Current Concept Of Prevention of Nosocomial Pneumonia

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Definition of nosocomial Pneumonia

Pneumonia occurring after 48 hours of hospitalization in non intubated patients is called nosocomial pneumonia.

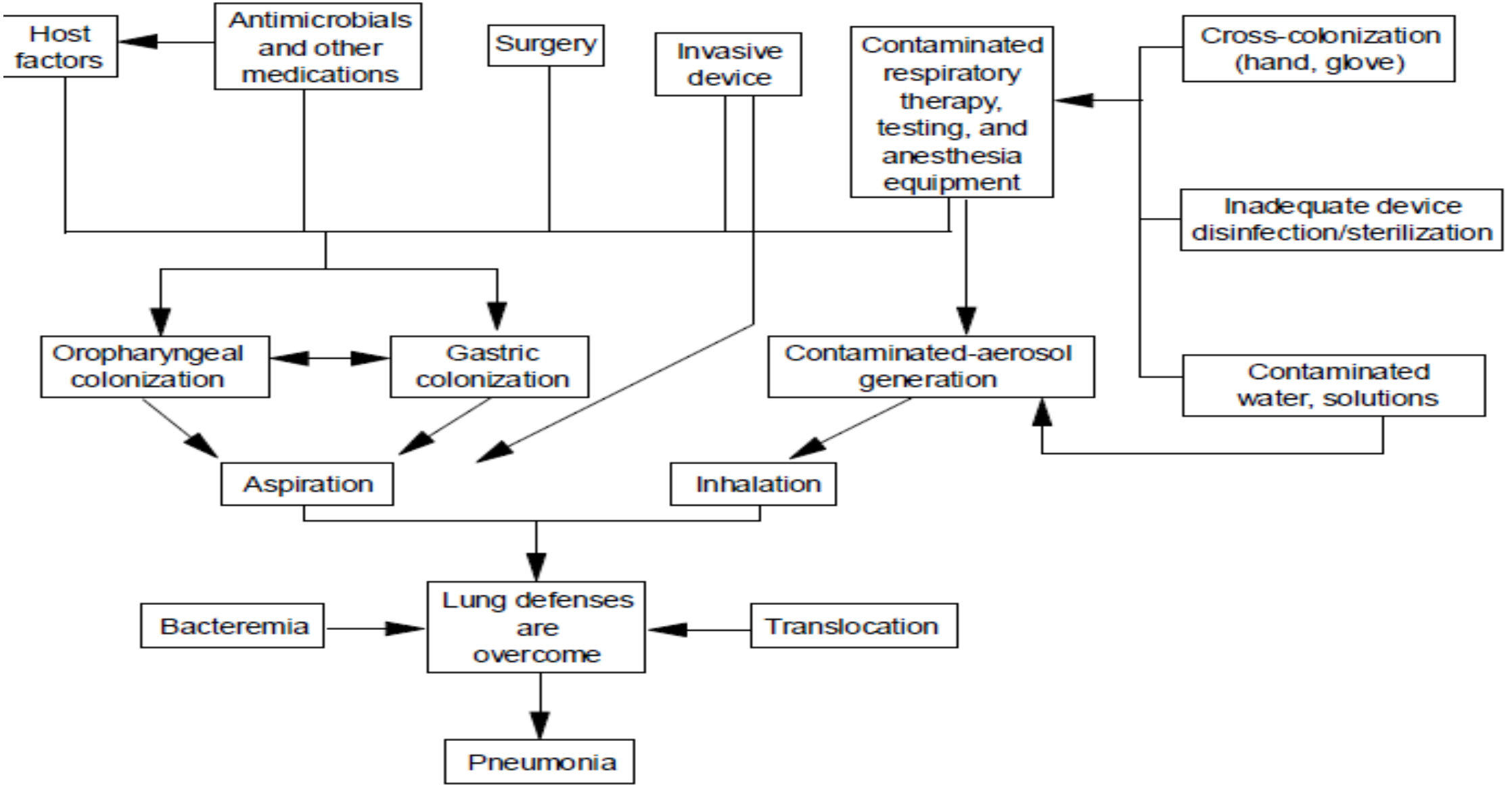
VAP refers to pneumonia occurring more than 48 hours after intubation.

- ATS/IDSA Am J Respir Crit Care Med. 2005;171: 388-416

- HCAP is defined as pneumonia in non hospitalized patient with extensive health care contact
- Risk factor of HCAP as follows-
- Antibiotic therapy in preceding 90 days
- Acute care hospitalization for at least 2 days in the preceding 90 days.
- Residence In a nursing home or extended care facility.
- Home infusion therapy including chemotherapy within the past 30 days.

- Long term dialysis within the past 30 days.
- Home wound care
- Family member with an infection involving multiple drug resistant pathogens.
- Immunosuppressive disease or immunosuppressive therapy.

Pathogenesis of nosocomial bacterial pneumonia



- Bacteria can invade the lower respiratory tract by

1. aspiration of oropharyngeal organisms, inhalation of aerosols containing bacteria

2.hematogenous spread from a distant body site

3.Translocation from the gastrointestinal tract.

Of these routes, aspiration is believed to be the most important for both nosocomial and community-acquired pneumonia.

- The high incidence of gram-negative bacillary pneumonia in hospitalized patients result from factors that promote colonization of the pharynx by gram negative bacilli and the subsequent entry of these organisms into the lower respiratory tract.

- Oropharyngeal or tracheobronchial colonization by gram-negative bacilli begins with the adherence of the microorganisms to the host’s epithelial cells .

- Malnutrition,
- severe illness
- postoperative states
- increases the adherence of gram negative bacteria.

- The stomach is an important reservoir of organisms that cause nosocomial pneumonia. In healthy persons, few bacteria entering the stomach survive in the presence of hydrochloric acid at pH <2.

However, when gastric pH increases from the normal levels to 4 microorganisms are able to multiply to high concentrations in the stomach.

This can occur in elderly patients ; in patients who have achlorhydria, ileus, or upper gastrointestinal disease; and in patients receiving enteral feeding, antacids, or H2 blocker.

- Bacteria also can enter the lower respiratory tract of hospitalized patients through inhalation of aerosols generated primarily by contaminated respiratory-therapy or anesthesia-breathing equipment ,contaminated nebulizers, humidification devices that produce large amounts of aerosol droplets <4 mm via ultrasound, spinning disk, or the Venturi mechanism.

- Bacterial pneumonia has resulted, in rare instances, from hematogenous spread of infection to the lung from purulent phlebitis or right-sided endocarditis.
- Translocation of viable bacteria from the lumen of the gastrointestinal tract through epithelial mucosa to the mesenteric lymph nodes and to the lung, has been demonstrated in animal models . Translocation is postulated to occur in patients with immunosuppression, cancer, or burns.

Risk factor of nosocomial pneumonia

- include extremes of age and severe underlying conditions, including immunosuppression
- persons who have increased risk of aspiration- endotracheal intubation and/or mechanically assisted ventilation, supine body position, nasogastric tube insertion
- a depressed level of consciousness (particularly those with closed-head injury),
- underlying chronic lung disease;

- Conditions requiring prolonged use of mechanical ventilator support with potential exposure to contaminated respiratory equipment and/or contact with contaminated or colonized hands of health care providers.

- Factors that impede adequate pulmonary toilet (e.g., undergoing surgical procedures that involve the head, neck, thorax, or upper abdomen or being immobilized as a result of trauma or illness

- Patients receiving mechanically assisted ventilation have higher mortality rates than do patients not receiving ventilation support;

Guideline For Prevention of Nosocomial Pneumonia

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

January 3, 1997 / Vol. 46 / No. RR-1

MMWR™
MORBIDITY AND MORTALITY WEEKLY REPORT

Recommendations and Reports

Risk factor and control mrasures

- **Oropharyngeal, tracheal or gastric colonization**-.
- ICU patients receiving mechanically assisted ventilation who were treated either with only antacids or with antacids and H-2 blockers had increased gastric pH, high bacterial counts in the gastric fluid, and increased risk for pneumonia .

Journal of Critical Care, Vol 17, No 4 (December), 2002: 240-245

- Occurrence of Ventilator-Associated Pneumonia in Mechanically Ventilated Pediatric Intensive Care Patients During Stress Ulcer Prophylaxis With Sucralfate, Ranitidine, and Omeprazole
- DincerYildizdas, HacerYapicioglu, and Hayri LeventYilmaz

- A prospective study conducted at the pediatric intensive care unit (PICU) between August 2000 and February 2002
- 160 patients who needed mechanical ventilation were randomized into group (S) (n = 38) received sucralfate suspension 60 mg/kg/d in 4 doses
- group (R), (n = 42) received ranitidine 2 mg/kg/d intravenously in 4 doses;
- group (O), (n = 38} received omeprazole 1 mg/kg/d intravenously in 2 doses;
- group (P), (n = 42) did not receive any medication for stress ulcer prophylaxis. Treatment was begun within 6 hours of PICU admission.

- The VAP rate was
- 42% (16 of 38)in the sucralfate group,
- 48% (20 of 42) in the ranitidine group,
- 45% (17 of 38) in the omeprazole group, and
- 41% (17 of 42) in the nontreated group.
-

- The overall mortality rate was 22% (35 of 160).
- The mortality rate was 21% (8 of 38) in the sucralfate group,
- 23% (10 of 42) in the ranitidine group,
- 21% (8 of 38) in the omeprazole group,
- 21% (9 of 42) in the nontreated group.
- There was no statistically significant difference between these groups in terms of VAP and mortality rate (P = .963, 99% confidence interval

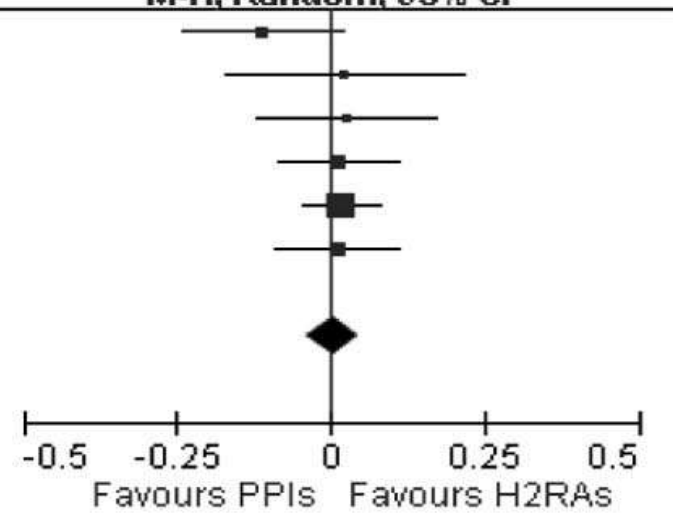
- **The efficacy and safety of proton pump inhibitors vs histamine-2 receptor antagonists for stress ulcer bleeding prophylaxis among critical care patients: A meta-analysis**
- Pei-Chin Lin, MSCP; Chia-Hsuin Chang, MD, ScD; Ping-I Hsu, MD; Pi-Lai Tseng, MS; Yaw-Bin Huang, PhD

A Pneumonia

Study or Subgroup	PPIs Events	PPIs Total	H2RAs Events	H2RAs Total	Weight	Risk Difference M-H, Random, 95% CI	Year
Levy	1	32	5	35	10.1%	-0.11 [-0.24, 0.02]	1997
Phillips	6	33	4	25	4.6%	0.02 [-0.17, 0.22]	1998
Azevedo	5	38	4	38	8.2%	0.03 [-0.12, 0.17]	1999
Kantorova	8	72	7	71	17.1%	0.01 [-0.09, 0.11]	2004
Conrad	20	178	17	181	43.7%	0.02 [-0.04, 0.08]	2005
Somberg	16	167	3	35	16.3%	0.01 [-0.09, 0.11]	2008
Total (95% CI)		**520**		**385**	**100.0%**	**0.00 [-0.04, 0.05]**	
Total events	56		40				

Heterogeneity: Tau² = 0.00; Chi² = 3.39, df = 5 (P = 0.64); I² = 0%

Test for overall effect: Z = 0.17 (P = 0.86)

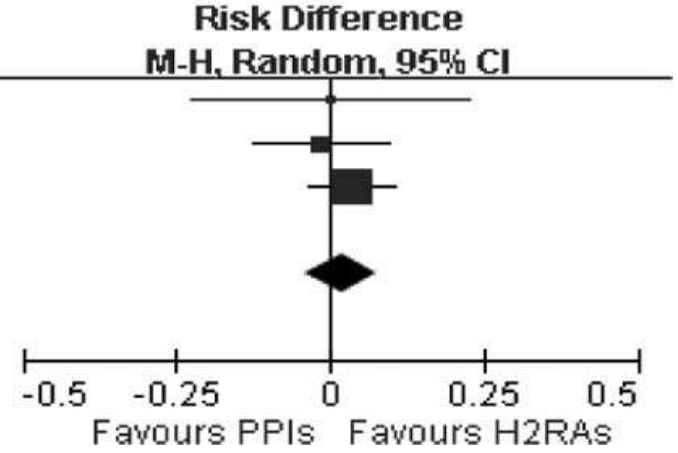


B The intensive care unit mortality

Study or Subgroup	PPIs Events	PPIs Total	H2RAs Events	H2RAs Total	Weight	Risk Difference M-H, Random, 95% CI	Year
Levy	11	32	12	35	6.4%	0.00 [-0.23, 0.23]	1997
Kantorova	9	72	10	71	26.7%	-0.02 [-0.13, 0.10]	2004
Conrad	27	178	21	181	66.9%	0.04 [-0.03, 0.11]	2005
Total (95% CI)		**282**		**287**	**100.0%**	**0.02 [-0.04, 0.08]**	
Total events	47		43				

Heterogeneity: Tau² = 0.00; Chi² = 0.62, df = 2 (P = 0.73); I² = 0%

Test for overall effect: Z = 0.67 (P = 0.50)



