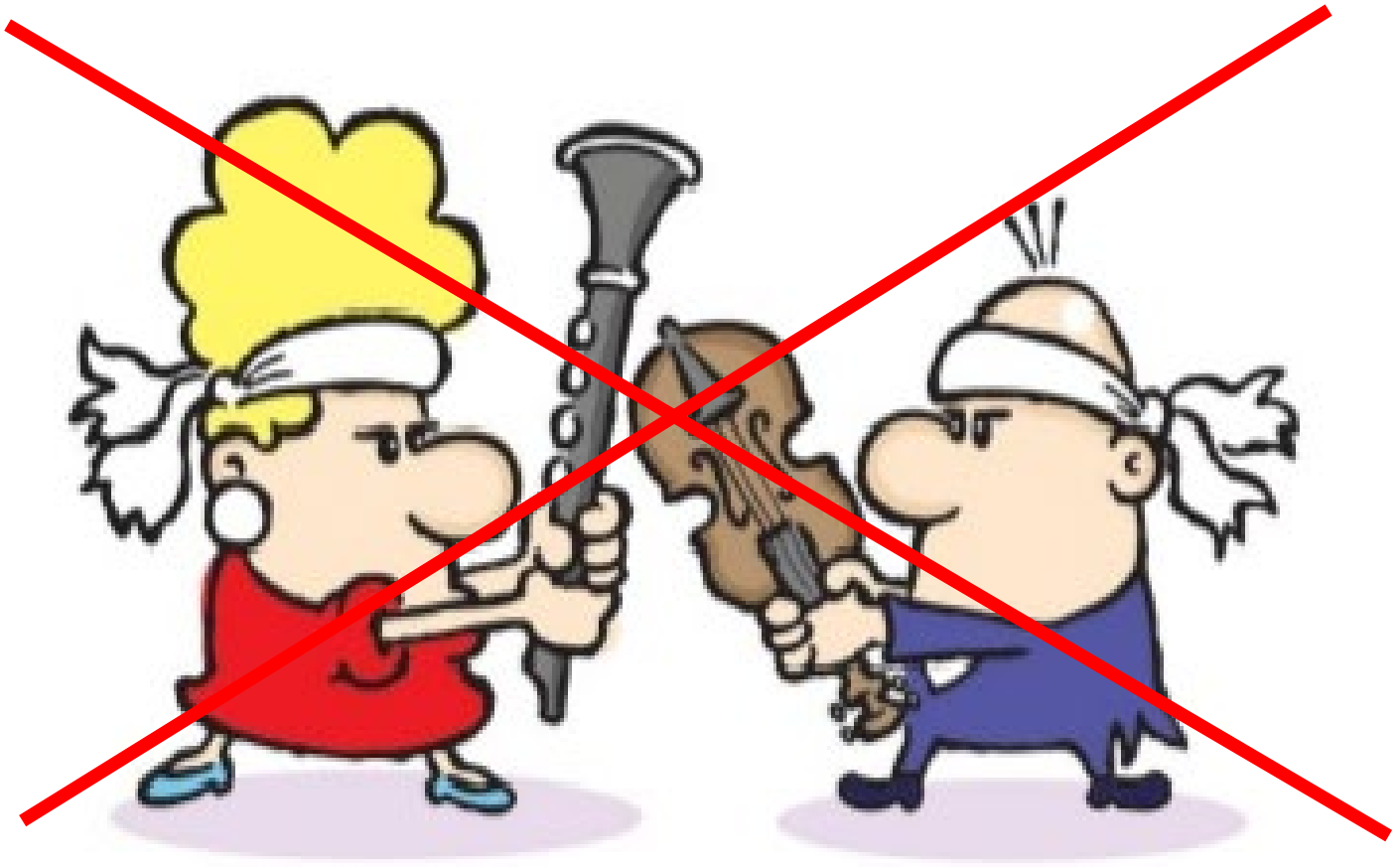
AKUTNE.CZ®

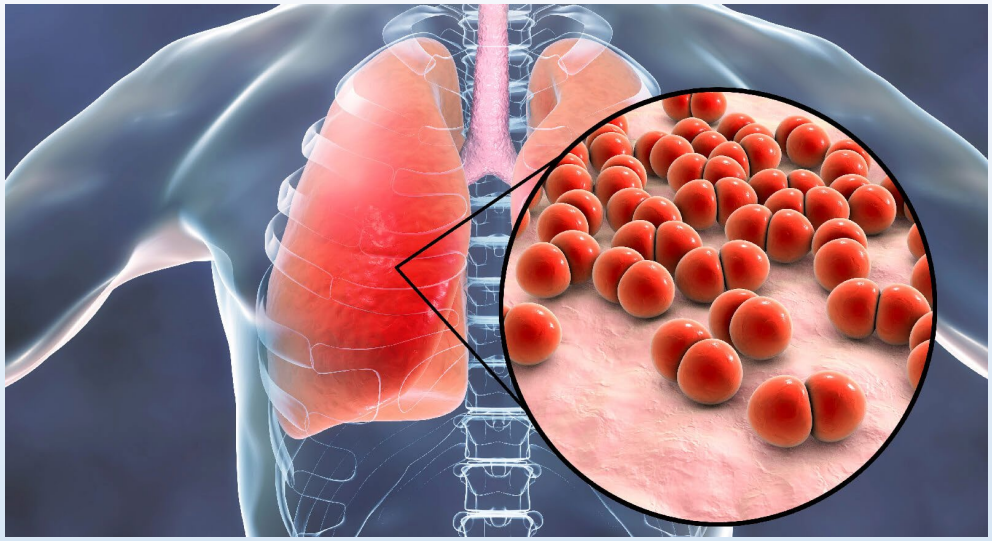
ventilátorová pneumonie na JIP

Jan Máca
KARIM FNO a LF OU

No Conflict of Interest

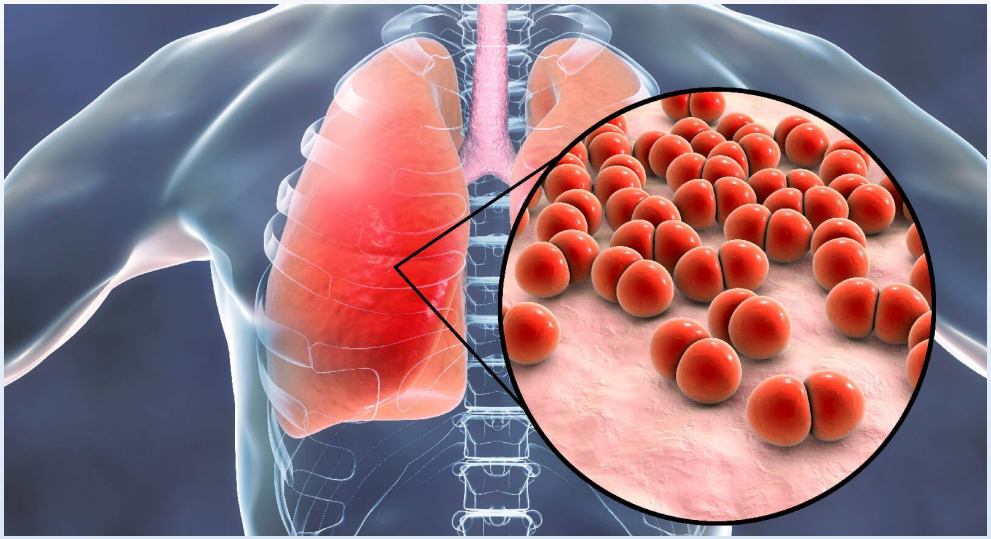


VAP



- definice - VAP vs. VAE
- etiopatogeneze
- diagnostika
- prevence
- ~~terapie~~

VAP



- **definice - VAP vs. VAE**
