# Summary

Continuous or frequent intermittent suctioning of subglottic secretions, via an endotracheal tube (ETT) specially designed with a dorsal lumen to accommodate this, is associated with up to a 50 percent decreased incidence of aspiration and ventilator-associated pneumonia (VAP). Guidelines support the use of subglottic suctioning and drainage for patients dependent on mechanical ventilation.

## Society for Healthcare Epidemiology of America

*2014 – Strategies to Prevent Ventilator-Associated Pneumonia in Acute Care Hospitals: 2014 Update*1

* Recommends the use of endotracheal tubes with subglottic secretion drainage ports for patients likely to require greater than 48 or 72 hours of intubation.

## ZAP the VAP: Ventilator Associated Pneumonia

*2008 – Canadian VAP Prevention Guidelines: Evidence-based clinical practice guidelines for the prevention of VAP*2

* Subglottic secretion drainage is recommended for patients requiring to be mechanically ventilated for more than 72 hours.

## American Thoracic Society

*2004 – Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia*3

* Recommends the use of specifically designed ETT with dorsal lumen for the continuous aspiration of subglottic secretion.

## Centers for Disease Control and Prevention

*2003 – CDC Guidelines for preventing Health-Care-Associated Pneumonia; Evidence-based, clinical practice guidelines for the prevention of healthcare-associated pneumonia, including VAP* 4

* Recommends the use of an ETT dorsal lumen above the endotracheal cuff to allow drainage by continuous or frequent intermittent suctioning of tracheal secretion that accumulates in patient’s subglottic area.

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| **Relevant Studies, 1992–2011** | |
| **Study Type and Author** | **Results** *–* **Details in Annotated Bibliography** |
| Retrospective Chart Review  (Mareiniss, 2016)5 | **NEITHER PRO NOR CON:** Retrospectively analyzed 2,159 records of ventilated patients to determine which patients should be intubated with subglottic endotracheal tubes. Analysis was based on length of stay. Nonoperative intubation, emergent intubation, history of dementia, admission to the neurocritical care unit and acute kidney injury all appear to be independently associated with increased risk ratios for either ≥48 or 72 hours of ventilation. |
| Retrospective Chart Review  (Hubbard, 2016)6 | **PRO:** A retrospective review of 1,135 adult trauma patients from 2011 to 2014 at a Level 1 trauma center. 667 had standard endotracheal tubes (ETT) and 468 had endotracheal tubes allowing subglottic secretion drainage (SSD). SSD-ETT was associated with decreased ventilator-associated pneumonia (VAP) rate, ventilator days, and intensive care unit length of stay in trauma patients. |
| Randomized Controlled Trial (RCT)  (Damas, 2015)7 | **PRO:** 352 adult patients were intubated with an endotracheal tube allowing subglottic secretion suctioning. Patients were randomized to suctioning (170) or not (182). Subglottic suctioning resulted in a significant reduction of ventilator-associated pneumonia and an associated reduction in antibiotic use. Ventilator-associated condition occurrence did not differ between the two groups and appeared to be related to other medical features than VAP. |
| Cost Benefit Analysis  (Hallais, 2011)8 | **PRO:** Study in France analyzed the cost benefit of 416 surgical intensive care unit (ICU) patients receiving mechanical ventilation for 3,487 ventilation days. Findings showed replacing conventional ventilator tubes with continuous subglottic suctioning tubes averted €1,383.69 ($1,500 USD) per VAP episode. Replacement of conventional ventilator tubes with continuous subglottic suctioning tubes for all patients was cost effective even when assuming pessimistic scenario of VAP incidence and costs. |
| Retrospective Chart Review  (Juneja, 2011)9 | **PRO:** Data for 311 patients requiring mechanical ventilation for more than 72 hours were collected retrospectively. These patients were divided into four groups: no intervention; only continuous subglottic suctioning, only intermittent subglottic suctioning, and intermittent subglottic suctioning and continuous subglottic suctioning combined. Intermittent subglottic suctioning reduces the incidence of ventilator-associated pneumonia. |
| Business Case  (Speroni, 2011)10 | **PRO:** Study was focused on medical and surgical ICU patients who were expected to be ventilated for more than 48 hours. Study findings recommend the use of continuous suctioning ETT over standard ETT based on the final attributable cost of VAP. |
| RCT  (Lacherade, 2010)11 | **PRO:** RCT at four French centers. 333 adult patients intubated with subglottic ETTs who were expected to be intubated for more than 48 hours, randomly assigned to receive SSD (n=169) or no SSD (n=164). Findings showed SSD results in a significant reduction in VAP, including late-onset VAP. |
| Observational Study  (Dragoumanis, 2007)12 | **CON:** Studied 40 patients with Hi-Lo® Evac ETT. Dysfunction of the suction lumen occurred in 19 of 40 patients, 17 of which were attributable to blockage of the subglottic suction port by suctioned tracheal mucosa. |
| RCT  (Smulders, 2002)13 | **PRO:** Randomized controlled study of 150 patients with an expected duration mechanical ventilation of more than 72 hours. Patients were randomly assigned to either an endotracheal tube for intermittent subglottic secretions drainage or a standard endotracheal tube. Four percent of the patients receiving intermittent subglottic secretion drainage developed VAP, versus 16 percent of the patients in the control group. Intermittent subglottic secretion drainage reduces the incidence of VAP in patients receiving mechanical ventilation. |
| Cost Effectiveness Study  (Shorr, 2001)14 | **PRO:** Hypothetical cohort of 100 patients requiring nonelective endotracheal intubation being treated in an ICU. Patients were managed with either traditional endotracheal tubes or endotracheal tubes capable of continuous subglottic suctioning (CSS). For patients intubated at least 72 hours, CSS resulted in a relative risk reduction of VAP of 30 percent. This tactic yielded a savings of $4,992 per case of VAP prevented. When inputs were adjusted by 50 percent, CSS resulted in $1,924 saved per case of VAP prevented. CSS represents a strategy for the prevention of VAP that may result in savings for patients intubated for at least 72 hours. |
| RCT  (Bo, 2000)15 | **PRO:** RCT focused on mechanically ventilated surgical ICU patients. All patients were intubated with subglottic secretion drainage endotracheal tubes. These patients were assigned to two groups: one with subglottic secretion drainage and one without. The VAP rate was lower (23%) in the group with subglottic secretion drainage than in the other group (45%). Subglottic secretion drainage may be a simple and effective method for prevention of VAP. |
| RCT  (Kollef, 1999)16 | **PRO:** RCT focused on cardiothoracic surgery patients requiring mechanical ventilation. Findings showed that the occurrence of VAP could be significantly delayed with the use of continuous aspiration of subglottic secretions. |
| RCT  (Bouza, 2008)17 | **PRO:** RCT comparing the incidence of VAP in patients admitted for major heart surgery. 714 patients were randomized over a 2-year period. 359 patients were randomized to the intervention arm (continuous aspiration of subglottic secretions [CASS]) versus the control arm (conventional care). Findings showed that CASS is safe and reduces the use of antimicrobial agents in the overall population and the incidence of VAP in patients who are at risk. Should be encouraged in patients undergoing major heart surgery. |

