



มหาวิทยาลัยมหิดล
สถาบันแพทยศาสตร์
#55ระบอบใหม่

วันอาทิตย์ที่ 13 ตุลาคม 2562

09:00-10:30 AM Combating MDRs: can we win?
Prof. Yong Rongrungruang, MD, PhD, FRCPC, FRCGS, FRCR
Emerging issues in infection control
• Antibiotic resistance • Antimicrobial resistance • Antimicrobial stewardship



Emerging Issues in Infection Control


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ปญญาพจน/แพทย

Topics

- Emerging ventilator-associated pneumonia (VAP) surveillance
- Gut microbiota & role in preventing antimicrobial resistant infections
- Antimicrobial textiles and infection prevention & control



January 2019

Device-associated Module
PNEU

Pneumonia (Ventilator-associated [VAP] and non-ventilator-associated Pneumonia [PNEU]) Event

Introduction: In 2011, an estimated 157,000 healthcare-associated pneumonias occurred in acute care hospitals in U.S.; 39% of these pneumonias were ventilator-associated (VAP).¹ Patients receiving invasive mechanical ventilation are at risk for numerous complications, including pneumonia. Ventilator-associated pneumonia (VAP) and other healthcare-associated pneumonias are important, common healthcare-associated infections, but national surveillance for VAP has long been a challenge because of the lack of objective, reliable definitions. Due to these challenges, in January 2013 the National Healthcare Safety Network (NHSN) replaced surveillance for ventilator-associated pneumonia (VAP) in adult inpatient locations with surveillance for ventilator-associated events (VAE).² Based on discussions with an expert working group in 2012-2013, NHSN also discontinued in-plan VAP surveillance in neonatal locations. As of January 2014, in-plan VAP surveillance is only available in pediatric inpatient locations.

Imaging Test Evidence	Signs/Symptoms/Laboratory
Two or more serial chest imaging test results with at least <u>one</u> of the following: ^{1,2,3,4}	For ANY PATIENT, at least <u>one</u> of the following: <ul style="list-style-type: none"> Fever ($>38.0^{\circ}\text{C}$ or $>100.4^{\circ}\text{F}$) Leukopenia ($\leq 4000 \text{ WBC/mm}^3$) or leukocytosis ($\geq 12,000 \text{ WBC/mm}^3$) For adults ≥ 70 years old, altered mental status with no other recognized cause
New and persistent or progressive and persistent	And at least <u>two</u> of the following: <ul style="list-style-type: none"> New onset of purulent sputum⁵ or change in character of sputum⁶, or increased respiratory secretions, or increased suctioning requirements New onset or worsening cough, or dyspnea, or tachypnea⁷ Rales⁸ or bronchial breath sounds Worsening gas exchange (for example: O_2 desaturations (for example: $\text{PaO}_2/\text{FiO}_2 \leq 240$)⁹, increased oxygen requirements, or increased ventilator demand)
Infiltrate	ALTERNATE CRITERIA, for infants ≤ 1 year old: <ul style="list-style-type: none"> Temperature instability Leukopenia ($\leq 4000 \text{ WBC/mm}^3$) or leukocytosis ($\geq 15,000 \text{ WBC/mm}^3$) and left shift ($\geq 10\%$ band forms) New onset of purulent sputum⁵ or change in character of sputum⁶, or increased respiratory secretions or increased suctioning requirements Apnea, tachypnea⁷, nasal flaring with retraction of chest wall or nasal flaring with grunting Wheezing, rales⁸, or rhodchi Cough Bradycardia ($<100 \text{ beats/min}$) or tachycardia ($>170 \text{ beats/min}$)
Consolidation	ALTERNATE CRITERIA, for child >1 year old or ≥ 12 years old, at least <u>three</u> of the following: <ul style="list-style-type: none"> Fever ($>38.0^{\circ}\text{C}$ or $>100.4^{\circ}\text{F}$) or hypothermia ($<36.0^{\circ}\text{C}$ or $<96.8^{\circ}\text{F}$) Leukopenia ($\leq 4000 \text{ WBC/mm}^3$) or leukocytosis ($\geq 15,000 \text{ WBC/mm}^3$) New onset of purulent sputum⁵ or change in character of sputum⁶, or increased respiratory secretions, or increased suctioning requirements New onset or worsening cough, or dyspnea, apnea, or tachypnea⁷ Rales⁸ or bronchial breath sounds Worsening gas exchange (for example: O_2 desaturations (for example: pulse oximetry $<94\%$), increased oxygen requirements, or increased ventilator demand)
Cavitation	
Pneumatoceles, in infants ≤ 1 year old	
Note: In patients without underlying pulmonary or cardiac disease (for example: respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive imaging test result is acceptable. ¹	

