maintaining Pcuff within an optimal range, and Pcuff decreased over time without intervention
Comment	The point of this study is that, due to resource limitations it is unrealistic to manually assess and adjust Pcuff a mean of 8 times per day.

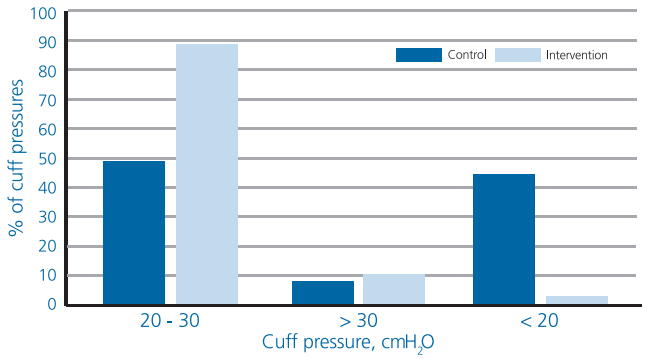

Figure 3: Continuous monitoring lead to pressure values spending more time in the normal pressure range, between 20 and 30 cmH2O

A cross-over study of continuous tracheal cuff pressure monitoring in critically-ill children

Vottier G, Matrot B, Jones P, Dauger S.
Intensive Care Med. 2016 Jan;42(1):132-3.
PMID 26515515 , **http://www.ncbi.nlm.nih.gov/pubmed/26515515**

Design	Crossover study: manual regulation and automatic regulation
Patients	30 children weighing less than 15 kg
Objectives	Compare the cuff pressure by manual or automatic regulation in pediatric patients.
Main Results	The percentage of time spent out of range was reduced from 48 % during manual regulation period to 0 % during automatic regulation period
Conclusion	Automatic regulation of Pcuff in pediatric patients decreased the time spent out of range

Prevalence and predictors of out-of-range cuff pressure of endotracheal and tracheostomy tubes: a prospective cohort study in mechanically ventilated patients

Alzahrani AR, Al Abbasi S, Abahoussin OK, Al Shehri TO, Al-Dorzi HM, Tamim HM, Sadat M, Arabi YM
BMC Anesthesiol. 2015 Oct 15;15(1):147
PMID 26471790 , **http://www.ncbi.nlm.nih.gov/pubmed/26471790**

Design	Prospective observational study of Pcuff in endotracheal tube and tracheostomy
Patients	2120 cuff-pressure measurements taken by RT using handheld manometer
Objectives	Find predictor for out of range Pcuff
Main Results	Among all patients, 37.8% patients had low cuff pressure (at least two pressures < 20 cm-H2O). Low cuff pressure was more common with smaller tube size (OR, 0.34 per 0.5 unit increase in ETT size; 95% CI,0.15 to 0.79) and with lower peak airway pressure (OR per cm-H2O, 0.93; 95% CI, 0.87 to 0.99)
Conclusion	Patients with small tubes and low Pinsp must be carefully monitored

Continuous control of tracheal cuff pressure and microaspiration of gastric contents in critically ill patients

Nseir S, Zerimech F, Fournier C, Lubret R, Ramon P, Durocher A, Balduyck M
Am J Respir Crit Care Med. 2011 Nov 1;184(9):1041-7
PMID 21836137, **http://www.ncbi.nlm.nih.gov/pubmed/21836137**

Design	RCT: continuous regulation with pneumatic device or routine care of Pcuff
Patients	122 patients expected to receive mechanical ventilation for at least 48 h
Objectives	Determine the impact of continuous control of Pcuff on microaspiration of gastric contents
Main Results	The pneumatic device was effective in controlling Pcuff. The percentage of patients with abundant microaspiration (18% vs. 46%), bacterial concentration in tracheal aspirates (1.6 ±2.4 vs. 3.1 ± 3.7 log(10) cfu/ml), and VAP rate (9.8% vs. 26.2%) were significantly lower in the intervention group compared with the control group. No significant difference was found in tracheal ischemia score between the two groups.
Conclusion	Continuous control of Pcuff is associated with a decrease of microaspiration and VAP

Assessment of endotracheal cuff pressure by continuous monitoring: a pilot study

Sole ML, Penoyer DA, Su X, Jimenez E, Kalita SJ, Poalillo E, Byers JF, Bennett M, Ludy JE
Am J Crit Care. 2009 Mar;18(2):133-43
PMID 19255103, **http://www.ncbi.nlm.nih.gov/pubmed/19255103**

