



# Ventilator Associated Pneumonia: Evidence for Prevention

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The Intensive care hospital acquired pneumonia represent almost 40% of the hospital acquired pneumonia. The ventilator associated pneumonia is behind 86% of these cases. It was estimated that the cost of treating these patients in Europe was around 6 Billion Euros.

The prevention guidelines used in this presentation are adopted from CDC and the Healthcare Infection and Control Practices Advisory Committee, Canadian critical care group trials, Canadian Critical Care Society and Centre for Infectious Disease Prevention and Control, Public Health Agency of Canada <sup>1-2</sup> They were updated by the guidelines published in 2008 by National institute of clinical excellence NICE and British Society for

Antimicrobial Chemotherapy, and Association of Medical Microbiology and Infectious Disease of Canada and the Canadian Thoracic Society <sup>3-4</sup> The guidelines comprises many non pharmacological strategies. Only the most important ones will be discussed in the next 20 minutes.

The route of endotracheal intubation, oral and nasal, were studied. Oral endotracheal intubation is associated with a lower incidence of VAP and a lower incidence of sinusitis when compared to nasotracheal intubation.<sup>5-6</sup>

Furthermore the occurrence of VAP is lower in patients who do not develop sinusitis<sup>7</sup>. In spite the old concept, that nasal route provide a safer fixation and stability yet the incidence of VAP prevailed and the recommendation is to use the oral route.

Bacterial colonization of condensates in ventilatory circuits plays a role in the pathogenesis of VAP. Vigilance is required to prevent flushing the condensate into the lower airway or into in-line medication nebulizers during turning patients. Theoretically frequent changes of ventilator circuits should lower the risk of bacterial colonization. However, many trials showed no advantage to change circuits less than once a week, changing circuits more often was only associated with a higher cost<sup>17-18-19-20-21</sup>.

The recent trend in the indication of tracheostomy is not related to time since intubation but rather to the benefit of the patients. Tracheostomy is indicated either for the interest of the patient management: phonation, socialization, early ambulance and discharge; or as a part of the treatment strategy: easier and safer suction of secretions or decreasing the dead space. Until 2008, there was no recommendation, due to insufficient evidence in favor of either early or late tracheostomy<sup>24</sup>. A well designed RCT appeared recently which might change the recommendation in favor of early tracheostomy.

The semirecumbent position in bed is associated with a decrease incidence of VAP particularly during feeding.

Although unsafe for some patients e.g. spinal fracture, yet if not contraindicated it is feasible and low costs. It even decreases the mortality <sup>25</sup>. The prone position may decrease VAP too but methodology, lack of feasibility and universal application are not in its favor. Kinetic beds may decrease incidence of VAP. They did not reduce mortality or duration of MV and feasibility and cost may be a barrier in implementation<sup>26</sup>.

**Key words: endotracheal intubation, oral ,nasal, mechanical ventilation MV, ventilator associated pneumonia VAP.**



28 14:35

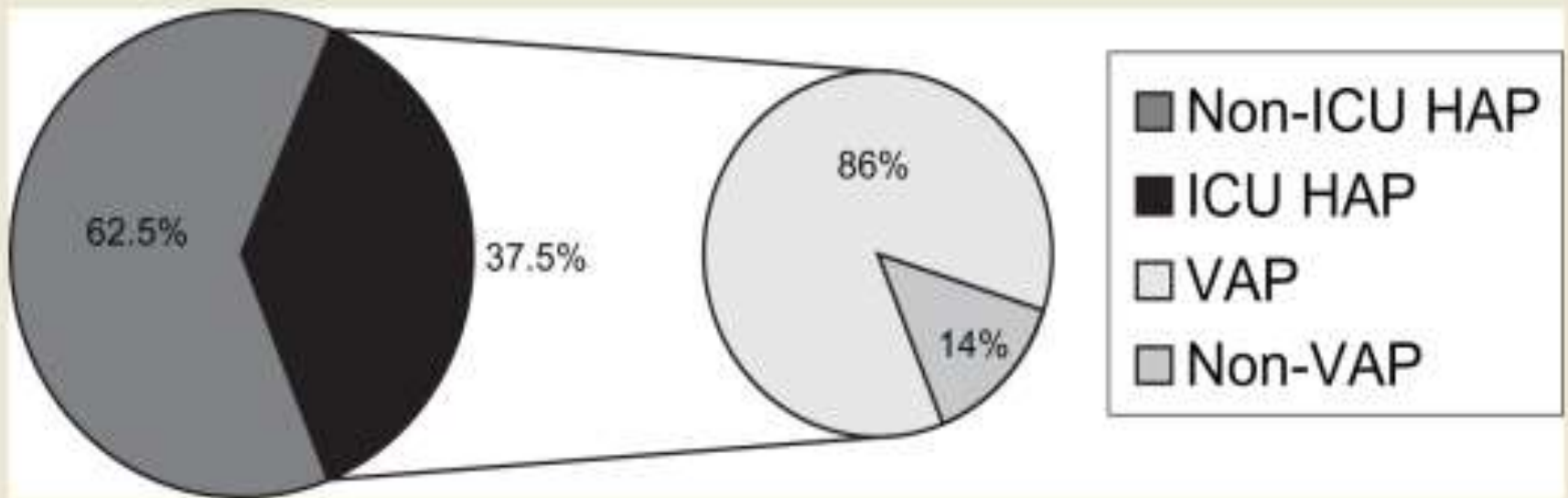


28 14:38





# Breakdown of hospital-acquired pneumonia/intensive care unit (HAP/ICU) and HAP/ventilator-associated pneumonia (VAP).



6.3/1000 day ventilation

• *Can J Infect Dis Med Microbiol.* 2008 January; 19(1): 19–53





# Prevention of VAP

**CDC and the Healthcare Infection and Control Practices Advisory Committee**  
Guidelines for preventing health-care-associated pneumonia, 2003  
Tablan et al MMWR Recomm Rep 2004;53:1-36.

- ∴ **Canadian critical care group trials, Canadian Critical Care Society and Centre for Infectious Disease Prevention and Control, Public Health Agency of Canada**  
Evidence-Based Clinical Practice Guideline for the Prevention of VAP.  
Dodek P et al. Annals of Internal Medicine 2004.141:4

**National institute of clinical excellence NICE and British Society for Antimicrobial Chemotherapy**  
Guidelines on the diagnosis, prevention and treatment of VAP in the UK.  
Masterton RG et al. Journal of Antimicrobial Chemotherapy 2008 62: 5–34

**Association of Medical Microbiology and Infectious Disease Canada and the Canadian Thoracic Society**  
Clinical practice guidelines for HAP and VAP in adults.  
Rotstein C et al. Can J Infect Dis Med Microbiol 2008; 19(1):19-53.



# Non-Pharmacological strategies

- 1- Route of endotracheal intubation
- 2- Endotracheal cuff & cuff pressure
- 3- Subglottic secretion drainage
- 4- Closed vs. open endotracheal suctioning system
- 5- Change of endotracheal suctioning system
- 6- Routine change of ventilator circuits
- 7- Type of airway humidification
- 8- Frequency of humidifiers changes
- 9- Avoiding delays in extubation
- 10- Non-Invasive MV (NPPV)
- 11- Early tracheostomy
- 12- Bed elevation and rotational therapy







# Route of Endotracheal Intubation

- Orotracheal intubation is associated with a lower incidence of VAP compared with nasotracheal intubation.  
Holzapfel et al. Crit Care Med 1993; 21:1132-1138
- Orotracheal intubation is associated with a decreased incidence of sinusitis. Rouby et al. Am J Respir Crit Care Med. 1994;150:776-83
- Incidence of VAP is lower in pts who do not develop sinusitis.  
Holzapfel et al. Am J Respir Crit Care Med. 1999;159:695-701
- ✓ Orotracheal route of intubation is recommended when intubation is necessary.



