COVID-19

Prevention of healthcare-associated respiratory tract infections (HA-RTI)

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March, 2022

Adapted from WHO Advanced Infection Prevention and Control (IPC) Training

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BE AWARE. PREPARE. ACT.
www.paho.org/coronavirus

Describe the problem of respiratory tract infections, its epidemiology and prevention

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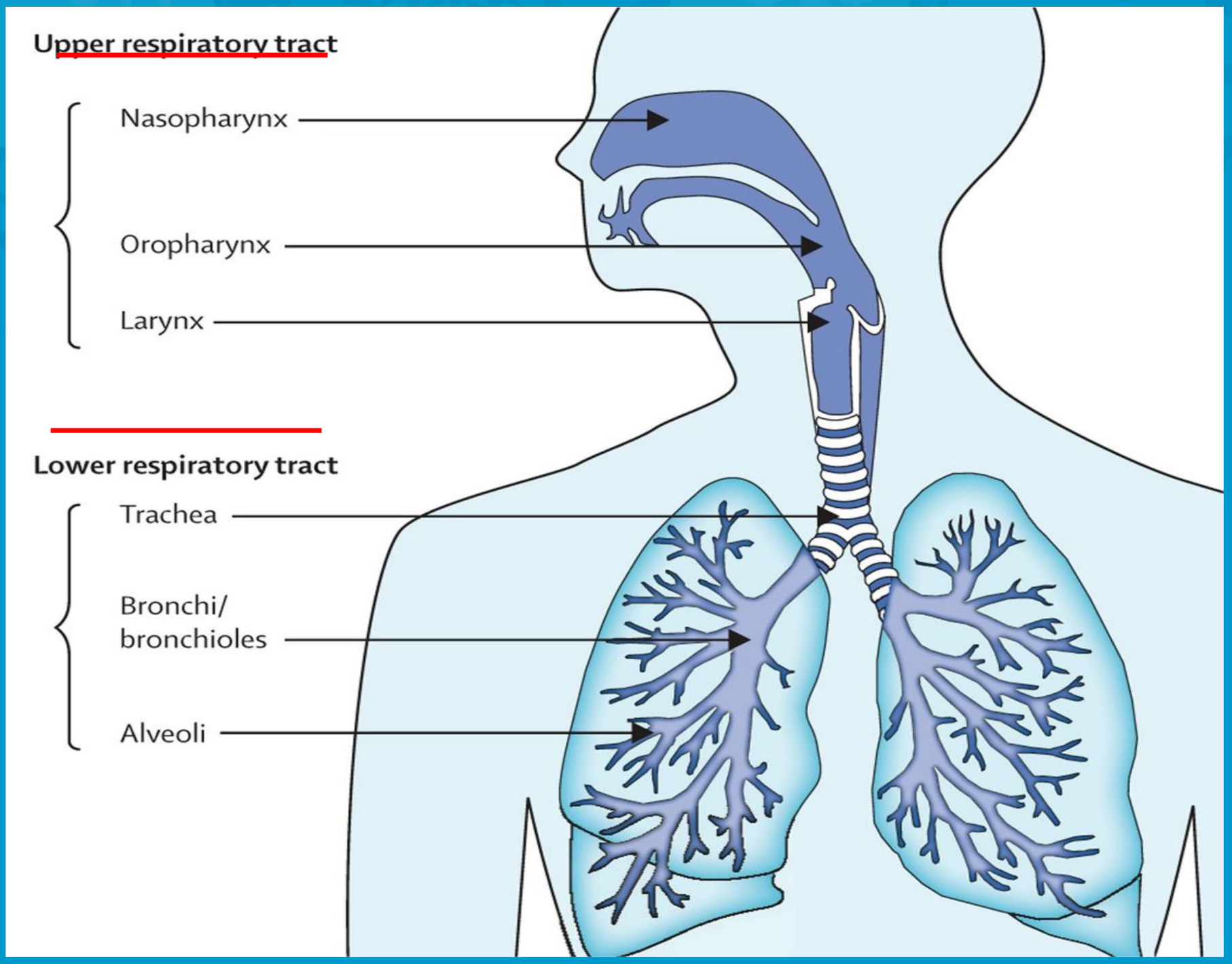
Respiratory tract



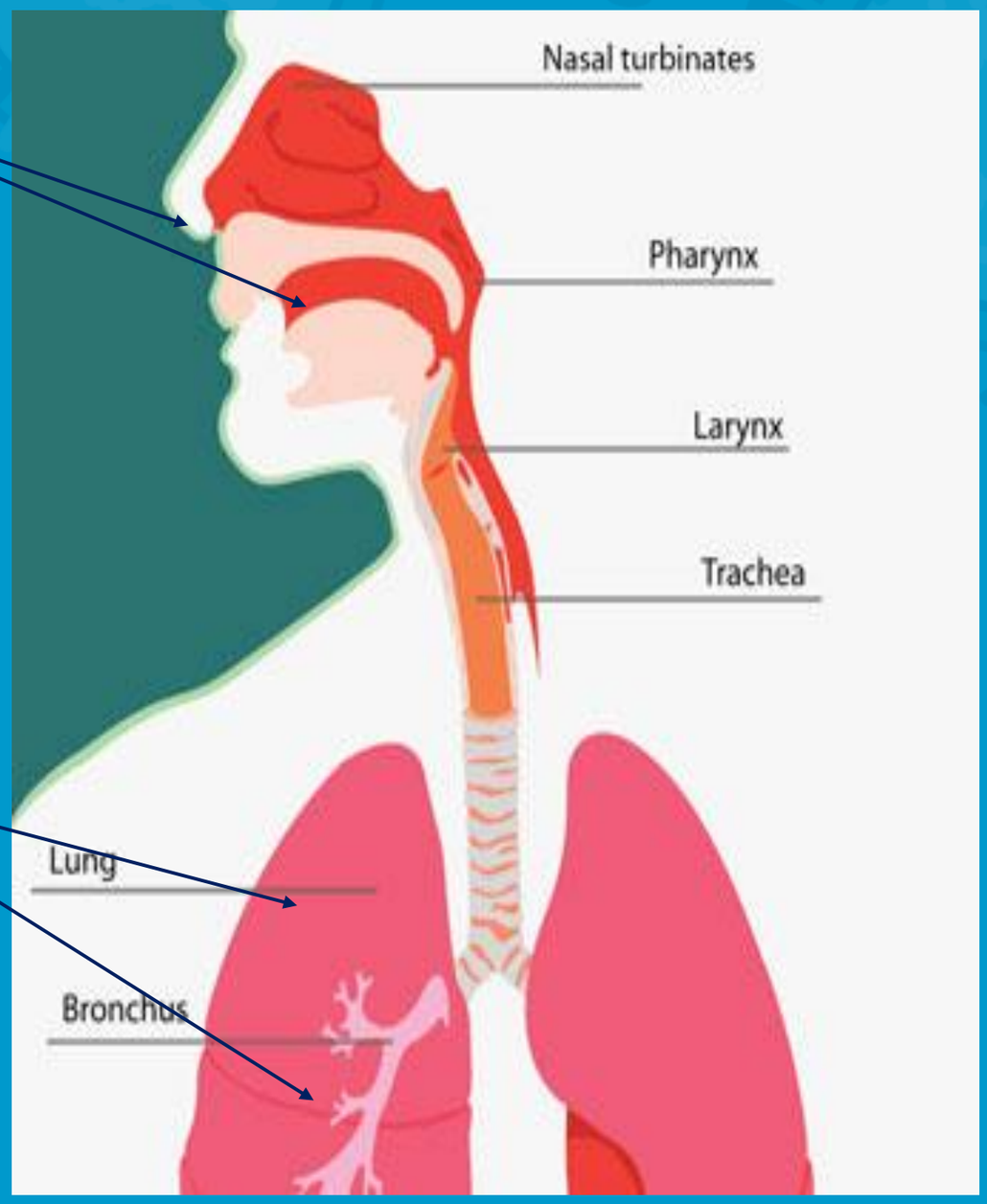
Colonisation of the respiratory tract

- Respiratory tract (particularly upper respiratory tract) is colonised with a range of microrganisms that are part of the local flora
- Colonisation: presence of certain bacteria and viruses which live symbiotically within the host without causing harm
- Infection: pathogens cause disease
- Advantages of colonising microbes
  - Occupy available space so disease-causing pathogens have difficult penetrating (i.e. competition for survival)
  - Maintain integrity of host mucous membranes
  - Produce protective enzymes and kinases (pH maintenance) which reduce or contrast pathogenic invasion