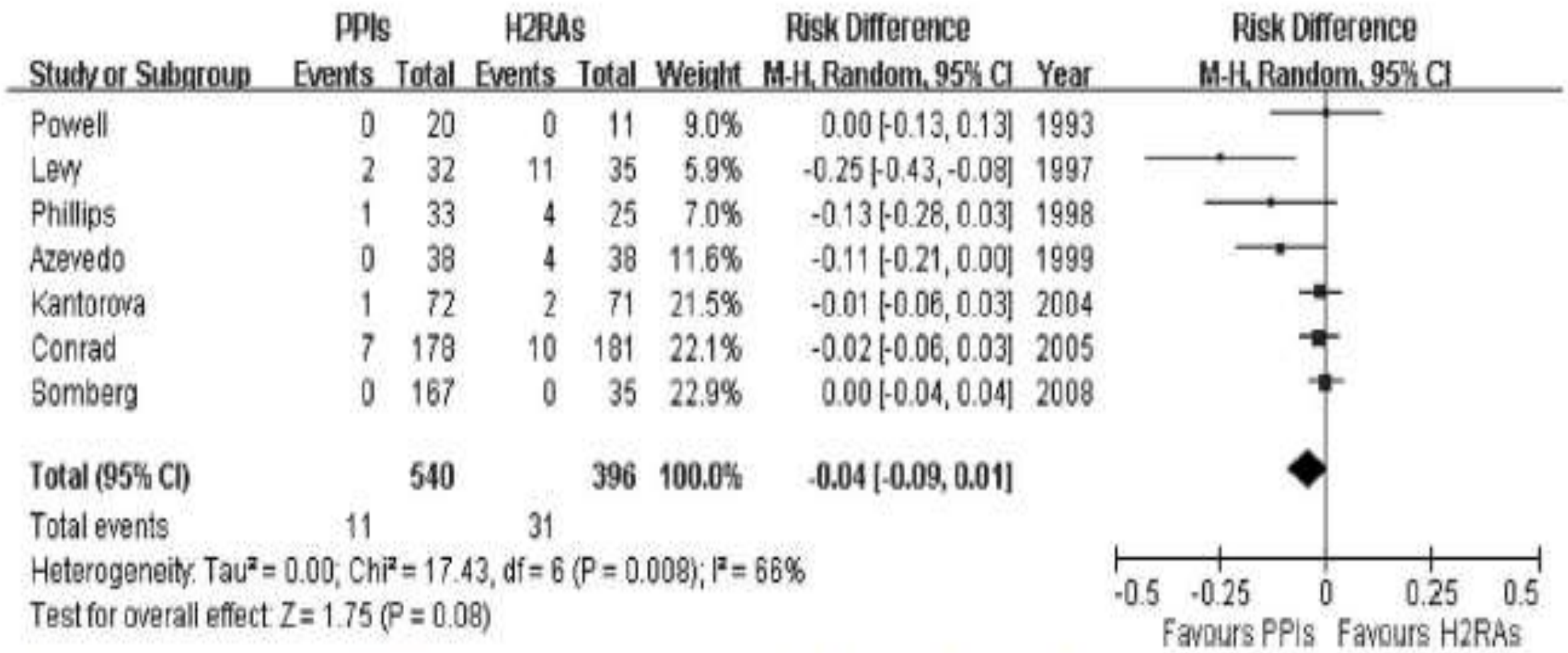


Figure 2. The overall effect of proton pump inhibitors (*PPIs*) vs. histamine-2 receptor antagonists (*H2RAs*) on the stress-related upper gastrointestinal bleeding prophylaxis. *CI*, confidence interval;

- ***Selective decontamination of the digestive tract (SDD)*** is another strategy designed to prevent bacterial colonization and lower respiratory tract infection in mechanically ventilated patients .
- SDD is aimed at preventing oropharyngeal and gastric colonization with aerobic gram-negative bacilli and Candida sp. without altering the anaerobic flora .

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Decontamination of the Digestive Tract and Oropharynx in ICU Patients

A.M.G.A. de Smet, M.D., J.A.J.W. Kluytmans, M.D., Ph.D., B.S. Cooper, Ph.D., E.M. Mascini, M.D., Ph.D., R.F.J. Benus, M.D., T.S. van der Werf, M.D., Ph.D.,

- The effectiveness of SDD and SOD were evaluated in a crossover study using cluster randomization in 13 intensive care units (ICUs), all in the Netherlands.

- In each ICU, three regimens (SDD, SOD, and standard care) were applied in random order over the course of 6 months.

- Mortality at day 28 was the primary end point.
- SDD consisted of 4 days of intravenous cefotaxime and topical application of tobramycin, colistin, and amphotericin B in the oropharynx and stomach.
- SOD consisted of oropharyngeal application only of the same antibiotic

- Result of study showed that an absolute reduction in mortality of 3.5 and 2.9 percentage points (corresponding to relative reductions of 13% and 11%) at day 28 with SDD and SOD, respectively, among patients admitted to Dutch ICUs .

- Among patients receiving SDD or SOD as compared with those receiving standard care, crude incidences of ICU-acquired bacteremia were significantly reduced for *S. aureus*, *Pseudomonas aeruginosa* and Enterobacteriaceae .
- Patients receiving SDD had a lower incidence of ICU-acquired bacteremia with Enterobacteriaceae than did those receiving SOD.

Aspiration of oropharyngeal or gastric flora

- Clinically important aspiration usually occurs in patients who
- a) have a depressed level of consciousness;
- b) have dysphagia resulting from neurologic or esophageal disorders;
- c) have an endotracheal (nasotracheal or orotracheal), tracheostomal, or enteral (nasogastric or orogastric) tube in place and receiving enteral feeding .
-

- Placement of an enteral tube may increase nasopharyngeal colonization, cause reflux of gastric contents, or allow bacterial migration via the tube from the stomach to the upper airway

- Chances of aspiration can be minimized by
- Placing the patient in a semi recumbent position
- withholding enteral feeding if the residual volume in the stomach is large or if bowel sounds are not heard upon auscultation of the abdomen)
- using flexible, small-bore enteral tubes
- placing the enteral tube below the stomach (e.g., in the jejunum)

- Drakulovic et al in their study showed- rate of VAP was 2/39 for patients in the semi-recumbent position and 11/47 for patients in the supine position (RR 0.22, 95% CI 0.05 to 0.92, p = 0.04).
- Mortality, however, was similar in the 2 groups (7/39 for semi-recumbent position and 13/47 for supine position, RR 0.65, 95% CI 0.29 to 1.47, p = 0.30).

Table 1 Randomized clinical trials to test the supine semirecumbent vs. horizontal position on the incidence of VAP

Author	Drakulovic *et al.* [14]	Van Nieuwenhoven *et al.* [15]	Keeley [16]
Year	1999	2006	2007
Study population	86	221	30
Center	Single-center One medical and one respiratory ICUs	Multicenter (three hospitals) Four mixed medical/surgical ICUs	Mono-center One mixed medical/surgical ICU
Exclusion criteria	Recent abdominal surgery Recent neurological surgery Shock refractory to vasoactive drugs Previous tracheal intubation	SDD Extensive abdominal surgery Recent neurological surgery	Severely obese Recent abdominal surgery Previous tracheal intubation
Interventions	Semirecumbent (45°) vs. supine horizontal (0°)	Semirecumbent (45°) vs. supine slightly inclined (10°)	Semirecumbent (45°) vs. supine slightly inclined (25°)
Position monitoring	Checked daily	Checked minutely	NA
Diagnosis of microbiologically confirmed VAP	Tracheal aspirate BAL PSB	BAL	Tracheal aspirate BAL PSB
Incidence of clinical suspected VAP	Semirecumbent position 3/39 (8%) Supine position 16/47 (34%) $P = 0.003$	Semirecumbent position 16/112 (18%) Supine position 20/109 (14%) NS	Semirecumbent position 5/17 (29%) Supine position 7/13 (54%) NS
Incidence of microbiologically confirmed VAP	Semirecumbent position 2/39 (5%) Supine position 11/47 (23%) $P = 0.018$	Semirecumbent position 13/112 (12%) Supine position 8/109 (7%) NS	Semirecumbent position 4/17 (24%) Supine position 5/13 (38%) NS

- In their recommendations, the Centers for Disease Control and Prevention states,
- “In the absence of medical contraindications, elevate at an angle of 30–45 degrees the head of the bed of a patient at high risk for aspiration (eg, a person receiving mechanical ventilation and/or who has an enteral tube in place).”

New insights from laboratory and clinical investigation into VAP pathogenesis and effects of body position

- The primary mechanism for the development of VAP is through the aspiration of bacteria-laden subglottic secretions across the ETT cuff .
- Semi recumbent position reduces aspiration of gastric contents
- Raising the head of the bed potentially increases the hydrostatic pressure exerted above the ETT cuff by oropharyngeal secretions, resulting in risk of aspiration.

- Panigada et al. done comprehensive analysis in sheep of the effects of ETT and body position on the development of VAP. Animals were ventilated for up to 72 h and randomized either to the ‘head up’ position, or the ‘head down’ position, with the orientation of the trachea/ETT respectively above, or below the horizontal.
- All sheep in ‘head up’ position -significant decrease in lung function and heavy bacterial colonization of the lungs.
- Sheep in ‘head down’ position –
- retained excellent lung function
- no evidence of bacterial lung colonization and VAP .

- Following tracheal intubation, mucus flow is reversed in the semi recumbent position: Possible role in the pathogenesis of ventilator-associated pneumonia
- Gianluigi Li Bassi, MD; Alberto Zanella, MD; Massimo Cressoni, MD; Mario Stylianou, PhD; Theodor Kolobow, MD

- Tracheal mucus velocity was measured through radiographic tracking of radiopaque tantalum disks, insufflated into the trachea. After 24 hrs, sheep were euthanized, and samples from the airways and lungs were taken for microbiological analysis.

Pneumonia was found in 6/8 of trachea-up sheep and the same microorganisms were isolated from the lungs and the proximal trachea. No pneumonia was found in trachea-down sheep (*p* .007).

Table 2. Clinical and autopsy findings

	Sheep	WBC After 24 Hrs (K/μL)	Body Temperature (°C) After 24 Hrs	Pao_2/Fio_2 Baseline	Pao_2/Fio_2 After 24 Hrs (Increase/Decrease % From Baseline)	New Pulmonary Opacities	Congested Lobes With Bacterial Colonization $\geq 10^6$ CFUs/g	Pneumonia[a]
ETT and trachea oriented below horizontal								
Group A	951	9.4	38.8	490	493 (+0.6)	No	—	No
	965	5.9	38.4	477.5	495 (+3.7)	No	—	No
	989	8.3	38.5	520	540 (+3.8)	No	—	No
	1007	5.3	38.5	392.5	481.5 (+22.7)	No	—	No
Group B	978	6	38.4	491.25	535 (+8.9)	No	—	No
	983	7.1	38.3	538	512.9 (−4.7)	No	—	No
	992	12.2	38.3	497.5	518.7 (+4.3)	No	—	No
	1003	6.7	38.6	478	444.5 (−7.0)	No	—	No
ETT and trachea oriented above horizontal								
Group C	889	6.2	38.9	487.5	229 (−53)	Yes	LUL; LLL	Yes
	976	6.2	38.5	521.75	137.8 (−73.6)	Yes	RUL; RML; RLL; LUL; LLL	Yes
	982	4.9	38.5	512.75	225.2 (−56.1)	Yes	RUL; RML	Yes
	1008	5.8	38.2	401.75	491.5 (+22.3)	No	—	No
Group D	971	7.2	38.5	500	554.2 (+10.9)	No	—	No
	974	12.4	38.4	598.75	226 (−62.3)	Yes	RUL; RML; RLL	Yes
	975	4.5	38.3	519.25	219 (−57.8)	Yes	RML; LUL; LLL	Yes
	1004	10.3	38.6	481.75	354 (−26.5)	Yes	RML	Yes

- *Conclusions:* Following tracheal intubation gravitational force influences tracheal mucus clearance.
- When the trachea is oriented above horizontal, a flow of mucus from the proximal trachea toward the lungs is highly associated with bacterial colonization of the airways and pneumonia.

- Hence, -among patients presenting oropharyngeal colonization, the semi recumbent position could potentially enhance aspiration of pathogen into the airways and produce more harm than benefit .

- PRONE POSITIONING-

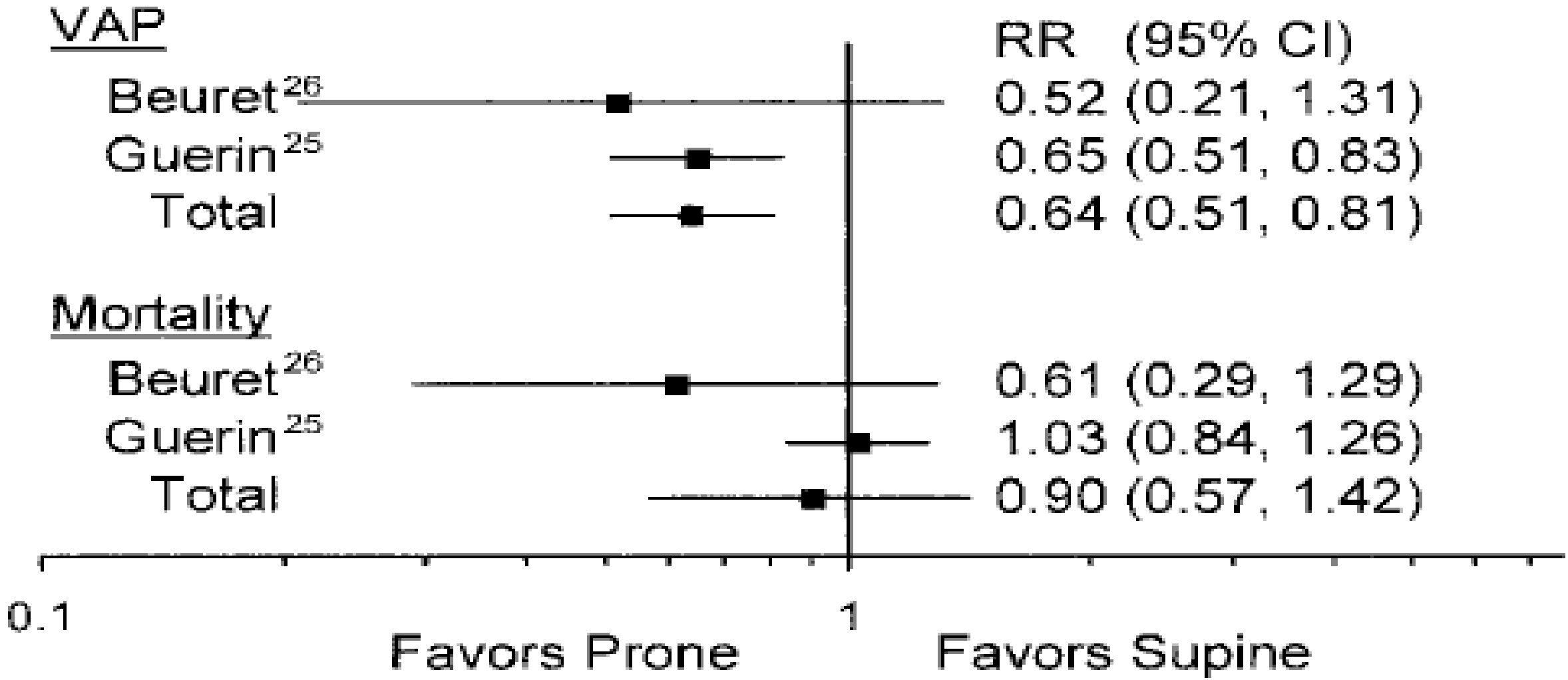


Fig. 3. Pooled analysis of ventilator-associated pneumonia (
and mortality in studies evaluating the use of prone position

