James Waterson. RN, M.Med.ED. Infusion Nursing Society. **ETTubes and VAP**





Learning Objectives.

At the end of this session the participant will be able to:

- Define of VAP, broadly and as a focused diagnosis.
- Describe the pathophysiology, diagnosis, mortality and cost to healthcare organizations of VAP.
- Understand the central tents of VAP Prevention.
- Describe the central issue of audit tools for Vap Prevention.
- Understand the emerging role of technology in VAP prevention.

VAP Defined

Patients mechanically ventilated for greater than 48 hours

Exhibit at least 3 or 5 following symptoms:

- Fever.
- Leukocytosis.
- Change in sputum (color and/or amount).
- Radiographic evidence of new infiltrates.
- Worsening oxygen requirements.





CDC 2003

Focussed Definition

Inflammation of lung parenchyma > 48 hours post intubation, due to organisms not present or incubating at the time mechanical ventilation was commenced.

- Early onset within first 4 days: usually antibiotic sensitive
- Late onset > 5 days: commonly multi-drug resistant pathogens.



Pathophysiology + Diagnosis

- Aspiration of pathogenic organisms from the oropharynx.
- Normal flora replaced by pathogenic organisms

(S. aureus, P. aeruginosa, H. influenzae, and Enterobacteriaceae.

- Mixed infection in 50%
- 'Endotracheal tube associated pneumonia': But plaque, NG, hands...
- Clinical Pulmonary Infection Score (CPIS)
- Temp, Leucocytosis, PaO2/FiO2, CXR, Tracheal secretions Culture
- BAL cultures.

No gold standard

• Even autopsy does not always provide certainty: missed areas of pneumonia, negative micro despite inflammation, pathologists disagree.

A Randomized Trial of Diagnostic Techniques for Ventilator-Associated Pneumonia. The Canadian Critical Care Trials Group. N Engl J Med 2006; 355:2619-2630, 2006



Mortality and Cost.

- The leading cause of death among HAIs, exceeding deaths due to central line infections, severe sepsis, and respiratory tract infections in non-intubated patients.
- Rates ranges from 15% to 70% depending on the patient population.
- Approximately 60% of deaths among patients with hospital acquired pneumonia.
- Increases LOS in ICU by an average of 4 to 9 days.
- Costs to up to \$40,000 per patient.







Prognosis



Fig. 1 Mortality rate by pneumonia category. Adapted from *Chest.* 2005;128:3854-3862.

VAP Prevention: Fairly Basic...



'Vent Bundle'

- Suctioning
- Head of bed > 30°
- Oral Care
- Sedation holiday
- SSD-ETT



...

The Bundle is Straightforward: Applying, Enforcing and Auditing It, Is Not.

- Routine practice change tubing only if they become soiled with secretions or damaged: 100%
- Compliance with hand hygiene: 87.5%
- Sedation vacation and assessment of readiness of extubation. 66% [Excl. HFO, high ICP, difficult to ventilate]
- Elevation of head of bed 30-45 degrees: 100% [Excl. Spine injury]
- Oral hygiene with chlorhexidine 100%: [Excl. Oro-pharyngeal trauma]
- Subglottic suction: 0%: [Not available... HEOR?]

天上有法天下有道.... Fatto la legge, trovato l'inganno...

Al Harthy et Al. VAP bundle compliance in ICU. The Online Journal of Clinical Audits. 2014; Vol 6(2). [KSA Paper]

Tools of the Trade: We have progressed...



Early ETT: high-pressure and lowvolume cuffs, which increased the patient's risk of tracheal mucosal ischemia and necrosis. The design of these tubes allowed secretions to pool below the vocal cords and above the cuff...



Endotracheal tube cuff





High volume Low volume Low pressure cuff High pressure

SSD-ETTs





SSD-ETTs in patients mechanically ventilated for more than 72 hours

SSD-ETT Specific VAP Prevention Guidelines



Centers for Disease Control and Prevention

Recommends 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

Typo5 ATS

American Thoracic Society

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

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;53:1-36. PMID: 15048056.

American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcareassociated pneumonia. Am J Respir Crit Care Med. 2005;171(4):388-416. PMID: 15699079.

So, We have the Tools But are They Applied?: Audit is not a passive process.

- Physician Rounding Tool to address VAP bundles.
- Unit champions.
- Formalize oral care process using chlorhexidine
- Train nursing auxiliaries in oral care.
- Oral care a shared responsibility by RNs, RTs and NAs increasing oral care from 4 times per day to 10 times per day.
- Computerized reminder alerts for the care team.
- Isolation supplies –gowns, gloves, masks at entrance to every patient room
- Standardized sedation protocol
- Sedation holiday practices
- Elevation of bed
- Daily sedation break + weaning assessment: 2.4 vent days, 3.5 ICU days saved

Drakulovic et Al. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomized trial. Lancet. 354(9193):1851-8, 1999 Nov 27.

Dodek P. et al., Evidence-Based Clinical Practice Guideline for the Prevention of Ventilator-Associated Pneumonia, Ann Intern Med. 2004;141:305-313.

Sepsis Maggie... VAP Jimmy?