Colonising microbes of respiratory tract

Upper respiratory tract (nares, nasopharynx):
Staphylococcus epidermidis, S. aureus, **Corynebacterium,** ***Neisseria*** **spp including** ***N. meningitidis,*** ***Haemophilus*** **including** ***H. influenzae,*** ***Streptococcus pneumoniae***

Lower respiratory tract (trachea, bronchi and pulmonary tissues)
Usually sterile but invasion can occur from the nasopharynx:
H. influenzae, S. pneumoniae, S. aureus, Moraxella catarrhalis



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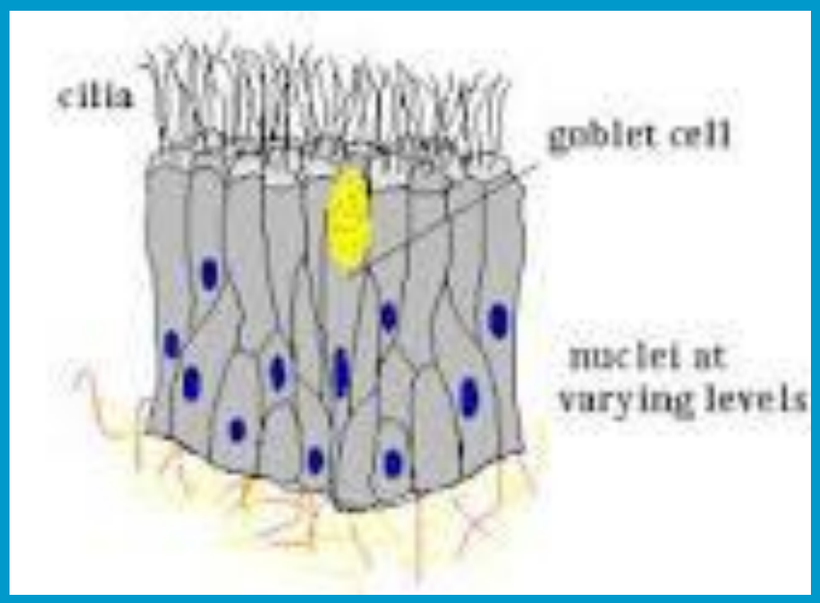
Defences of respiratory tract against infection

- In addition to colonisation, the respiratory tract is also protected against infection by:
  - •Ciliated epithelium and mucous producing goblet cells
  - •Cough and clearance of mucous from lung

- When the lung is invaded, protective mechanisms are activated and immune responses of the host are stimulated (i.e. cellular and humoral immune responses)



Risk of respiratory tract infection

- With inactivity during hospital, protective mechanisms are suppressed and risk of respiratory tract infection increases
- Colonisation can also be altered by (increasing risk of respiratory tract infection):
  - Antimicrobial agents
  - Chemical irritants like, smoke and pollution
  - Foreign bodies such as endotracheal intubation
  - Immunosupression, e.g. chemical or pathology

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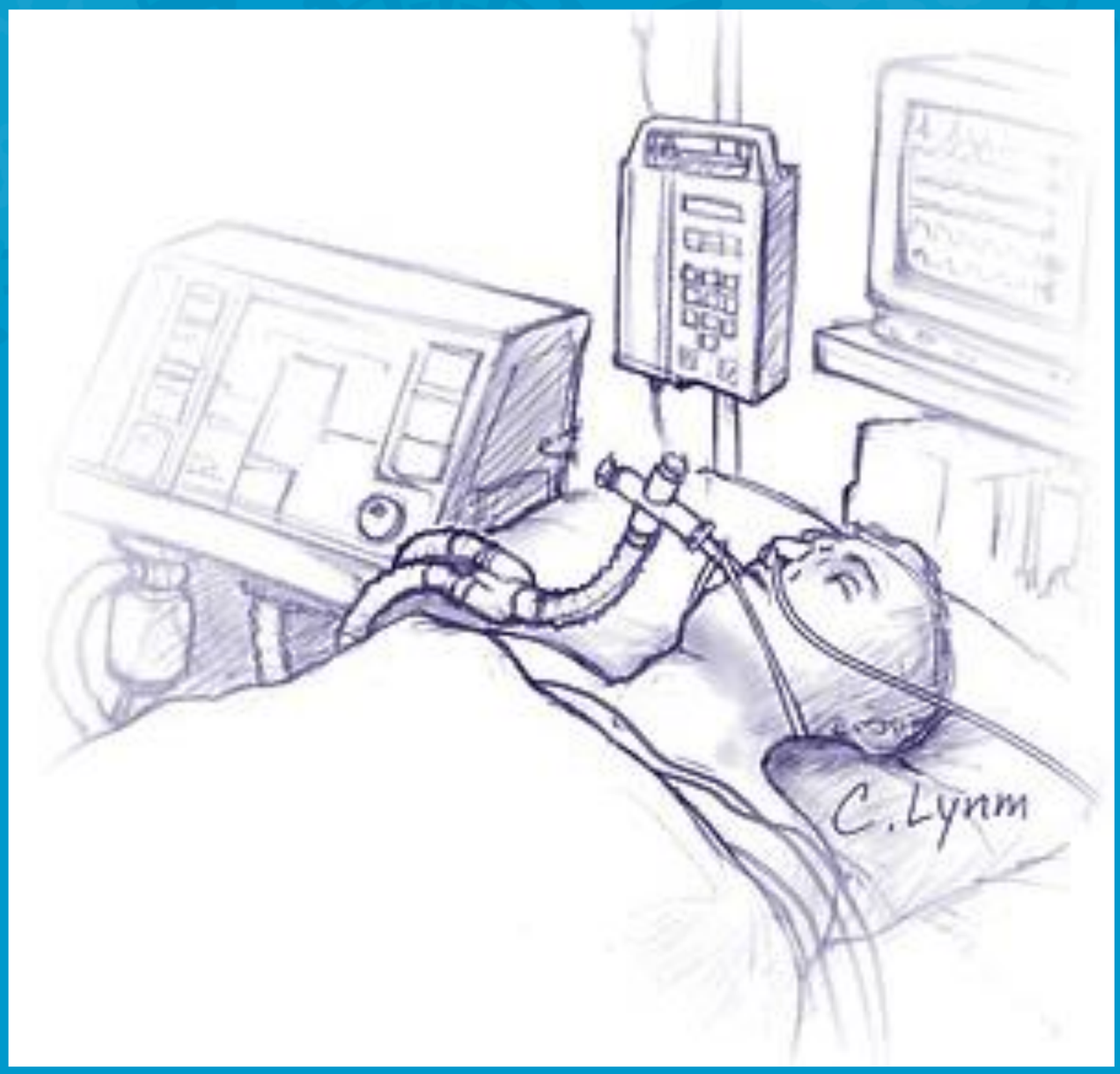
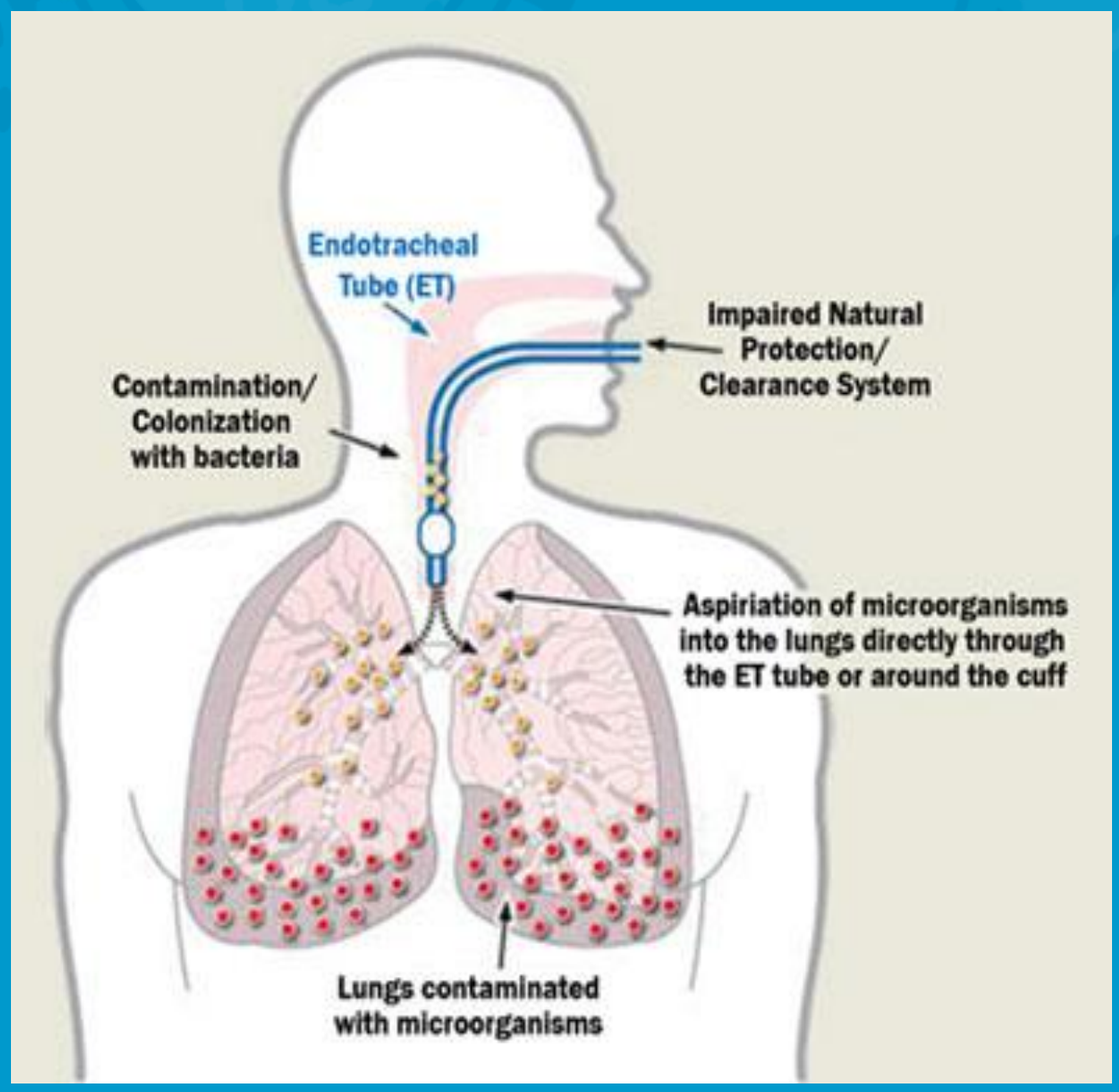
VAP