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| RCT  (Valles, 1995)18 | **PRO:** RCT focused on ICU patients requiring prolonged intubation (more than 3 days). The study findings conclude that using continuous subglottic suctioning through the dorsal lumen can significantly reduce the incidence of nosocomial pneumonia in mechanically ventilated patients. |
| RCT  (Mahul,1992)19 | **PRO:** RCT focused on patients requiring mechanical ventilation for more than 3 days. Patients were assigned to SSD and/or treatment with sucralfate. SSD was associated with a lower incidence of nosocomial pneumonia, a prolonged time to onset of nosocomial pneumonia, and a decrease in the colonization rate from admission to endpoint in tracheal aspirates and in subglottic secretions. The use of sucralfate was not associated with a decrease in nosocomial pneumonia rates. |

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| **Reviews and Meta-Analyses** | |
| **Study Type and Author** | **Results** *–* **Details in Annotated Bibliography** |
| Systematic Review and Meta-analysis  (Caroff, 2016)20 | Study reviewed 17 eligible trials with a total of 3,369 patients. Subglottic secretion drainage was associated with lower VAP rates but there were no significant differences between groups in duration of mechanical ventilation, ICU length of stay, hospital length of stay, ventilator-associated events, or mortality. Further data are required to demonstrate the benefits of subglottic secretion drainage. |
| Systematic Review and Meta-analysis  (Wang, 2012)21 | Study reviewed 10 RCTs with a total of 2,213 patients. Findings confirmed that SSD was beneficial in preventing VAP. Finding showed that SSD reduced incidence of VAP (relative risk = 0.56, confidence interval: 0.42 to0.69, p<0.00001). |
| Systematic Review and Meta-analysis  (Leasure, 2012)22 | Study reviewed 12 original articles and 4 reviews that evaluated the effectiveness of SSD in reducing the occurrence of VAP. The findings of review support the recommendation for use of ETTs with SSD based on a 52 percent reduction rate. |
| Review  (Barbas, 2012)23 | Review of 10 RCTs (n=2,213 patients) assessing the effectiveness of subglottic suctioning ETTs in the prevention of VAP. Findings showed that the use of subglottic suctioning ETTs reduces the incidence of VAP, early-onset VAP, and duration of mechanical ventilation, and increases time to development of VAP. However, the use of subglottic ETTs does not decrease the incidence of late-onset VAP, the length of stay in the ICU or hospital, or hospital mortality. |
| Review  (Blot, 2011)24 | Review of recent, new, nonpharmacological VAP prevention measures. Supported the use of subglottic secretions drainage using an ETT with a separate dorsal lumen to avoid micro aspiration. |
| Systematic Review and Meta-analysis  (Muscedere, 2011)25 | Study focused on 13 RCTs evaluating SSD in adult mechanically ventilated patients. Study findings supported the use of SSD-ETT in reduction rate of VAP. |
| Correspondence re: Lacherade study (Taylor, 2011)11,26 | Discussed the validity of the analysis in the Lacherade 2010 study. Stated that while there were significant decreases in VAP rates in the intervention arm, the decreases did not translate into any reduction in the rate of clinically relevant outcomes. |
| Correspondence re: Lacherade study  (Silvestri, 2011)11,27 | Discussed the validity of the analysis in the Lacherade 2010 study. Stated that the results were not strong enough for the inclusion of this technique in VAP prevention strategies. Mortality was not impacted. However, this study had a small sample size and was underpowered. |
| Systematic Literature Review  (Scherzer, 2010)28 | Review ofsix randomized control studies regarding subglottic secretion aspiration in the prevention of VAP. Results consistently showed that subglottic secretion drainage significantly reduces the incidence of VAP in a variety of patient populations. |
| Review  (Deem, 2010)29 | Review of nine RCTs and one prospective observational trial regarding the use of SSD-ETTs in the prevention of VAP. There is no clear evidence about the efficacy and effectiveness of subglottic suctioning in reducing the development of VAP. |
| Literature Review and Meta-analysis  (Gentile, 2010)30 | Review of six RCTs regarding the use of SSD=ETTs in the prevention of VAP. Analysis included a total of 896 patients. Findings showed that subglottic suctioning reduced the incidence of VAP by nearly half in patients expected to require 72 hours of mechanical ventilation, primarily by reducing early-onset VAP. |
| Review  (Depew, 2007)31 | Review of meta-analysisthat looked at five RCTs that compared aspiration of subglottic secretion versus standard ETT care. Although VAP reduction using subglottic secretion drainage has been implicated by multiple randomized and controlled studies, the data on ventilator days and length of stay in the ICU and the hospital are insufficient as a consequence of limitations and weaknesses of those very same studies. A much larger multicenter study is needed. |
| Review and Meta-analysis  (Dezfulian, 2005)32 | Review and meta-analysis. Drainage versus standard endotracheal treatment. Study evaluated 896 patients who required mechanical ventilation from five RCTs. SSD appears effective in preventing early-onset ventilator-associated pneumonia among patients expected to require at least 72 hours of mechanical ventilation. |