Algorithms for Clinically Defined Pneumonia (PNU1)

Signs/Symptoms/Laboratory

For ANY PATIENT, at least one of the following:

- Fever ($>38.0^{\circ}\text{C}$ or $>100.4^{\circ}\text{F}$)
- Leukopenia ($\leq 4000 \text{ WBC/mm}^3$) or leukocytosis ($\geq 12,000 \text{ WBC/mm}^3$)
- For adults ≥ 70 years old, altered mental status with no other recognized cause

And at least two of the following:

- New onset of purulent sputum³ or change in character of sputum⁴, or increased respiratory secretions, or increased suctioning requirements
- New onset or worsening cough, or dyspnea, or tachypnea³
- Rales⁶ or bronchial breath sounds
- Worsening gas exchange (for example: O_2 desaturations (for example: $\text{PaO}_2/\text{FiO}_2 \leq 240$)⁷, increased oxygen requirements, or increased ventilator demand)

Pneumonia category & code

Category	Code	Criteria
Clinically-Defined	PNU 1	A + B + 2C
Laboratory-confirmed	PNU 2	A + B + C + D
Opportunistic agents	PNU 3	A + B + C + E

CDC NHSN Device-associated Module PNU Jan 2019

Surveillance definitions for ventilator-associated events (VAEs)

Surveillance for ventilator-associated events in the National Healthcare Safety Network (NHSN) prior to 2013 was limited to VAP. For the year 2012, VAP incidence for various types of hospital units ranged from 0.0-4.4 per 1,000 ventilator days [6]. However, there is currently no valid, reliable definition for VAP, and even the most widely-used VAP criteria and definitions are neither sensitive nor specific [7-10].

A particular difficulty with many commonly-used VAP definitions, including the NHSN PNEU definitions (revised in 2002), is that they require radiographic findings of pneumonia. Evidence suggests that chest radiograph findings do not accurately identify VAP. The subjectivity and variability inherent in chest radiograph technique, interpretation, and reporting make chest imaging ill-suited for inclusion in a definition algorithm to be used for the potential purposes of

A particular difficulty with many commonly-used VAP definitions, including the NHSN PNEU definitions (revised in 2002), is that they require radiographic findings of pneumonia. Evidence suggests that chest radiograph findings do not accurately identify VAP. The subjectivity and variability inherent in chest radiograph technique, interpretation, and reporting make chest imaging ill-suited for inclusion in a definition algorithm to be used for the potential purposes of

Name	Definition
Ventilator-associated condition (VAC)	≥2 Calendar days of stable or decreasing daily minimum positive end-expiratory pressure or daily minimum fraction of inspired oxygen, followed by a rise in daily minimum positive end-expiratory pressure of ≥3 cm of water or a rise in the daily minimum percentage of inspired oxygen by >20 points sustained for ≥2 calendar days
Infection-related ventilator-associated complication (IVAC)	VAC plus a temperature of <36°C or >38°C or a leukocyte count of ≤4000 or ≥12,000 per cubic millimeter, plus one or more new antibiotics continued for at least 4 days within 2 calendar days before or after onset of a VAC, excluding the first 2 days of mechanical ventilation

Klompas M, et al. N Eng J Med 2013;368:1472-5.