http://jamanetwork.com/journals/jama/fullarticle/206551

Risk of VAP during endotracheal intubation

- Colonising microbes can be pushed into lower tract during intubation
- Risks of intubation:
  - Lower tract becomes colonised by bacteria
  - Aspiration of gastric contents may occur particularly in altered mental status
  - Transmission of health care associated infection (HAI) pathogens via equipment or hands may occur



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Pathogenesis of VAP

Access of microbes to lower respiratory tract:

- **Risks during intubation**
- **Biofilm (i.e. cluster of microorganisms), typically Gram-negative bacteria and fungal species within the endotracheal tube**
- **Pooling and trickling of secretions around the cuff**
- **Impairment of muco-ciliary clearance of secretions with gravity dependence of mucus flow within airways**
- **Pathogenic material can also collect in surrounding anatomic structures, such as the stomach, sinuses, nasopharynx and oropharynx, with replacement of normal flora by more virulent strains**

Key risk factors of HA-RTI

What are key risk factors for HA-RTI?

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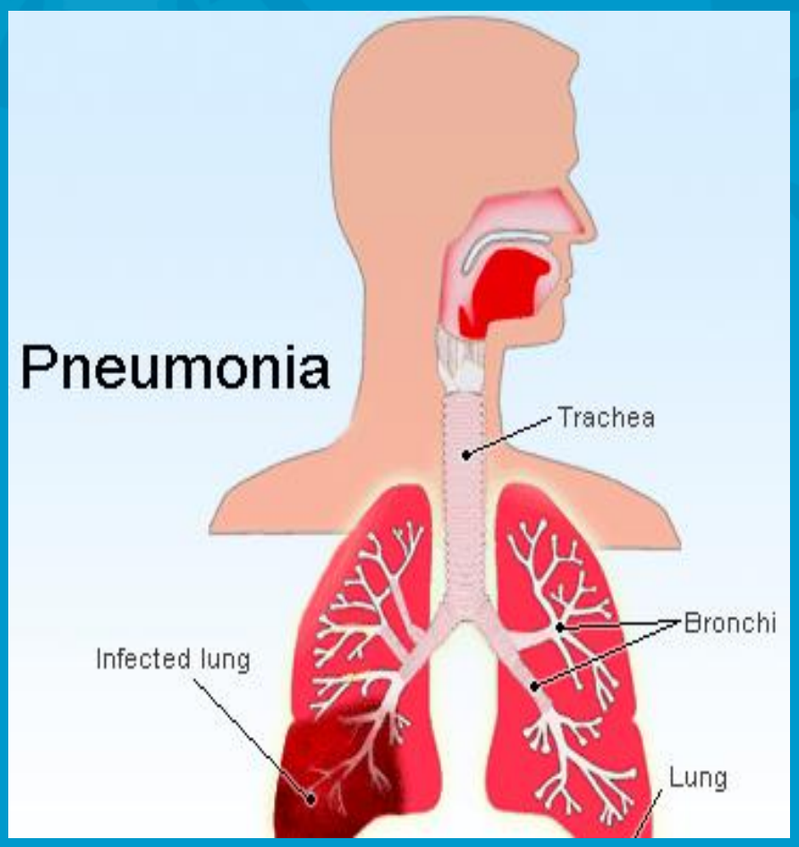
Key risk factors of HA-RTI

- Type and duration of ventilation
- Quality of respiratory care
- Prior antibiotic use
- Previous hospitalisation
- Other patient factors



http://new.paho.org/hq/dmdocuments/2011/ENG_Modulo_I_final.pdf;
http://www.cdc.gov/nhsn/PDFs/pscManual/17pscNosInfDef_current.pdf

Patient risk factors for HA-RTI

- Elderly and children <5
- Pregnancy
- Pre-existing pulmonary disease
- HIV/AIDS, malignancy, chemotherapy, long term steroid use
- Diabetes, chronic liver disease, chronic kidney disease
- Malnutrition
- Prolonged hospitalizations etc. (high risk of multidrug-resistant organisms)

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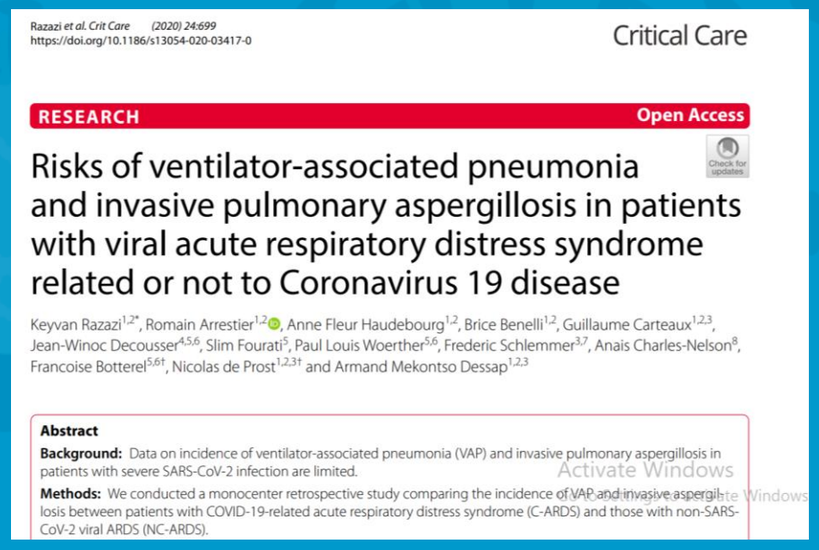
Characteristic of Patients with C-ARDS



Razazi et al. Crit Care (2020) 24:699
https://doi.org/10.1186/s13054-020-03417-0

Critical Care

RESEARCH Open Access

Risks of ventilator-associated pneumonia and invasive pulmonary aspergillosis in patients with viral acute respiratory distress syndrome related or not to Coronavirus 19 disease

Keyvan Razazi[1,2*], Romain Arrestier[1,2], Anne Fleur Haudebourg[1,2], Brice Benelli[1,2], Guillaume Carteaux[1,2,3], Jean-Winoc Decousser[4,5,6], Slim Fourati[5], Paul Louis Woerther[5,6], Frederic Schlemmer[3,7], Anais Charles-Nelson[8], Francoise Botterel[5,6†], Nicolas de Prost[1,2,3†] and Armand Mekontso Dessap[1,2,3]

Abstract

Background: Data on incidence of ventilator-associated pneumonia (VAP) and invasive pulmonary aspergillosis in patients with severe SARS-CoV-2 infection are limited.