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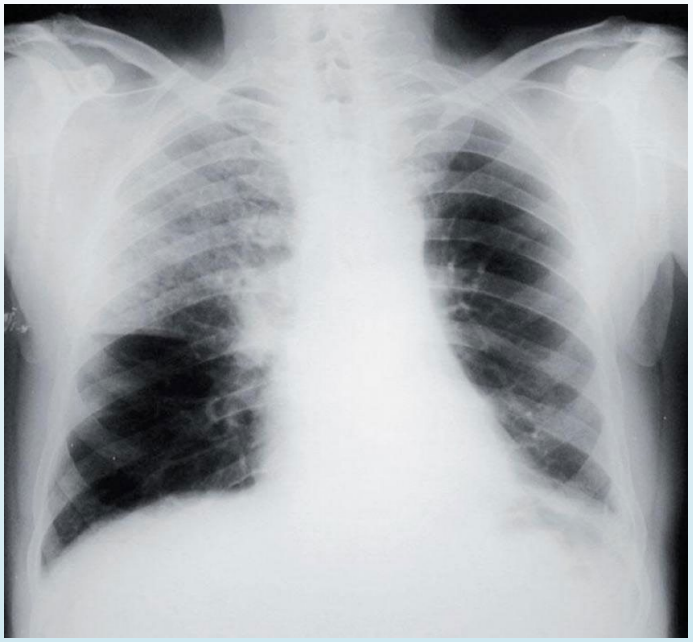
VAP

klinické a epidemiologické dělení pneumonií



- **CAP** (community[illegible] pneumonia)
- **HAP** (ho[illegible]ed pneumonia)
- **VAP** [illegible]**tor-associated pneumonia**

healthcare-associated infection

the American Thoracic Society (ATS) and the Infectious Disease Society of America (IDSA), 2016