The CDC's New Surveillance Paradigm for Ventilator-Associated Events

Possible pneumonia	IVAC plus Gram's staining of endotracheal aspirate or bronchoalveolar lavage showing ≥ 25 neutrophils and ≤ 10 epithelial cells per low-power field, or a positive culture for a potentially pathogenic organism, within 2 calendar days before or after onset of a VAC, excluding the first 2 days of mechanical ventilation
Probable pneumonia	IVAC plus Gram's staining of endotracheal aspirate or bronchoalveolar lavage showing ≥ 25 neutrophils and ≤ 10 epithelial cells per low-power field, plus endotracheal aspirate with $\geq 10^5$ colony-forming units per milliliter or bronchoalveolar-lavage culture with $\geq 10^4$ colony-forming units per milliliter, or endotracheal-aspirate or bronchoalveolar-lavage semiquantitative equivalent, within 2 calendar days before or after onset of a VAC, excluding the first 2 days of mechanical ventilation

Klompas M, et al. N Eng J Med
2013;368:1472-5.

Probable pneumonia	IVAC plus Gram's staining of endotracheal aspirate or bronchoalveolar lavage showing ≥ 25 neutrophils and ≤ 10 epithelial cells per low-power field, plus endotracheal aspirate with $\geq 10^5$ colony-forming units per milliliter or bronchoalveolar-lavage culture with $\geq 10^4$ colony-forming units per milliliter, or endotracheal-aspirate or bronchoalveolar-lavage semiquantitative equivalent, within 2 calendar days before or after onset of a VAC, excluding the first 2 days of mechanical ventilation
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Patient has a baseline period of stability or improvement on the ventilator, defined as for 2 calendar days of stable or decreasing daily minimums* PEEP, or PEEP values. The baseline period is defined as the 1 calendar day immediately preceding the first day of increased daily minimum PEEP or FIO₂.

*Daily minimum defined by lowest value of PEO₂ or PEEP during a calendar day that is maintained for at least 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:

- 2) Increase in daily minimums* (20 points) over the daily minimum FIO₂ in the baseline period, sustained for 2 calendar days.
- 2) Increase in daily minimums* PEEP values of 3 cmH₂O over the daily minimum PEEP in the baseline period*, sustained for 2 calendar days.

*Daily minimum defined by lowest value of PEO₂ or PEEP during a calendar day that is maintained for at least 1 hour.

*Daily minimum PEEP values of 3 cmH₂O are considered equivalent for the purposes of VAE surveillance.

Ventilator-Associated Complication (VAC)

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, the patient meets both of the following criteria:

- 1) Temperature > 38 °C or < 36 °C, OR white blood cell count ≥ 12,000 cells/mm³ or < 4,000 cells/mm³.
- AND
- 2) A new antimicrobial agent(s) [see Appendix for eligible antimicrobial agent(s)] is started, and is continued for ≥ 2 calendar days.

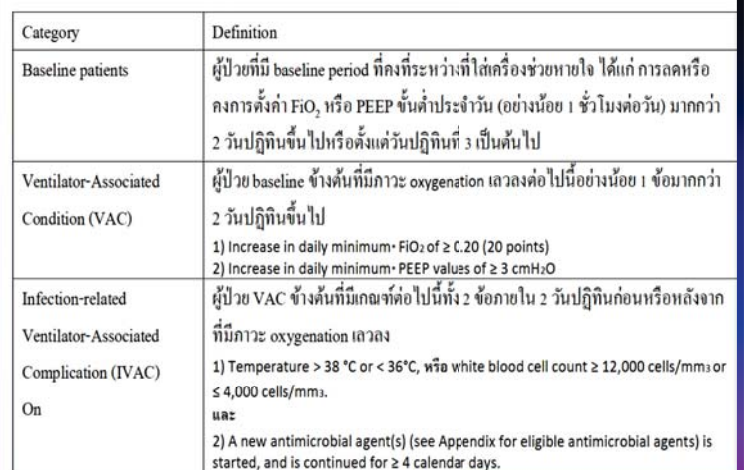
Infection-related Ventilator-Associated Complication (VIAc)