Rotation therapy

- Normal persons, even during sleep, change their position approximately every 12 min, which is minimum physiologic mobility requirement.
- In contrast, critically ill patients are often cared for in the supine position for extended periods of time.
- In the supine position, the functional residual capacity is decreased because of alveolar closure in dependent lung zones. Immobility may impair mucociliary clearance, with the accumulation of mucus in dependent lung regions. This can lead to atelectasis and infection of dependent lung zones.
- As standard practice, patients in the ICU are usually turned every 2 hours by the nursing staff

- Rotational therapy, which includes kinetic therapy and continuous lateral rotation therapy (CLRT)
- Kinetic therapy is the continuous turning of a patient to at least 40 degrees on each side. The entire kinetic bed frame rotates the patient from side to side at a speed of about half a degree per second.
- With CLRT, the degree of turn to each side is less than 40 degrees. The degree of turning and the length of time the patient spends on each side are programmable .
- kinetic beds can provide percussion and vibration therapy, and they allow for elevation of the head of the bed

Kinetic bed therapy for prevention of VAP

Study	Therapy	Pneumonia Rate		RR of Pneumonia (95% CI)	Ventilator Days		WMD for Ventilator Days (95% CI)	ICU Days		WMD for ICU Days (95% CI)
		Therapy	Control		Therapy	Control		Therapy	Control	
Gentilello[8]	Kinetic	5/27	13/38	0.54 (0.22 to 1.34)	8.5 (mean)	10 (mean)	−1.5 (−4.8 to 1.79)	15 (mean)	16.8 (mean)	1.8 (−5.34 to 8.9)
Summer[9]	Kinetic	4/43	7/43	0.57 (0.18 to 1.81)	NR	NR	NR	7.3 (mean)	9.6 (mean)	NR
Fink[10]	Kinetic	7/51	19/48	0.35 (0.16 to 0.75)	4 (median)	7 (median)	NR	5 (median)	8 (median)	NR
deBoisblanc[11]	CLRT	6/69	11/51	0.40 (0.16 to 1.02)	6.1 (mean)	9.9 (mean)	−3.8 (−7.7 to 0.13)	7.8 (mean)	10.8 (mean)	−3.0 (−6.1 to 0.1)
Traver[12]	CLRT	8/44	17/59	0.63 (0.30 to 1.33)	3 (median)	3 (median)	NR	7 (median)	5 (median)	NR
Whiteman[13]	CLRT	10/33	14/36	0.78 (0.40 to 1.51)	13.8 (mean)	16.1 (mean)	−2.3 (−10.7 to 5.5)	29.8 (mean)	32.0 (mean)	−2.2 (−20.1 to 15.7)
MacIntyre[14]	CLRT	9/52	13/51	0.68 (0.32 to 1.45)	NR	NR	NR	NR	NR	NR
Kirschenbaum[15]	CLRT	3/17	10/20	0.35 (0.12 to 1.08)	55 (mean)	58 (mean)	−3.0 (−7.2 to 1.2)	NR	NR	NR
Ahrens[16]	CLRT	14/97	45/137	0.44 (0.26 to 0.75)	10.8 (mean)	10.1 (mean)	0.6 (−2.4 to 3.6)	13.5 (mean)	13.5 (mean)	−0.2 (−3.4 to 3.1)

Relative risk of pneumonia was lower in patients receiving rotational therapy (0.54), but this did not reach statistical significance (95% confidence interval [CI] 0.22 to 1.34). There was no significant difference in ventilator days or ICU length of stay between the groups.

There was no difference in mortality between the groups (relative risk [RR] 1.97, 95% confidence interval 0.70 to 5.55).

Gentilello L, Thompson DA, Tonnesen AS, Hernandez D, Kapadia AS, Allen SJ, et al. Effect of a rotating bed on the incidence of pulmonary complications in critically ill patients. Crit Care Med 1988;16(8):783–786.

Recommendation of prevention of nosocomial pneumonia

- 1. Staff education and infection surveillance;
- 2. Interruption of transmission of microorganisms by eradicating infecting microorganisms from their epidemiologically important reservoirs and/or preventing person-to-person transmission;
- 3. Modifying host risk for infection
- CDC guideline Jan ,1997

Interruption of transmission of microorganism

- Thorough cleaning of instruments before sterilization or disinfections.

- Sterilize or use high-level disinfection for semi critical equipment or devices (i.e., items that come into direct or indirect contact with mucous membranes of the lower respiratory tract)
- CDCguideline,Jan1997

- Use sterile (not distilled, unsterile) water for rinsing reusable semi critical equipment and devices used on the respiratory tract after they have been disinfected chemically.

Do not reprocess equipment or devices that are manufactured for a single use only, unless data indicate that reprocessing such items poses no threat to the patient, is cost-effective, and does not change the structural integrity or function of the equipment or device

CDC guideline Jan 1997

- Do not routinely change more frequently than every 48 hours the breathing circuit, including tubing and exhalation valve, and the attached bubbling or wick humidifier of a ventilator that is being used on an individual patient .

- Sterilize reusable breathing circuits and bubbling or wick humidifiers or subject them to high-level disinfection between their uses on different patients

- CDC guideline Jan 1997

- Periodically drain and discard any condensate that collects in the tubing of a mechanical ventilator, taking precautions not to allow condensate to drain toward the patient. Wash hands after performing the procedure or handling the fluid. Do not place bacterial filters between the humidifier reservoir and the inspiratory-phase tubing of the breathing circuit of a mechanical ventilator.
- Humidifier fluid-Sterile water for bubbling humidifier
- CDC guideline Jan 1997

- No Recommendation for preferential use of hygroscopic condenser humidifier or heat-moisture exchanger rather than a heated humidifier to prevent nosocomial pneumonia.

Hygroscopic condenser-humidifier or heat-moisture exchanger should be changed according to the manufacturer's recommendation and/or when evidence of gross contamination or mechanical dysfunction of the device is present

CDC guideline Jan 1997

- Wall humidifier-Between uses on different patients, change the tubing, including any nasal prongs or mask, used to deliver oxygen from a wall outlet.

- CDC guideline Jan 1997

Interruption of person to person transmission of bacteria

- Regardless of whether gloves are worn, wash hands after contact with mucous membranes, respiratory secretions, or objects contaminated with respiratory secretions. Regardless of whether gloves are worn, wash hands both before and after contact with
- a) a patient who has an endotracheal or tracheostomy tube in place and
- b) any respiratory device that is used on the patient.

- Change gloves and wash hands
- a) after contact with a patient;
- b) after handling respiratory secretions or objects contaminated with secretions from one patient and before contact with another patient, object, or environmental surface; and
- c) between contacts with a contaminated body site and the respiratory tract (or respiratory device), of the same patient.
- Wear a gown if soiling with respiratory secretions from a patient is anticipated, and change the gown after such contact and before providing care to another patient.

Care of tracheostomy tube

- Perform tracheostomy under sterile conditions.

When changing a tracheostomy tube, use aseptic techniques and replace the tube with one that has undergone sterilization or high-level disinfection.

CDC guideline Jan1997

Suctioning of respiratory tract secretion

- No Recommendation for wearing sterile gloves rather than clean but unsterile gloves when suctioning a patient's respiratory secretions.
- If the open-suction system is employed, use a sterile single-use catheter.
- Use only sterile fluid to remove secretions from the suction catheter if the catheter is to be used for re-entry into the patient's lower respiratory tract.
- CDC guideline1997

- No Recommendation for preferential use of the multiuse closed-system suction catheter or the single-use open-system catheter for prevention of pneumonia .
- Change the entire length of suction-collection tubing between uses on different patients.
- Change suction-collection canisters between uses on different patients except when used in short-term–care units

CDC guideline 1997

Sterilization of breathing circuit

- Clean and then sterilize or subject to high-level liquid chemical disinfection or pasteurization reusable components of the breathing system or patient circuit (e.g., tracheal tube or face mask, inspiratory and expiratory breathing tubing, y-piece, reservoir bag, humidifier, and humidifier tubing) between uses on different patients .
- CDC guideline 1997

- Periodically drain and discard any condensate that collects in the tubing of a breathing circuit, taking precautions not to allow condensate to drain toward the patient. After performing the procedure or handling the fluid, wash hands with soap and water or with a waterless hand washing preparation .
- .No Recommendation for placing a bacterial filter in the breathing system or patient circuit of anesthesia equipment .

CDC GUIDELINE 1997

Interruption of person to person transmission of bacteria

- Regardless of whether gloves are worn, wash hands after contact with mucous membranes, respiratory secretions, or objects contaminated with respiratory secretions. Regardless of whether gloves are worn, wash hands both before and after contact with a) a patient who has an endotracheal or tracheostomy tube in place and b) any respiratory device that is used on the patient.

CDC guideline 1997

Barrier precaution

- Wear gloves for handling respiratory secretions or objects contaminated with respiratory secretions of any patient .
- Change gloves and wash hands a) after contact with a patient; b) after handling respiratory secretions or objects contaminated with secretions from one patient and before contact with another patient, object, or environmental surface; and c) between contacts with a contaminated body site and the respiratory tract of, or respiratory device on, the same patient

CDC guideline 1997

- Wear a gown if soiling with respiratory secretions from a patient is anticipated, and change the gown after such contact and before providing care to another patient

CDC GUIDELINE 1997

Other prophylactic measures

- Pmeumococcal vaccinations in patients of age >65 years of , chronic cardiovascular or pulmonary disease, diabetes mellitus, alcoholism, cirrhosis, cerebrospinal fluid leaks, immunosuppression, functional or anatomic asplenia, or infection with human immunodeficiency virus (HIV).

CDC guideline1997

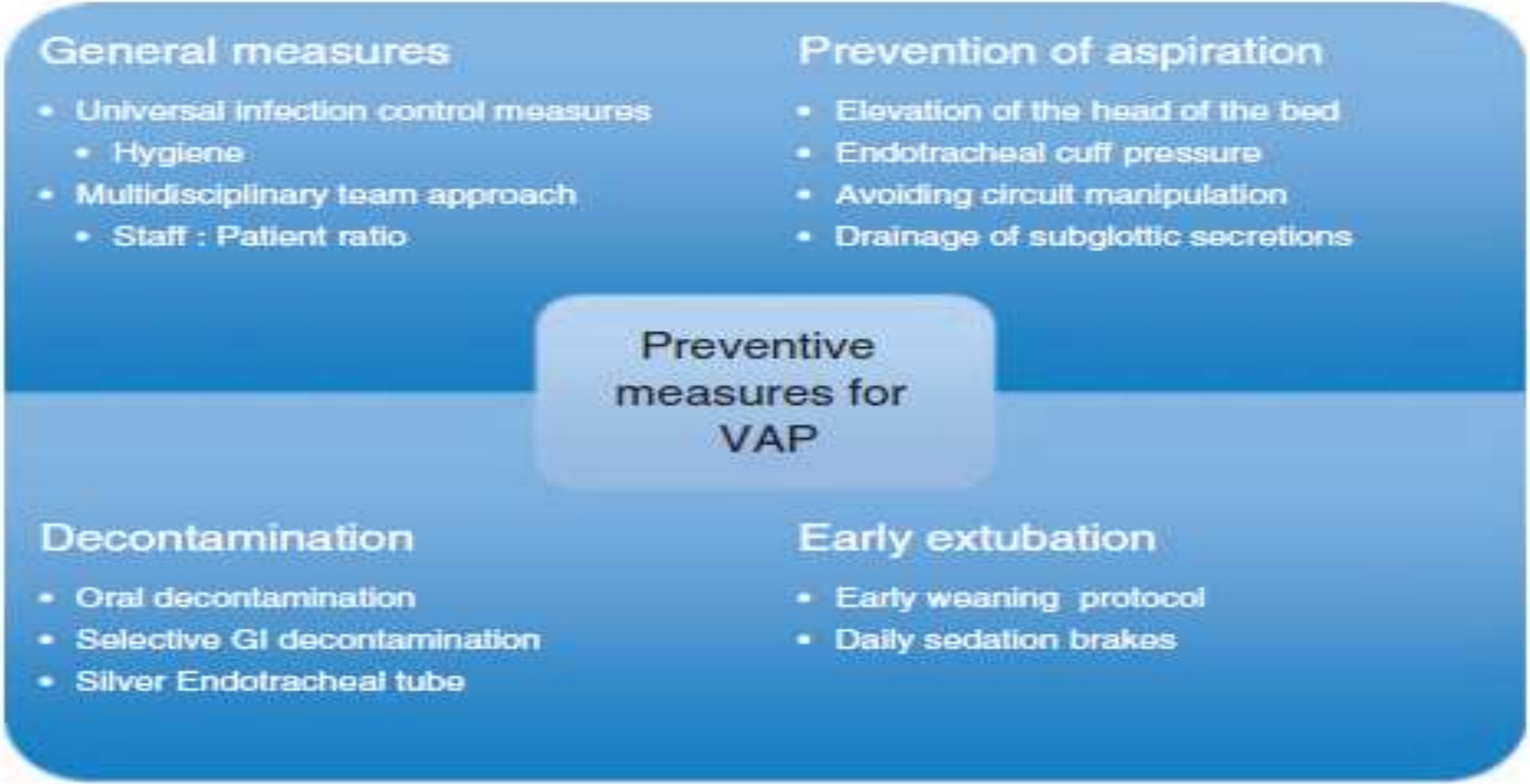
- Prophylaxis with Systemic Antimicrobial Agents. The systemic administration of antimicrobials is commonly used to prevent nosocomial pneumonia— for patients who are
- receiving mechanical ventilation,
- are postoperative, and/or are critically ill .
- Efficacy of this practice is questionable, and superinfection, is possible as a result of any antimicrobial therapy .
- CDC guideline 1997

VAP PREVENTION

- The Ventilator Bundle contains four components,
- elevation of the head of the bed to 30–45 degree,
- daily ‘sedation vacation’ and
- daily assessment of readiness to extubate,
- peptic ulcer disease prophylaxis, and deep venous thrombosis prophylaxis