Audit: A fairly painful process... Can Tech Help?

FV VAP Bundle (*SICS Bundle)					VAP: % All Bundle Compliance						
	Daily?	Per Shift?	4 Hrly?	AI??	100 - 96 100						
Patient at 30°- 45°					90 78						
Subglottic ETDT											
Oral chlorhex					60 50 41						
Tubing/HMEF											
Daily weaning plan											
Sedation stop					March April May June July						
All elements					Month 08						

Stanford Partnership in AI-Assisted Care

Intelligent Hand Hygiene Support

Big Brother is Watching You...



Maximum limits on pumps make sense... prevent overdose errors and control behavior in terms of over-sedation and extra boluses...



But what about the soft minimum? Any Value?



UTR

UOL LIME

So Soft Minimum limits on smart pumps have value... if reported in real time....

Real time monitoring of compliance. Audit logging. Viewable from home...







Overview of every infusion... centrally and web based.

١	1 Smith , John 120 min to next EOI	# †*	2 Smith, . 120 min to nex	John t EOI	₩ŧ★	3 Smith, Joh 120 min to next EC	nn 📲	P#*	4 Sm 120 mln	ith , John to next EOI	# †*
	💧 DOPAmine	8 <i>m1/</i> h	💧 aceta Z	DLAMIDE	Birth	💧 DOPAmine	in -	8m/dt	() AL	ARIS CC	
57	A Near end of infusion	Sector		on		💧 DOBUtamii		15mi/b	A Ne		Swith
	💧 DOBUtamine	15min	💧 DOBUta		15mi/h	🔥 Near end o		8m/t	A DX	OBUtamine	15wirt
曲	🛆 Occlusion			СС		💧 aceta ZOL/	MIDE	3m/dr	40	clusion	
	💧 DOBUtamine	15 <i>mb</i> ts	💧 DOBUta	mine	15mi/b	💧 DOBUtamii	ne	15mith	6 DX	OBUtamine	15min
	() ALARIS CC		🛕 Near en	d of infusion	8mi/h				b DX	OPAmine	8mith
	💧 aceta ZOLAMIDE	3mich	💧 DOPAm	ine	8mi/h				💧 ac	eta ZOLAMIDE	3mith
	5 Smith , John 120 min to next EOI	# †*	6 Smith, . 120 min to nex	John teol	# †*	7 Smith, Joh 120 min to next EC	nn 🖣	P#+	8 Em	pty	
	() ALARIS CC		💧 DOPAm		8mi/h	💧 aceta ZOLA	MIDE	3mi/t			
	A Near end of infusion	8mi/h	💧 DOBUla		15min						
	💧 DOBUtamine	15with	🛕 Near en		8mi/h	💧 DOBUtamii		15m//b			
			💧 aceta Z	OLAMIDE	Birith						
	ODBUtamine 15wuk		💧 DOBUta	imine	15midt	DOBUtamine 15mg					
	DOPAmine 8min U AL			CC		A Near end of infusion 8mm					
	💧 aceta ZOLAMIDE	3ml/h		on		💧 DOPAmine		8m//F			
TRAL		DC	DSE	RATE	PRESSURE	VOLUME	TIME	ROT	ATE		
Gen	Patient SMITH, JOHN	ADM	MENU	ALARM (DEM	MO MODE) BED-3		23/07	HELP			





Evidence for Core Bundle: 'Every patient, every time'. 'All necessary and all sufficient' 1A...

Can Do...

S/C Enoxaparin and Ranitidine. [Changing Gastric Ph is controversial]

Enteral feeding encouraged – if tolerated ranitidine cessation considered.

- NIV avoiding intubation
- Kinetic beds no evidence
- HME vs Heated Water Humidification equally effective
- Glycemic protocol to keep glucose between 80 and 150 mg/dl

Smulders K, et al. A randomized clinical trial of intermittent subglottic secretion drainage in patients receiving mechanical ventilation. Chest 2002; 121: 858-862. CAT.

Kollef M, et al. A randomised clinical trial of continuous aspiration of subglottic secretions in cardiac surgery patients. Chest 1999; 116: 1339-1346. CAT.

Valles J, et al. Continuous aspiration of subglottic secretions in preventing ventilator-associated pneumonia. Ann Intern Med 1995; 122: 179-186. CAT.

Mahul P, 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: 20-25. CAT.

Alternate Thoughts: TCI and Dexmedetomidine as an option for optimum sedation: Easy to wake, easy to wean.





Hannivoort et Al. Development of an Optimized Pharmacokinetic Model of Dexmedetomidine Using Target-controlled Infusion in Healthy Volunteers. Anesthesiology 2015;123(2):357-367. doi: 10.1097/ALN.0000000000740.

FMEA... Review of Risk- Transport.