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met (Take into account oxygenation evaluations specified in the protocol):

- 1) Criterion 1: Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds as outlined in protocol, **ADDITIONAL** requirement for purulent respiratory secretions:
 - Endotracheal aspirate, ≥ 10⁵ CFU/mL or corresponding semi-quantitative result
 - Bronchoalveolar lavage, ≥ 10⁴ CFU/mL or corresponding semi-quantitative result
 - Lung tissue, ≥ 10⁵ CFU/g or corresponding semi-quantitative result
 - Protected specimen brush, ≥ 10³ CFU/brush or corresponding semi-quantitative result
- 2) Criterion 2: Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain ≥ 25 neutrophils and ≥ 10 squamous epithelial cells per low power field [X400]) **ADDITIONAL** requirement identified from one of the following specimens (Do include quantitative culture, or quantitative/semi-quantitative culture without sufficient growth to meet criterion #1):
 - Sputum
 - Endotracheal aspirate
 - Bronchoalveolar lavage
 - Lung tissue
 - Protected specimen brush

*If the laboratory reports semi-quantitative results, these results must correspond to the above quantitative thresholds. See additional instructions for using the purulent respiratory secretions criterion in the VAE Protocol.
- 3) Criterion 3: One of the following positive tests:
 - Organism identified from pleural fluid (before specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
 - Lung histopathology, defined as ≥ 10 alveolar macrophages with intense neutrophil accumulation in bronchioles and alveoli, 2) evidence of lung parenchymal injury or fungi (gigaspori, pseudogigaspori 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 for respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

Possible Ventilator-Associated Pneumonia (VPAP)



Possible Ventilator-Associated Pneumonia (PVAP)

ผู้ป่วย IVAC ข้างต้นที่มีเกณฑ์ต่อไปนี้อย่างน้อย 1 ข้อภายใน 2 วันปฏิทินก่อนหรือหลังจากที่เริ่มภาวะ oxygenation เสื่อม

Criterion 1:

Positive culture of one of the following specimens

- ☐ Endotracheal aspirate, $\geq 10^5$ CFU/ml or corresponding semi-quantitative result
- ☐ Bronchoalveolar lavage, $\geq 10^4$ CFU/ml or corresponding semi-quantitative result
- ☐ Lung tissue, $\geq 10^4$ CFU/g or corresponding semi-quantitative result
- ☐ Protected specimen brush, $\geq 10^3$ CFU/ml or corresponding semi-quantitative result

Criterion 2:

Purulent respiratory secretions (>25 neutrophils and <10 squamous epithelial cells per low power field) plus organism identified from one of the following specimens

- ☐ Sputum
- ☐ Endotracheal aspirate
- ☐ Bronchoalveolar lavage
- ☐ Lung tissue
- ☐ Protected specimen brush

Criterion 3:

One of the following positive tests:

- ☒ Organism identified from pleural fluid
- ☐ Lung histopathology
- ☐ Diagnostic test for Legionella species
- ☐ Diagnostic test for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

From VAE baseline

MV day	PEEP (cmH2O)	FiO2 (conc, %)	VAE condition
1	Intubated 8	1.0	Negative
2	6	0.5	Insignificant change
3	5	0.35	
4	5	0.4	Negative
Ext day 1	Extubated		Not applicable
Ext day 2	Extubated		Not applicable

From baseline to VAC

MV day	PEEP (cmH2O)	FiO2 (conc, %)	VAE condition
1	Re-intubated 5	1.0	Negative
2	5	0.5	Negative
3	5	0.5	Negative
4	5	0.5	Negative
5	8	0.5	VAC day 1
6	8	0.5	VAC day 2

- 1) Temperature $> 38^{\circ}\text{C}$ or $< 36^{\circ}\text{C}$, OR white blood cell count $\geq 12,000$ cells/mm³ or $\leq 4,000$ cells/mm³.