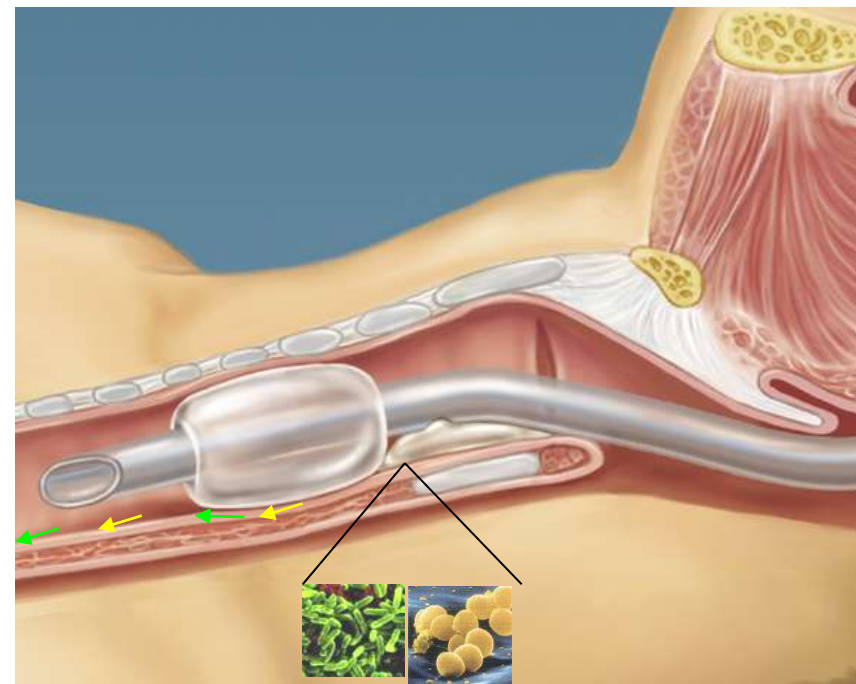
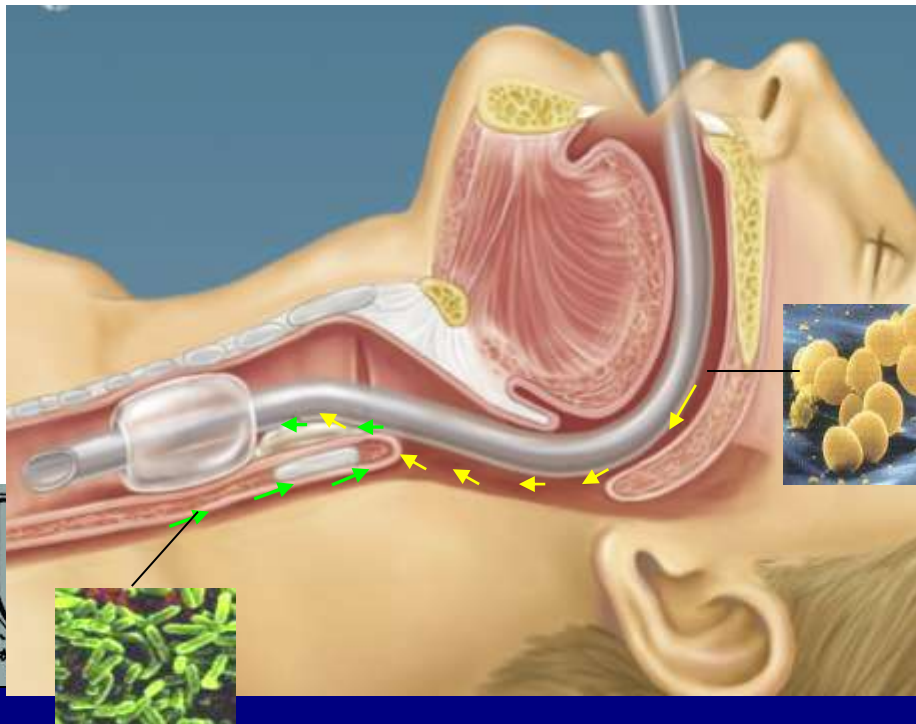
# Endotracheal cuff & cuff pressure

Cuff should make an adequate seal

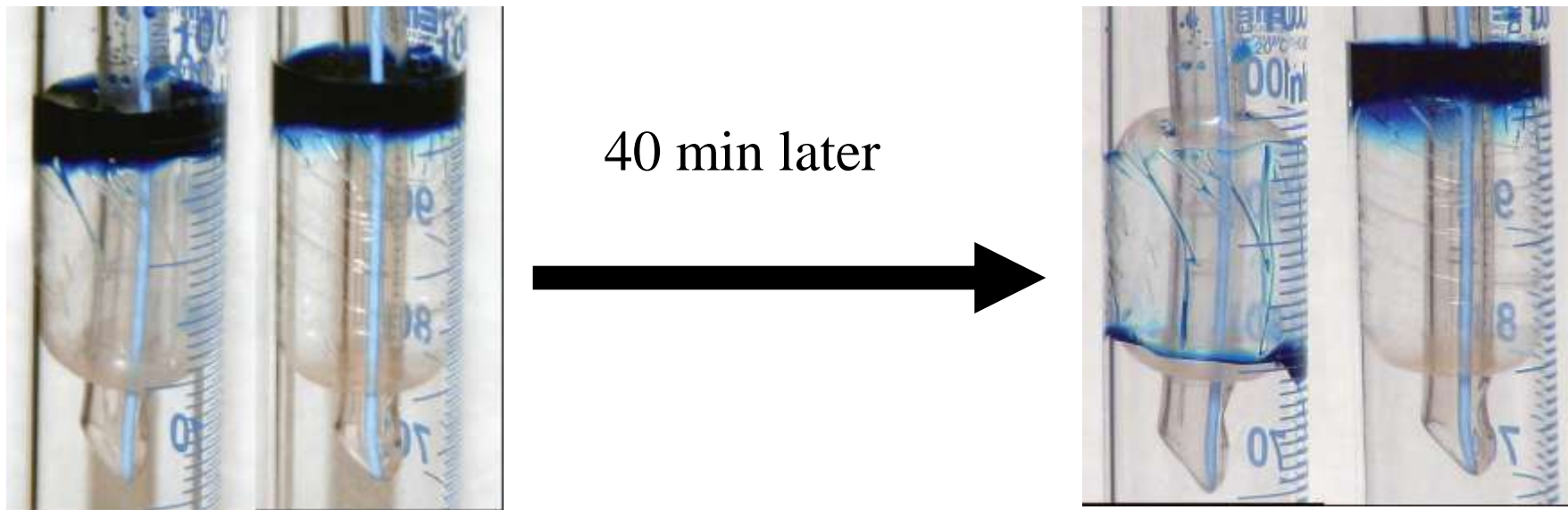
Prevent loss of gas during MV

Avoid leakage of bacterial pathogens into the lower respiratory tract.

Cuff pressure ???