Design	Prospective observational study
Patients	10 intubated patients
Objectives	Assess the accuracy and feasibility of continuous monitoring of Pcuff, describe changes in cuff pressure over time, and identify clinical factors that influence Pcuff
Main Results	54% of Pcuff measurements were within the recommended range of 20 to 30 cmH2O. Pcuff was high in 16% of measurements and low in 30%. No significant changes over time were noted. Endotracheal suctioning, coughing, and positioning affected Pcuff.
Conclusion	Continuous monitoring of cuff pressure is feasible and accurate. Pcuff varied with endotracheal suctioning, coughing, and positioning
Comment	Cuff pressures, if measured at all, are most commonly done every 8-12 hrs, during which time cuff pressure often drops below 20 cmH2O. Cuff pressures below 20 cmH2O were not associated with audible leaks, so a 'minimal leak' cuff technique does not insure adequate cuff pressure

Automatic control of tracheal tube cuff pressure in ventilated patients in semirecumbent position: a randomized trial

Valencia M, Ferrer M, Farre R, Navajas D, Badia JR, Nicolas JM, Torres A
Crit Care Med. 2007 Jun;35(6):1543-9
PMID 17452937, **http://www.ncbi.nlm.nih.gov/pubmed/17452937**

Design	RCT: continuous regulation with automatic device or routine care of Pcuff
Patients	142 intubated patients without aspiration or pneumonia at admission
Objectives	Assess the efficacy of an automatic device for the continuous regulation of tracheal Pcuff in preventing VAP
Main Results	Cuff pressure <20 cmH2O was more frequently observed in the control than in the automatic group (45.3% vs. 0.7%). However, the rate of clinical VAP, microbiological confirmation, the distribution of early and late onset, the causative microorganisms, and ICU and hospital mortality were similar for the automatic and control group.
Conclusion	Pcuff is better controlled with an automatic device. Rate of VAP, distribution, microorganisms, and ICU and hospital mortality were similar in both groups
Comment	All patients were managed with continuous aspiration of subglottic secretions. This decreased early VAP. The study was not blinded.

Pneumonia in intubated patients: role of respiratory airway care

Rello J, Soñora R, Jubert P, Artigas A, Rué M, Vallés J
Am J Respir Crit Care Med. 1996 Jul;154(1) :111-5
PMID 8680665, **http://www.ncbi.nlm.nih.gov/pubmed/8680665**

Design	Prospective observational study
Patients	83 patients undergoing continuous aspiration of subglottic secretions
Objectives	Assess risk factors for VAP in patients undergoing CASS
Main Results	Persistent intracuff pressure below 20 cmH2O (RR = 4.23, 95% CI = 1.12 to 15.92) were factors independently associated with the development of pneumonia even if CASS ETTs were used, if patients were not receiving antibiotics. When the cuff pressure was maintained at less than 20 cmH2O, the risk for ventilator-associated pneumonia (VAP) was four times higher than when pressure was maintained at higher values
Conclusion	The study confirms the importance of maintaining adequate intracuff pressure and effective aspiration of subglottic secretions in preventing pneumonia in intubated patients who are not receiving antibiotic treatment

Cuff pressure of endotracheal tubes after changes in body position in critically ill patients treated with mechanical ventilation

Lizy C, Swinnen W, Labeau S, Poelaert J, Vogelaers D, Vandewoude K, Dulhunty J, Blot S
Am J Crit Care. 2014 Jan;23(1):e1-8
PMID 24382623, **http://www.ncbi.nlm.nih.gov/pubmed/24382623**

Design	Prospective observational study of Pcuff in 16 different body positions
Patients	12 ICU patients under neuromuscular blockers
Objectives	Assess the effect of changes in body position on Pcuff compared with Pcuff in neutral position (backrest, head-of-bed elevation 30°, head in neutral position)
Main Results	192 measurements were made. 40.6% were above the upper limit of 30 cmH2O. No measurement was lower than 20 cmH2O. There is a significant variability in patients' Pcuff across the 16 positions.
Conclusion	Changes in body position increased Pcuff compared with maintaining a neutral position
Comment	This physiological study strongly supports the use of automatic control of cuff pressure to adapt to the changes occurring during patient care.

Efficiency of a pneumatic device in controlling cuff pressure of polyurethane-cuffed tracheal tubes: a randomized controlled study

Jaillette E, Zerimech F, De Jonckheere J, Makris D, Balduyck M, Durocher A, Duhamel A, Nseir S
BMC Anesthesiol. 2013 Dec 26;13(1):50
PMID 24369057, **http://www.ncbi.nlm.nih.gov/pubmed/24369057**

Design	Prospective crossover randomized study: continuous control or routine care of Pcuff
Patients	64 patients expected to receive mechanical ventilation for at least 48 h
Objectives	Determine the efficacy of a pneumatic device in controlling Pcuff
Main Results	The percentage of patients with underinflation (31% vs 68%) or overinflation (53% vs 100%) of tracheal cuff, and percentage of time spent with underinflation (0.9 [0, 17] vs 14% [4, 30]) or overinflation (0 [0, 2] vs 32% [9, 54]) were reduced during continuous control of Pcuff compared with routine care.
Conclusion	Pneumatic device was effective in controlling Pcuff
Comment	This pneumatic device still let Pcuff be less than 20 cmH2O for more than 30 minutes in 25% of patients. An electronically controlled continuous cuff inflation system can respond faster.