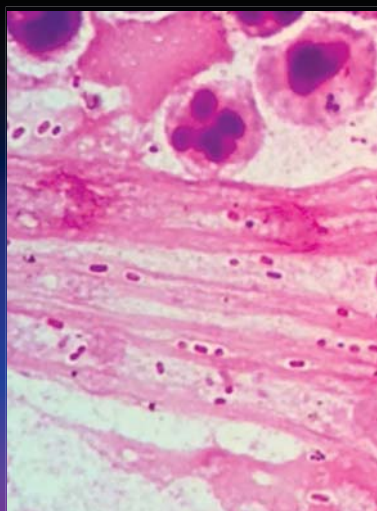
AND

- 2) A new antimicrobial agent(s)* is started, and is continued for ≥ 4 calendar days.

Infection-related Ventilator-Associated Complication (IVAC)

From VAC to IVAC

MV day	PEEP (cmH2O)	FiO2 (conc, %)	VAE condition
1	Re-intubated 5	1.0	Negative
2	5	0.5	Negative
3	5	0.5	Negative
4	5	0.5	Negative
5	8	0.5	VAC day 1
6	8	0.5	VAC day 2
7	8 + fever & ATB	0.5	IVAC day 1
8	8 + fever & ATB	0.5	IVAC day 2
9	8 + fever & ATB	0.5	IVAC day 3
10	8 + fever & ATB	0.5	IVAC day 4



Tier 3: Possible VAP

From IVAC to PVAP

MV day	PEEP (cmH2O)	FiO2 (conc, %)	VAE condition
1	Re-intubated 5	1.0	Negative
2	5	0.5	Negative
3	5	0.5	Negative
4	5	0.5	Negative
5	8	0.5	VAC day 1
6	8	0.5	VAC day 2
7	8 + fever & ATB	0.5	IVAC day 1
8	8 + fever & ATB	0.5	IVAC day 2
9	8 + fever & ATB	0.5	IVAC day 3
10	8 + fever & ATB	0.5	IVAC day 4
11	8 + fever & ATB	0.5	Possible VAP

Extubated > 1 day, MV day recounted

Significant PEEP change ≥ 3 cm H2O for ≥ 2 days

Fever, CBC & sputum Gram & predominant bacteria
No CXR & probable VAP!

VAE surveillance definition algorithm

- Objective
- Streamlined
- Easily implemented
- Make use of electronic medical record
- Automate event detection
- Identify clinically important events and associated with outcomes (eg., ICU & hospital length of stay and mortality)

NHSN January 2019

Conclusions

- Given the disrupting technology in health-care, a novel VAP diagnosis to standardize & reduce subjectivity among health-care facilities emerging
- The emerging VAP diagnosis associated with patient outcome & above all, quality improvement in IPC

Gut microbiota & role in preventing infections

- Gut microbiota play an important role in preventing infections
- by exogenous pathogens through a mechanism called 'colonization resistance'
- Firmicutes, Bacteroidetes and Actinobacteria phyla that confer this mechanism of colonization resistance

Tavoukjian V. Journal of Hospital Infection 2019;102:174-88

Faecal microbiota transplantation (FMT) & antibiotic-resistant bacteria

- Antibiotic therapy shown to cause many metabolic alterations, enhance *C. difficile* & antimicrobial resistant bacteria to proliferate, causing infections
- FMT proven effective for curing recurrent CDI
- FMT study to decolonize antibiotic-resistant bacteria ongoing
- Proposed mechanisms of FMT involve restoration of traditional metabolic > microbial composition