VAP – časové dělelní

1) **časná**

*vznik v průběhu prvních **4 dnů** UPV*

2) **pozdní**

*vznik od **5. dne** UPV a dále*

VAP

- výskyt až u **30%** pacientů na UPV
- mortalita **20-50%**
- **až 70%** - u rezistentních patogenů
- přítomnost VAP ↑ mortalitu o **30%**
- ↑ **délku UPV**
- ↑ **délku hospitalizace**
- ↑ **náklady**

VAE

VAEs – *ventilator associated events*

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

reakce na **problematické** zíkávání relevantních epidemiologických dat týkajících se **VAP**

2 důvody:

- **radiologicko-diagnostický (rtg, dif. dg.)**
- **ekonomicko-společenský (zero VAP)**

VAEs: *definice*

zhoršení oxygenace (**↑ potřeby FiO_2**) nebo **↑ PEEP** po **2 dnech** stabilního nastavení ventilačně/oxygenačních parametrů

VAE is **not synonymous** with VAP

Only ~**25%–33%** of VAEs are due to pneumonia

most VAE are caused by **pneumonia**, **fluid overload**, **atelectasis**, and/or **ARDS**

VAEs – *ventilator associated events*

filozofie VAEs

- nejde o klinickou definici
- není určena pro klinické použití

výhodou je snaha:

1. brát vážně ventilačně/oxygenační **změny**
2. o **včasné** nalezení jejich příčiny
3. zároveň se **vyvarovat** změn léčebné strategie při nevýznamných příčinách („ATB terapie atelektáz“)

problémem může být jejich interpretace poskytovatelem zdravotní péče, kontrolními institucemi

automated VAE detection (AI?)

VAEs in adults

1. **ventilator-associated conditions (VACs)**
2. **infection-related ventilator-associated complications (IVACs)**
3. **possible VAP (PVAP)**

VAEs and **VACs** are synonymous and are defined as:

- **↑** in the daily minimum **PEEP of ≥3 cmH_2O** sustained for ≥2 calendar days after ≥2 days of stable or decreasing daily minimum PEEP

nebo

- **↑ FiO_2 of ≥0.2** points sustained for ≥2 days after ≥2 days of stable or decreasing daily minimum FiO_2 levels

IVAC is defined as

- VAC with concurrent indications of **possible infection**, namely an abnormal temperature **(<36°C or >38°C)** or white blood cell count (**≤4,000 or≥12,000 cells/mm^3**)

a

- 1 or more **new antibiotic starts** that continue for ≥4 days, all beginning within 2 days before or 2 days after VAC onset

PVAP is defined as

- IVAC with indications that infection might be **localized to the lungs**. It requires **positive respiratory secretion** cultures, **pleural fluid**, positive assays for respiratory **viruses or Legionella**, or suggestive **histopathology** concurrent with the IVAC.
- The culture criterion can be fulfilled via **quantitative cultures** above various thresholds that vary depending upon specimen type or through **positive cultures** with any amount of growth if there is concurrent Gram-stain evidence of purulence

Figure 1: Ventilator-Associated Events (VAE) Surveillance Algorithm

Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum* FiO_2 or PEEP values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO_2.

*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for > 1 hour.

↓

After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:

1) Increase in daily minimum* FiO_2 of ≥ 0.20 (20 points) over the daily minimum FiO_2 of the first day in the baseline period, sustained for ≥ 2 calendar days.
2) Increase in daily minimum* PEEP values of ≥ 3 cmH_2O over the daily minimum PEEP of the first day in the baseline period†, sustained for ≥ 2 calendar days.

*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for > 1 hour.

†Daily minimum PEEP values of 0-5 cmH_2O are considered equivalent for the purposes of VAE surveillance.

↓

Ventilator-Associated Condition (VAC)

↓

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worseni… meets <u>both</u> of the following criteria:

1) Temperature > 38 °C or < 36°C, **OR** white blood cell count ≥ 12,000 cells/mm^3 or ≤ 4,000 …

AND

2) A new antimicrobial agent(s) (see Appendix for eligible antimicrob… (QAD).