## Annotated Bibliography

1. Klompas M, Branson R, Eichenwald EC, et al. Strategies to prevent ventilator-associated pneumonia in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014 Aug;35(8):915-36. PMID: 25026607.
2. Muscedere J, Dodek P, Keenan S, et al. Comprehensive evidence-based clinical practice guidelines for ventilator-associated pneumonia: Prevention. J Crit Care. 2008 Mar;23(1):126-37. PMID: 18359430.
3. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med. 2005 Feb;171(4):388-416. PMID: 21481251.
4. Tablan OC, Anderson LJ, Besser R, et al. Guidelines for preventing healthcare-associated pneumonia, 2003: Recommendations of CDC and the healthcare infection control practices advisory committee. MMWR Recomm Rep. 2004 Mar;53:1-36. PMID: 15048056.
5. Mareiniss DP, Xu T, Pham JC, et al. Predicting which patients will likely benefit from subglottic secretion drainage endotracheal tubes: A retrospective study. J Emerg Med. 2016 Mar;50(3):385-93. PMID: 26806317.

**NEITHER PRO NOR CON:** Retrospective chart review to determine risk factors associated with intubations of ≥48 or 72 hours. Medical records of 2,159 ventilated patients, intubation reason, were reviewed for intubation duration, age, sex, race, body mass index, weight, whether the intubation was emergent, operative status, intensive care unit (ICU) diagnosis, intubation location, ICU location, comorbidities (e.g., congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, dementia and liver disease), acute kidney injury (AKI), and chronic renal injury. A multivariate analysis was performed. The following were associated with intubation of ≥48 hours: Neurocritical care unit (NCCU) admission (risk ratio [RR]=1.85; 95% confidence interval [CI] 1.34-2.56), emergent intubation (RR=1.97; 95% CI1.28-3.03), comorbid dementia (RR=2.31; 95% CI 1.28-4.18), nonoperative intubation (RR=1.77; 95% CI 1.28-4.18), and AKI (RR-3.32; 95% CI 2.46-4.3). The following were independently associated with intubation of ≥72 jours: NCCU admission (RR = 2.2; 95% CI 1.57-3.08), nonoperative intubation (RR = 3.38; 95% CI 2.63-4.35, comorbid dementia (RR = 3.03; 95% CI 1.67-5.48), and AKI (RR = 3.11; 95% CI 2.38-4.07). Nonoperative intubation, emergent intubation, history of dementia, admission the NCCU and AKI al appear to be indepndently associated with increased RRs for either ≥48 or 72 hours of ventilation.

1. Hubbard JL, Veneman WL, Dirks RC, et al. Use of endotracheal tubes with subglottic secretion drainage reduces ventilator-associated pneumonia in trauma patients. J Trauma Acute Care Surg. 2016 Feb;80(2):218-22. PMID: 26595709.