Methods: We conducted a monocenter retrospective study comparing the incidence of VAP and invasive aspergillosis between patients with COVID-19-related acute respiratory distress syndrome (C-ARDS) and those with non-SARS-CoV-2 viral ARDS (NC-ARDS).

The mechanical ventilation lasted longer in C-ARDS than in NC-ARDS group: 16.5 [9.0–28.8] vs 9.0 [6.0–17.3] days, p<0.0001

At day 28 of ICU admission, significantly more patients developed at least one VAP episode in C-ARDS group than in NC-ARDS group: 56 (62%) vs. 35 (43%), p=0.016

Table 1 Characteristics of patients with acute respiratory distress syndrome related to Coronavirus disease 19 (C-ARDS) or other viruses (NC-ARDS)

Variables	NC-ARDS (*n* = 82)	C-ARDS (*n* = 90)	*p* value
Prone position	34 (42%)	75 (83%)	<0.001
Neuromuscular blockade	53 (65%)	83 (92%)	<0.001
First VAP	36 (44%)	58 (64%)	0.007
ICU length of stay among survivors, days	15 [10–20]	30 [19–45]	<0.001

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7747772/pdf/13054_2020_Article_3417.pdf

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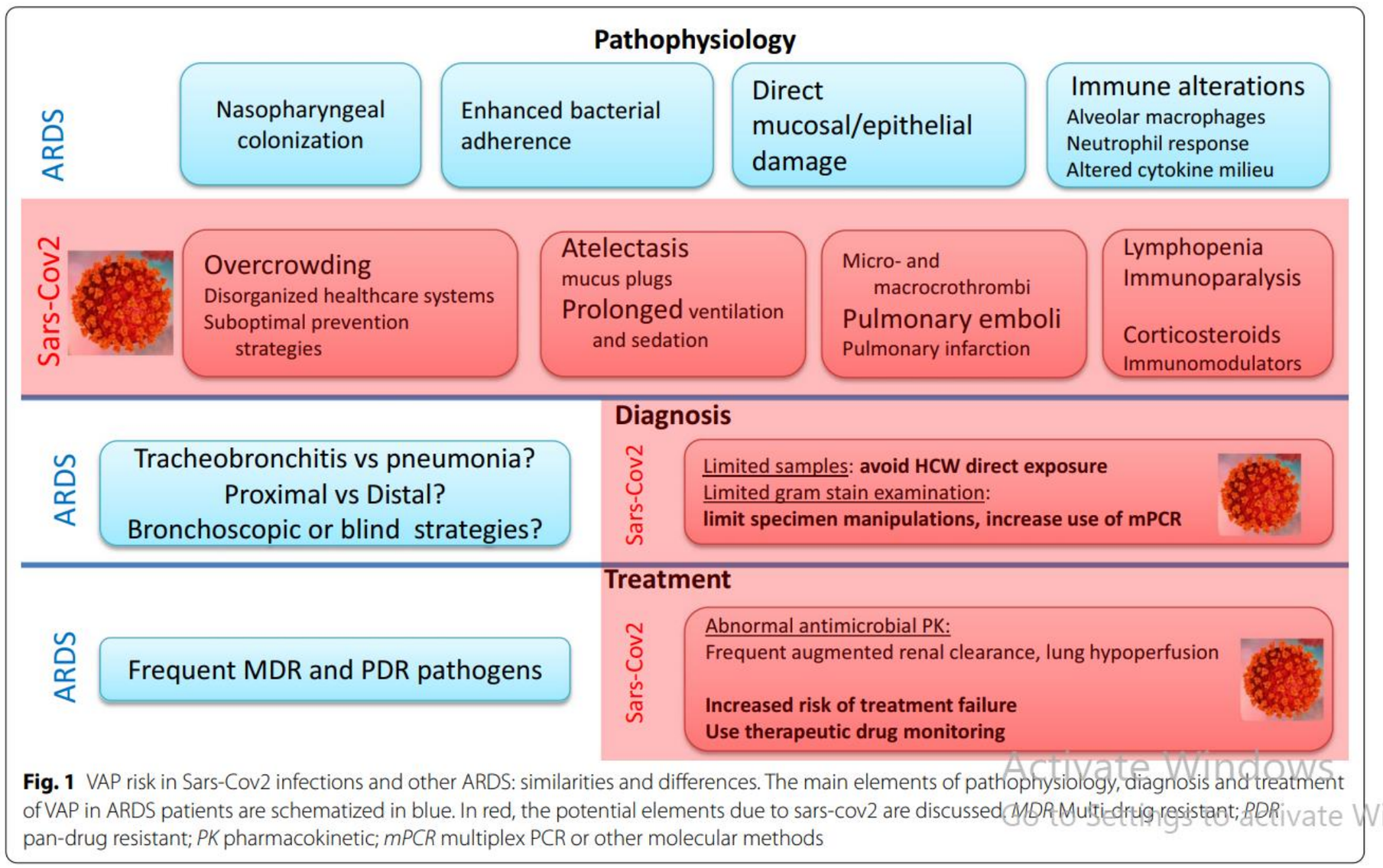

Fig. 1 VAP risk in Sars-Cov2 infections and other ARDS: similarities and differences. The main elements of pathophysiology, diagnosis and treatment of VAP in ARDS patients are schematized in blue. In red, the potential elements due to sars-cov2 are discussed. *MDR* Multi-drug resistant; *PDR* pan-drug resistant; *PK* pharmacokinetic; *mPCR* multiplex PCR or other molecular methods

SARS-CoV-2 ARDS patients have different clinical features than other ARDS patients, characterized by more profound hypoxia, and in comparative studies, the duration of mechanical ventilation was twice as long in COVID-19 patients compared with other types of ARDS

Wicky et al. Crit Care (2021) 25:153 available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8059113/pdf/13054_2021_Article_3571.pdf

Wicky *et al. Crit Care* (2021) 25:153
https://doi.org/10.1186/s13054-021-03571-z

Critical Care

EDITORIAL Open Access

Ventilator-associated pneumonia in the era of COVID-19 pandemic: How common and what is the impact?

Paul-Henri Wicky[1], Michael S. Niedermann[2,3] and Jean-François Timsit[1,4*]

Abstract

We reviewed similarities and differences of ventilator associated pneumonia in Sars-Cov2 infection and with other ARDS. The differences in epidemiology and outcome will be detailed. Possible explanations of differences in pathophysiology of VAP in Sarscov2 infections will be cited and discussed.