- University of Michigan School of Medicine, Ann Arbor, Michigan, USA

- The following are the selected preventive measures in the European care bundle developed for the prevention of ventilator-associated pneumonia
- (1) no ventilator circuit tube changes unless specifically indicated;
- (2) strict hand hygiene practice with the use of alcohol based hand rub;
- (3) appropriately educated and trained staff;
- (4) sedation vacation and weaning protocol;
- (5) oral care with the use of chlorhexidine


General measures
Universal infection control measures
Hygiene
Multidisciplinary team approach
Staff : Patient ratio
Prevention of aspiration
Elevation of the head of the bed
Endotracheal cuff pressure
Avoiding circuit manipulation
Drainage of subglottic secretions
Preventive measures for VAP
Decontamination
Oral decontamination
Selective GI decontamination
Silver Endotracheal tube
Early extubation
Early weaning protocol
Daily sedation brakes

CHEST

Postgraduate Education Corner

CONTEMPORARY REVIEWS IN CRITICAL CARE MEDICINE

Technologic Advances in Endotracheal Tubes for Prevention of Ventilator-Associated Pneumonia

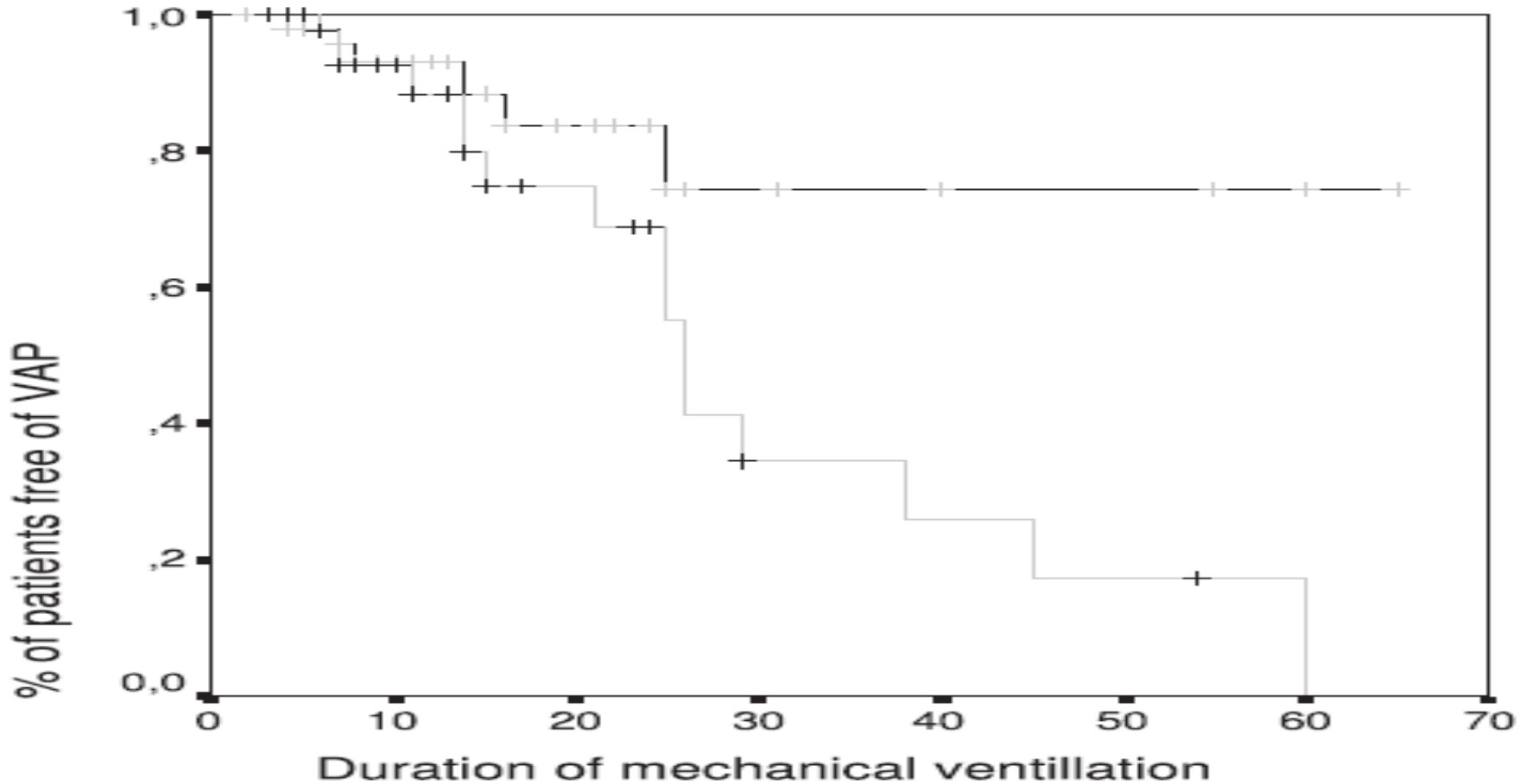
Juan F. Fernandez, MD; Stephanie M. Levine, MD, FCCP; and Marcos I. Restrepo, MD, FCCP

ET tube cuff pressure and incidence of VAP

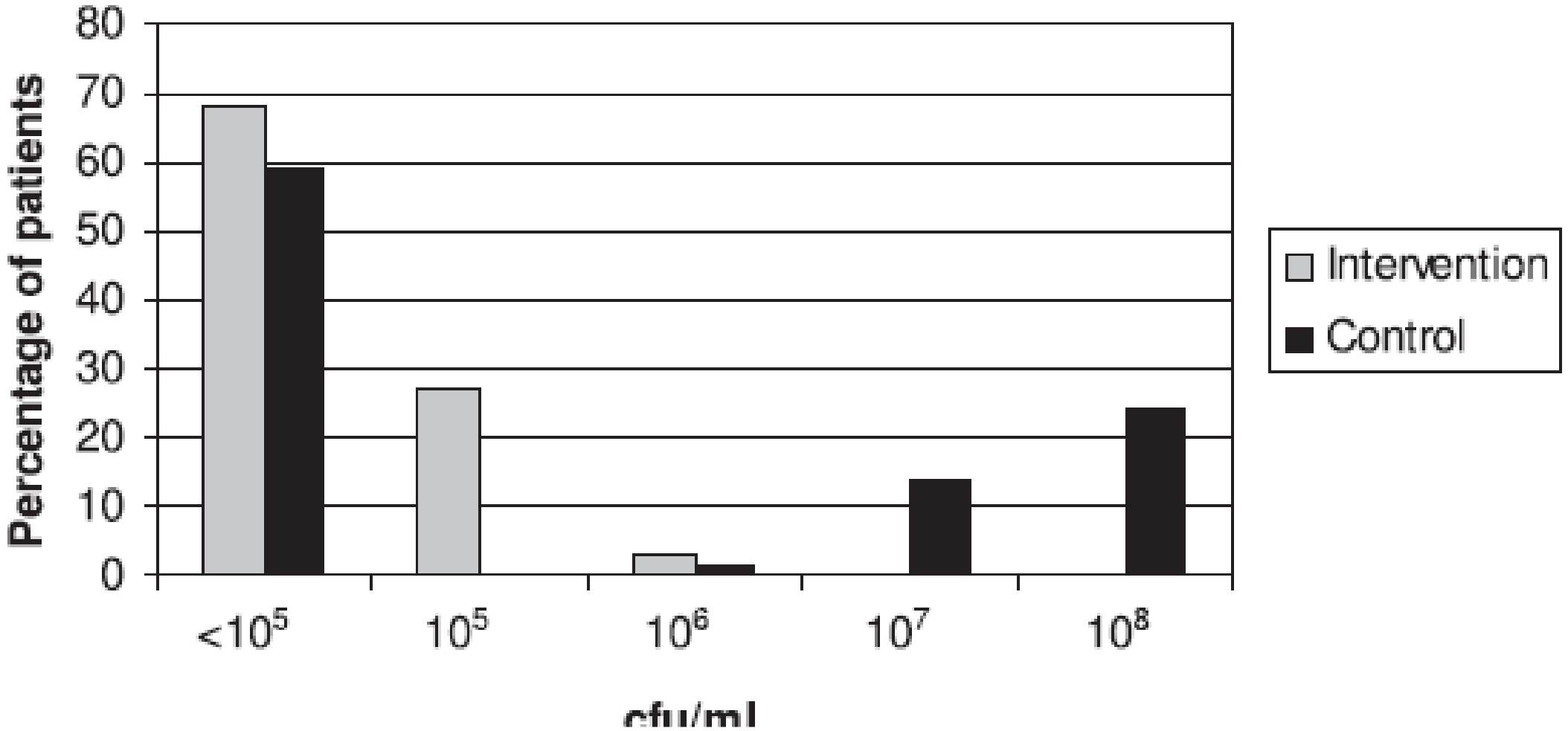
- Rello et al also evaluated the outcomes of cuff pressure on the incidence of VAP, reporting that a constant cuff pressure below 20 cm H 2 O during the first 8 days of intubation was an independent risk factor for the development of VAP (relative risk [RR], 4.23; 95% CI, 1.12-15.92).

Continuous Control of Tracheal Cuff Pressure and Microaspiration of Gastric Contents in Critically Ill Patients

Saad Nseir[1,2], Farid Zerimech[3], Clément Fournier[4], Rémy Lubret[1], Philippe Ramon[4], Alain Durocher[1,2], and Malika Balduyck[3,5]


1,0
,8
,6
,4
,2
0,0
% of patients free of VAP
0
10
20
30
40
50
60
70
Duration of mechanical ventillation

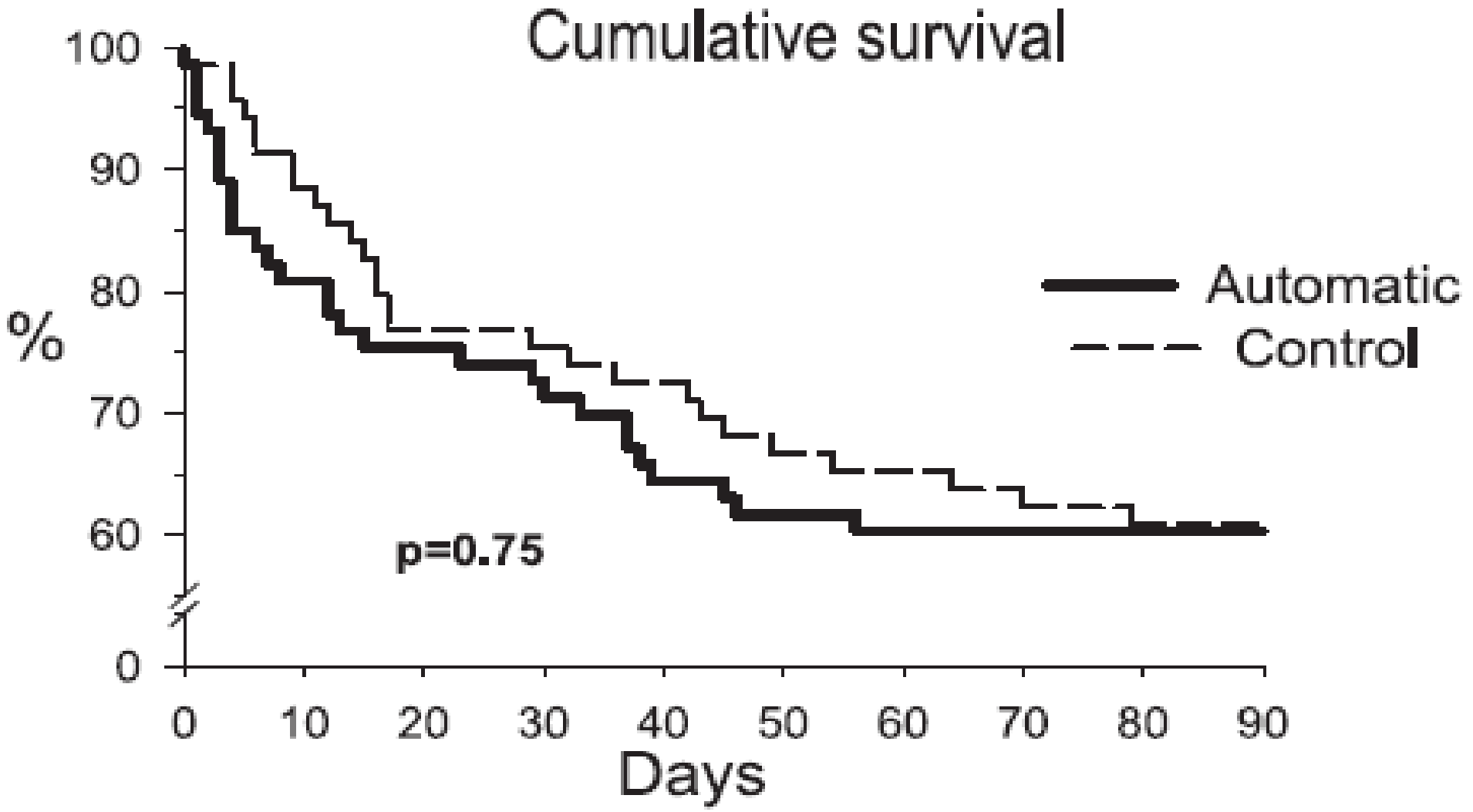
Tracheobronchial bacterial colonization in intervention and control group



- Percentage of patients with abundant microaspiration was significantly lower in the intervention compared with the control group.

- Pepsin level
- rate of patients with suspected VAP
- rate of patients with microbiologically confirmed VAP
- significantly lower in the intervention compared with the control group.

- In the study by Valencia and colleagues, 142 patients were randomized to receive either mechanical ventilation with continuous regulation of the cuff pressure with an automatic device (which continuously displays the levels of cuff pressure in real time) or routine care of the cuff pressure with a manual manometer.
- In the routine care group, cuff pressure was checked every 8 hours or in case of audible leakage



Kaplan-Meier curves for surviving patients within 90 days after entry into the protocol.

- No differences between the groups in the rate of VAP with clinical criteria, VAP with microbiological confirmation, ICU mortality, hospital mortality, and length of ICU or hospital stay.