↓

On or after ca… …ation, ONE of the foll… …-quantitative thresholds† as outlined in …

- …quantitative result
- …ding semi-quantitative result
- …g semi-quantitative result
- …^{5} CFU/ml or corresponding semi-quantitative result
- …ory secretions (defined as secretions from the lungs, bronchi, or trachea that contain ≥ 25 neutrophils and …epithelial cells per low power field [lpf, x100])† **<u>PLUS</u>** organism identified from one of the following specimens (to include …ative culture, or quantitative/semi-quantitative culture without sufficient growth to meet Criterion #1):
  - Sputum
  - Endotracheal aspirate
  - Bronchoalveolar lavage
  - Lung tissue
  - Protected specimen brush

3) Criterion 3: One of the following positive tests:
   - Organism identified from pleural fluid (where specimen was obtained during thoracentesis or within 24 hours of chest tube placement; pleural fluid specimens collected after a chest tube is repositioned or from a chest tube in place > 24 hours are not eligible for PVAP)
   - Lung histopathology, defined as: 1) abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli; 2) evidence of lung parenchyma invasion by fungi (hyphae, pseudohyphae, or yeast forms); 3) evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
   - Diagnostic test for *Legionella* species
   - Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

† If the laboratory reports semi-quantitative results, those results must correspond to the quantitative thresholds. Refer to Table 2 and 3.

↓

Possible Ventilator-Associated Pneumonia (PVAP)

NHSN NATIONAL HEALTHCARE SAFETY NETWORK

CDC CENTERS FOR DISEASE CONTROL AND PREVENTION

potential risk factors for VAE

potential **risk factors for VAE**:

- **sedatives** (especially benzodiazepines and propofol)
- **opioids**
- **positive fluid balance**
- mandatory modes of mechanical ventilation with **high tidal volumes** and/or **high inspiratory driving pressures**
- **blood transfusions**
- **oral care** with **chlorhexidine**
- **stress ulcer prophylaxis**
- patient **transport**
- **gastric retention**
- **reintubation**
- **neuromuscular blockade**

interventions **associated with ↓ VAE rates** in interventional trials include:

- spontaneous **awakening trials**
- spontaneous **breathing trials**
- **conservative fluid management**
- **dexmedetomidine**

VAP

- definice - VAP vs. VAE
- **etiopatogeneze**
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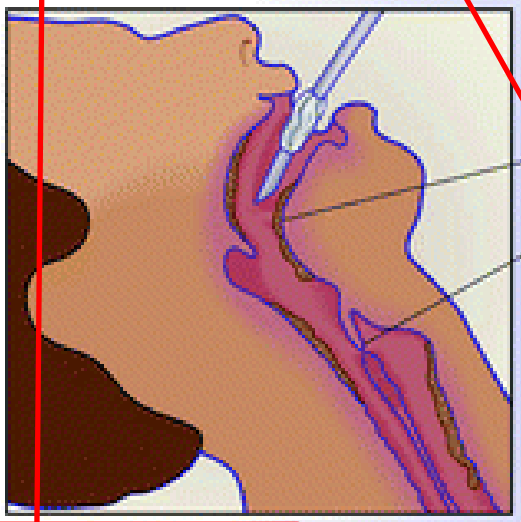
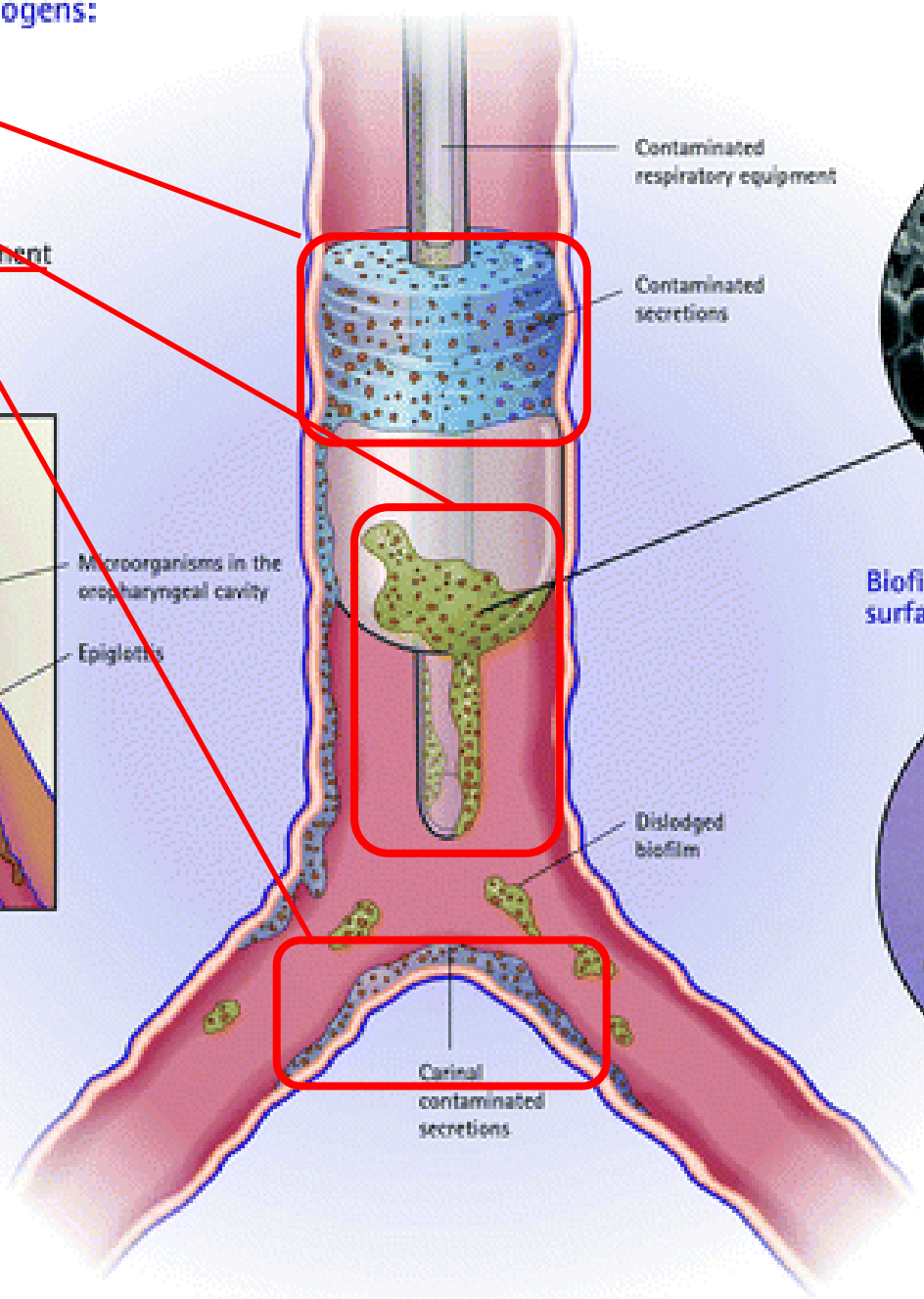
- prevence