**PRO:** Retrospective chart review to determine if the use of subglottic secretion drainage endotracheal tubes (SSD-ETT) would reduce ventilator-associated pneumonia (VAP) in trauma patients. This was performed at a level 1 trauma center for patients orotracheally intubated for >48 hours from 2010 to 2014. Diagnosis of VAP was made by quantitative bronchoalveolar lavage. Patients with SSD-ETT were matched to patients with standard ETT based on age group, sex, mechanism of injury, Glasgow Coma Scale score, alcohol intoxication, or Injury Severity Score. In matched cohorts, SSD-ETT had a lower VAP rate (5.7 vs. 9.3 for ETT, p=0.03), decreased ventilator days (12 vs. 14, p=0.04) and decreased ICU length of stay (13 days vs. 16 days, p=0.003). After controlling for confounding factors, SSD-ETTs decreased VAP rate, ventilator days and ICU length of stay in trauma patients.

1. Damas P, Frippiat F, Ancion A, et al. Prevention of ventilator-associated pneumonia and ventilator-associated conditions: A randomized controlled trial with subglottic secretion suctioning. Crit Care Med. 2015 Jan;43(1):22-30. PMID: 25343570.

**PRO:** Randomized controlled trial in 5 ICUs of the same hospital. 352 patients intubated with an endotracheal tube allowing subglottic secretion suctioning were randomized to undergo suctioning (n=170, group 1) or not (n=182, group 2. During ventilation, microbilogically confirmed VAP occurred in 15 patients (8.8%) of group 1 and 32 patients (17.6%) of group 2 (p=0.018). VAP rates were 9.6 per 1,000 ventilator days for group 1 and 19.8 per 1,000 ventilator days for group 2 (p=0.0076). Ventilator-associated condition prevalence was 21.8% in group 1 and 22.5% in group 2 (p=0.84). Neither ICU length of stay nor mortality differed between the groups. The total number of antibiotic days was 1.696 in group 1, representing 61.6% of the 2,754 ICU days and 1,965 in group 2, representing 68.5% of 2,868 ICU days (p<0.0001). Subglottic suctioning resulted in a significant reduction of VAP prevalence associated with a significant decrease in antibiotic use.

1. Hallais C, Merle V, Guitard PG, et al. Is continuous subglottic suctioning cost-effective for the prevention of ventilator-associated pneumonia? Infect Control Hosp Epidemiol. 2011 Feb;32(2):131-5. PMID: 21460467.

**PRO:** Cost/benefit analysis – Study analyzed the cost benefit of 416 surgical patients receiving mechanical ventilation for 3,487 ventilation days in the surgical intensive care unit. A total of 32 VAP episodes were observed (7.9 episodes per 100 ventilated patients; incidence density, 9.2 episodes per 10,000 ventilation-days). Based on a hypothesized 29 percent reduction in the risk of VAP with continuous subglottic suctioning (CSS) tubes than conventional ventilation (CV) Tubes, 9 VAP episodes could have been averted. The additional cost of CSS for 2006 was estimated to be €10,585.34 ($11,802.53). The cost per averted VAP episode was €1,176.15 ($1,211.52). Assuming a VAP cost of €4,387 ($4,891.95), a total of three averted VAP episodes would neutralize the additional cost. For a low VAP incidence of 6.6 percent, the cost per averted VAP would be €1,323 ($1,475.28). The cost of a CV tube was €1.01 ($1.12). The cost of a CSS tube (Hi-Lo Evac) was €5.50 ($6.13), and the cost of one secretion-receiving bottle was €2.50 ($2.78). If each patient required two tubes during ventilation, the cost would be €1,383.69 ($1,542.94) per averted VAP episode. Findings conclude that replacement of CV with CSS was a cost-effective method for treatment and for reducing VAP rates.

1. Juneja D, Javeri Y, Singh O, et al. Comparing influence of intermittent subglottic secretions drainage with/without closed suction systems on the incidence of ventilator associated pneumonia. Indian J Crit Care Med. 2011;15(3):168-72. PMID: 22013309.

**PRO:** Intermittent versus continuous suctioning – Study focused on 311 patients requiring mechanical ventilation for more than 72 hours. Data were collected retrospectively for following four groups: group A, no intervention; group B, only continues suctioning; group C, only intermittent drainage; and group D, intermittent drainage with continuous suctioning. Incidence of VAP per 1,000 ventilator days in groups A, B, C, and D was 25, 23.9, 15.7, and 14.3, respectively (p=0.04). There was no significant difference in the duration of mechanical ventilation (p=0.33), length of intensive care unit (p=0.55) and hospital stay (p=0.36) and ICU mortality (p=0.9) among the four groups. Intermittent drainage of secretions reduces the incidence of VAP. Continuous suctioning alone or in combination with intermittent has no significant effect on VAP incidence.

1. Speroni KG, Lucas J, Dugan L, et al. Comparative effectiveness of standard endotracheal tubes vs. endotracheal tubes with continuous subglottic suctioning on ventilator-associated pneumonia rates. Nurs Econ. 2011 Jan-Feb;29(1):15-20, 37. PMID: 21469484.