# Endotracheal cuff & cuff pressure



Lucangelo U et al. Crit Care Med 2008; 36:1132-1138

- ✓ ET tube cuff should maintain an adequate seal by maintaining pressure inside the cuff at 20-30 cmH<sub>2</sub>O

Cook et al. JAMA 1998;279:781-7.

Rello et al. Am J Respir Crit Care Med 1996;154:111-5

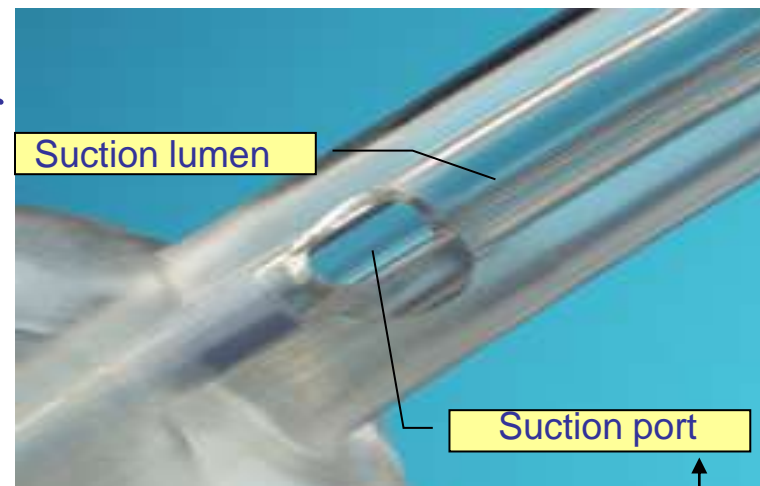
# Subglottic Secretions Drainage SSD



Continuous aspiration of subglottic secretions that accumulate above ETT cuff

Use of specially designed endotracheal tube significantly reduces the incidence of early-onset VAP

Less effective strategy for late onset disease with AROs, and higher mortality and morbidity



Cross Section



Repositioning ETT

Re-intubation

Cuff issues

Mahul, et al. Intensive Care Med 1992;18:20-5.

Vallés et al. Ann Intern Med 1995;122:179-86.

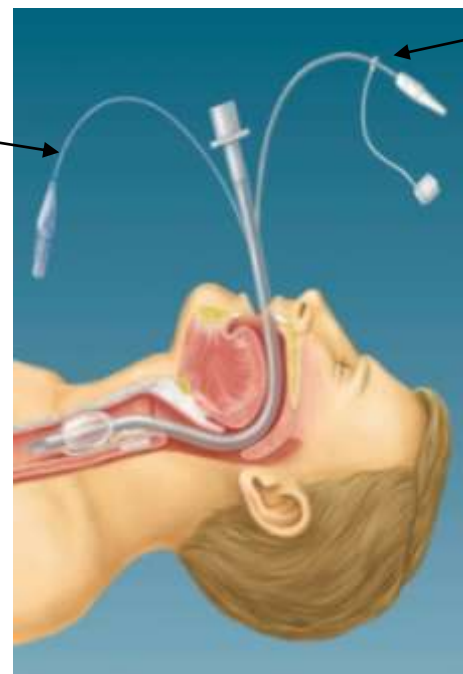
Pneumatikos et al. Intensive Care Med 2002;28:432