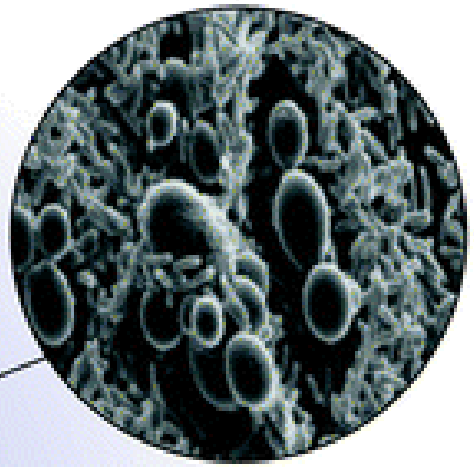
Common sources of VAP pathogens:

- Aspiration
- Intubation procedure
- Biofilm formation
- Contaminated secretions
- Contaminated respiratory equipment

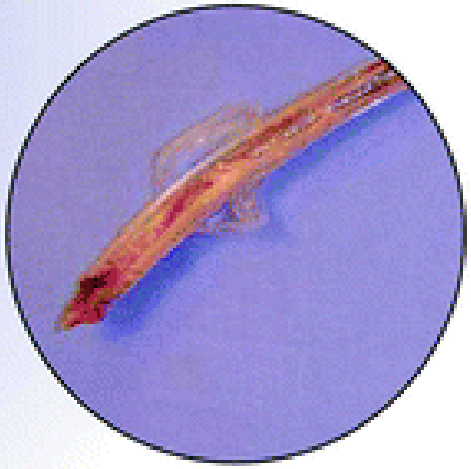


Intubation procedure





Biofilm formation on inner and outer surface of the endotracheal (ET) tube



ET tube upon extubation

VAP

- definice - VAP vs. VAE
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- **diagnostika**
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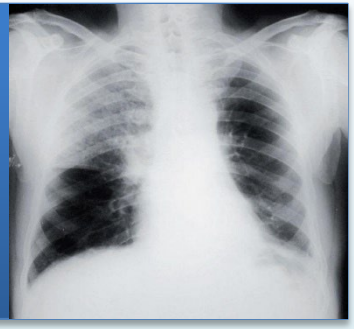
VAP - diagnostika

1. klinická manifestace — **základní fyzikální vyš.**
2. zobrazovací techniky — **rtg, HRCT, UZ**
3. metody vyšetření a interpretace tracheálních a bronchoalveolárních vzorků — **invazivní vs. neinvazívní metody (TBA, BAL, PBS)**
4. biomarkery — **PCT, CRP, IL-6, sCD14-ST, sTREM-1**

exhaled breath condensate? — **benzen, cyklohexanon, pentanol a undecyl aldehyd**