**PRO:** Business case – Study focused on 154 intubated adult patients (77=standard endotracheal tube [S-ETT]; 77=continuous subglottic suctioning ETT [CSS-ETT]). The S-ETT group had one case of ventilator-associated pneumonia (VAP); the CSS-ETT group had none. The mean total hospital charges were higher for the S-ETT group ($103,600; CSS-ETT=$88,500) (p=0.3). Although the average number of intubation days and intensive care unit days were greater for the CSS-ETT group, there were no cases of VAP compared to the S-ETT group. Based upon the one S-ETT VAP case and the VAP attributable costs, it is cost effective to use the CSS-ETT.

1. Lacherade JC, De Jonghe B, Guezennec P, et al. Intermittent subglottic secretion drainage and ventilator-associated pneumonia: A multicenter trial. Am J Respir Crit Care Med. 2010 Oct 1;182(7):910-17. PMID: 20522796.

**PRO:** Randomized control trial at four French centers. All patients were intubated with subglottic endotracheal tubes and were expected to require mechanical ventilation for at least 48 hours. The intervention arm (n=169) received intermittent subglottic suctioning, while the control arm (n=164) did not. Primary outcome was the overall incidence of VAP based on quantitative culture of distal pulmonary samplings performed after each clinical suspicion. Other outcomes included incidence of early- and late-onset VAP, duration of mechanical ventilation, and hospital mortality. Microbiologically confirmed VAP occurred in 67 patients, 25 of 169 (14.8%) in the SSD group and 42 of 164 (25.6%) in the control group (p=0.02), yielding a relative risk reduction of 42.2% (95% confidence interval, 10.4–63.1%). Using the Day 5 threshold, the beneficial effect of SSD in reducing VAP was observed in both early-onset VAP (2 of 169 [1.2%] patients undergoing SSD versus 10 of 164 [6.1%] control patients (p=0.02) and late-onset VAP (23 of 126 [18.6%] patients undergoing SSD versus 32 of 97 [33.0%] control patients (p=0.01). VAP was clinically suspected at least once in 51 of 169 (30.2%) patients undergoing SSD and 60 of 164 (36.6%) control patients (p=0.25). No significant between-group differences were observed in duration of mechanical ventilation and hospital mortality.

1. Dragoumanis C, Vretzakis G, Papaioannou V, et al. Investigating the failure to aspirate subglottic secretions with the evac endotracheal tube. Anesth Analg. 2007 Oct;105(4):1083-5. PMID: 17898392.

**CON:** Observational study – studied 40 adult patients intubated with Hi-Lo® Evac endotracheal tubes. Dysfunction of the suction lumen occurred in 19 of the 40 patients (48%). In 17 (43%) the failure was attributed to blockage of the subglottic suction port by suctioned tracheal mucosa. This finding raises significant questions concerning the safety of aspiration of subglottic secretions using the evac tube.

1. Smulders K, van der Hoeven H, Weers-Pothoff I, et al. A randomized clinical trial of intermittent subglottic secretion drainage in patients receiving mechanical ventilation. Chest. 2002 Mar;121(3):858-62. PMID: 11888973.

**PRO:** Intermittent drainage versus S-ETT – Study focused on 150 patients expected to be mechanical ventilated more than 72 hours in the general intensive care unit. VAP was seen in three patients (4%) receiving suction secretion drainage and in 12 patients (16%) in the control group (RR, 0.22; 95% CI, 0.06 to 0.81; p=0.014). Intermittent subglottic secretion drainage reduces the incidence of VAP in patients receiving mechanical ventilation.

1. Shorr AF, O'Malley PG. Continuous subglottic suctioning for the prevention of ventilator-associated pneumonia: Potential economic implications. Chest. 2001 Jan;119(1):228-35. PMID: 11157609.

**PRO**: The marginal cost-effectiveness of subglottic suctioning endotracheal tubes (SSD-ETT) was calculated as the savings resulting from cases of VAP averted minus the additional costs of the sub-glottic endotracheal tubes, and expressed as cost (or savings) per episode of VAP prevented. Sensitivity analysis of the impact of the major clinical inputs on the cost-effectiveness was performed. The base case assumed that the incidence of VAP in patients requiring more than 72 hours of mechanical ventilation was 25 percent, that SSD-ETT had no impact on patients requiring mechanical ventilation for less than 72 hours, and that SSD-ETT resulted in a relative risk reduction of VAP of 30percent. Despite the higher costs of SSD-ETT, this tactic yielded a net savings of $4,992 per case of VAP prevented. For sensitivity analysis, model inputs were adjusted by 50 percent individually and then simultaneously. This demonstrated the model to be only moderately sensitive to the calculated cost of VAP. With the relative risk reduction at 50 percent of the base-case estimate, SSD-ETT resulted in $1,924 saved per case of VAP prevented. When all variables were skewed against subglottic endotracheal tubes, total outlays were trivial (approximately $14 per patient in the cohort).

1. Bo H. Influence of the subglottic secretion drainage on the morbidity of ventilator associated pneumonia in mechanically ventilated patients.Chinese J Tuberc Respir Dis. 2000 Aug;23(8):472-4. PMID: 11778260.