Keywords: COVID-19, ARDS, Ventilation-associated pneumonia, Superinfections, Prognostic

- **less rigorous use of standard prevention strategies during COVID-19,**
- **disease and therapy-associated immune impairment,**
- **more prolonged duration of mechanical ventilation,**
- **prolonged use of sedation,**
- **more frequent need for prone ventilation,**
- **higher risk for pulmonary infarction with associated superinfection.**

Wicky et al. Ventilator-associated pneumonia in the era of COVID-19 pandemic: How common and what is the impact? Crit Care (2021) 25:153 available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8059113/pdf/13054_2021_Article_3571.pdf

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Respiratory tract infection

- **Healthcare associated respiratory tract infection (HA-RTI): Any type of respiratory tract infection acquired in hospital**
  - **Upper respiratory tract infection (URTI): Acute infections of nose, paranasal sinuses, pharynx and/or larynx**
  - **Acute infections of the trachea, bronchi and/or lungs (pneumonia)**
    - **Hospital acquired pneumonia [HAP]: respiratory viruses, (influenza, MerCOV, RSV, measles, tuberculosis, legionella, aspergillosis**
    - **Ventilator associated pneumonia [VAP], Lower respiratory tract infection (LRTI)**

https://www.cdc.gov/infectioncontrol/guidelines/pdf/guidelines/healthcare-associated-pneumonia.pdf

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Respiratory tract infection

- **Hospital-acquired pneumonia (HAP): Pneumonia that occurs 48 hours or more after hospital admission (and that was not present at the time of admission)**
- **Ventilator-associated pneumonia (VAP): Pneumonia that occurs more than 48-72 hours after endotracheal intubation**
  - **Characterized by new or progressive infiltrate, signs of systemic infection (fever, altered white blood cell count), changes in sputum characteristics**
  - **Early-onset: Within 96 hours of intubation**
  - **Late-onset: After 96 hours of intubation, usually associated with growth of gram-negative bacilli on tracheal aspiration**

https://www.cdc.gov/infectioncontrol/guidelines/pdf/guidelines/healthcare-associated-pneumonia.pdf

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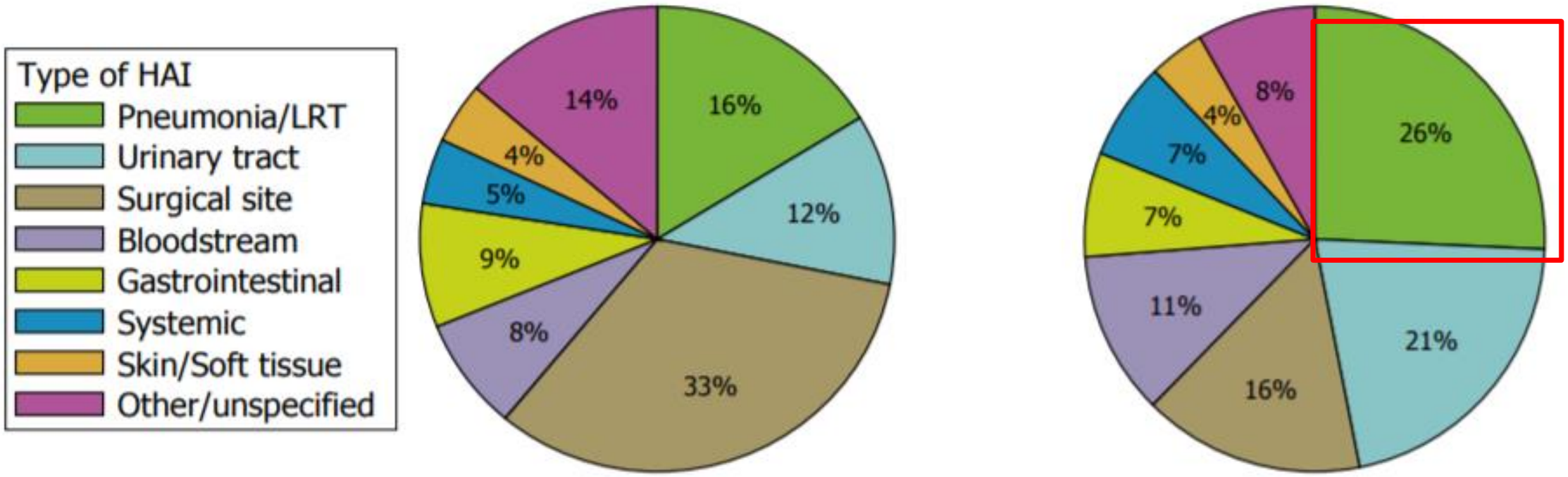
Epidemiology of HA-RTI

- **Associated with high mortality and morbidity**
- **In United States…**
  - **•Attributable mortality (i.e. deaths that could be avoided if HAP was prevented) has been estimated to be 30-50%**
  - **•Can increase hospital stay by an average of 7-9 days and produce an excess cost of $40,000 per patient in US**

http://www.atsjournals.org/doi/abs/10.1164/rccm.200405-644ST?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%3dpubmed;
http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(10)61458-4/abstract

Point prevalence survey of HAI in European acute care hospitals

Figure 1. Distribution of HAI types by presence of HAI on admission, HAI present on admission (left) HAI onset during hospitalisation (right)



Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals 2011–2012; https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/healthcare-associated-infections-antimicrobial-use-PPS.pdf

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Incidence of HAI - respiratory infection on COVID 19 patients

Clinical Microbiology and Infection 27 (2021) 83–88

Contents lists available at ScienceDirect

Clinical Microbiology and Infection

journal homepage: www.clinicalmicrobiologyandinfection.com

Original article

Incidence of co-infections and superinfections in hospitalized patients with COVID-19: a retrospective cohort study

Carolina Garcia-Vidal [1,*,†], Gemma Sanjuan [1,†], Estela Moreno-García [1], Pedro Puerta-Alcalde [1], Nicole Garcia-Pouton [1], Mariana Chumbita [1], Mariana Fernandez-Pittol [2], Cristina Pitart [2], Alexy Inciarte [1], Marta Bodro [1], Laura Morata [1], Juan Ambrosioni [1], Ignacio Grafia [1], Fernanda Meira [1], Irene Macaya [1], Celia Cardozo [1], Climent Casals [2], Adrian Tellez [3], Pedro Castro [3], Francesc Marco [2], Felipe García [1], Josep Mensa [1], José Antonio Martínez [1], Alex Soriano [1] for the COVID-19 Researchers Group[1]

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S. aureus	1/7 (14.2)
Hospital-acquired superinfections complicating patients admitted for COVID-19	44/74 (59.5)
Ventilator-associated pneumonia	11/44 (25)
S. aureus	4/11 (36.4)
P. aeruginosa	3/11 (27.3)
Stenotrophomonas maltophilia	2/11 (18.2)
K. pneumoniae	1/11 (9)
Serratia marcescens	1/11 (9)
Hospital-acquired pneumonia	4/44 (9)
S. aureus	1/4 (25)
P. aeruginosa	1/4 (25)
S. maltophilia	1/4 (25)
K. pneumoniae	1/4 (25)
Bacteraemia	16/44 (36.3)
Coagulase-negative staphylococci	7/16 (43.7)
P. aeruginosa	3/16 (18.7)
E. faecium	3/16 (18.7)
E. coli	2/16 (12.5)
Streptococcus anginosus	1/16 (6.2)
Urinary tract infection	12/44 (27.3)
E. coli	4/12 (33.5)
K. pneumoniae	3/12 (25)
Enterococcus faecalis	2/12 (16.7)
E. faecium	1/12 (8.3)
P. aeruginosa	1/12 (8.3)
S. marcescens	1/12 (8.3)
Polymicrobial intra-abdominal infection (*E. coli, E. faecium, E. faecalis*)	1/44 (2.3)

Some patients had more than one bacterial infection.
COVID-19, coronavirus disease 2019.