VAP – diagnostika (*Johanson*)

clinical, laboratory, radiographic, and microbiological criteria



- **nový nebo progredující infiltrát na rtg**

+ **alespoň 2 další kriteria:**

- **leukocytóza** > 12 000 nebo **leukopenie** < 4 000x10^9
- **febrilie** > 38°C
- změna **množství** anebo změna **charakteru** (*purulentní*) sekrece

ATS Consensus Conference (2005)

substantial interobserver variability

CPIS points	0	1	2
1. Tracheal secretions	Rare		
2. Chest X-ray infiltrates	No infiltrate		
3. Temperature, °C	≥ 36.5 and ≤ 3		
4. Leukocytes count, per mm3	≥ 4,000 and ≤		
5. PaO_2/FiO_2, mmHg	> 240 or ARD		
6. Microbiology	Negative		

Footnote to Table 2. The modified CPIS

Criterion	Values	Score
Temperature	36-38.4	0
	38.5-39.8	1
	Less than 36 and over 39	2
WBC	4000-11,000	0
	Less than 4000 or over 11,000	1
	Over 500 WBCs (bands)	2
Pulmonary secretions	Absence of pulmonary secretions	0
	Existence of non-infectious pulmonary secretions	1
	Existence of infectious pulmonary secretions	2
Oxygenation: PO_2/FiO_2 ratio (mmHg)	Over 240 or existence of ARDS signs	0
	Less or equal to 240 and absence of ARDS signs	2
Chest X-ray	Existence of infiltration	0
	Disseminative infiltration	1
	Local infiltration	2

WBC: White blood cell

Clinical Pulmonary Infection Score - CPIS

MCPIS

VAP - diagnostika

vitální požadavek je **rychlost** stanovení diagnosy

- u sepse do **1 (-2) hod** od stanovení diagnosy je nutno nasadit ATB terapii
- jakékoliv prodlení významně negativně ovlivňuje outcome pacienta

VAP

- definice - VAP vs. VAE
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- **prevence**

prevence VAP - dříve

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

SHEA/IDSA/APIC Practice Recommendation

Infection Control & Hospital Epidemiology (2022), **43**, 687–713
doi:10.1017/ice.2022.88

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2022

- Society for Healthcare Epidemiology (SHEA)
- Infectious Diseases Society of America (IDSA)
- American Hospital Association (AHA)
- Association for Professionals in Infection Control and Epidemiology (APIC)
- Centers for Disease Control and Prevention

SHEA/IDSA/APIC Practice Recommendation

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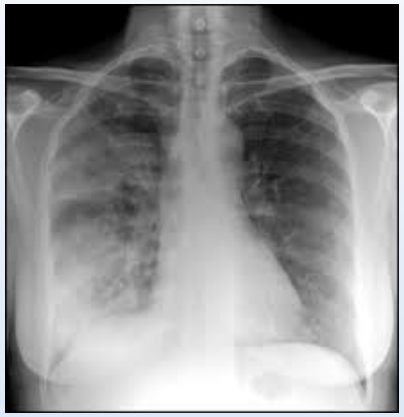
2022

strategies to **prevent**

- **ventilator-associated pneumonia (VAP)**
- ventilator-associated events (VAE)
- non-ventilator hospital-acquired pneumonia (NV-HAP)

in adults, children, and neonates

update of the Strategies to Prevent Ventilator-Associated Pneumonia in Acute Care Hospitals published in **2014**



SHEA/IDSA/APIC Practice Recommendation

I. kategorizace doporučení pro prevenci VAP

essential practices

- **should be** adopted by **all acute-care hospitals**
- good evidence that the intervention ↓ the average **duration of IMV, LOS**, **mortality**, **VAEs**, **antibiotic utilization**, and/or **costs benefits** likely outweigh **risks**

in 2014 these were "basic practices," renamed to highlight their importance as foundational for hospitals' healthcare-associated infection (HAI) prevention programs

essential practices

changes

- **added** a recommendation for **HFNO** or **NIPPV** as options to **avoid intubation**, **minimize duration of intubation**, and **prevent reintubations** (compared to COT)
- **added** a recommendation for **spontaneous awakening trials** or **sedation protocols** as effective strategies to **minimize sedation in adults**
- **added** a recommendation for **daily toothbrushing**
- **reclassified** endotracheal tubes with **subglottic secretion drainage** from an Essential Practice to an **additional approach**

essential practices

doporučení

1. **avoid intubation and prevent reintubation**

   ✓ use HFNO or NIPPV as appropriate whenever safe and feasible

2. **minimize sedation**

   ✓ avoid benzodiazepines in favor of other agents
   ✓ use a protocol to minimize sedation
   ✓ implement a ventilator liberation protocol