# Subglottic Secretion Tubes



Cuff Inflation  
line



Suction  
lumen





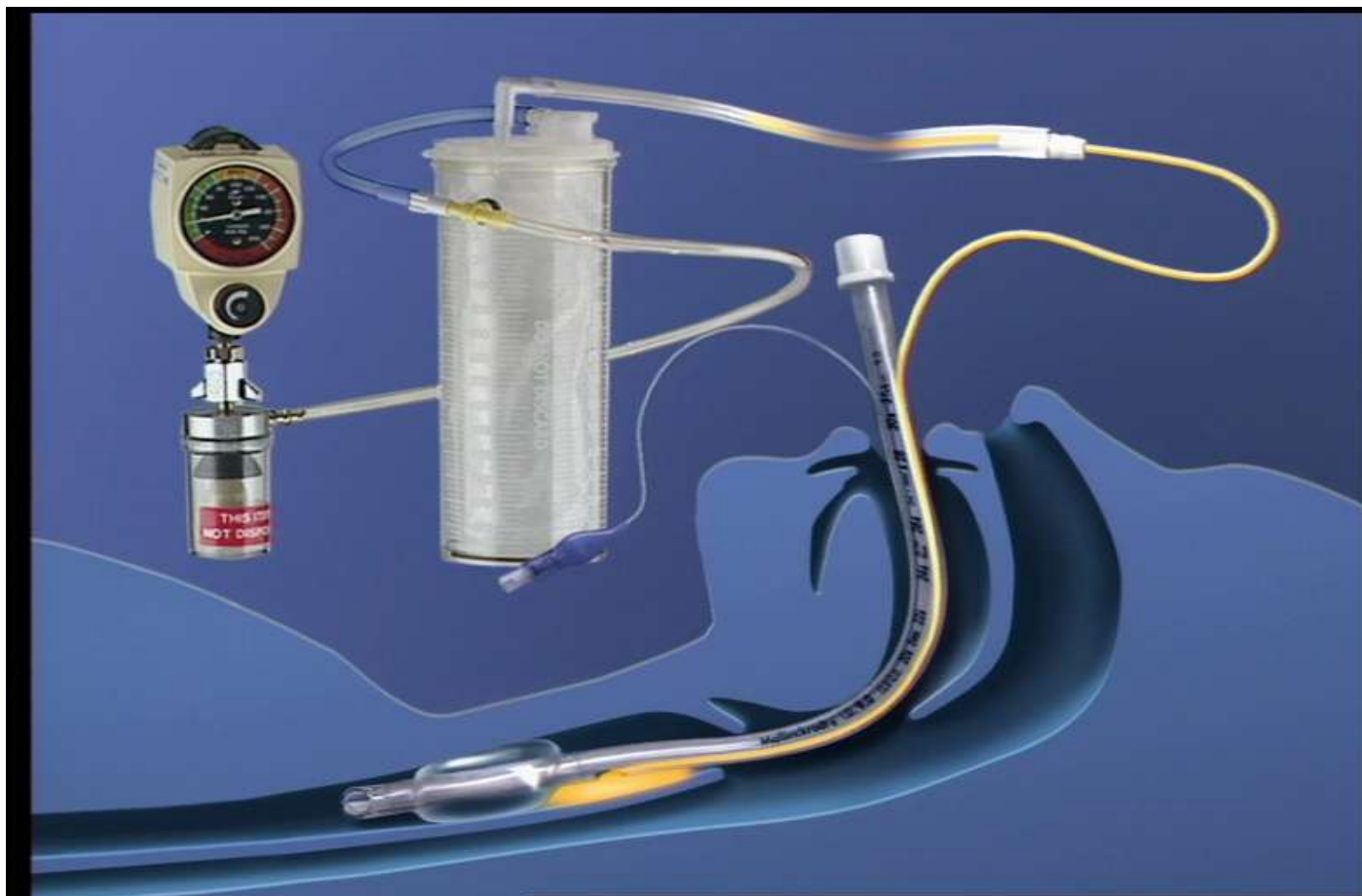
# SSD practices



Automatic intermittent -20 and -100mmhg

manual

# Subglottic Secretions Drainage Systems



Automated cycled suction

# Subglottic Secretions Drainage (SSD)



## Outcomes

### Risk of VAP

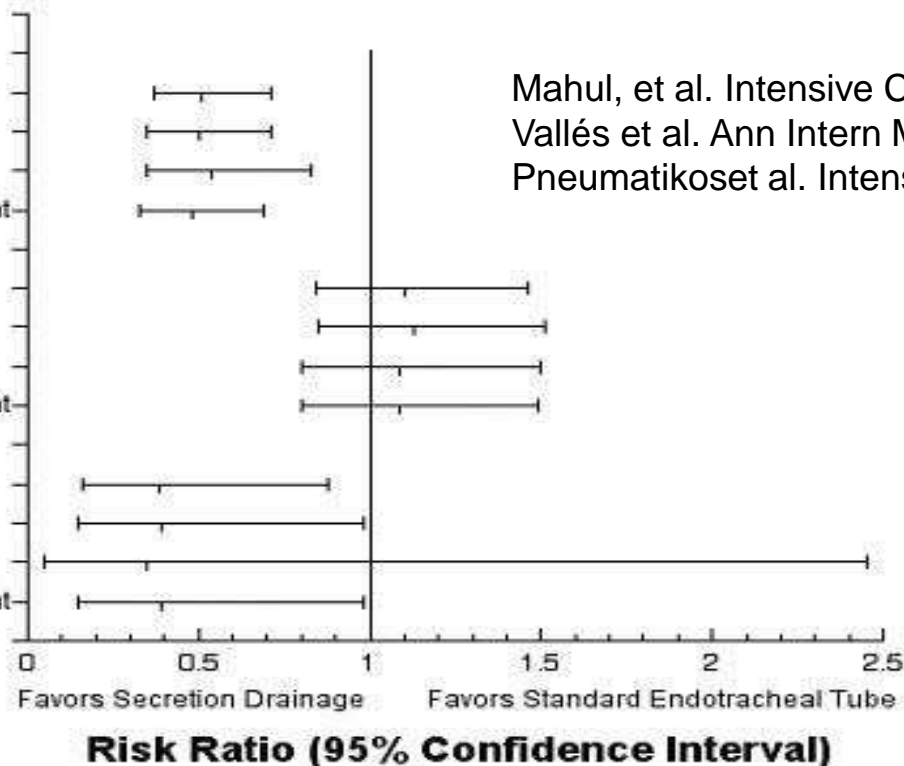
- Overall
- Exclude Kollef
- Intention-to-Treat
- Non-intention-to-Treat

### Mortality

- Overall
- Exclude Kollef
- Intention-to-Treat
- Non-intention-to-Treat

### Risk of Early VAP

- Overall
- Exclude Kollef
- Intention-to-Treat
- Non-intention-to-Treat



Mahul, et al. Intensive Care Med 1992;18:20-5.  
 Vallés et al. Ann Intern Med 1995;122:179-86.  
 Pneumatikos et al. Intensive Care Med 2002;28:432-7.

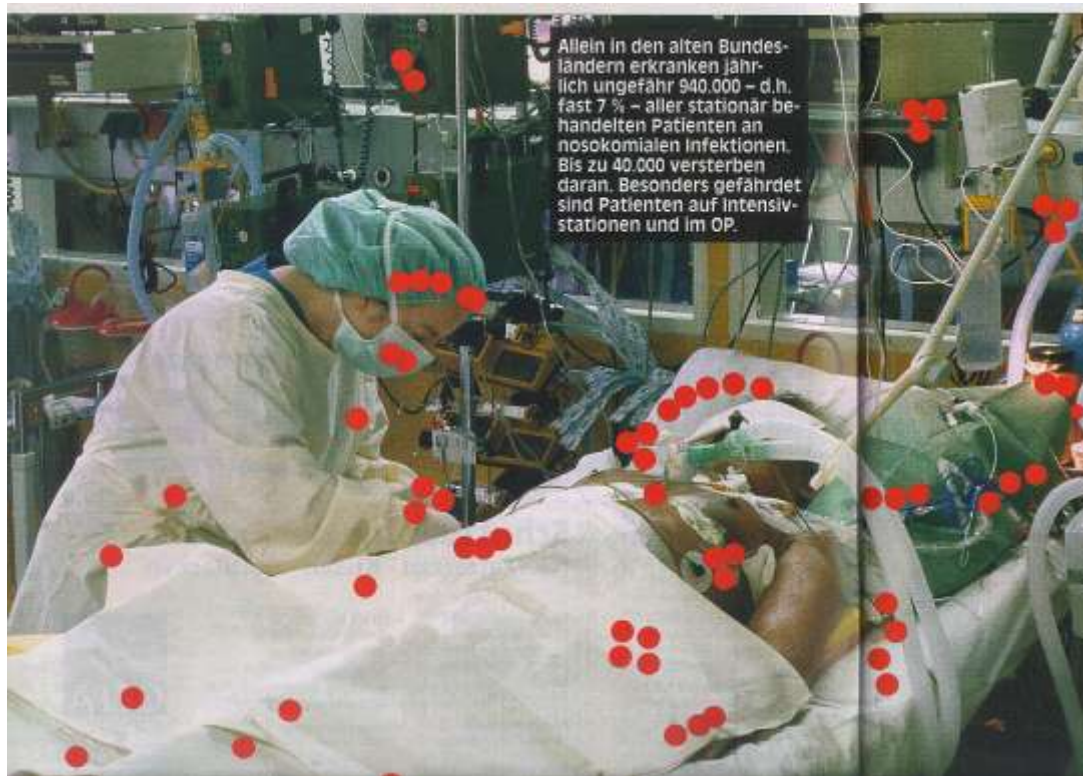
Dezfulian C et al.  
 Am J Med 2005;  
 118:11-18

✓ Use of subglottic secretion drainage is recommended in patients expected to be mechanically ventilated > 72 hours