HAI 59.5%
VAP 25%
HAP 9%

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VAP and mortality COVID 19 patients

Nseir et al. Crit Care (2021) 25:177
https://doi.org/10.1186/s13054-021-03588-4

Critical Care

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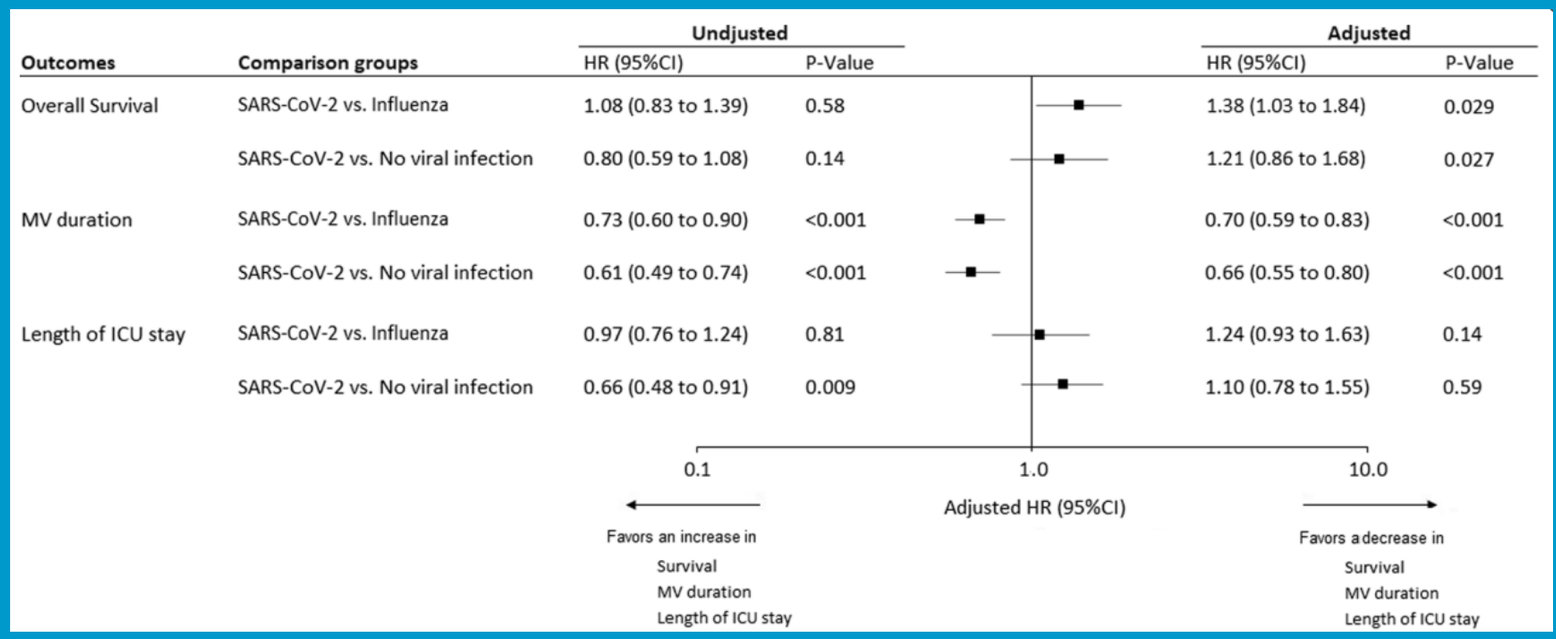
Relationship between ventilator-associated pneumonia and mortality in COVID-19 patients: a planned ancillary analysis of the coVAPid cohort

Saad Nseir[1,2*], Ignacio Martin-Loeches[3,4], Pedro Povoa[5,6], Matthieu Metzelard[7], Damien Du Cheyron[8], Fabien Lambiotte[9], Fabienne Tamion[10], Marie Labruyere[11], Demosthenes Makris[12], Claire Boulle Geronimi[13], Marc Pinetonde Chambrun[14], Martine Nyunga[15], Olivier Pouly[16], Bruno Mégarbane[17], Anastasia Saade[18], Gemma Gomà[19], Eleni Magira[20], Jean-François Llitjos[21], Antoni Torres[22], Iliana Ioannidou[23], Alexandre Pierre[24], Luis Coelho[5], Jean Reignier[25], Denis Garot[26], Louis Kreitmann[27], Jean-Luc Baudel[28], Guillaume Voiriot[29], Damien Contou[30], Alexandra Beurton[31], Pierre Asfar[32], Alexandre Boyer[33], Arnaud W. Thille[34], Armand Mekontso-Dessap[35], Vassiliki Tsolaki[12], Christophe Vinsonneau[36], Pierre-Edouard Floch[37], Loïc Le Guennec[38], Adrian Ceccato[39], Antonio Artigas[40], Mathilde Bouchereau[1], Julien Labreuche[41], Alain Duhamel[41] and Anahita Rouzé[1,2]the coVAPid study group

	568 SARS-CoV2	482 influenza	526 no viral infection	399 (25.3%) VAP	167 (10.6%) VAT
28-day mortality	28.8% (164 of 568 patients)	, 22% (125 of 482 patients	32.9% (173 of 526 patients)		

Outcomes	Comparison groups	Undjusted HR (95%CI)	Undjusted P-Value	Adjusted HR (95%CI)	Adjusted P-Value
Overall Survival	SARS-CoV-2 vs. Influenza	1.08 (0.83 to 1.39)	0.58	1.38 (1.03 to 1.84)	0.029
	SARS-CoV-2 vs. No viral infection	0.80 (0.59 to 1.08)	0.14	1.21 (0.86 to 1.68)	0.027
MV duration	SARS-CoV-2 vs. Influenza	0.73 (0.60 to 0.90)	<0.001	0.70 (0.59 to 0.83)	<0.001
	SARS-CoV-2 vs. No viral infection	0.61 (0.49 to 0.74)	<0.001	0.66 (0.55 to 0.80)	<0.001
Length of ICU stay	SARS-CoV-2 vs. Influenza	0.97 (0.76 to 1.24)	0.81	1.24 (0.93 to 1.63)	0.14
	SARS-CoV-2 vs. No viral infection	0.66 (0.48 to 0.91)	0.009	1.10 (0.78 to 1.55)	0.59



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Understand clinical and laboratory diagnosis of health care-associated RTI (HA-RTI)…

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Diagnosis of HA-RTI

- **Depending on available resources at health care facility, HA-RTI can be identified by:**
  - **Clinical diagnosis (e.g. diagnosis made by a practitioner)**
  - **Laboratory investigation (e.g. respiratory samples): Diagnosis is more specific when quantitative microbiological samples are obtained**

- **Rapid identification of HA-RTI are important in order to:**
  - **Provide appropriate antimicrobial therapy**
  - **Identifying patients with transmissible infections to rapidly implement IPC measures**

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Incidence of RTI coinfection with COVID 19

Reported incidence of

- community-acquired pulmonary bacterial coinfections with COVID-19 is as low as 3%
- 5–16% for ward and Intensive Care Units (ICU) patients respectively [1, 2].
- However, the frequency of VAP is uncertain, and its incidence, characteristics and prognosis remain to be further explored

Wicky et al. Ventilator-associated pneumonia in the era of COVID-19 pandemic: How common and what is the impact? Crit Care (2021) 25:153 available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8059113/pdf/13054_2021_Article_3571.pdf

Precautions to be used

depend on

Modes of transmission of HA-RTI

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HA-RTI transmission routes

Key routes that HA-RTI is transmitted in health care facilities

- **Droplet**
- **Airborne**
- **Other: Via contaminated equipment or hands**

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Precautions and types of RTIs

Type of Precaution	No pathogen identified	Bacterial RTI	TB	Seasonal Influenza	Other viruses	Novel RTI
Standard	✔	✔	✔	✔	✔	✔
Droplet	✔			✔	✔	
Airborne			✔			✔
Contact					✔	✔

Control of communicable diseases manual 20th edition;
http://apps.who.int/iris/bitstream/10665/112656/1/9789241507134_eng.pdf

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Decontamination of patient care items and equipment