**PRO:** Drainage versus control – Study focused on 68 patients who required intubation in the surgical intensive care unit. The morbidity of VAP in the drainage group (n=35) (23%) was lower than that in the control group (n=33) (45%) (p<0.05). The difference was due to the significant reduction of VAP caused by gram-positive cocci and Haemophilus influenzae organisms. However, no difference was observed in the incidence of VAP caused by nonfermenting bacteria. After intubation, the onset of VAP was delayed in drainage group (14±8 day) as compared with the control group (6±4 day) (p<0.05). The same organisms were isolated among 61 percent (14/23) of patients with VAP as what were previously isolated from the subglottic secretions. The presence of subglottic secretion may be an origin of the pathogenetic organisms of VAP. The morbidity of VAP in mechanically ventilated patients can be reduced by drainage, especially for VAP caused by gram-positive cocci and Haemophilus influenzae organisms. Subglottic secretion drainage may be a simple and effective method for prevention of VAP.

1. Kollef MH, Skubas NJ, Sundt TM. A randomized clinical trial of continuous aspiration of subglottic secretions in cardiac surgery patients. Chest. 1999 Nov;116(5):1339-46. PMID: 1559097.

**PRO:** Continuous versus without suctioning – Study focused on 371 cardiac surgery patients requiring mechanical ventilation in the cardiothoracic intensive care unit. VAP was seen in eight patients (5.0%) receiving continues suctioning and in 15 patients (8.2%) receiving routine postoperative medical care without suctioning (relative risk, 0.61%; 95% confidence interval, 0.27 to 1.40; p=0.238). Episodes of VAP occurred statistically later among patients receiving continuous suctioning ([mean ± standard deviation] 5.6±2.3 days) than among patients who did not receive suctioning (2.9±1.2 days); (p=0.006). No statistically significant differences for hospital mortality, overall duration of mechanical ventilation, lengths of stay in the hospital or cardiothoracic ICU, or acquired organ system derangements were found between the two treatment groups. The occurrence of VAP can be significantly delayed among patients undergoing cardiac surgery using this simple-to-apply technique of continuous suctioning.

1. Bouza E, Pérez M, Muñoz P, et al. Continuous aspiration of subglottic secretions in the prevention of ventilator-associated pneumonia in the postoperative period of major heart surgery. Chest. 2008 Nov;134(5):938-46. PMID: 18641114.

**PRO:** Randomized controlled trial where the intervention arm received continuous aspiration of subglottic secretions (CASS) (n=359) and the control arm received conventional therapy (n=331). Study participants were undergoing major heart surgery and were recruited from a general reference hospital. The results for CASS patients and control subjects (per protocol and intention-to-treat analysis) were as follows: VAP incidence, 3.6 percent versus 5.3 percent (p=0.2) and 3.8 percent versus 5.1 percent, respectively; incidence density, 17.9 versus 27.6 episodes per 1,000 days of mechanical ventilation (MV) [p=0.18] and 18.9 versus 28.7 episodes per 1,000 days of MV, respectively; hospital antibiotic use in daily defined doses (DDDs), 1,213 versus 1,932 (p<0.001) and 1,392 versus 1,932, respectively (p<0.001).

In patients who had received mechanical ventilation for >48 hours, the comparisons of CASS patients and control subjects were as follows: VAP incidence, 26.7% versus 47.5% (p=0.04), respectively; incidence density, 31.5 versus 51.6 episodes per 1,000 days of MV, respectively (p=0.03); median length of intensive care unit stay, 7 versus 16.5 days (p=0.01), respectively; hospital antibiotic use, 1,206 versus 1,877 DDDs (p<0.001), respectively. CASS was the only significant protective factor (relative risk, 0.40; 95% confidence interval, 0.16 to 0.99; p=0.04). CASS is a safe procedure that reduces the use of antimicrobial agents in the overall population and the incidence of VAP in patients who are at risk. CASS use should be encouraged, at least in patients undergoing major heart surgery.

1. Valles J, Artigas A, Rello J, et al. Continuous aspiration of subglottic secretions in preventing ventilator-associated pneumonia. Annals of Internal Medicine. 1995 Feb(122):179–86. PMID: 7810935.

**PRO:** Continuous versus closed lumen ETT – Study focused on 190 intensive care unit patients expected to be intubated for more than 3 days. The incidence rate of ventilator-associated pneumonia was 19.9 episodes/1,000 ventilator days in the patients receiving continuous aspiration of subglottic secretions and 39.6 episodes/1,000 ventilator days in the control patients (closed lumen ETT) (relative risk, 1.98; 95% CI, 1.03 to 3.82). Episodes of ventilator-associated pneumonia developed later in patients receiving continuous aspiration (12.0±7.1 days) than in the control patients (5.9±2.1 days) (p<0.001). This difference was due to a significant (p<0.03) reduction in the number of gram-positive cocci and Haemophilus influenzae organisms in the patients receiving continuous aspiration.

1. Mahul P, Auboyer C, Jospe R, et al. Prevention of nosocomial pneumonia in intubated patients: Respective role of mechanical subglottic secretions drainage and stress ulcer prophylaxis. Intensive Care Medicine. 1992;18(1):20-5. PMID: 1578042.