# Closed vs. Open Suctioning System

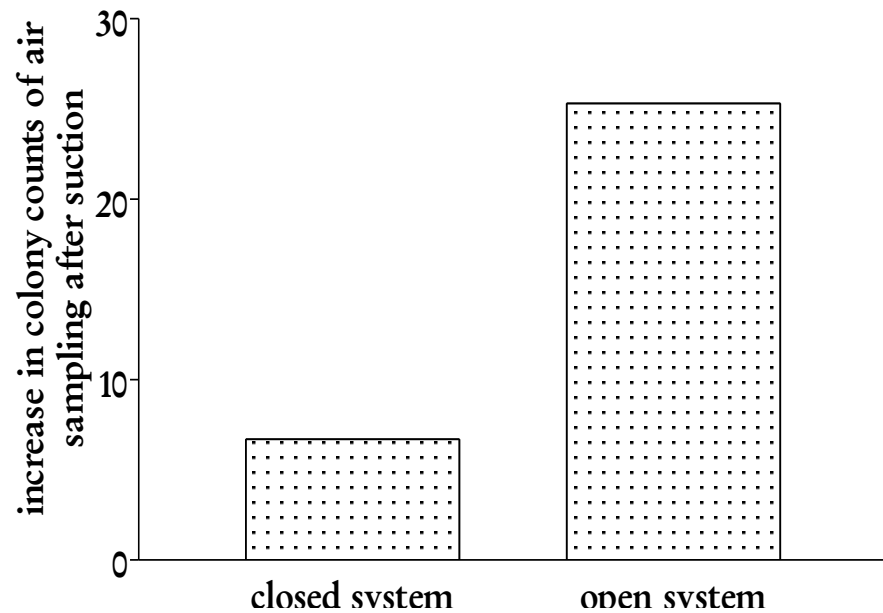
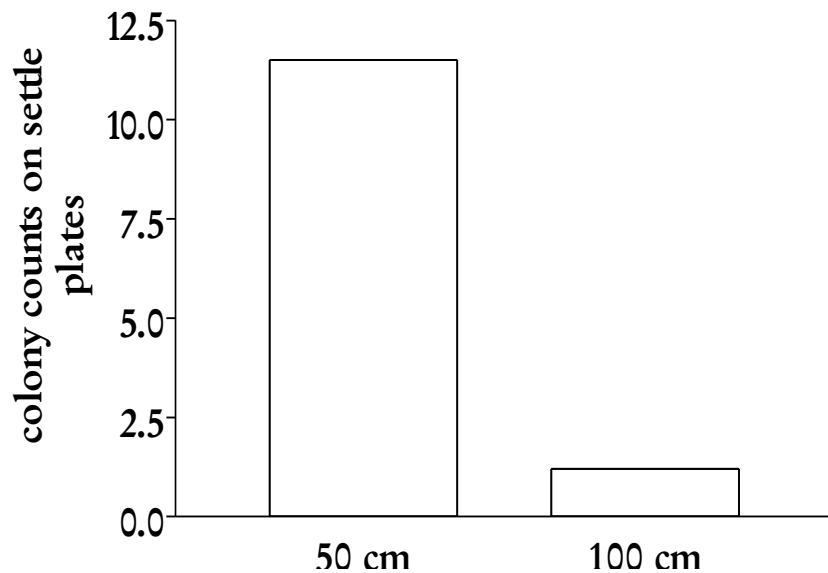
## Spread of contamination



At every disconnection, aerosolized secretions are expelled and spread for up to 1-2 meters around the patient's area

# Closed vs. Open Suctioning System

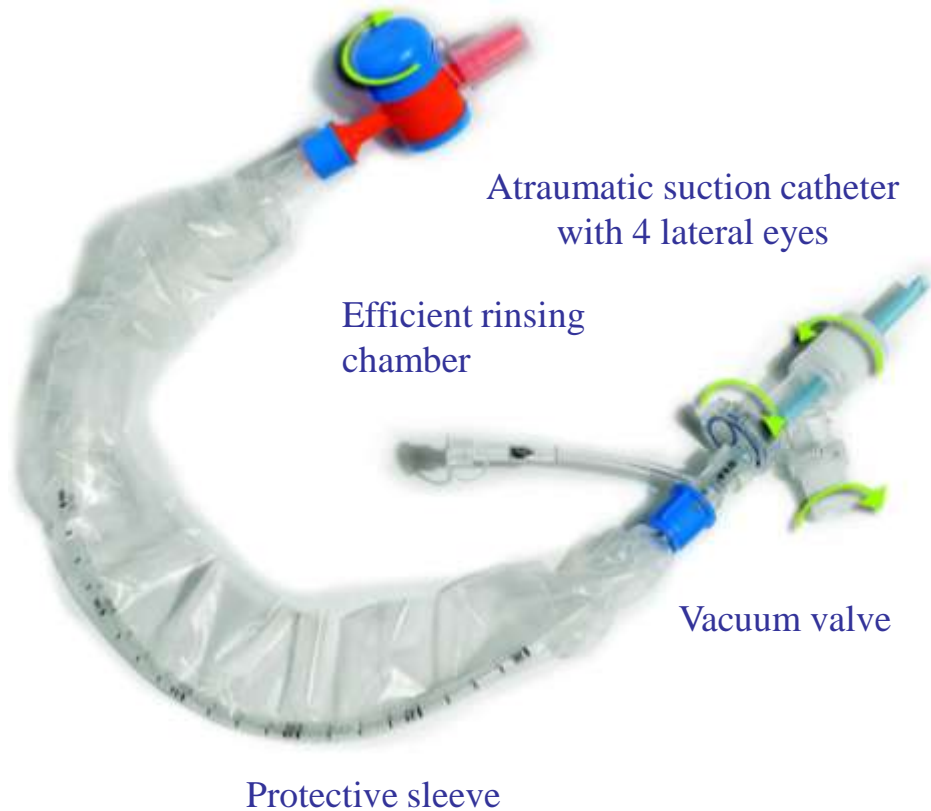
## Spread of contamination



Cobley et al. Anaesthesia 1991; 46:957-961



# Closed system suctioning



## Advantages

- Reduce patient & environmental contamination
- Reduce hand contamination even with multi-drug resistant micro-organisms
- Loss of PEEP (Collapse of alveoli, loss of end-expiratory lung volume, lung de-recruitment, hypoxemia)
- Closed system suctioning are recommended as part of a global strategy against nosocomial infection and cross contamination
- Cost considerations favour closed suction changed for each new patient and as clinically indicated

# Frequency of change of closed suction

## CTSS without daily change vs. OTSS

Lorente L et al. Crit Care Med 2006; 32:538-544

**Table 2** Percentage of patients with ventilator-associated pneumonia per period of mechanical ventilation

Length of mechanical ventilation (days)	CTSS ( <i>n</i> = 236)	OTSS ( <i>n</i> = 221)	Significance ( <i>p</i> )
0	0 of 90 (0)	0 of 88 (0)	0.99
1–2	1 of 34 (2.9)	1 of 32 (3.1)	0.99
3–4	2 of 23 (8.6)	2 of 22 (9.1)	0.99
5–14	5 of 30 (16.6)	5 of 27 (18.5)	0.99
15–24	8 of 24 (33.3)	7 of 21 (33.3)	0.99
≥ 25	17 of 35 (48.5)	16 of 31 (51.6)	0.99
Total	33 of 236 (13.9)	31 of 221 (14.1)	0.99

- ✓ Despite they do not have an impact on VAP rate, closed tracheal suction system should be used and changed for each new patient and as clinically indicated



# Change of Ventilator Circuits

- Bacterial colonization of condensates in ventilatory circuits plays a role in the pathogenesis of VAP
- Vigilance to prevent flushing the condensate into the lower airway or into in-line medication nebulizers during turning patients
- Theoretically frequent changes of ventilator circuits should lower the risk of bacterial colonization
- Many trials showed no advantage to change circuits less than once a week changing circuits more often was only associated with a higher cost

Craven et al. N Engl J Med 1982;306:1505-9.

Craven et al. Am J Med 1984;77:834-8.

Craven et al Am Rev Respir Dis 1984;129:625-8.

Dreyfuss et al. Am Rev Respir Dis 1991;143:738-43.

Kollef et al. Ann Intern Med 1995;123:168-74.



# Type of Airway Humidifiers

“Passive” Heat and Moisture Exchange Filters (HMEF)



“Active” Humidification and Heating (HH)



✓ Despite the fact that they do not have an impact on VAP rate, HMEF are recommended as part of a global strategy against nosocomial infection and cross contamination particularly when ventilators or anesthesia machines do not provide “machine end protection”.