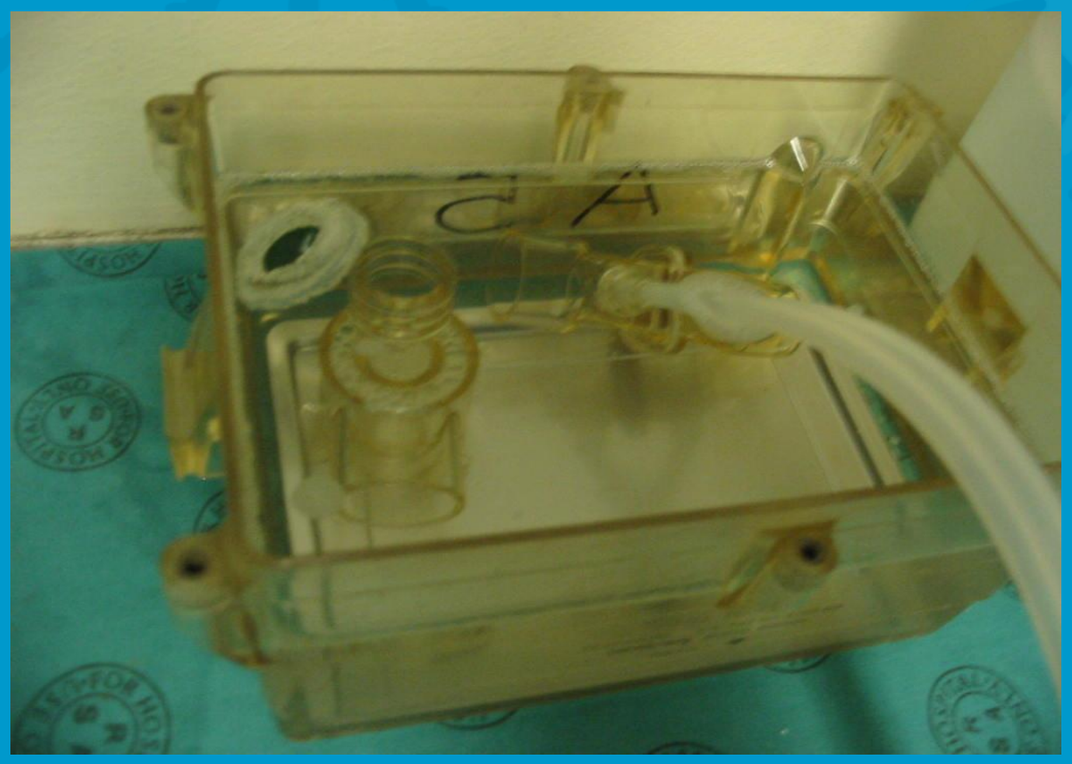
- **Thoroughly clean all equipment and devices to be sterilized or disinfected using manufacturer's instructions and established protocols (e.g. *CDC Guidelines for preventing healthcare-associated pneumonia)***
- **All items that come into direct or indirect contact with mucous membranes of the lower respiratory tract**
  - **Mechanical ventilators**
  - **Breathing circuits, humidifiers, heat-moisture exchanger (HME)**
  - **Nebulizers**
  - **Mistents**
  - **Other devices associated with respiratory therapy**
  - **Anesthesia machines and breathing systems or patient circuits**
  - **Pulmonary-function testing equipment**
  - **Room-air "humidifiers" and faucet aerators**

https://www.cdc.gov/infectioncontrol/guidelines/pdf/guidelines/healthcare-associated-pneumonia.pdf

Decontamination of patient care items and equipment

Challenges

- Reuse of single use items, e.g. respiratory circuits
- Soaking in open container disinfectants on the ward-contaminated with MDROs
- Colonisation of linen with MDROs



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Disinfection by water or water jet

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Liquid chemical methods

High level disinfection

- **Glutaraldehyde**
- **Hydrogen peroxide**
- **Ortho-phthaldehyde**
- **Peracetic acid with hydrogen peroxide**

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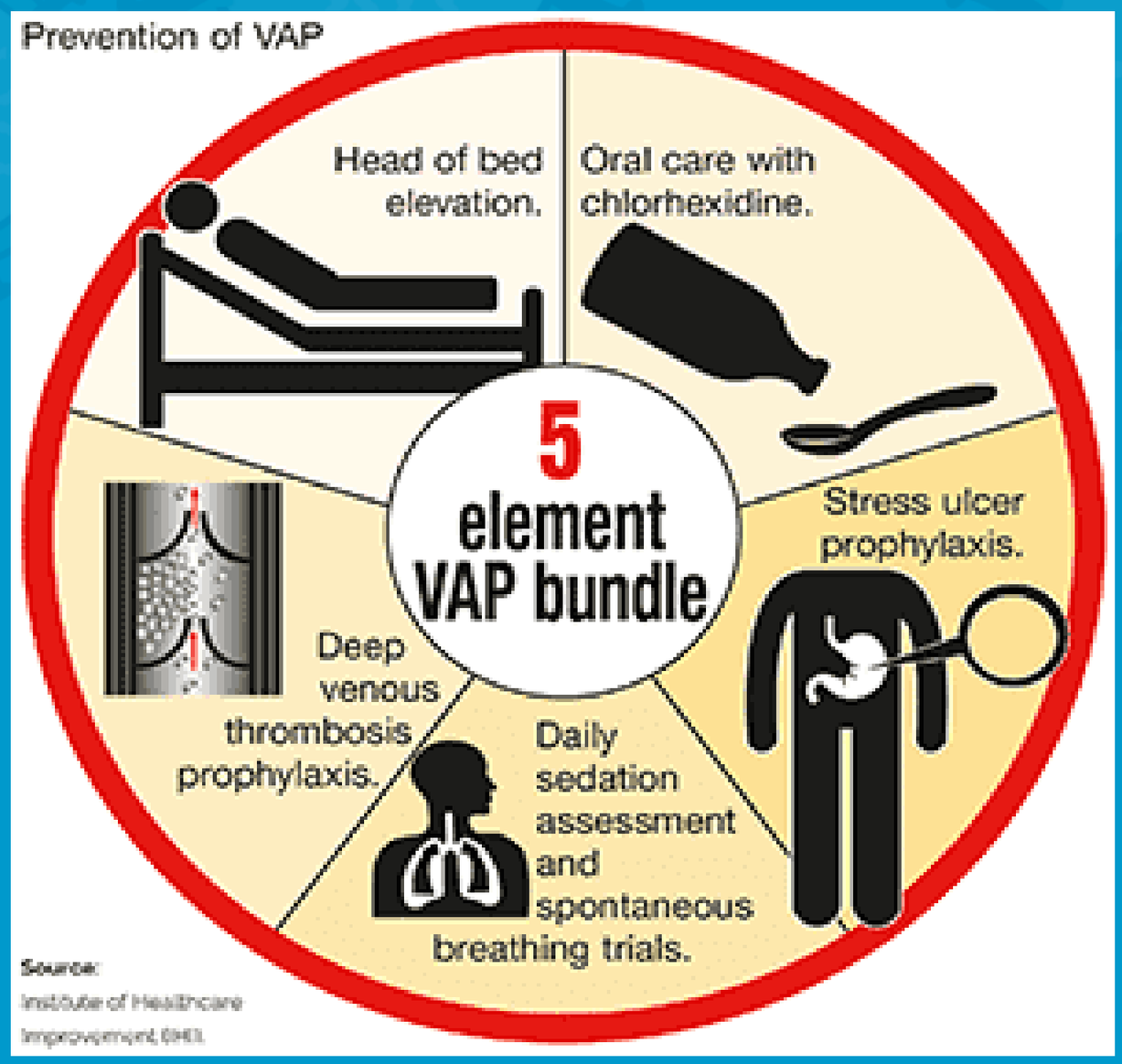
VAP bundle components

1. Elevation of the head of the bed to 30-45 degrees
2. Daily 'sedation vacation' & Daily assessment of readiness to extubate
3. Peptic ulcer disease prophylaxis,
4. Deep venous thrombosis prophylaxis.
5. Oral care with chlorhexidine (if available)

Hand hygiene is a given and a must!



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Prevention reports COVID 19

- Impact of the modification of a cleaning and disinfection method of mechanical ventilators of COVID-19 patients and ventilator-associated pneumonia: One year of experience. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8451981/
- **Decontamination of Mechanical ventilator with enzymatic detergent.**

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REVIEW ARTICLE

NURSING FORUM AN INDEPENDENT VOICE FOR NURSING WILEY

Prevention of VAP: Endless evolving evidences–systematic literature review

Chandrani Isac MSc Nursing | Hema Roslin Samson MSc Nursing | Anitha John MSc Nursing

Nursing Forum 2021:56:905-915
https://onlinelibrary.wiley.com/doi/epdf/10.1111/nuf.12621

VAP prevention – Systematic review

Results: Evidence-based VAP preventive strategies are prevention of aspiration, minimizing ventilator days, reducing the pathogen load, safe endotracheal suction practices, and pharmaceutical preventive measures. The mandates for VAP preventive measures among coronavirus disease 2019 (COVID-19) patients is included. **Conclusion:** Though some of these themes identify with the past, the nuances in their implementation are highlights of this review. The review reiterates the need to revisit ambiguous practices implemented for VAP prevention. Adherence to evidence-based practices, by education, training, and reduction of workload is the key to VAP prevention.