Tracheal pressure and endotracheal tube obstruction can be detected by continuous cuff pressure monitoring: in vitro pilot study

Efrati S, Deutsch I, Gurman GM, Noff M, Conti G
Intensive Care Med. 2010 Jun;36(6):984-90
PMID 20232044, **http://www.ncbi.nlm.nih.gov/pubmed/20232044**

Design	Simulation study: Phase I evaluated the correlation between Pinsp and Pcuff. Phase II evaluated the relation between Pcuff versus ventilator Pinsp and ETT obstruction (range of obstruction 0-58%). In Phase III, the analytical model developed in phase II was used to predict the degree of obstruction of five tubes removed from ICU patients.
Patients	Bench
Objectives	Evaluate whether the degree of tube obstruction can be predicted by changes of Pcuff as a function of Pinsp
Main Results	In phases I and II, it was found that Pcuff correlates significantly with Pisnp. The gradient Pcuff/Pinsp reflected the degree of tube obstruction. The degree of obstruction of the tube could be predicted in ICU patients.
Conclusion	Monitoring of Pcuff allowed prediction of the degree of tube obstruction
Comment	An interesting article for future consideration but would need more studies. The study does not address all of the other causes for increased peak airway pressure that have nothing to do with ETT occlusion.

Rapid pressure compensation by automated cuff pressure controllers worsens sealing in tracheal tubes

Weiss M, Doell C, Koepfer N, Madjdpour C, Woitzek K, Bernet V
Br J Anaesth. 2009 Feb;102(2):273-8
PMID 19112060, **http://www.ncbi.nlm.nih.gov/pubmed/19112060**

Design	In vitro laboratory study
Objectives	To compare the effects of manual vs. two automated cuff controllers on ETT sealing
Main Results	On the basis of in vitro findings, automatic cuff pressure regulators may interfere with the self-sealing mechanism of HVLP tube cuffs, as long as the set cuff pressures are lower than PIPs
Conclusion	An ideally designed automated cuff pressure controller should immediately stabilize any acute cuff pressure drops (sudden widening of the trachea before coughing) or chronic fall in cuff pressure (out diffusion of air from the cuff), whereas elevated cuff pressures by respiratory pressures or coughing should be corrected only by slow decompression.
Comment	The IntelliCuff automated Pcuff controller algorithm immediately increases cuff pressure if it is too low, whereas if cuff pressure is too high, cuff pressure is reduced slowly and only if high Pcuff is sustained so as to not drop cuff pressure associated with coughing, etc.

Continuous control of endotracheal cuff pressure and tracheal wall damage: a randomized controlled animal study

Nseir S, Duguet A, Copin MC, De Jonckheere J, Zhang M, Similowski T, Marquette CH
Crit Care. 2007 Oct;11(5):R109
PMID 17915017, **http://www.ncbi.nlm.nih.gov/pubmed/17915017**

Design	Animal randomized study: manual vs. automatic control of Pcuff
Patients	12 piglets ventilated for 48 h
Objectives	Test whether control of Pcuff using a pneumatic device would reduce tracheal ischemic lesions due to overinflation of the cuff
Main Results	Pcuff was lower with the pneumatic device than in the control group. No difference was found in the percentage of time spent with Pcuff <15 cmH2O and with Pcuff between 30 and 50 cmH2O. The percentage of time between 15 and 30 cmH2O of Pcuff was higher with the pneumatic device than in the control group. The percentage of time with Pcuff >50 cmH2O was lower with the pneumatic device than in the control group. Histological examination showed no difference in tracheal lesions between animals with and without the pneumatic device.
Conclusion	The pneumatic device provides effective continuous control of Pcuff in this experimental model without difference in tracheal lesions

Changes in endotracheal tube cuff pressure in mechanically ventilated adult patients

Motoyama A, Asai S, Konami H, Matsumoto Y, Misumi T, Imanaka H, Nishimura M
Journal of Intensive Care. 2014 Jan 31; 2:7
PMID 25520824 , **http://www.ncbi.nlm.nih.gov/pubmed/25520824**

Design	Prospective observational study of Pcuff
Patients	27 ICU patients
Objectives	Determine the cuff pressure variation by manual measurement every 2 h
Main Results	Cuff pressure was < 20 cmH2O in 45% of the measurements, < 24% in 93%, and > 30% in 0.05% of the measurements
Conclusion	During manual control of Pcuff, the pressure decreased in less than 2 h
Comment	The limitations of the study are: a) the format because letters describe only the main results without details about methodology, b) the relatively low number of patients (27)