# Frequency of humidifiers changes

Table 3. Rates of bronchial colonization, ventilator-associated pneumonia, and secondary outcome measures

	HME, 1 Day (n = 84)	HME, 7 Days (n = 71)
No. of patients with bronchial colonization (%)	68 (81)	58 (82)
Duration before colonization, no. of patients (%)		
≤4 days	54 (79)	46 (79)
≥5 days	14 (21)	12 (20)
No. of patients with pneumonia (%)	22 (26)	10 (14)
Pneumonia per 1,000 ventilator days	32.5	22.8
Duration of prior mechanical ventilation, no. of patients (%)		
≤4 days	10 (12)	3 (4)
≥5 days	12 (14)	7 (10)
Death from pneumonia	0	0
Length of ICU stay, days	19.6 ± 15.2	20.3 ± 14.6
Multiple organ failure score		
Day of inclusion	2.0 ± 0.3	2.0 ± 0.2
End of study	0.25 ± 0.02	0.20 ± 0.02
Hospital mortality (%)	27	29

HME, heat and moisture exchanger; ICU, intensive care unit.

Means are expressed as ±SD.

Thomachot L et al. Crit Care Med 2002; 30:232-237

- ✓ Recommendation to change the HMEF every 5 to 7 days or as clinically indicated

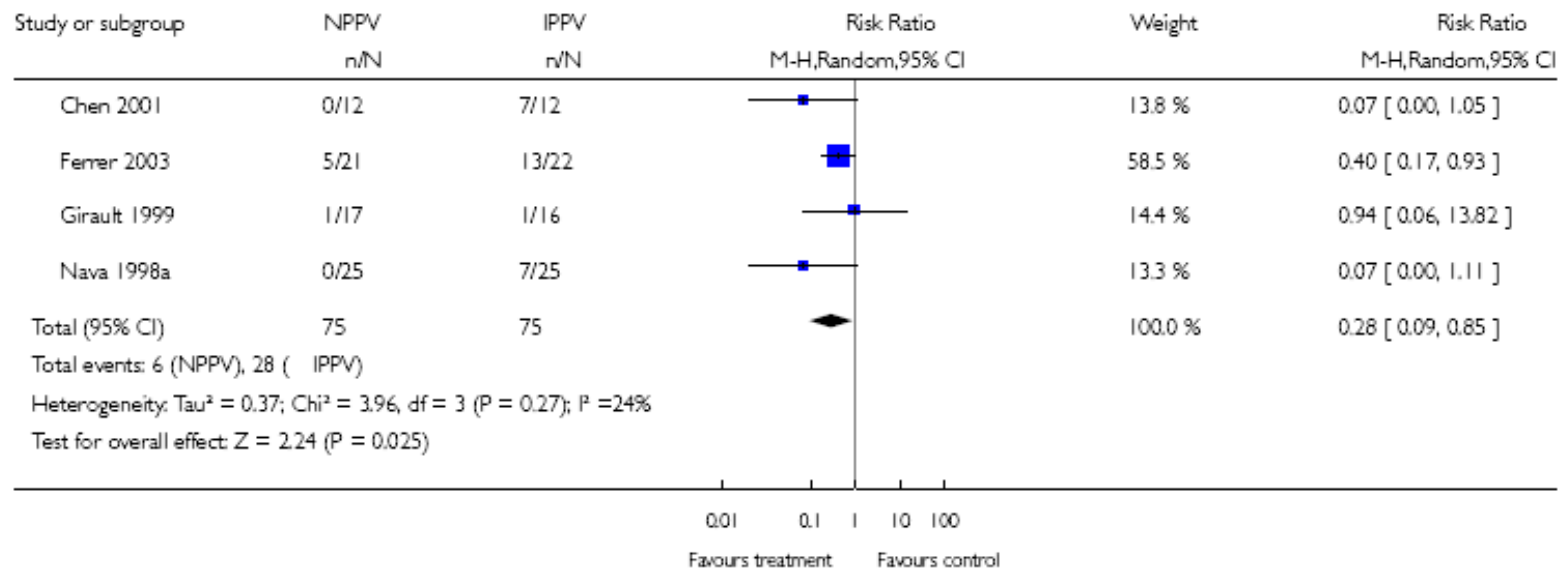


# Early Extubation

- Fast Track Weaning and extubation
- Avoid unnecessary prolonged MV
- Advantage for using “weaning modes and protocols”
- Early resumption of spontaneous breathing
- Less need for sedation and better cough and clearance of secretions
- NIV

# Non-Invasive Ventilation

Outcome: nosocomial pneumonia



Burns K et al. Cochrane Review 2006; 1-33

# Early vs Late Tracheostomy

Rodriguez et al. Surgery. 1990;108:655-9

Dunham et al. J Trauma. 1984;24:120-4.

Sugerman et al..J Trauma. 1997;43:741-7

No difference

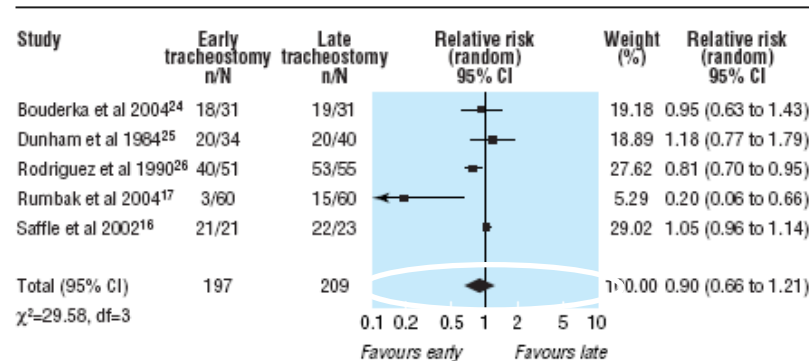


Fig 3 Random effects meta-analysis of relative risk (95% confidence interval) of hospital acquired pneumonia with early compared with late tracheostomy

Griffiths J et al. BMJ 2005; 330:1243-1246

✓ No recommendation due to insufficient evidence as regard VAP



# Position in Bed

- Semirecumbent position (bed elevation 30-45°) is associated with a decrease in incidence of VAP particularly during enteral feeding
- Unsafe for some patients e.g. spinal fracture
- Feasible and low costs
- Prone position may decrease VAP but methodology, lack of feasibility and universal application

Torres et al.. Ann Intern Med 1992;116:540-3.

Rotstein et al. Can J Infect Dis Med Microbiol 2008. 19 :1

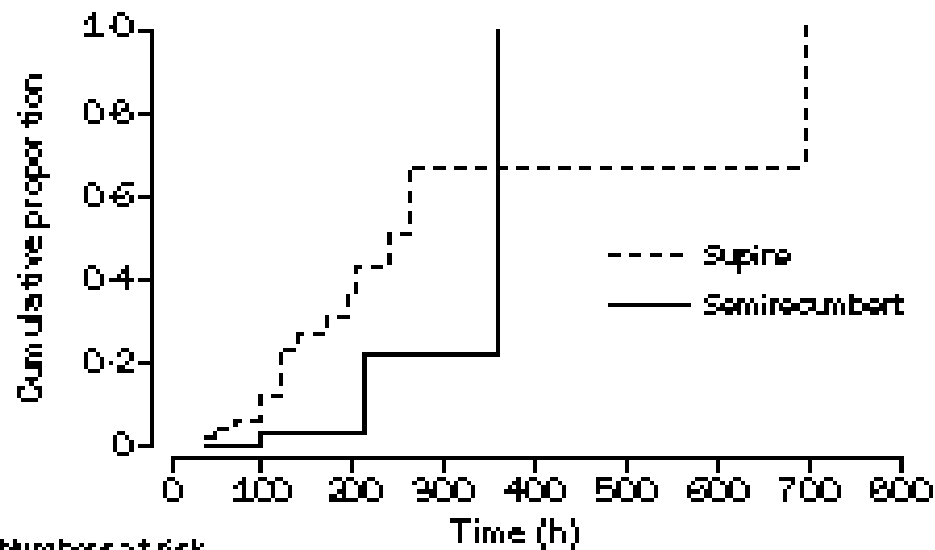
Orozco-Levi et al. Am J Respir Crit Care Med 1995;152:1387-90.