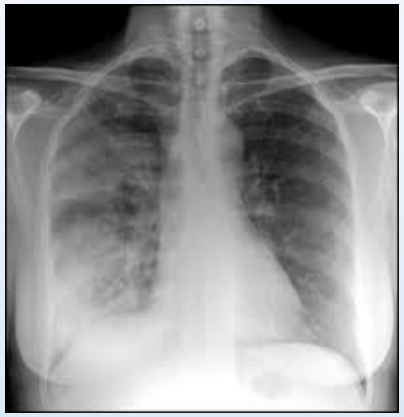
3. **maintain and improve physical conditioning**

4. **elevate the head of the bed to 30–45°**

5. **provide oral care with toothbrushing but without chlorhexidine**

6. **provide early enteral vs. parenteral nutrition**

7. **change the ventilator circuit only if visibly soiled or malfunctioning** (or per manufacturers' instructions)



SHEA/IDSA/APIC Practice Recommendation

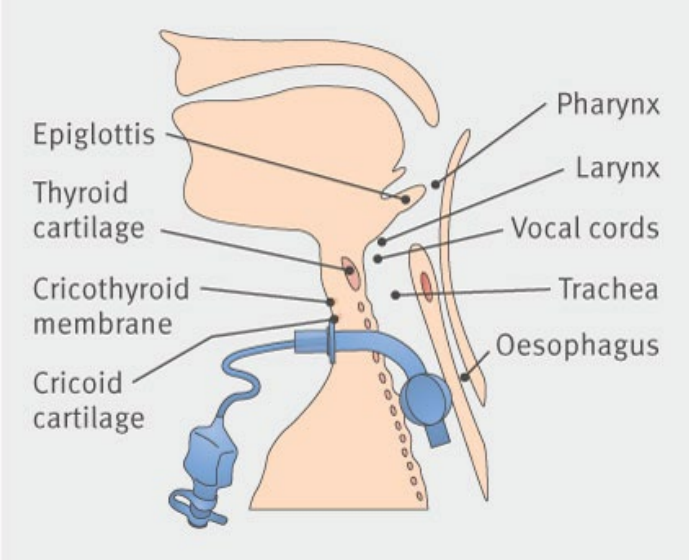
II. kategorizace doporučení pro prevenci VAP

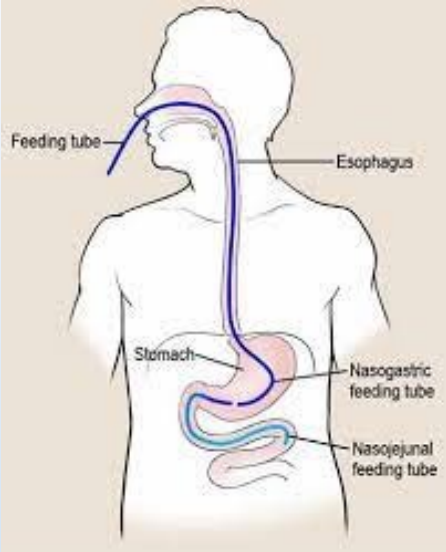
additional approaches

- **considered** for use in locations and/or populations **within hospitals** when these **HAIs are not controlled after implementation of essential practices**

- good evidence that the intervention **improves outcomes** in some populations, but may confer **some risk** in others
- may **lower VAP rates** but insufficient data to determine impact on duration of IMV, LOS, or mortality

in 2014 these were "special approaches"





additional approaches

changes

- **reclassified** endotracheal tubes with **subglottic secretion drainage** as an **additional approach** rather than an **essential practice** for adults and older children
- **added** a recommendation to consider **early tracheostomy**
- **added** a recommendation to consider **postpyloric** rather than **gastric feeding** in patients at high risk for aspiration

additional approaches

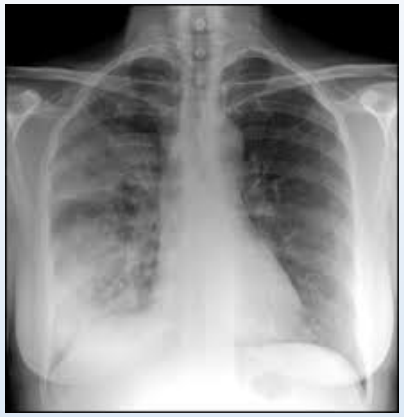
doporučení

1. use **selective oral** or **digestive decontamination** in countries and ICUs with **low prevalence of antibioticresistant organisms**

2. utilize endotracheal tubes with **subglottic secretion drainage** ports for patients expected to require **>48–72 hours of IMV**

3. consider **early tracheostomy**

4. consider **postpyloric** rather than **gastric feeding** for patients with **gastric intolerance** or at **high risk for aspiration**