**PRO:** Drainage Versus sucralfate – Study focused on 145 patients who were mechanically ventilated for more than 3 days. SSD treatment was associated with: (a) a lower incidence of nosocomial pneumonia (NP) (no-SSD: 29.1%, SSD: 13%);

(b) a prolonged time of onset of NP (no-SSD: 8.3±5 days, SSD: 16.2±11 days); and

(c) a decrease in the colonization rate from admission to endpoint day in tracheal aspirates (no-SSD:+21.3%, SSD:+6.6%) and in subglottic secretions (no-SSD:+33.4%, SSD:+2.1%).

Study concluded that the prevention of micro aspiration with the use of subglottic drainage was effective at reducing NP, but sucralfate prevention was not.

1. Caroff DA, Li L, Muscedere J, Klompas M. Subglottic secretion drainage and objective outcomes: A systematic review and meta-analysis. Crit Care Med. 2016 Apr;44(4):830-40. PMID: 26646454.

**Systematic review and meta-analysis:** Looked at the impact of SSD on duration of mechanical ventilation, ICU and hospital length of stay, ventilator-associated events, mortality, antibiotic utilization, stridor and reintubations to better understand the net benefits and limitations of this intervention. Seventeen trials were included with a total of 3,369 patients. SSD was associated with lower VAP rates (RR, 0.58; 95% CI, 0.51-0.67; *I*2=0%), but there were no significantdifferences between groups in duration of mechanical ventilation (weighted mean difference, -0.16 d; 95% CI, -0.64 to 0.33; *I*2=0%), ICU length of stay (weighted mean difference, +0.17 da; 95% CI, -0.62 to 0.95; *I*2=0%), hospital length of stay (weighted mean difference, -0.57 d; 95% CI, -2.44 to 1.30; *I*2=0%), ventilator -associated events (RR, 0.97; 95% CI, 0.65-1.43), or mortality (RR, 0.93; 95% CI, 0.84-1.03; *I*2=0%). Two studies observed significantly less antibiotic use with SSD and a third did not. There were no significant differences between groups in stridor or reintubations. SSD is associated with lower VAP rates but does not clearly decrease duration of mechanical ventilation, length of stay, ventilator-associated events, mortality, or antibiotic usage.

1. Wang F, Bo L, Tang L, et al. Subglottic secretion drainage for preventing ventilator-associated pneumonia: An updated meta-analysis of randomized controlled trials. J Trauma Acute Care Surg. 2012 May;72(5):1276-85. PMID: 22673255.

Literature review and meta-analysis – Ten randomized controlled trials with 2,213 patients were identified. SSD significantly reduced incidence of VAP (relative risk [RR] 0.56, 95% CI: 0.45 to 0.69, p=(0.00001) and early-onset VAP (RR 0.23, 95% CI: 0.13 to 0.43, p=(0.00001), shortened ventilation duration by 1.55 days (95% CI: 2.40 to 0.71 days, p=(0.0003), and prolonged time to VAP by 3.90 days (95% CI: 2.56 to 5.24 days). Subgroup analyses suggested a significant reduction in incidence of VAP when stratified by intermittent ([RR] 0.49, 95% CI: 0.34 to 0.71; p=0.0001) and continuous SSD ([RR] 0.61, 95% CI: 0.46 to 0.79; p=0.0003). No significant differences were observed regarding incidence of late-onset VAP, overall mortality, or length of intensive care unit or hospital stay. SDD was beneficial in preventing VAP.

1. Leasure A, Stirlen J, Lu S. Prevention of ventilator-associated pneumonia through aspiration of subglottic secretions: A systematic review and meta-analysis. Dimensions of Critical Care Nursing. 2012 Mar-Apr;31(2):102-17. PMID: 22333720.

Systematic review and meta-analysis – Study reviewed 12 original articles and 4 reviews that evaluated the effectiveness of subglottic secretion aspiration in reducing the occurrence of VAP. Study findings showed that the effectiveness of subglottic secretion aspiration in reducing VAP rates was 52 percent across a pooled total of 1,701 cases (RR, 0.52; 95% CI, 0.43 to 0.64 in rates).

1. Barbas CS, Couto LP. Do endotracheal tubes with suction above the cuff decrease the rate of ventilator-associated pneumonia, and are they cost-effective? Rev Bras Ter Intensiva. 2012 Dec;24(4):320-21. PMID: 23917926.

Review – The introduction of tubes that allow the aspiration of secretions from the subglottic space in Brazilian intensive care units may reduce VAP incidence and may be cost effective. Kelley et al. calculated that it is necessary to use tubes with suction above the cuff in 33 patients to prevent one episode of VAP, which indicates that this protocol would be cost-effective.

1. Blot S, Rello J, Vogelaers D. What is new in the prevention of ventilator-associated pneumonia? Curr Opin Pulm Med. 2011 May;17(3):155-9. PMID: 21326100.

Review – Indicated that the use of SSD-ETT for the prevention of VAP probably needs more research.

1. Muscedere J, Rewa O, McKechnie K, et al. Subglottic secretion drainage for the prevention of ventilator-associated pneumonia: A systematic review and meta-analysis. Crit Care Med. 2011 Aug;39(8):1985-91. PMID: 21478738.