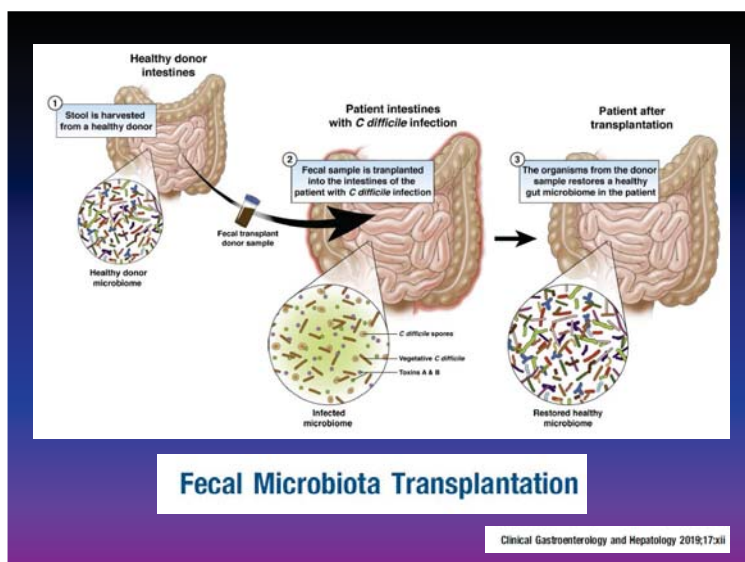
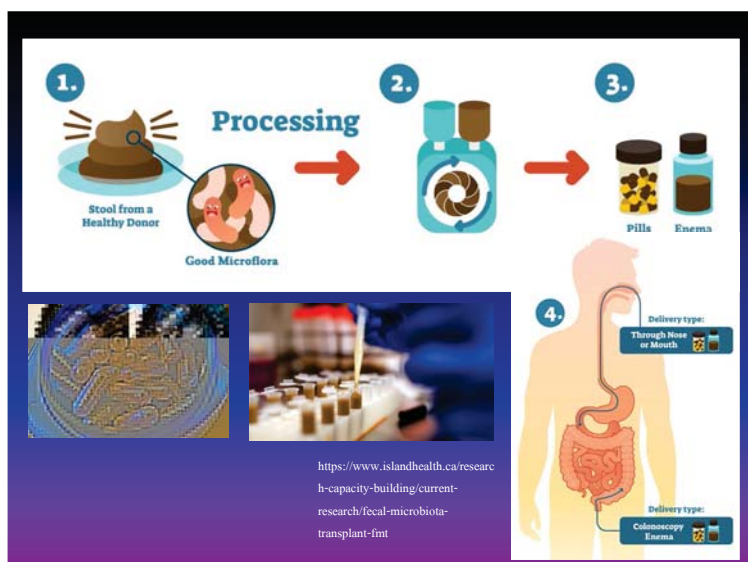
Tavoukjian V. Journal of Hospital Infection 2019;102:174-88

Faecal microbiota transplantation (FMT) & antibiotic-resistant bacteria

- Based on the beneficial role of the gut microbiota,
- FMT reported to be efficient in carbapenemase-producing *Enterobacteriaceae* (CPE) and vancomycin-resistant *Enterococcus* (VRE)-colonised patients
- FMT administrated by infusion of faecal material obtained from the faeces of a healthy donor into the dysbiotic gut of a recipient with the aim of restoring its healthy ecological state

Saidani N, International Journal of Antimicrobial Agents 2019;53:355-61

Tavoukjian V. Journal of Hospital Infection 2019;102:174-88



FMT & carbapenemase-producing *Enterobacteriaceae* or *Acinetobacter* (CPE/A) decolonisation

- Single-centre French study with matched case-control retrospective
- Adjusted two controls per case based on sex, age, bacterial species, and carbapenemase type
- The primary outcome was delay in negativation of rectal-swab cultures