- Cuff pressure better controlled with the automatic device,
- Insufficient evidence to make a definitive recommendation regarding its use

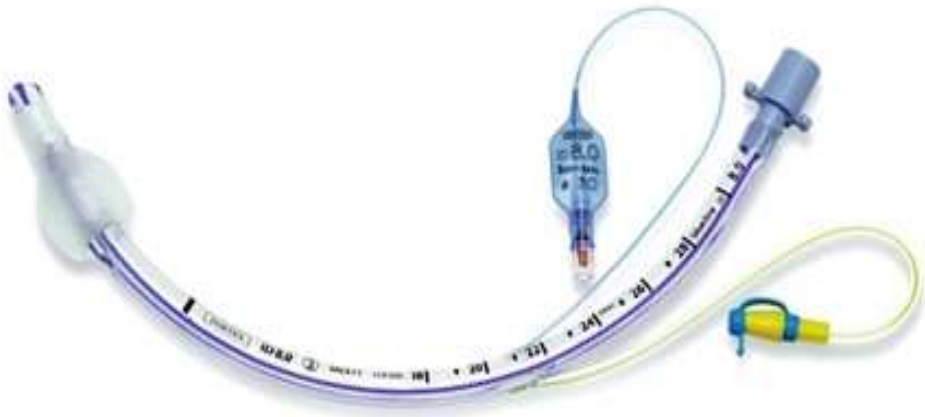
- Cuff made of polyurethane material has an ultrathin cuff membrane (thickness of 7 mm compared with a thickness of 50 mm in the conventional HVLP ETT) may prevent the formation of folds within the ETT cuff.
- Compared with the conventional HVLP ETT (polyvinyl cuff), the new HVLP ETT with ultrathin polyurethane cuff (PUC) showed less fluid leakage when the cuff pressure was between 25 and 30 cm H2O .
- *J Crit Care* . 2011 ; 26 (3): 280 - 286

- ETT PUC need lower sealing pressure (8-12 cm H 2 O) to prevent air leakage and a reduction in VAP .
- RCT by Poelaert et al.- polyurethane cuffed endotracheal tubes resulted in a significant reduction of early postoperative pneumonia in post cardiac surgery patients (adjusted odds ratio 0.31, 95% CI 0.13–0.77) compared to conventional polyvinylchloride (PVC) cuffed ET tubes..

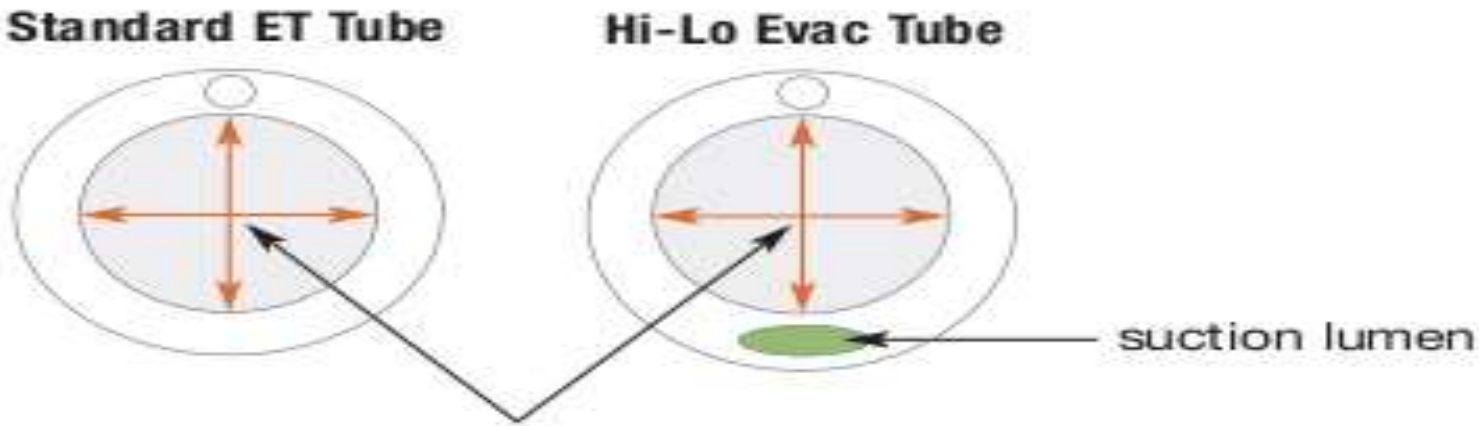
Millar et al	**Polyurethrane cuff**	**VAP rate decreased from 5.3/1000 to 2.8/1000**	**P=0.013**	
Poelaert et al.	Polyurethane cuff	Reduction in postoperative pneumonia in post cardiac surgery patients	Adjusted ODDS ratio 0.31 95%CI 0.13-0.77 compared to conventional PVC CUFF	
Lorente et al	Polyurethene cuff ETT combined with SDD	Significant reduction in early onset VAP(3.6 Vs 10.7,P=0.02 Late onst VAP(9.5Vs 26.7%)P=0.01		

SUBGLOTIC SECRETION DRAINAGE ET tube

- The subglottic secretion drainage (SSD) was designed to evacuate the secretions that accumulate on top of the cuff when a good seal is provided by the pressure and/or material or shape of ETT cuffs.
- A method that intermittently or continuously suctions secretions in the subglottic area may decrease the aspiration risk and prevent VAP.
- SSD consists of an ETT with a separate dorsal lumen port that opens above the ETT cuff .




Evacuation Port -
to suction secretions



Inner diameter is same as that of a standard tube.
Outer diameter is 0.8-1.0 mm larger because of the suction lumen.

Author, Year	Population (n)	Inclusion Criteria	Clinical Suspicion of VAP[a]	VAP[b]	Cointerventions[c]	Score[d]	Rate of VAP a. Cases/1000 Ventilator-Days b. Cases/Patients		
							SSD	Control	*p*
Mahul, 1992	145	Expected duration of MV >3 days	Chest radiograph	BAL	None specified	6	a. 8/1000 b. 9/70	a. 17.5/1000 b. 21/75	a. <.05 b. NR
Valles, 1995	153	Expected duration of MV >3 days	Chest radiograph plus temp >38.5°C, WBC >12 or <4, purulent secretions	BAL or PSB	None specified	9	a. 19.9/1000 b. 14/76	a. 39.6/1000 b. 25/77	a. NR b. NR
Metz, 1998	24	Expected duration of MV >3 days	Chest radiograph, temp > 38.5°C, WBC >12 or <3, purulent secretions	ETA or BAL	None specified	7	a. NA/1000 b. 5/10	a. NA/1000 b. 10/14	a. NA b. NS
Kollef, 1999	343	Need for MV after cardiac Surgery	Chest radiograph plus pulmonary abscess or histology or positive blood or pleural cultures or 2 of 3 of the following: fever, leukocytosis, purulent sputum	ETA or no micro	None specified	11	a. 34.5/1000 b. 8/160	a. 43.2/1000 b. 15/183	a. NR b. 0.24
Bo, 2000	68	Expected duration of MV >72 hrs	Chest radiograph + temp ≥38.3°C or WBC >12 or <4 or purulent sputum	BAL or PSB	None specified	8	a. NA/1000 b. 8/35	a. NA/1000 b. 15/33	a. NA b. <.05

Smulders, 2002	150	Expected duration of MV >72 hrs	Chest radiograph ± evidence for cavitation, histology, positive blood culture, a positive pleural fluid culture, or any of the 2 following symptoms/ signs: fever (rectal >38°C), WBC <3 or >10, purulent tracheal aspirate (>25 WBC per field)	ETA	None specified	9	a. 9.2/1000 b. 3/75	a. 22.5 b. 12/75	a. NR b. .01
Girou, 2004	18	Expected duration of MV >5 days	Chest radiograph, temp ≥38.3°C or WBC >12, or purulent sputum	PSB or BAL	Elevation of head of bed in SSD group	9	a. NA/1000 b. 5/8	a. NA/1000 b. 6/10	a. NA b. NS
Liu, 2006	86	Age older than 60 yrs, expected MV >48 hrs	Chest radiograph and 3 of 4: temp >38.0°C or <35.5°C, WBC >10 or <3, >10 WBC high-power field in ETA, or a positive ETA culture	PSB or BAL or positive blood or pleural fluid culture	Elevation of head of bed, gastrointestinal agents in SSD group	9	a. NA/1000 b. 14/41	a. NA/1000 b. 30/45	a. NA b. <.01
Lorente, 2007	280	Expected MV >24 hrs	Chest radiograph, purulent secretions, temp >38°C or <35.5°C, WBC >10 or <4	Quantitative ETA	Polyurethane cuff in addition to SSD	13	a. 7.5/1000 b. 11/140	a. 19.9/1000 b. 31/140	a. .001 b. .003
Bouza, 2008	714	Major heart surgery	Chest radiograph and 2 of: temp >38.5°C or <36°C, WBC > 12, purulent secretions, reduction in PF >15% or CPIS >6	Quantitative ETA or PSB	None specified	12	a. 17.9/1000 b. 12/359	a. 27.6 b. 19/331	a. .2 b. .18
Yang, 2008	91	MV >48 hrs	Chest radiograph and 2 of: temp >38.3°C, WBC >12, WBC <4.0, purulent secretions	No micro or ETA or positive blood culture	None specified	9	a. NA/1000 b. 12/48	a. NA/1000 b. 20/43	a. NA b. .03

Study or Subgroup	SSD Events	SSD Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
Mahul 1992	9	70	21	75	6.2%	0.46 [0.23, 0.93]	1992
Valles 1995	14	76	25	77	9.5%	0.57 [0.32, 1.01]	1995
Metz 1998	5	10	10	14	6.3%	0.70 [0.35, 1.41]	1998
Kollef 1999	8	160	15	183	4.5%	0.61 [0.27, 1.40]	1999
Bo 2000	8	35	15	33	6.1%	0.50 [0.25, 1.03]	2000
Smulders 2002	3	75	12	75	2.1%	0.25 [0.07, 0.85]	2002
Girou 2004	5	8	6	10	5.7%	1.04 [0.50, 2.18]	2004
Liu 2006	14	41	30	45	13.9%	0.51 [0.32, 0.82]	2006
Lorente 2007	11	140	31	140	7.4%	0.35 [0.19, 0.68]	2007
Yang 2008	12	48	20	43	9.1%	0.54 [0.30, 0.97]	2008
Bouza 2008	12	331	19	359	6.2%	0.69 [0.34, 1.39]	2008
Zheng 2008	9	30	16	31	7.5%	0.58 [0.31, 1.11]	2008
Lacherade 2010	25	169	42	164	15.6%	0.58 [0.37, 0.90]	2010
Total (95% CI)		**1193**		**1249**	**100.0%**	**0.55 [0.46, 0.66]**	
Total events	135		262				

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 7.78$, df = 12 (P = 0.80); $I^2 = 0\%$

Test for overall effect: Z = 6.57 (P < 0.00001)

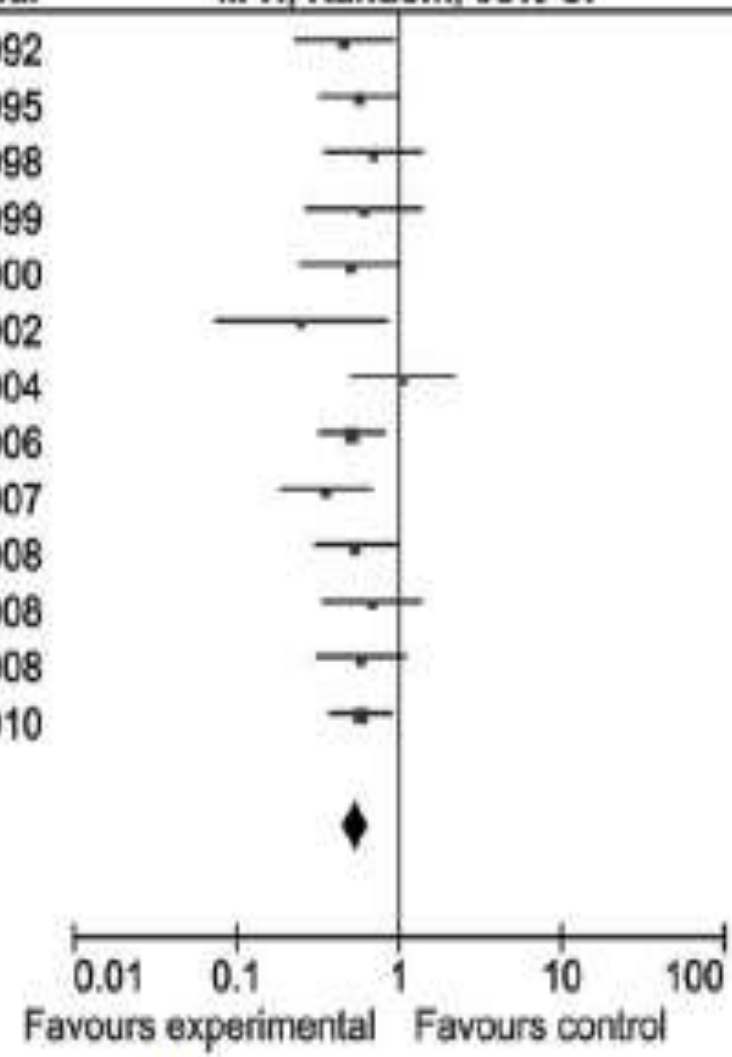


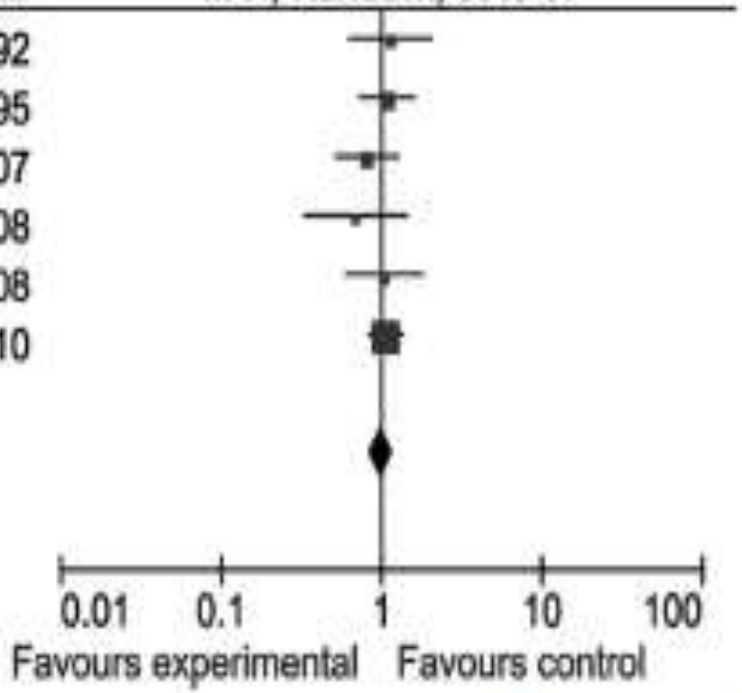
Figure 1. Rate of ventilator-associated pneumonia between groups with subglottic secretion and without subglottic secretion. *M-H*, Mantel-Henszel; *SSD*, subglottic secretion drainage; *CI*, confidence interval.