Control of tracheal cuff pressure: a pilot study using a pneumatic device

Duguet A, D'Amico L, Biondi G, Prodanovic H, Gonzalez-Bermejo J, Similowski T
Intensive Care Med. 2007 Jan;33(1):128-32
PMID 17063357, **http://www.ncbi.nlm.nih.gov/pubmed/17063357**

Design	Prospective, randomized, crossover pilot study
Patients	9 intubated patients
Objectives	Compare the efficacy of a mechanical device and manometer (control) to maintain constant Pcuff
Main Results	Pcuff > 50 cmH20 were recorded in 6 patients during the control, but never during the prototype day. During the control day, Pcuff was between 30 and 50 cmH20 for 29+/-25% of the time, vs 0.3+/-0.3% during the prototype day. Pcuff was between 15 and 30 cmH20 for 56+/-36% of the time during the control day, vs 95+/-14% during the prototype day. During the control day, Pcuff was below 15 cmH20 for 15+/-17% of the time, vs 4.7+/-15% during the prototype day.
Conclusion	The automatic control of Pcuff is more effective than using a manometer to maintain Pcuff constant and within the target range

Automatic regulation of the cuff pressure in endotracheally intubated patients

Farré R, Rotger M, Ferre M, Torres A, Navajas D
Eur Respir J. 2002 Oct;20(4):1010-3
PMID 12412697, **http://www.ncbi.nlm.nih.gov/pubmed/12412697**

Design	Simulation bench study and prospective interventional study
Patients	8 intubated patients during 24 h
Objectives	Evaluate the performance of a device to maintain constant Pcuff
Main Results	The bench test showed that the procedure was able to maintain Pcuff at a constant level, regardless of the changes imposed in the tracheal section. PCuff recorded values coincided with the target value within +/-2 cmH2O in all of the patients.
Conclusion	Tight control of Pcuff is feasible

Additional files

Optimal care and design of the tracheal cuff in the critically ill patient

Jaillette E, Martin-Loeches I, Artigas A, Nseir S
Ann Intensive Care. 2014 Feb 27;4(1):7
PMID 24572178, **http://www.ncbi.nlm.nih.gov/pubmed/24572178**

Design	Review
Conclusion	Provides an overview of continuous Pcuff monitoring and regulation and its benefits
Comment	The authors cite a study stating the use of a pneumatic controller is more 'efficient' than an electronic controller. But the electronic devices did not include IntelliCuff and its algorithms to prevent 'over compensation' of increased cuff pressures.

Continuous control of tracheal cuff pressure for the prevention of ventilator-associated pneumonia in critically ill patients: where is the evidence?

Rouzé A, Nseir S
Curr Opin Crit Care. 2013 Oct;19(5):440-7
PMID 23856895, **http://www.ncbi.nlm.nih.gov/pubmed/23856895**

Design	Review
Conclusion	Why and how to continuously monitor Pcuff

Strategies to prevent ventilator-associated pneumonia in acute care hospitals

Coffin SE, Klompas M, Classen D, Arias KM, Podgorny K, Anderson DJ, Burstin H, Calfee DP, Dubberke ER, Fraser V, Gerding DN, Griffin FA, Gross P, Kaye KS, Lo E, Marschall J, Mermel LA, Nicolle L, Pegues DA, Perl TM, Saint S, Salgado CD, Weinstein RA, Wise R, Yokoe DS
Infect Control Hosp Epidemiol. 2008 Oct;29 Suppl 1:S31-40
PMID 18840087, **http://www.ncbi.nlm.nih.gov/pubmed/18840087**

Design	Review
Objectives	Practice recommendations to prevent ventilator-associated pneumonia in acute care hospitals
Main Results	Maintain an endotracheal cuff pressure of at least 20 cmH2O

Evidence on measures for the prevention of ventilator-associated pneumonia

L Lorente, S Blot, J Rello

Eur Respir J. 2007 Dec;30(6)1193-207
PMID 18055704, **http://www.ncbi.nlm.nih.gov/pubmed/18055704**

Design	Review
Objectives	2007 review of guidelines of European Task Force, US Centers for Disease Control and Prevention, Canadian Critical Care Society, American Thoracic Society, and Infectious Diseases Society of America
Main Results	The intracuff pressure should be persistently maintained between 20–30 cmH2O
Conclusion	Main reasons for non adherence to guidelines is unavailability of resources

Hamilton Medical AG
Via Crusch 8, 7402 Bonaduz, Switzerland
☎ +41 58 610 10 20
info@hamilton-medical.com
www.hamilton-medical.com