Davis et al. Crit Care 2001;5:81-7.



# Semirecumbent Position

Drakulovic M et al. Lancet 1999; 354:1851-1858



Numbers at risk		Time (h)							
Supine	47	34	11	2	2	2	1	0	
Semi-recumbent	39	32	6	1	0	0	0	0	

- ✓ Recommendation to keep patient in semi-recumbent position particularly if on enteral feeding



# Kinetic Beds

- May decrease incidence of VAP
- Did not reduce mortality or duration of MV
- Feasibility and cost may be a barrier in implementation

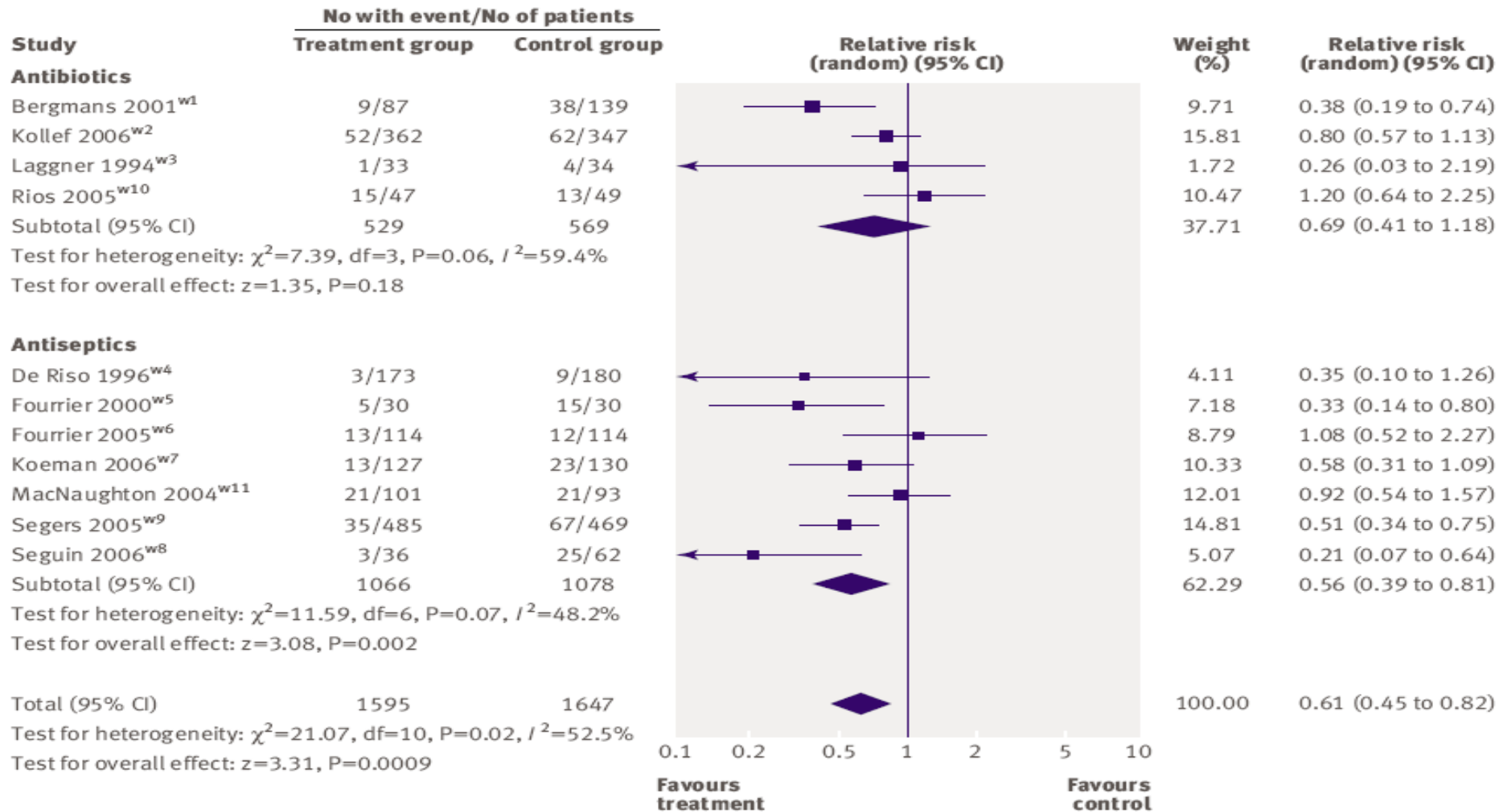
Delaney et al. Crit Care 2006;10:R70.