ICU MORTALITY

	SSD		Control			Risk Ratio		Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI	Year	M-H, Random, 95% CI
Mahul 1992	17	70	16	75	8.3%	1.14 [0.62, 2.07]	1992	
Valles 1995	30	76	28	77	18.2%	1.09 [0.72, 1.63]	1995	
Lorente 2007	26	140	32	140	14.1%	0.81 [0.51, 1.29]	2007	
Zheng 2008	8	30	12	31	5.5%	0.69 [0.33, 1.44]	2008	
Bouza 2008	22	331	23	359	9.4%	1.04 [0.59, 1.83]	2008	
Lacherade 2010	71	169	65	164	44.6%	1.06 [0.82, 1.37]	2010	
Total (95% CI)		**816**		**846**	**100.0%**	**1.01 [0.85, 1.20]**		
Total events	174		176					

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.30$, df = 5 (P = 0.81); $I^2 = 0\%$

Test for overall effect: Z = 0.06 (P = 0.95)

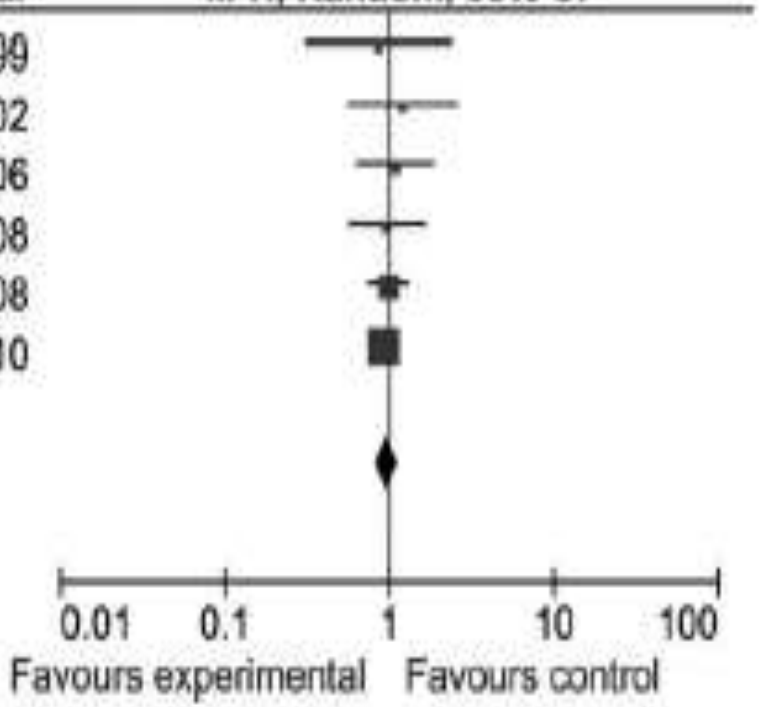


HOSPITAL MORTALITY

Study or Subgroup	SSD Events	SSD Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
Kollef 1999	6	160	8	183	2.2%	0.86 [0.30, 2.42]	1999
Smulders 2002	12	75	10	75	3.9%	1.20 [0.55, 2.61]	2002
Liu 2006	13	30	18	45	8.0%	1.08 [0.63, 1.87]	2006
Bouza 2008	23	331	26	359	8.1%	0.96 [0.56, 1.65]	2008
Yang 2008	32	48	29	43	28.3%	0.99 [0.74, 1.32]	2008
Lacherade 2010	80	169	84	164	49.5%	0.92 [0.74, 1.15]	2010
Total (95% CI)		**813**		**869**	**100.0%**	**0.97 [0.83, 1.13]**	
Total events	166		175				

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.71$, $df = 5$ ($P = 0.98$); $I^2 = 0\%$

Test for overall effect: $Z = 0.45$ ($P = 0.65$)



Contineous Vs intermittent SSD

- Of the 13 studies, five utilized intermittent suction SSD whereas the rest utilized continuous SSD
- Reduction in VAP was similar between continuous suction (RR, 0.50; 95% confidence interval, 0.37–0.66;p <.00001) and intermittent SSD (RR, 0.59; 95% confidence interval, 0.47–0.74;p <.00001)

- Lacherade et al reported stridor in eight of 79 (10.1%) SSD patients vs. four of 89 (4.5%) control patients (p 0.25)

- Current guidelines recommend the use of SSD to reduce early- and late-onset VAP .
- Disadvantage- costlier,
- more incidence of post extubation stridor

Saline instillation before suctioning

- This practice may be beneficial because greater amounts of secretions may be removed; it stimulates coughing and may decrease biofilm formation in the endotracheal tube .
- On the other hand, saline instillation may promote VAP development by dislodging more bacterial colonies from the tube resulting in contamination of the lower airways.
- Study by Caruso et al. , patients randomized to the saline group experienced less microbiologically confirmed VAP (10.8 vs. 23.5%; P=0.008)

- No significant differences were found in the incidence of endotracheal tube obstruction, pulmonary and lobar atelectasis, and mortality, or between the duration of mechanical ventilation and ICU stay.
- This one study is not considered sufficient to recommend its routine use.
- In specific situations (e.g., patients with thick and difficult to drain secretions), saline instillation may be a temporary option.

Chest physiotherapy

- Pattanshetty and Gaude evaluated the value of multimodality chest physiotherapy in the prevention of VAP.
- Patients in the control group received twice daily chest physiotherapy by manual hyperinflation and suctioning, whereas patients in the experimental group received additional chest wall vibrations.
- Study outcomes showed more successful weaning (62 vs. 31%; P=0.007) and a greater reduction in clinical pulmonary infection scores in the study group (average scores reduction: 3.4 vs. 1.9; P<0.001)

Prevention of biofilm formation

When microbes come in contact with a surface, it release adhesive molecules (adhesions) that firmly attach it to the surface .The microbe then begins to proliferate and newly formed cells release polysaccharides that coalesce to form a matrix known as slime which then encase the proliferating microbes .

The encasement formed by polysaccharide matrix is called biofilm. It is protective barrier that shields microbes from surrounding environment and allows to thrive and proliferates . Bacteria producing biofilm are resistant to host defense and antibiotic therapy.

- ETT coating –silver sulphadizene with or without chlorhexidine,, chlorhexidine and silver carbonate.
- Silver sulphadiazene can act on both gram positive and gm negative organisms ,fungi, protozoa. When exposed to cell surface the silver sulphadiazne moity breaks and silver is released and enter through the cell wall ,attach to the DNA and subsequently prevent cell proliferation. Chlorhexidine fecilitates sulfadiazine moity to enter into the cell .
- PHOTODYNAMIC THERAPY with rose Bengal coated ETT
- Antiadhesive coating of ETT with lactoferin, impregnation of PVC with surfactant containing lecithin or cholesterol

Table 3. Studied Endotracheal Tube Coatings

Category	Mechanism of Action	Studied Coating Types
Antimicrobial	Silver and sulfadiazine have cytotoxic and cytostatic properties by binding to DNA and other compounds. Chlorhexidine causes structural changes in cellular membrane, facilitating silver and sulfadiazine entry into the cell.	Silver sulfadiazine Silver sulfadiazine and chlorhexidine Silver sulfadiazine and carbon Silver sulfadiazine, chlorhexidine and carbon
Oligodynamic iontophoresis	Coating polymer and biological fluids contact causes release of silver ions. The reaction is counterbalanced by the movement of electrons from silver to platinum or another element, creating a low voltage local electric current.	Silver and carbon Silver/platinum Silver/platinum
Photodynamic	Photosensitizer pigments release singlet oxygen when exposed to ultraviolet light.	Rose bengal

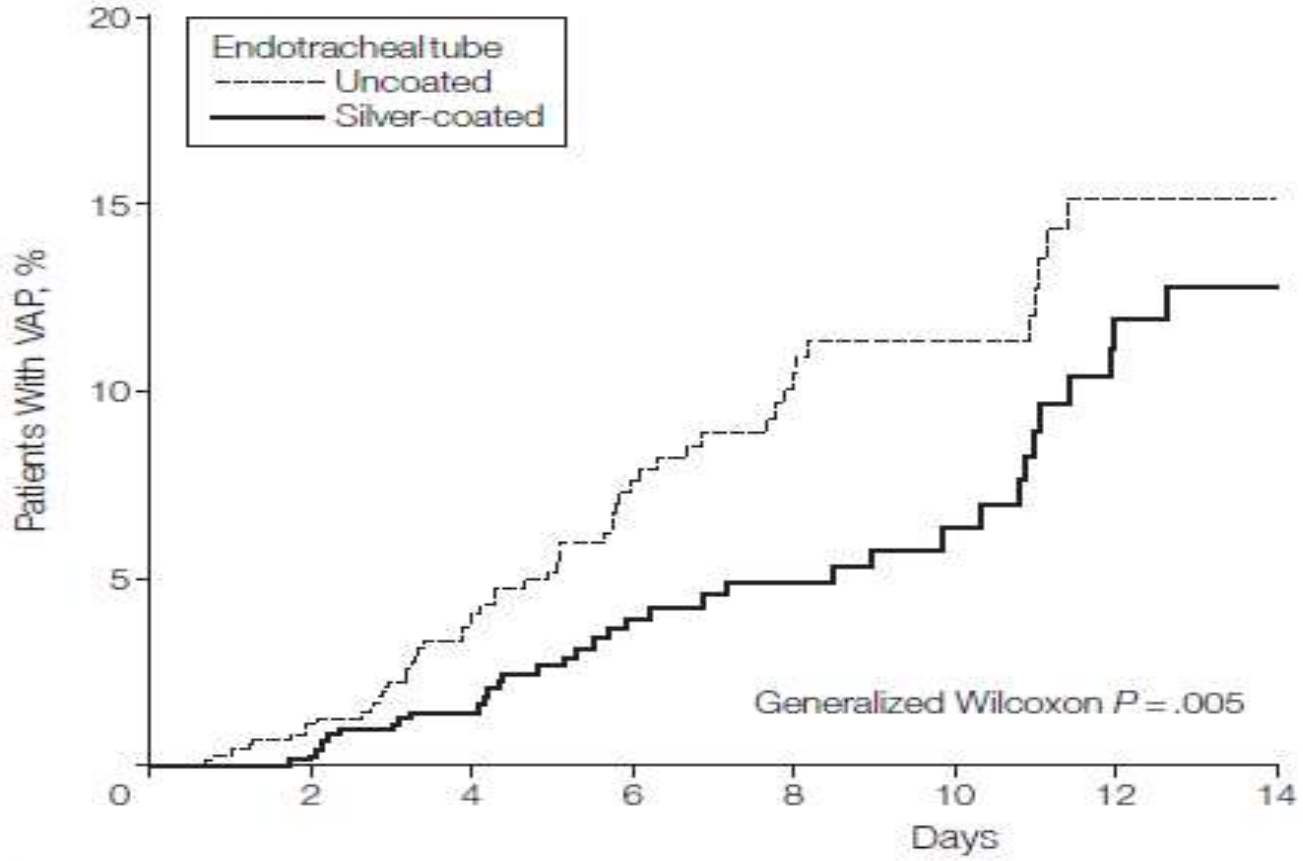
- Antibiotic coated(tobramycin gentamycin or rifampicin) ET tube- Abundant use of antibiotic coating not only increases chances of bacterial resistance but also promotes development of bacterial biofilms

Silver-Coated Endotracheal Tubes and Incidence of Ventilator-Associated Pneumonia The NASCENT Randomized Trial

Table 2. Incidence of Microbiologically Confirmed Ventilator-Associated Pneumonia (VAP)[a]

	Evaluable Patients With VAP, No./Total (%) [95% CI]			
	Silver-Coated Tube	Uncoated Tube	RR Reduction, % (95% CI)	*P* Value
VAP at any time				
Intubated ≥24 h	37/766 (4.8) [3.4-6.6]	56/743 (7.5) [5.7-9.7]	35.9 (3.6-69.0)	.03
All intubated	37/968 (3.8) [2.7-5.2]	56/964 (5.8) [4.4-7.5]	34.2 (1.2-67.9)	.04
VAP within 10 d of intubation				
Intubated ≥24 h	27/766 (3.5) [2.3-5.1]	50/743 (6.7) [5.0-8.8]	47.6 (14.6-81.9)	.005
All intubated	27/968 (2.8) (1.9-4.0)	50/964 (5.2) (3.9-6.8)	46.2 (12.6-81.1)	.007
Microbiology[b]				
Staphylococcus aureus	9	16		
Methicillin-resistant *S aureus*	3	7		
Pseudomonas aeruginosa	8	11		
Enterobacteriaceae	10	5		
Yeast	5	7		
Streptococcus species	4	7		
Haemophilus influenzae	3	3		
Acinetobacter baumannii	1	5		
Other[c]	5	17		

Kaplan Meier analysis for occurrence of microbiologically confirmed VAP In patients intubated 24 hours or longer



Uncoated, No.								
At risk	743	718	529	359	235	157	106	75
New VAP cases	0	9	20	13	8	0	5	0
Silver-coated, No.								
At risk	766	750	565	387	264	179	124	79
New VAP cases	0	7	8	7	3	3	7	2

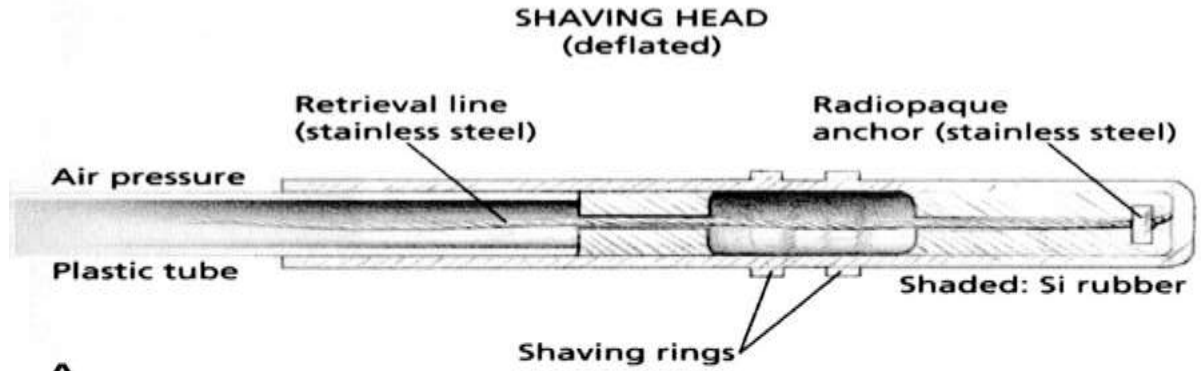
- Patients receiving a silver-coated endotracheal tube had a statistically significant reduction in the incidence of VAP and delayed time to VAP occurrence compared with those receiving a similar, uncoated tube.
- Disadvantage-costlier

Mucous shaver

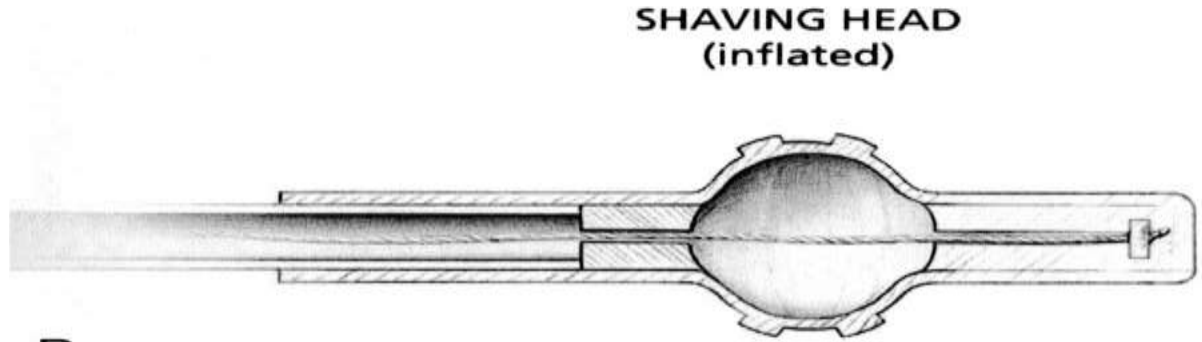
This device was made to remove the biofilm formation on the inner side of the endotracheal tube. Conventional clearing of ET tube by suction catheter may not remove all secretions.