Systematic review – Study focused on 13 randomized controlled trials that reported a reduction in VAP rates in the subglottic secretion drainage arm. The overall RR for VAP was 0.55 (95% CI, 0.46 to 0.66; p<0.00001) with no heterogeneity (I=0%). The use of subglottic secretion drainage was associated with reduced intensive care unit length of stay (-1.52 days; 95% CI, -2.94 to -0.11; p=0.03); decreased duration of mechanically ventilated (-1.08 days; 95% CI, -2.04 to -0.12; p=0.03), and increased time to first episode of VAP (2.66 days; 95% CI, 1.06 to 4.26; p=0.001).

1. Taylor NJ, Auzinger G. Intermittent subglottic secretion drainage and ventilator-associated pneumonia. Am J Respir Crit Care Med. 2011 May 15;183(10):1435-6; author reply 1436-7. PMID: 21596837.

Correspondence on study by Lacherade23 – Comment stated that while the study found a difference in VAP rates, it did not find a difference in clinically relevant outcomes, such as duration of mechanical ventilation, or intensive care unit or hospital length of stay. Also states that there is still insufficient evidence of clinical efficacy to recommend the universal use of subglottic secretion drainage in patients ventilated for longer than 48 hours who are at risk for VAP.

1. Silvestri L, Piacente N, van Saene HK, Grogori D, Zandstra DF. Intermittent subglottic secretion drainage and ventilator-associated pneumonia. Am J Respir Crit Care Med. 2011;183(10):1435; author reply 1436-7. PMID: 21596836.

Correspondence on study by Lacherade23 – Comment stated that while the study found a difference in VAP rates, this may have been due to sample size, or diagnostic error due to the fact that approximately 40 percent of VAP episodes are not microbiologically proven. Stated that study is not strong enough for inclusion of the technique in VAP prevention strategies.

1. Scherzer P. Subglottic secretion aspiration in the prevention of ventilator-associated pneumonia: A review of the literature. Dimens Crit Care Nurs. 2010 Nov-Dec;29(6):276-80. PMID: 20940579.

Systematic literature review – 1,848 patients were studied in 6 clinical trials. Treatment groups received some form of subglottic secretion aspiration. Control groups received standard care without subglottic suctioning. While the findings differed in the studies, the percentage of patients who developed VAP in the intervention groups was lower than the percentage in the control groups. Despite research confirming the benefits of subglottic suctioning, nurses only perform subglottic suctioning 17.6 percent of the time. Reasons include lack of availability of equipment and the perception that subglottic suctioning may cause patient discomfort or adverse events. Subglottic secretion aspiration is a safe and effective therapy and should be implemented in patients requiring mechanical ventilation.

1. Deem S, Treggiari MM. New endotracheal tubes designed to prevent ventilator-associated pneumonia: Do they make a difference? *Respir Care*. 2010;55(8):1046-55. PMID: 20667152.

Review – After a review of the literature regarding the use of SSD-ETTs, they found no difference in clinical outcomes including duration of mechanical ventilation, length of intensive care unit and hospital stay and mortality. Stated there is no clear evidence regarding the efficacy and effectiveness of subglottic suctioning in reducting the development of VAP. It is difficult to predict duration of ventilation at the time of intubation, particularly in the emergency setting. Large-scale use of SSD-ETTs has not been proven effective.

1. Gentile MA, Siobal MS. Are specialized endotracheal tubes and heat-and-moisture exchangers cost-effective in preventing ventilator associated pneumonia? Respir Care. 2010 Feb;55(2):184-96; discussion 196-7. PMID: 20105344.

Review – In five studies, subglottic suctioning was found to reduce the risk of VAP by nearly half in patients expected to be mechanically ventilated for more than 72 hours, primarily by reducing early-onset VAP. SSD-ETTs are more expensive than conventional ETTs and will more likely benefit patients who are expected to require prolonged intubation.

1. Depew C, McCarthy M. Subglottic secretion drainage: A literature review. AACN Adv Crit Care. 2007 Oct-Dec;18(4):366-79. PMID: 17978611.

Review of meta-analysis (Dezfulian, 2005) that looked at five randomized controlled trials that compared aspiration of subglottic secretion versus standard endotracheal tube care. Findings concluded that there is insufficient outcome evidence to support the use of subglottic technology, aside from the VAP rate reduction.

1. Dezfulian C, Shojania K, Collard HR, Kim HM, Matthay MA, Saint S. Subglottic secretion drainage for preventing ventilator-associated pneumonia:A meta-analysis. American Journal of Medicine. 2005 Jan;11-18(118). PMID: 15639202.

Meta-analysis – Drainage Versus Standard Endotracheal Treatment. Study evaluated 896 patients from 5 randomized controlled trials who required mechanical ventilation. SSD reduced the incidence of VAP by nearly half (RR=0.51; 95% CI: 0.37 to 0.71), primarily by reducing early-onset pneumonia (pneumonia occurring within 5 to 7 days after intubation). SSD appears effective in preventing early-onset VAP among patients expected to require more than 72 hours of mechanical ventilation.

AHRQ Pub. No. 16(17)-0018-21-EF

January 2017