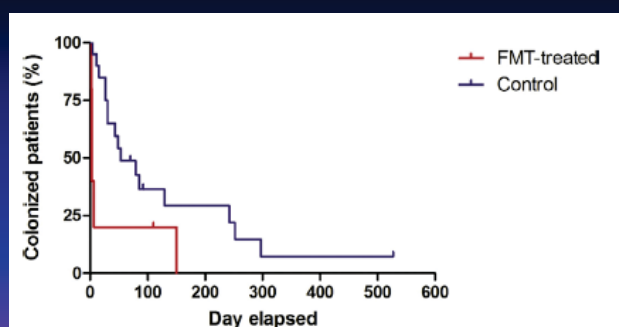
Saidani N, International Journal of Antimicrobial Agents 2019;53:355–61

FMT & CPE/A decolonization at day14

Category	FMT	Control	<i>p</i> value
Clearance of CPE/A, n(%)	8/10 (80)	2/20 (10)	< 0.001
Decolonization period, median, days	3	50.5	< 0.001
Discharge from hospital post intervention, median, days	19.5	41	NA

Saidani N, International Journal of Antimicrobial Agents 2019;53:355–61

Effect of faecal microbiota transplantation on CPE/A carriage



Saidani N, International Journal of Antimicrobial Agents 2019;53:355–61

FMT & antibiotic-resistant bacteria in the gut: a systematic review and meta-analysis

- Five studies (3 case series, 2 case reports), 52 participants
 - Evidence of low quality study achieved in half of the cases one month after FMT
 - Higher response in *Pseudomonas aeruginosa* (100%), and lower response in NDM-1 and ESBL *Klebsiella pneumoniae* (36.4–100%)
 - 70% of decolonization occurred within the first week after FMT
 - Few temporary adverse events were identified
 - Potential benefit of FMT as a decolonization intervention
- Tavoukjian V. Journal of Hospital Infection 2019;102:174–88

Decolonization success rate at the 1-month time point

Study	Definition of decolonization	n decolonized	Total N	Percentage
Bilinski et al., 2017 [37]	At least two consecutive negative rectal swab cultures (\pm qPCR for CPE ARG)	12	18	67%
Dinh et al., 2018 [40]	At least two consecutive negative rectal swabs (culture + PCR) with 24-h interval	9	17	53%
Singh et al., 2018 [38]	Negative rectal swab cultures	3	15	20%
Singh et al., 2014 [54]	Negative rectal swab cultures	1	1	100%
Stalenhoef et al., 2017 [55]	Negative stool sample cultures	0	1	0%
Total		25	52	48.1%

ARG, antibiotic-resistance genes; CPE, carbapenem-producing Enterobacteriaceae; qPCR, quantitative polymerase chain reaction.

Tavoukjian V. Journal of Hospital Infection 2019;102:174-88

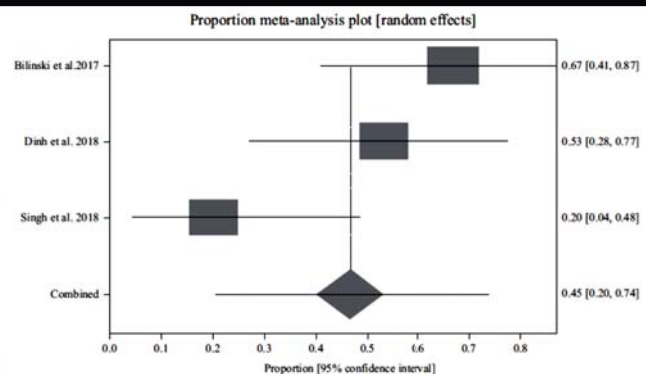


Figure 2. Forest plot, meta-analysis of proportions for decolonization success at 1 month.