. The device is introduced through the tube until its tip reaches just beyond the end of the tube, when the balloon is inflated sufficiently to force the two shaving rings firmly against the wall of the tube.

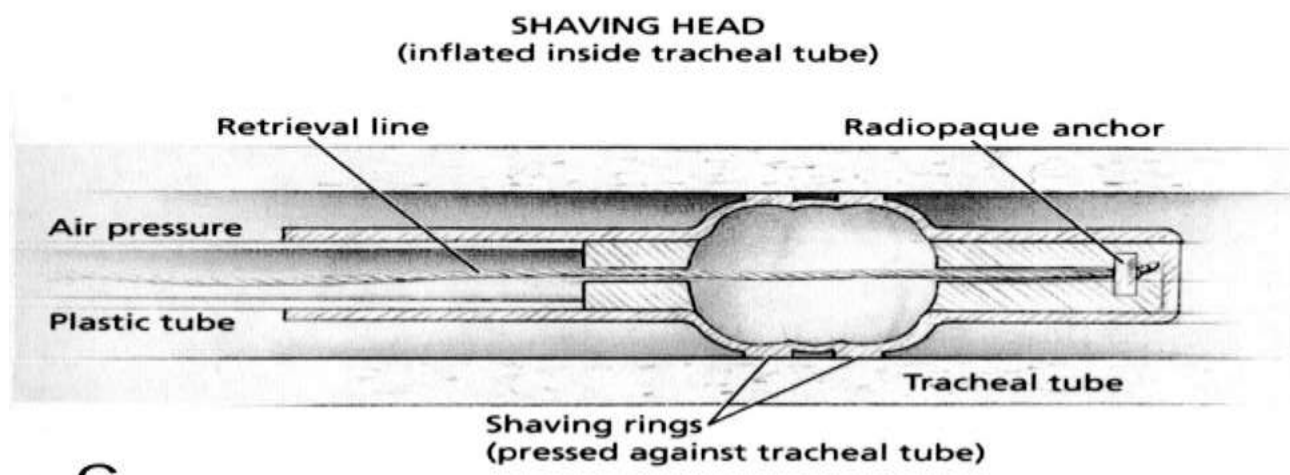
Thereafter, the device is gently retrieved during a period of 3–5 seconds to remove the remaining accumulated mucus from the lumen of the tube


SHAVING HEAD
(deflated)
Retrieval line
(stainless steel)
Radiopaque
anchor (stainless steel)
Air pressure
Plastic tube
Shaded: Si rubber
Shaving rings

A


SHAVING HEAD
(inflated)

B


SHAVING HEAD
(inflated inside tracheal tube)
Retrieval line
Radiopaque anchor
Air pressure
Plastic tube
Tracheal tube
Shaving rings
(pressed against tracheal tube)

C

Novel System for Complete Removal of Secretions within the Endotracheal Tube
*The Mucus Shave Theodor Kolobow, M.D.,*et al

- The study group included six sheep. Every 6 h, after routine suctioning, the Mucus Shaver was introduced through the connector piece of the ETT .
- In the study group, scanning electron microscopy of the internal lumen of the ETT showed no biofilm or proteinaceous material
- In the control group, there was extensive biofilm formation .

- **Mucous slurper**- used to remove secretion from proximal trachea
- It is a modified tracheal tube that allows automatic aspiration of mucous as it reaches immediate vicinity of ETT.
- Kolobow T et al and Li Basi G et al in there study with mucous slurper showed that it is safe and prevented all mucous accumulation within the ETT

Shape of ET cuff

- Dave et al. demonstrated that endotracheal tubes with taper-shaped cuffs have superior sealing capacity compared to cylindrical-shaped cuffs and are equally effective as cylindrical-shaped polyurethane cuffed endotracheal tubes.

BMJ

- Oral decontamination for prevention of pneumonia in mechanically ventilated adults: systematic review and meta-analysis
- Ee Yuee Chan, nurse educator,1 Annie Ruest, infectious diseases consultant ,2 Maureen O Meade, associate professor,3 Deborah J Cook, professor3

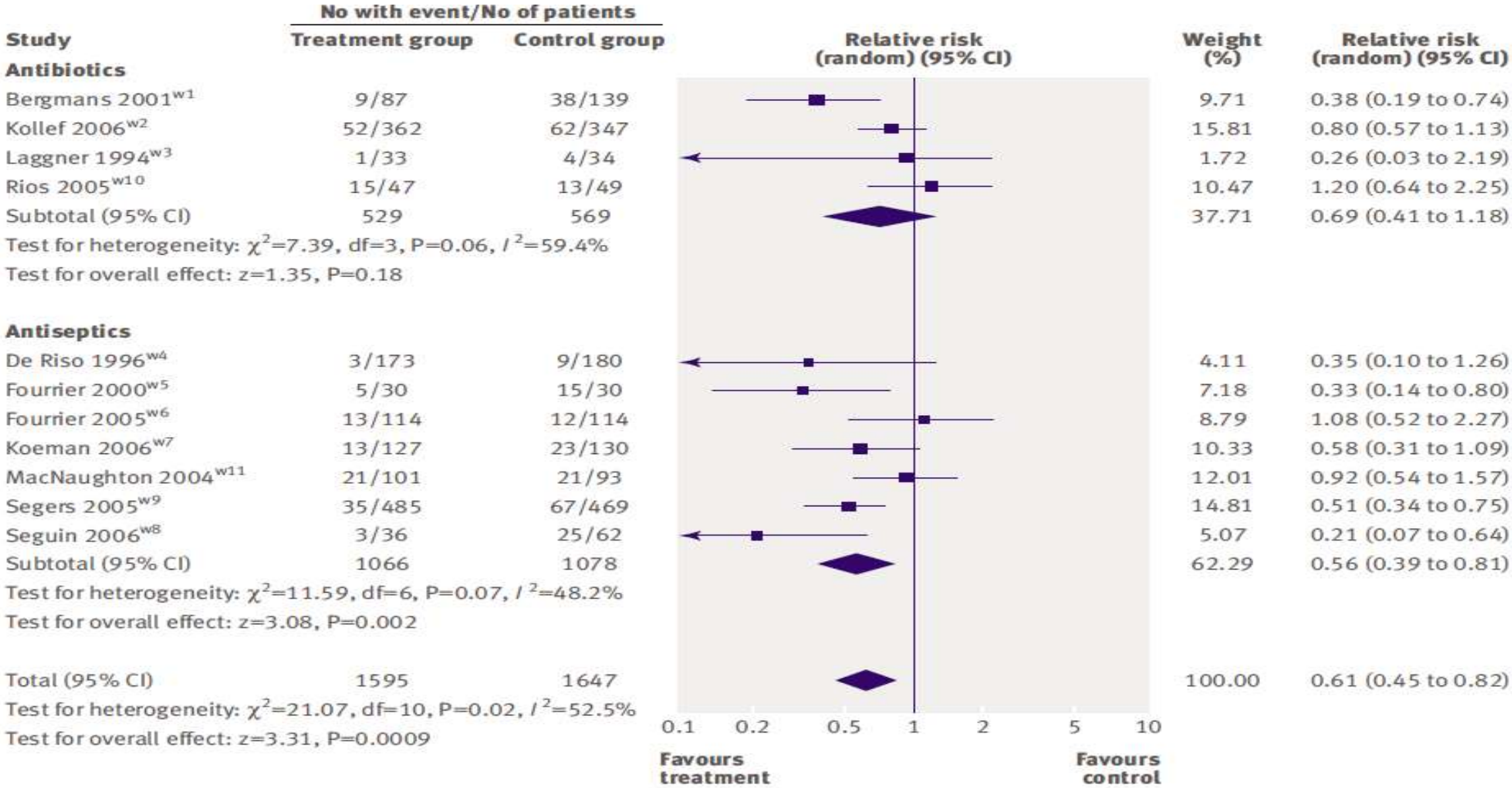


Fig 2 | Forest plot showing effect of oral decontamination prophylaxis compared with no prophylaxis on risk of ventilator associated pneumonia

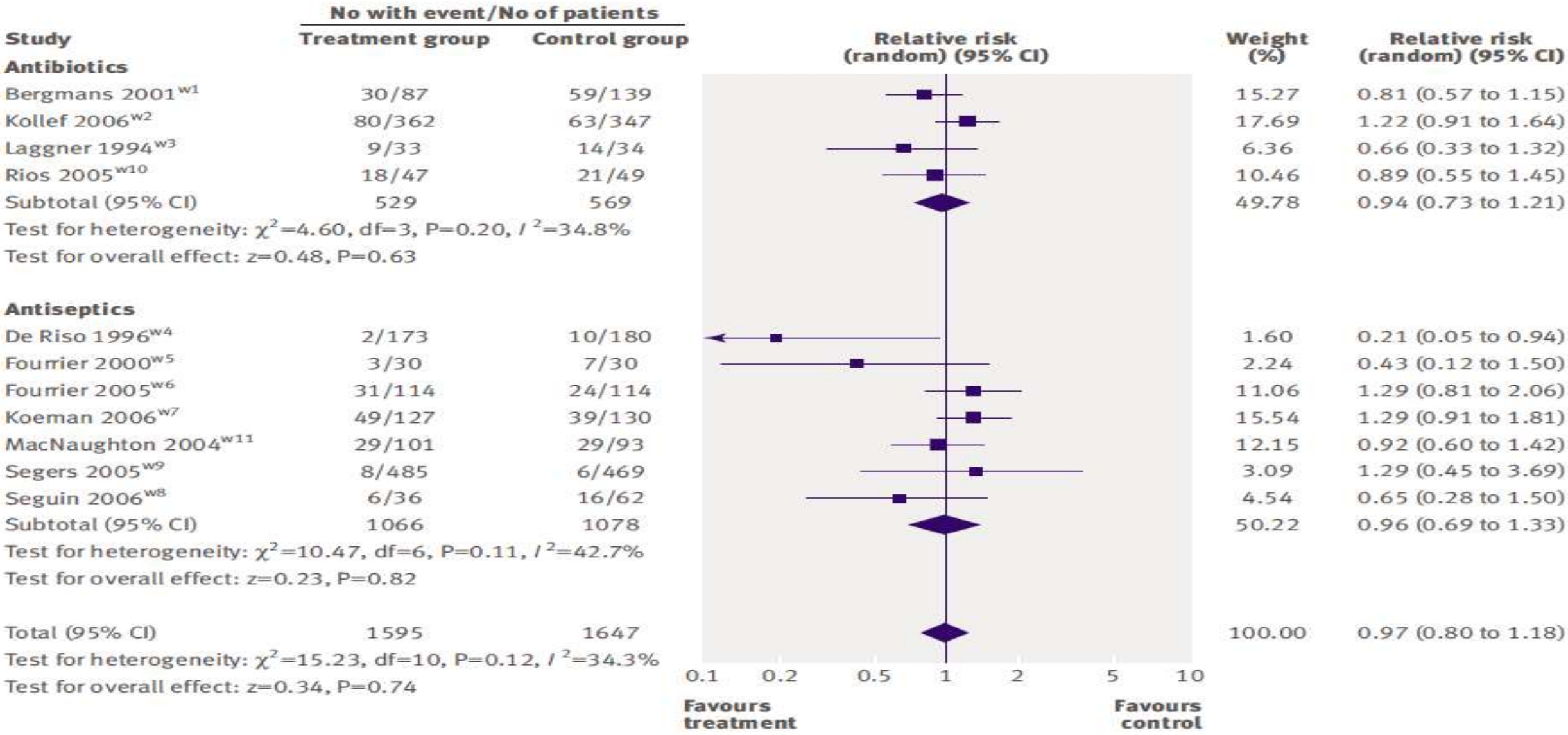


Fig 3 | Forest plot showing effect of oral decontamination prophylaxis compared with no prophylaxis on overall mortality

- Oral decontamination using antiseptics reduces the incidence of ventilator associated pneumonia Neither antibiotic nor antiseptic oral decontamination reduces overall mortality or duration of mechanical ventilation or stay in intensive care