Nursing Forum 2021:56:905-915
https://onlinelibrary.wiley.com/doi/epdf/10.1111/nuf.12621

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VAP prevention – Systematic review

4.1 | Preventing aspiration

The upper airway and gastrointestinal tract are with bacterial colonization. Hence, aspiration of oropharyngeal secretions predominantly

4.1.1 | Head of bed elevation [30°–45°]

Literature magnifies that head of bed elevation should be the default order for all mechanically ventilated patients. Patients with logroll protocol; pelvic fractures, morbid obesity, prone position, and intra-aortic balloon pump device are listed as some of exemptions for this intervention. Measures to promote adherence to this simple yet live saving intervention is to monitor head of bed elevation every 4 h, and to post cues in the patient rooms.[5]

4.1.2 | Draining of subglottic secretions

The drainage of secretions collected above the cuff of the endotracheal tube has significant reduction in incidence of VAP.[21] Patients expected to require mechanical ventilation for more than 48 h are candidates for drainage of subglottic secretions. The drainage system of subglottic secretions is continuous or intermittent. Recent empirical evidence does not statistically differentiate between intermittent and continuous subglottic suctioning in terms of VAP prevention and tracheal mucosal damage. However, closed subglottic secretion drainage has significant reduction in mechanical ventilation days and ICU stay,[16] and intermittent subglottic suction drainage has significant increased volume of suctioned secretion.[15]

4.1.3 | Maintain adequate endotracheal cuff pressure

Literature advocates maintaining endotracheal cuff pressures between 20 and 30 cmH_2O,[22] with meticulous checks every 6 h,[3] and with every position change.[17] Patients with greater risk for VAP, require a continuous cuff-pressure control device.[5]

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4.2 | Minimize ventilator days

Weaning from the ventilator follows three key steps. The first step is to reduce ventilator support as patient's health stabilizes. The second step is to assess patient's ability to breathe without support (spontaneous breathing trials). The third step is to extubate the patient and liberate them from the ventilator. This systematic approach in implementing weaning protocols reduces ventilator days,[23] which can be implementation by the following empirically routed measures.

4.2.1 | Sedation interruption

Mechanically ventilated patients receiving intravenous sedation are at risk for VAP, due to depressed respiration, cough, and gag reflexes. Reviewed literature exemplifies the need to build a protocol for daily sedation interruption for mechanically ventilated patients. Daily sedation interruption (DSI) is implemented by complete or partial discontinuation of sedation medication at a fixed time, for a period of 5 h, while ensuring a Richmond Agitation Sedation Score (RASS) score between zero and two. Ventilated patients exposed to DSI had 0% VAP on their third ventilator day, compared with 15% of their counterparts with routine sedation interruption developing VAP.[14] The decision for daily sedation interruption is contraindicated in patients with new intubation (within 24 h), escalating sedation dosages, neuromuscular blocking infusions, higher intracranial pressures, lower mean arterial blood pressure, higher fraction of inspired oxygen (FiO_2) and positive end expiratory pressure (PEEP) requirements, higher peak inspiratory airway pressure, and active seizures.[5]

4.2.2 | Daily assessment of readiness for extubation

Protocolized sedation interruption paves the way for early extubation. Nonsedated patients with RASS scores between zero and two, vital signs and saturation greater than 90%, lower requirements for FiO_2 (≤0.5), and PEEP < 8cmH_2O are good candidates' for

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4.3 | Reducing the pathogen load

Migration of the bacteria colonized in the upper respiratory tract and gastrointestinal tract to lower airways of the lung increases VAP incidence.[24] Empirical ventures report oral care with chlorhexidine gluconate 0.12% solution every 2–4 h, and tooth brushing every 12 h to reduce pathogen load. These ventures reduced VAP incidence from 144 between 2008 and 2010; to 14 between 2011 and 2013.[5] The provision of oral care with suction tooth brush and chlorhexidine mouth rinses every 4 h for ventilated patients reduced the VAP incidence from 12 in the baseline period to 3 in the intervention

4.4 | Safe endotracheal suction practices

Endotracheal suctioning involves the insertion of a catheter into the airway for removing the retained tracheobronchial secretions. Employing safe techniques prevents the introduction of infectious agents. Evidence-based safe practice standards, that remains undebated includes[8]:

- Endotracheal suctioning is performed only when necessary.
- Preoxygenation is considered in patients having clinically significant reduction in oxygen saturation with suctioning.
- The suction catheter should occlude less than half of the lumen of the endotracheal tube.
- Suctioning pressure maintained between 80 and 150 mmHg.
- A suction pass no longer than 15 seconds.
- No routine instillation of normal saline.
- Suction pressures not to exceed 150 mmHg.
- Strict aseptic technique.

Few of the endotracheal suction practices expose themselves to frequent debate and are tested and restated in literature. The ambivalence between shallow and deep suctioning is clarified by recent evidence, which states that hemodynamic and respiratory parameters significantly increase in both methods; however, the frequency of suctioning increased with shallow suction.[10] Similarly, the preference between open and closed suctioning techniques is inconclusive. The occurrence of VAP was 12 in the group with open tracheal suction system, and 10 in the group with closed tracheal suction system, with no significant difference between them. Closed suction is suggested for adults with high FiO_2, or PEEP requirements, and those requiring lung de-recruitment.[18]

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4.5 | Pharmaceutical preventive measures

Ventilated patients are at risk for stress ulcers, and prescribed acid suppressive medications prophylactically. These medications raise the pH of the gastric fluids, allowing bacterial overgrowth.[28] Sucralfate, a viscous paste of aluminum binds to gastric ulcers forming a direct protective barrier for 6 h. A meta-analysis with data surveyed between 1996 and 2013, reports that VAP incidences significantly reduced in ventilated patients receiving sucralfate.[9]

Reviewed literature documents that insulin resistance causing; a hyperglycemic state precedes the onset of VAP. Hence, hypothetically glycemic control will prevent VAP.[11] The institution of MIAR (measure, interpret, act, and reanalysis) is recommended for effective glycemic control.[29]

VAP preventive measures is not limited to the interventions broadcasted above. Multiple interventions as a "bundle of care" is required for VAP prevention. A systematic approach is required to choose the interventions, which is most feasible, suitable and effective. Speck et al. (2016), through their rigorous exploration using the modified Delphi technique, identified a comprehensive list of 5 process and 14 structural-driven interventions for VAP prevention.[30]

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4.6 | VAP prevention protocol in the context of COVID-19

The COVID-19 pandemic has escalated the prevalence of ventilated patients and the rigor for VAP prevention is mandated. World Health Organization recommends the implementation of the following standards for VAP prevention among COVID-19 patients[31]:

- Preference for oral instead of nasal intubation (adults and adolescents).
- Closed suctioning system, periodically drain and discard condensate in tubing.
- Keep patients in semirecumbent position (head-bed elevated 30°–45°).
- A new ventilator circuit for each patient, change circuit only if soiled or damaged.
- Change heat moisture exchanger, when soiled or every 5–7 days.

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Additional references

Management of adults with hospital-acquired and ventilator-associated pneumonia: 2016 Guidelines by Infectious Diseases Society of America and American Thoracic Society
https://academic.oup.com/cid/article-lookup/doi/10.1093/cid/ciw353

Centers for Disease Control and Prevention (CDC): 2003 Guidelines for preventing health care associated pneumonia
https://www.cdc.gov/infectioncontrol/guidelines/pdf/guidelines/healthcare-associated-pneumonia.pdf

Guidelines for management of hospital-acquired pneumonia in the UK: Report of Working Party on Hospital-Acquired Pneumonia of the British Society for Antimicrobial Chemotherapy
https://academic.oup.com/jac/article/62/1/5/844812/Guidelines-for-the-management-of-hospital-acquired

Institute of Healthcare Improvement How-to Guide: Prevent Ventilator-Associated Pneumonia
http://www.ihi.org/resources/Pages/Tools/HowtoGuidePreventVAP.aspx

Prevention of hospital-acquired pneumonia in non-ventilated adult patients: a narrative review
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5109660/

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