Tavoukjian V. Journal of Hospital Infection 2019;102:174-88

FMT & antibiotic-resistant bacteria in the gut: a systematic review and meta-analysis

- Twenty-one studies (1 RCT, 7 uncontrolled, 2 retrospective cohort, 2 case series, 9 case reports), assessing 192 patients
- Three studies preventing MDR infections, 16 MDRO colonization, 2 assessed both
- Data from 151 patients were included in the final analyses

Saha S. Clinical Microbiology and Infection 2019;25:958-63

FMT & antibiotic-resistant bacteria in the gut: a systematic review and meta-analysis

- In studies with low to moderate risk of bias, the eradication rate 37.5 to 87.5%
- FMT could be used eradicating MDR colonization and possibly preventing recurrent MDR infections

Saha S. Clinical Microbiology and Infection 2019;25:958-63

Characteristics of FMT in the different cohort studies

	CPE cohort (n)	Bacteria	FMT route administration	Antibiotic pre-treatment	Success rate (% patients)
Davido et al.	8	VRE, CPE	Nasoduodenal tube	N	37.5
Bilinski et al.	20	VRE, CPE, ESBL	Nasoduodenal tube	N	75
Current study	10	CPE, CPA	Nasogastric tube	Y	80

Saidani N, International Journal of Antimicrobial Agents 2019;53:355-61



Conclusions

- FMT could be used as a treatment for eradicating MDR colonization and possibly preventing recurrent MDR infections
- Larger well-designed randomized controlled trials are needed

Antimicrobial Textiles & Infection Prevention

- Clothing (patient gowns, towels, surgical gowns, scrub suits, lab coats, splash aprons, and privacy drapes)
- Inanimate environment (furnishings such as upholstered chairs as well as curtains, carpets and also bedding)

Rachel H. McQueen and Briana Ehnes

G. Bearman et al. (eds.), Infection Prevention, DOI 10.1007/978-3-319-60980-5_13



Antimicrobial Textiles & Infection Prevention

- Triclosan
- Metallic compound
- Quaternary ammonium compound
- Polybiguanides
- N-Halamines

Rachel H. McQueen and Briana Ehnes

G. Bearman et al. (eds.), Infection Prevention, DOI 10.1007/978-3-319-60980-5_13

The role of textiles in hospital environment contamination

- Double-blind RCT study evaluating Ag integrated into the fibre-treated hospital curtains vs standard curtains
- Ag curtains significantly lower in contamination than the standard curtains
- Ag treated surfaces of door furniture/safety rails, etc, 62 to 98% contamination lower than surfaces in the non-treated surfaces

Rachel H. McQueen and Briana Ehnes

G. Bearman et al. (eds.), Infection Prevention, DOI 10.1007/978-3-319-60980-5_13

The role of textiles in hospital-acquired infections (HAIs)

- Study of copper oxide-treated sheets, pillowcases and patients' clothing
- Significant reduction in HAIs associated with the eyes and gastrointestinal tract, as well as significantly less numbers of fever days and days of antibiotic use, observed
- Two clinical trials on copperoxide impregnated textiles in hospital facilities
- One significant reduction in HAIs due to MDR or *C. difficile*, the other significant reductions in the use of antibiotics and fever days

Rachel H. McQueen and Briana Ehnes

G. Bearman et al. (eds.), Infection Prevention, DOI 10.1007/978-3-319-60980-5_13

Health care-associated infection-related indicators: copper oxide-treated versus control textiles

Indicator	Control textiles	Copper oxide-treated textiles	Pvalue
ATIEs	95	69	NA
ATIEs per 1,000 HDs	23.46	16.59	.002
95% CI	19.09-28.69	13.02-21.08	
FDs (>37.6°C)	188	86	NA
FDs per 1,000 HDs	46.42	20.68	<.0001
95% CI	40.24-53.47	16.67-25.60	
dAB	689	545	NA
dAB per 1,000 HDs	170.12	131.04	<.0001
95% CI	158.71-182.09	121.01-141.76	
AB DDD	845	629	NA
DDD per 1,000 HDs	208.6	151.2	<.0001
95% CI	196.2-221.5	140.5-162.5	

E.-L. Marcus et al. / American Journal of Infection Control 45 (2017) 401-3

Conclusions

- Limited studies evaluating antimicrobial textiles, on hospital environment contamination & esp impact on HAIs
- Considerable potential to reduce contamination & HAIs, in conjunction with well-established hygiene practices