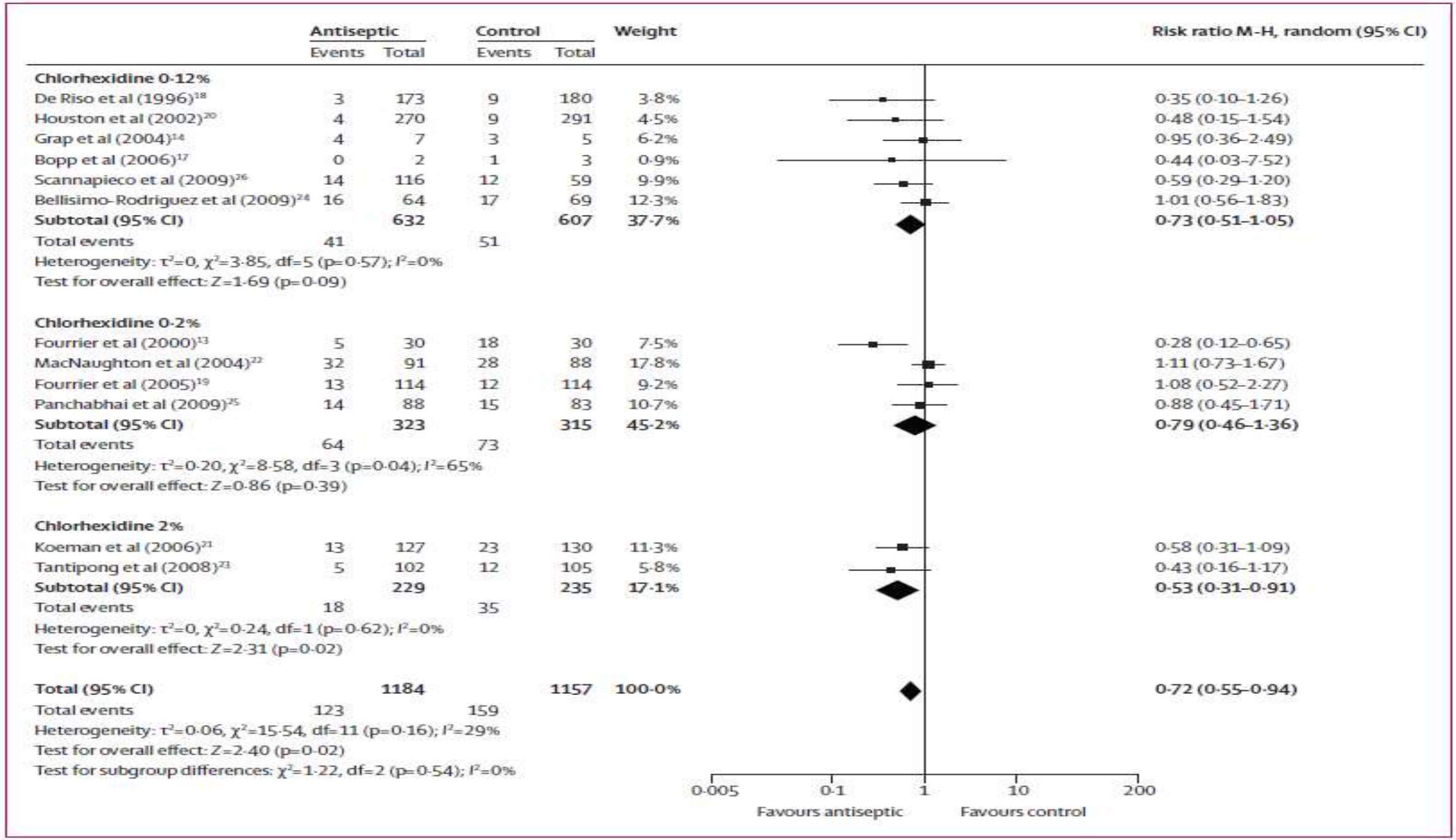
- **Prevention of ventilator-associated pneumonia with oral**
- **antiseptics: a systematic review and meta-analysis**
- **Sonia O Labeau, *Katrien Van de Vyver, Nele Brusselaers, Dirk Vogelaers, Stijn I Blot* lancet.com/infection **Vol 11 November 2011**

In this meta analysis of all 14 retrieved studies the pooled effect of oral care with topical chlorhexidine or povidone-iodine on the occurrence of ventilator-associated pneumonia were analyzed.

Result- reduction of the disease , with a moderate statistical heterogeneity.

Subgroup analysis based on type of antiseptic showed a significant reduction in cases of ventilator-associated pneumonia in the chlorhexidine studies, but the effect resulting from povidone-iodine remains unclear.

- To determine the most effective chlorhexidine concentration, subgroup analyses included chlorhexidine 2%,0.2% and 0.12%. Chlorhexidine. 2% was to be associated with a significant risk reduction with a low heterogeneity . This protective effect of chlorhexidine was less strong at lower concentrations, with an RR of 0.79 chlorhexidine 0.2% and 0.73 for chlorhexidine 0.12%, and with broad 95% CIs enclosing RR 1 .


Antiseptic
Control
Weight
Risk ratio M-H, random (95% CI)
Events Total Events Total
Chlorhexidine 0·12%
De Riso et al (1996)[18] 3 173 9 180 3·8% 0·35 (0·10–1·26)
Houston et al (2002)[20] 4 270 9 291 4·5% 0·48 (0·15–1·54)
Grap et al (2004)[14] 4 7 3 5 6·2% 0·95 (0·36–2·49)
Bopp et al (2006)[17] 0 2 1 3 0·9% 0·44 (0·03–7·52)
Scannapieco et al (2009)[26] 14 116 12 59 9·9% 0·59 (0·29–1·20)
Bellisimo-Rodriguez et al (2009)[24] 16 64 17 69 12·3% 1·01 (0·56–1·83)
Subtotal (95% CI) 632 607 37·7% 0·73 (0·51–1·05)
Total events 41 51
Heterogeneity: τ²=0, χ²=3·85, df=5 (p=0·57); I²=0%
Test for overall effect: Z=1·69 (p=0·09)
Chlorhexidine 0·2%
Fourrier et al (2000)[13] 5 30 18 30 7·5% 0·28 (0·12–0·65)
MacNaughton et al (2004)[22] 32 91 28 88 17·8% 1·11 (0·73–1·67)
Fourrier et al (2005)[19] 13 114 12 114 9·2% 1·08 (0·52–2·27)
Panchabhai et al (2009)[25] 14 88 15 83 10·7% 0·88 (0·45–1·71)
Subtotal (95% CI) 323 315 45·2% 0·79 (0·46–1·36)
Total events 64 73
Heterogeneity: τ²=0·20, χ²=8·58, df=3 (p=0·04); I²=65%
Test for overall effect: Z=0·86 (p=0·39)
Chlorhexidine 2%
Koeman et al (2006)[21] 13 127 23 130 11·3% 0·58 (0·31–1·09)
Tantipong et al (2008)[23] 5 102 12 105 5·8% 0·43 (0·16–1·17)
Subtotal (95% CI) 229 235 17·1% 0·53 (0·31–0·91)
Total events 18 35
Heterogeneity: τ²=0, χ²=0·24, df=1 (p=0·62); I²=0%
Test for overall effect: Z=2·31 (p=0·02)
Total (95% CI) 1184 1157 100·0% 0·72 (0·55–0·94)
Total events 123 159
Heterogeneity: τ²=0·06, χ²=15·54, df=11 (p=0·16); I²=29%
Test for overall effect: Z=2·40 (p=0·02)
Test for subgroup differences: χ²=1·22, df=2 (p=0·54); I²=0%
0·005
0·1
1
10
200
Favours antiseptic
Favours control

Early Vs late tracheostomy

- Blot and colleagues (41) reported the results of a trial in which 125 patients expected to require more than 7 days of mechanical ventilation were randomized to receive either prolonged intubation or early (within 4 d) tracheotomy. No difference was found between the two groups in mortality, VAP incidence, duration of mechanical ventilation, ICU stay, sedation use, or laryngeal or tracheal complications.
- Greater comfort was the sole benefit afforded by tracheotomy

Effect of Ventilator Circuit Changes on Ventilator-Associated Pneumonia: A Systematic Review and Meta-analysis

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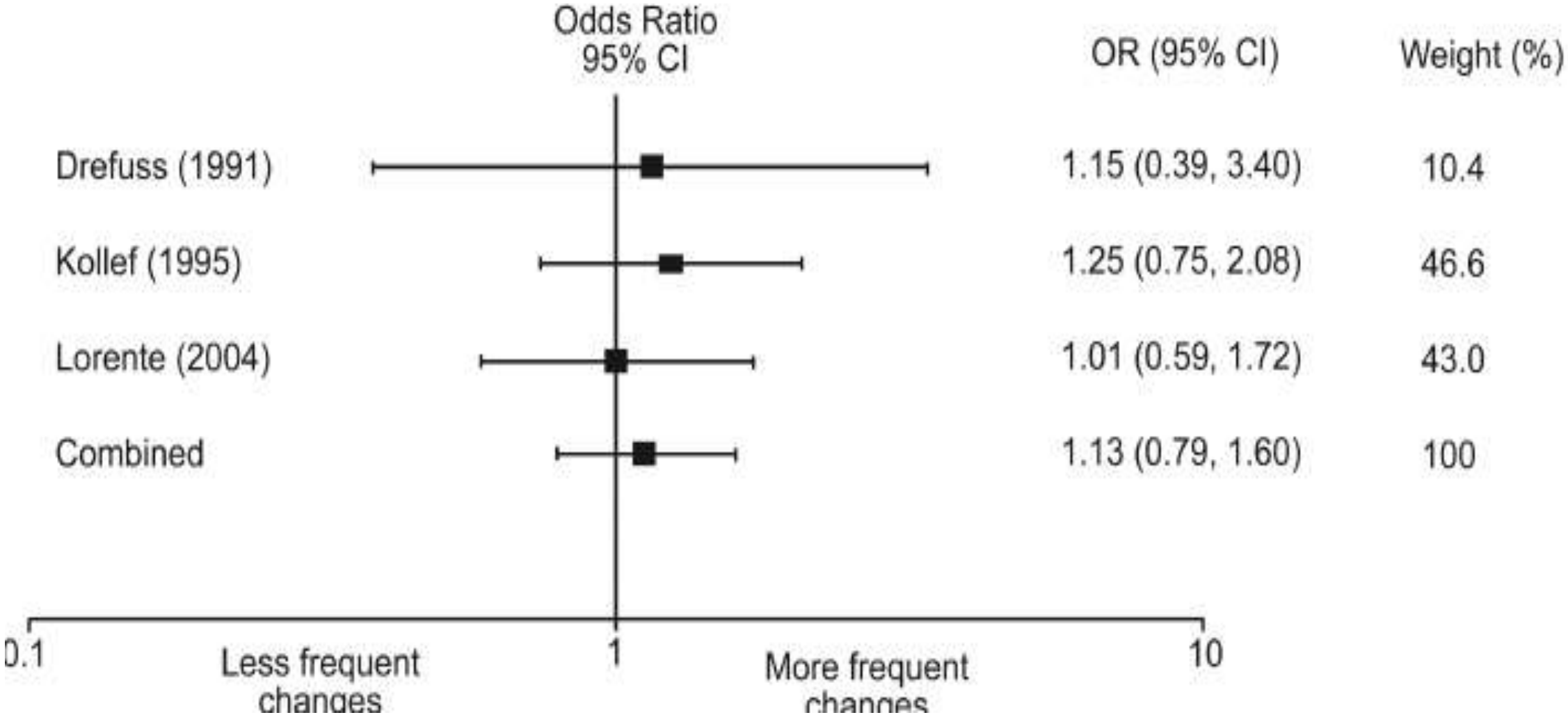
Table 2. Incidence of Pneumonia Associated With Circuit Changes

Study	Study Design	Circuit-Change Interval	Number of Patients	Ventilator-Associated Pneumonia	
				Events/Patients (%)	Events/1,000 Ventilator Days
Dreyfuss[4]	Randomized	2 d	35	31.4	NA
		No change	28	28.6	NA
Hess[14]	Sequential	2 d	1,708	5.6	9.6
		7 d	1,715	4.6	8.6
Kollef[15]	Randomized	7 d	153	28.8	17.4
		No change	147	24.5	16.4
Long[16]	Randomized	2–3 d	213	12.7	9.4
		7 d	234	11.1	9.9
Thompson[17]	Sequential	7 d	31	9.7	1.9
		14 d	18	11.1	1.6
Kotilainen[18]	Sequential	3 d	88	9.1	12.9
		7 d	146	6.2	7.4
Fink[6]	Sequential	2 d	336	10.7	11.9
		7 d	137	2.9	3.3
		30 d	157	6.4	6.3
Han[7]	Sequential	2 d	413	9.2	16.7
		7 d	231	3.5	8.2
Lien[19]	Sequential	2 d	6,213	2.8	2.7
		7 d	7,068	3.2	2.6
Lorente[20]	Randomized	2 d	143	23.1	15.5
		No change	161	23.0	14.8

Meta anlysis of 3 randomized trials on VAP with regular circuit changes every 2 days or every 7 days Vs no circuit changes



. Compared to patients exposed to circuit changes every 7 days, patients who received circuit changes every 2 days had a higher risk of ventilator-associated pneumonia (odds ratio 1.928, 95% confidence interval 1.080–3.443).

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Impact of passive humidification on clinical outcomes of mechanically ventilated patients: A meta-analysis of randomized controlled trials*

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- This Meta-analysis of randomized controlled trials compared HMEs(heat moisture exchanger) with HHs(heated humidifier) for the management of mechanically ventilated patients to determine the impact of these devices on clinical outcomes of such patients.

- *Results:* There was no difference in incidence of ventilator-associated pneumonia among patients managed with HMEs and HHs (OR 0.85, 95% CI 0.62–1.16).
- There was no difference between the compared groups regarding mortality (OR 0.98, 95% CI 0.80 –1.20), length of intensive care unit stay (weighted mean differences, 0.68 days, 95% CI 3.65 to 2.30), duration of mechanical ventilation (weighted mean differences, 0.11 days, 95% CI 0.90 to 1.12), or episodes of airway occlusion (OR 2.26, 95% CI 0.55–9.28).

- Recommendations for our RICU- Education of all category of staff regarding hand washing before and after examining patients
- Use of sterile gowns
- Use of ventilator circuits after proper sterilization and avoid frequent change of circuit unless there is obvious soiling
- Use of ET tube with SSD and ultrathin polyurethane cuff membrane
- Saline instillation before tracheal suctioning only if there is thick secretion obstructing ET lumen

- Early tracheostomy in those patients who require prolonged mechanical ventilation to decrease duration of mechanical ventilation and lCU stay only .
- Daily SBT after stopping sedation to wean the patient as early as possible .
- Use sterile water in humidifier ,not distilled water
- SDD may be tried
- Mouth wash with 2% chlorhexidine if available