- ✓ Clinicians should consider



# Effect of Oral Decontamination on Risk of VAP

Chan *BMJ* 2007;334;889

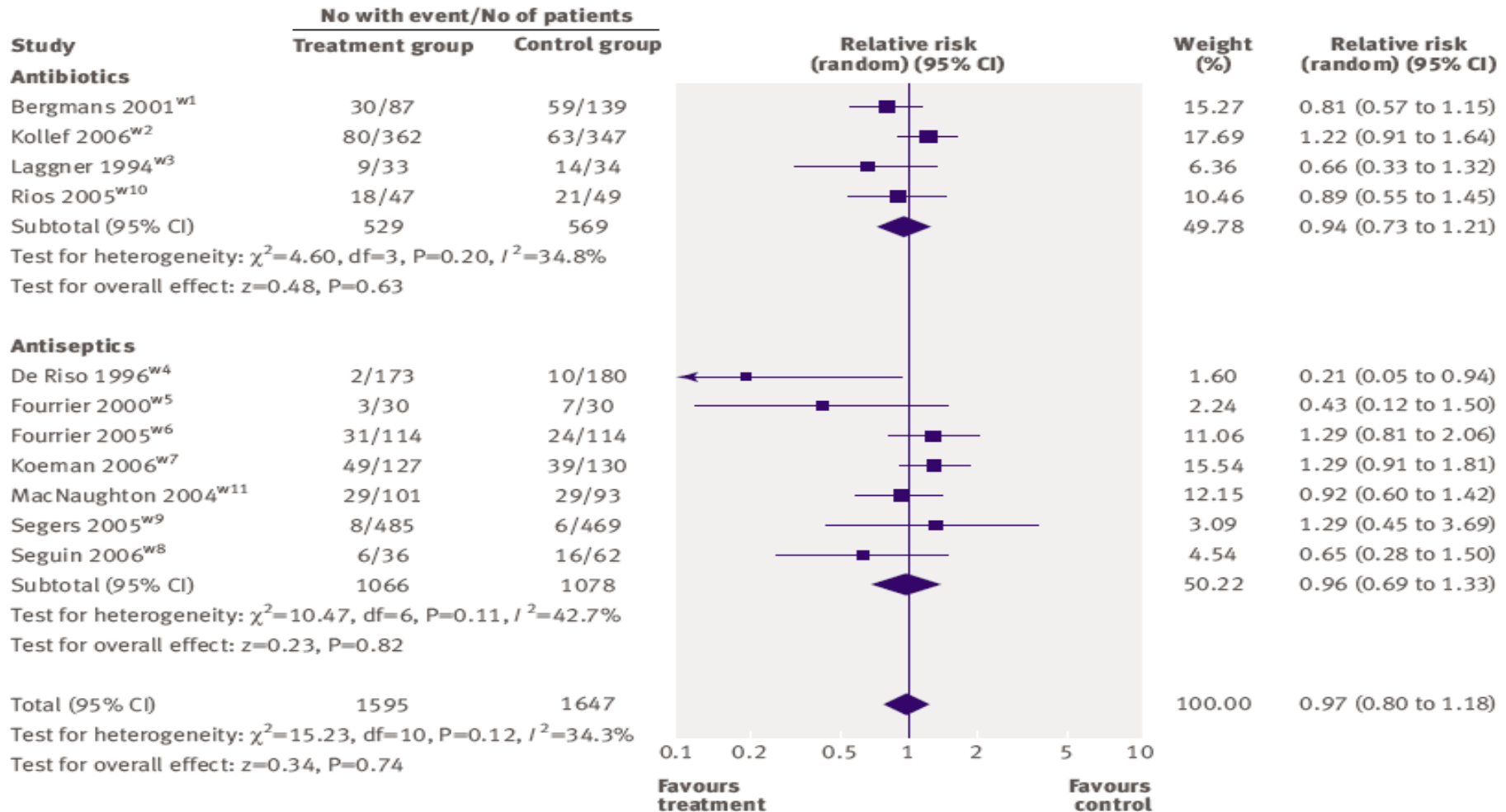


# E



## Effect of Oral Decontamination on Overall Mortality

Chan *BMJ* 2007;334:889





# Stress Ulcer Prophylaxis

- The use of sucralfate does not influence the incidence of VAP compared to placebo.  
Ben-Menachem et al. Ann Intern Med. 1994;121:568-75.  
Eddleston et al. Crit Care Med. 1994;22:1949-54.
- In patients at very low risk of bleeding (spontaneous breathing + no coagulopathy) better to avoid stress ulcer prophylaxis to decrease VAP
- In patient at high risk ( MV + coagulopathy) risk of bleeding balanced against risk of VAP



# Prophylactic AB and Selective Decontamination of Digestive Tract SDD



Topical antibiotics alone not to be used.

No recommendation for SDD using IV and topical AB because of insufficient data about AB resistance and cost effectiveness

No recommendation regarding IV AB alone because of insufficient evidence

Dodek. Ann Intern Med. 2004;141:305-313.





# „ვენტილატორთან ასოცირებული პნევმონიების პრევენცია“ იხატერი (კაირო, ეგვიპტე)



40%-ს. ამ შემთხვევათა 86%-ში ადგილი აქვს ვენტილაციასთან ასოცირებულ პლევმონიას. დადგენილია, რომ ამ ავადმყოფთა მკურნალობაზე ევროპაში დაახლოებით 6 მილიარდი ევროა დახარჯული.

ამ მოხესუნებაში გამოყენებული გაიდლაინები აღებულია CDC-დან და ჯანმრთელობის დაცვის ინფექციური და კონტროლის მრჩეველთა კომიტეტიდან, კანადის კრიტიკული მედიცინის ჯგუფთა ცდებიდან, კანადის კრიტიკული მედიცინის საზოგადოებიდან და ინფექციური დაავადებების პრევენციისა და კონტროლის ცენტრიდან, კანადის სახალხო ჯანმრთელობის დაცვის სააგენტოდან<sup>1-2</sup>. მათი განახლება მოხდა 2008 წელს კლინიკური საქმიანობის ეროვნული ინსტიტუტის და ბრიტანეთის ანტიმიკრობული ქიმიოთერაპიის საზოგადოების და კანადის სამედიცინო მიკრობიოლოგიის, ინფექციური დაავადებების ასოციაციის და კანადის ტორაკლური (მკერდის) საზოგადოების მიერ გამოცემული გაიდლაინებით<sup>3-4</sup>. გაიდლაინები მოიცავს ბევრ არაფარმაკოლოგიურ სტრატეგიას. მომდევნო 20 წუთში განვიხილავთ მათგან ყველაზე მნიშვნელოვან სტრატეგიებს.

სავენტილაციო ციკლებში კონდესანტების ბაქტერიული კოლონიზაცია დიდ როლს თამაშობს ვენტილაციასთან ასოცირებული პლევმონიის პათოგენეზში. საჭიროა სიფრთხილე, რათა თავიდან იქნეს აცილებული კონდენსატის მომატება დაბალ საჭაერო გზებში ან შიდა სამკურნალო საშუალებების საფრქვეველში, ავადმყოფების გადატრიალების დროს. თეორიულად ვენტილატორის წრიული ინფექციის ხშირმა ცვლამ შესაძლოა შეამციროს ბაქტერიული კოლონიზაციის რისკი. თუმცა, ბევრმა ცდამ აჩვენა, რომ კვირაში ერთჯერ მეტად ციკლების ცვლას შედეგი არ აქვს. ციკლების უფრო ხშირი ცვლა ასოცირდება მხოლოდ ხარჯებთან.





უახლესი ტენდენცია, ტრანსკლტომიის დანიშვნა არ უკავშირდება ინტუბაციამდე დროს, არამედ უფრო მეტად ორიენტირებულია ავადმყოფისათვის სარგებლის მიცემაზე. ტრანსკლტომია ინიშნება აგრეთვე ავადმყოფის მოვლის ინტერესებისათვისაც: ფონაცია, სოციალიზაცია, ადრეული ამბულატორია და გაწერა. ან როგორც მკურნალობის სტრატეგიის ნაწილი: სეკრეციების ადრეული და უსაფრთხო შეწოვა ან მკვდარი ადგილის შემცირება, რაც 2008 წლამდე რეკომენდირებული არ იყო, ადრეული ან გვიანი ტრანსკლტომიის სასარგებლოდ არადამაკმაყოფილებელი მტკიცებულების არსებობის გამო. ასევე ახლახანს გამოჩნდა დაგეგმილი დოქ, რომელმაც შესაძლოა შეცვალოს რეკომენდაცია ადრეული ტრანსკლტომიის სასარგებლოდ. საწოლში ნახევრადმწოლიარე მდგომარეობა ასოცირდება ვენტილაციასთან ასოცირებული პლევმონიის გაჩენის ზრდასთან, განსაკუთრებით კვების დროს. თუმცა უსაფრთხოა ზოგიერთი პაციენტისათვის, მაგ, სპინალური ტეხილი, თუ უკუჩვენება არ გამოვლინდა, იგი სასაგებლოა და ნაკლებ ხარჯთანაა დაკავშირებული. იგი ასევე ამცირებს სიკვდილიანობას. გულადმა წოლის პოზიციამ შესაძლოა ასევე შეამციროს ვენტილაციასთან ასოცირებული პლევმონია, მაგრამ მის სასარგებლოდ არ დანერგილა მეთოდოლოგია, განხორციელებადობა და უნივერსალური გამოყენება. კინეტიკურმა საწოლებმა შესაძლოა შეამციროს ვენტილაციასთან ასოცირებული პლევმონიის გაჩენა. იგი არ ამცირებს სიკვდილიანობას ან ხელოვნური ვენტილაციის ხანგრძლივობას და მის განხორციელებაში შესაძლოა ბარიერს წარმოადგენდეს ღირებულება.





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European Evidence Based Educational Survey for the  
prevention of VAP

Thank You