- Aspiration during transport
- Cuff leaks
- Unplanned extubations requiring reintubation

Failure Mode and Effects Analysis									
Data Source: Review of VAPs in MICU that occur in spite of high complaince rate					tilator Bundles	Completed	: March 2005		
RCAs of VAP showed three major causes of rer	naining VA	Ps:				Team:	Bela Patel	MD	
 Aspiration during transport 							Tammy Ca	mpos, RN,	MSN
2. Endotrachial cuff leaks							Michael Hewitt, RT		
3. Unplanned extubations requiring reintutation							Ruthie Sis	ka, RN	
	Occurance	Detection	Severity			Occurance	Detection	Severity	
			Potential					Potential	
	Likely to	Likely to	to cause			Likely to	Likely to	to cause	
Failure Mode for MICU VAP	Occur	detect	VAP	Total	Action taken	Occur	detect	VAP	Total
Aspiration during transport	8	5	5	200	All high risk patients transported with HOB elevated; Feeding stopped two (2) hours prior to transport	2	5	5	50
Endotrachial cuff leak	7	5	8	280	Changed how cuff pressures are measured and increased pressure	2	2	8	32
Umplanned extubations requiring reintubation	6	8	5	240	Risk Factors: PRN nurses working in unit & Shift ChangePRN nurses are closely supervised by charge nurse. Surveillance increased during shift change.	2	8	5	80
	Total Risk Priority Score			720		"After	" Risk Prio	rity Score	162

Ventilation Modes and Strategies: More Lung Protective but also avoid intubation, avoid long term ventilation if possible.

- Adaptive Ventilation Mode
- CPAP
- Mask BiPap
- Automated Vent Summary: Assists with the complexity of ventilator related weaning information







AI better than human with some complex decisions...

40-50% of the duration of mechanical ventilation is spent weaning.

Failure of extubation with reintubation within 48 hours is associated with high mortality.

Efficiency of weaning predictors is increased when predictors are summarized.

Esteban A. Modes of Mechanical Ventilation and Weaning. A National Survey of Spanish Hospitals. CHEST J. 1994;106(4):1188. doi:10.1378/chest.106.4.1188

Epstein SK, Nevins ML, Chung J. Effect of unplanned extubation on outcome of mechanical ventilation. Am. J. Respir. Crit. Care Med. 2000

Coplin WM, Pierson DJ, Cooley KD, Newell DW, Rubenfeld GD. Implications of extubation delay in brain-injured patients meeting standard weaning criteria. Am. J. Respir. Crit. Care Med. 2000



VAP – key points.

- The tools have existed for a very long time.
- Education.
- Audit... Watchdog and Champions.
- Process measurement / management.
- MDT dependant



- Resources without the above, bundles are futile.
- Oral Care with Chlorhexidine: Withdrawn in ICS and NICE Bundles except for cardiac patients

Hellyer et Al. The Intensive Care Society recommended bundle of interventions for the prevention of ventilatorassociated pneumonia. Journal of the Intensive Care Society. 2016, Vol. 17(3) 238–243.



Emerging technologies and novel technologies may have value....

References

Al Harthy et Al. VAP bundle compliance in ICU. The Online Journal of Clinical Audits. 2014; Vol 6(2). [KSA Paper]

American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilatorassociated, and healthcare-associated pneumonia. Am J Respir Crit Care Med. 2005;171(4):388-416. PMID: 15699079.

Coplin WM, Pierson DJ, Cooley KD, Newell DW, Rubenfeld GD. Implications of extubation delay in brain-injured patients meeting standard weaning criteria. Am. J. Respir. Crit. Care Med. 2000

Drakulovic et Al. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomized trial. Lancet. 354(9193):1851-8, 1999 Nov 27.

Dodek P. et al., Evidence-Based Clinical Practice Guideline for the Prevention of Ventilator-Associated Pneumonia, Ann Intern Med. 2004;141:305-313.

Epstein SK, Nevins ML, Chung J. Effect of unplanned extubation on outcome of mechanical ventilation. Am. J. Respir. Crit. Care Med. 2000

Esteban A. Modes of Mechanical Ventilation and Weaning. A National Survey of Spanish Hospitals. CHEST J. 1994;106(4):1188. doi:10.1378/chest.106.4.1188

Hannivoort et Al. Development of an Optimized Pharmacokinetic Model of Dexmedetomidine Using Target-controlled Infusion in Healthy Volunteers. Anesthesiology 2015;123(2):357-367. doi: 10.1097/ALN.000000000000740.

Hellyer et Al. The Intensive Care Society recommended bundle of interventions for the prevention of ventilator-associated pneumonia. Journal of the Intensive Care Society. 2016, Vol. 17(3) 238–243.

Kollef M, et al. A randomised clinical trial of continuous aspiration of subglottic secretions in cardiac surgery patients. Chest 1999; 116: 1339-1346. CAT.

Mahul P, 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: 20-25. CAT.

Smulders K, et al. A randomized clinical trial of intermittent subglottic secretion drainage in patients receiving mechanical ventilation. Chest 2002; 121: 858-862. CAT.

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;53:1-36. PMID: 15048056.

The Canadian Critical Care Trials Group. A Randomized Trial of Diagnostic Techniques for Ventilator-Associated Pneumonia. N Engl J Med 2006; 355:2619-2630, 2006

Valles J, et al. Continuous aspiration of subglottic secretions in preventing ventilator-associated pneumonia. Ann Intern Med 1995; 122: 179-186. CAT.