SHEA/IDSA/APIC Practice Recommendation

III. kategorizace doporučení pro prevenci VAP

generally not recommended

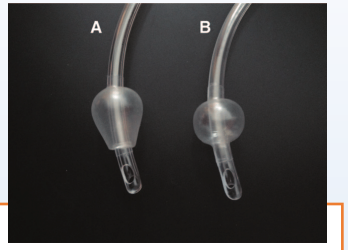
- **inconsistently** associated with **lower VAP rates**
- **no** or **negative** impact on duration of IMV, LOS, or mortality.
- **no impact** on **VAP rates**, **average impact** on duration of IMV, LOS, or mortality

not recommended

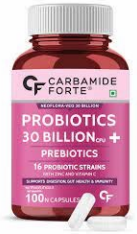
- **no** impact on **VAP rates** or other patient **outcomes**, **unclear** impact on **costs**

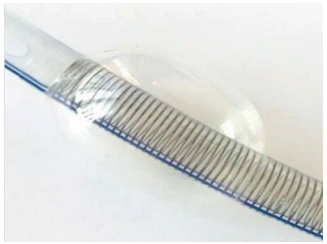
generally not recommended

Quality of Evidence: MODERATE



1. **tapered** endotracheal tube **cuffs**
2. **ultrathin** polyurethane endotracheal tube **cuffs**
3. **probiotics**
4. **frequent** endotracheal **cuff pressure monitoring**
5. **automated** control of endotracheal **cuff pressures**
6. oral care with **chlorhexidine, chlorhexidine bathing**
7. **silver-coated endotracheal tubes**
8. **kinetic beds**
9. **prone positioning**
10. **stress-ulcer prophylaxis**
11. **monitoring residual gastric volumes**
12. **early parenteral nutrition**





not recommended

1. **closed endotracheal suctioning systems**

implementation of VAP, VAE, and NV-HAP prevention strategies

engagement

Develop a multidisciplinary team

at minimum: **unit directors**, **physicians**, **nurses**, and **respiratory therapists**
other: infection preventionists, pharmacists, nutritionists, physical therapists, occupational therapists, family members, and patient advocates.

Involve local champions

medical director, **nursing** director, **charge** nurses, director of **respiratory therapy**, engaged **frontline staff** (informal leaders)

Utilize peer networks

Horizontal networking of **peers** across hospitals

Comparing progress and benchmarks between ICUs can help units better understand their local strengths and weaknesses, learn from best practices, brainstorm solutions to common problems

implementation of VAP, VAE, and NV-HAP prevention strategies

education

Provide education sessions

introduction of evidence-based practices in the clinical setting

workshops, hands-on training, conferences, slide presentations, and/or interactive discussions, simulations

Provide educational materials

smartphone applications, interactive websites, pocket cards, brochures, posters, fact sheets, daily guides, guideline summaries, flow sheets and 1-page bulletins

implementation of VAP, VAE, and NV-HAP prevention strategies

execution

Standardize care processes

implementation of guidelines, bundles, protocols or pathways

establish **new care processes** as “normal behaviors”

daily **multidisciplinary rounds** are widely recommended

Create redundancy

reminders about best practice and can take the form of posters, bulletins, pens, stamps, pocket cards, 1-page signs, daily goal lists in patient rooms, checklists, and preprinted order sets, text messages, and screensavers on clinical computers

engage family members to assist with preventive care

implementation of VAP, VAE, and NV-HAP prevention strategies

evaluation

Measure performance

frequent **formal** and **informal audits** of clinical practice

measuring process and outcome measures

evaluating performance provides an ongoing, real-time image of actual implementation rates

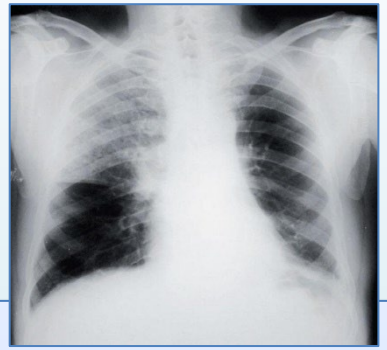
analyze all or a representative sample of VAEs for **etiology and preventability**. pneumonia, pulmonary edema, acute respiratory distress syndrome, and atelectasis are the precipitants for most VAEs

Provide feedback to staff

provide **regular feedback** on process and/or outcome data to staff

Feedback helps pinpoint **new areas for improvement** and marks successful transitions to new standards of care

VAP závěr



- VAP je **závažná** infekční komplikace v intenzívní péči
- diagnostika je **složitá** a **variabilní** (SE a SP nízká)
- je třeba na ni **myslet**
- diagnostika musí být **rychlá**
- nejasná budoucnost implementace **VAE**
- důraz na **důslednou aplikaci** preventivních opatření
- otázka **nezbytnosti** aktuálně **využívaných**, nicméně **nedoporučených preventivních opatření**
- důležitost **angažovanosti**, **edukace**, **vykonávání** a **vyhodnocování** prevence


děkuji za pozornost
BANKSY