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# What is new in infection prevention in critical care in 2014?

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Intensive care unit (ICU) patients reflect a population which (a) usually is characterized by significant comorbidities and underlying immunodeficiency, (b) experience immune paralysis caused by acute and severe disease, and (c) require invasive devices such as intubation and intravascular devices that bypass the defenses of the host. These "characteristics" render such patients prone to nosocomial infections and underline the utilization of antibiotic treatment that consequently increases selection pressures for antibiotic-resistant pathogens and amplifies the risk of cross-transmission with such pathogens, resulting in a vicious circle of reinfection. Consequently, the vulnerability of these patients during hospitalization mandates that effective infection control practices be employed to break this circle. Such practices must be focused on the proper use and overall reduction in the use of invasive devices, the direct prevention of infections, and the decrease of the occurrence of cross-transmission.

Prevention of ventilator-associated pneumonia (VAP) remains a challenge. A reduced VAP risk could be achieved using oral care strategies with chlorhexidine-based mouthwashes, albeit several aspects of oral care remain uncertain regarding optimal chlorhexidine concentration, frequency of mouthwashes, and overall contact time. There is no convincing evidence that routine toothbrushing in addition to mouthwashes further reduces VAP risk. However, toothbrushing remains an indispensible tool to prevent oral pathology [1]. A randomized controlled trial demonstrated that VAP risk was similar in patients that were not monitored for residual gastric volumes compared to patients in which residual volumes were checked every 6 h [2]. The most common approach for the prevention of VAP involves the use of a "bundle" employing several different prevention approaches. A recent study assessed the elements of a bundle to prevent VAP by sequentially implementing the bundle elements [3]. VAP rates dropped from 24 to 14/1,000 ventilator days ($p = 0.005$). The sequentially deployed bundle employed readily available elements to include clinician education, subglottic secretions drainage, use of inclinometers to assess head-of-bed elevation, and oral care. In another study, presence of VAP and additional intravascular devices were independently associated with carbapenem-resistant gram-negative bacilli (CR-GNB). Presence of VAP, presence of additional intravascular devices, and SOFA score on ICU admission were independently associated with carbapenem-sensitive GNB. The duration of exposure to carbapenems and colistin were independent risk factors for acquisition of CR-GNB. When the source of bacteremia was other than VAP, previous administration of carbapenems was the only factor related to the development of CR-GNB [4].

A bundled approach also demonstrated a reduction in the rates of external cerebral drainage-associated ventriculitis from 28 to 10.5 % [5]. The bundle consisted of education of personnel, meticulous intraventricular catheter handling precautions, cerebrospinal fluid sampling only when strictly indicated by signs of infection, and weekly replacement of the catheter when still required.

For the prevention of fungal infections, oral prophylaxis with nystatin was recently evaluated and shown to result in a reduction of *Candida* colonization. However, the study was not adequately powered to demonstrate a reduction in candidiasis [6].

Bloodstream infections (BSIs) are common in critically ill patients. Ziakis et al. [7] recently found that 6–8 % of ICU patients are colonized at admission with MRSA, with an upward trend in patient colonization observed between 1990 and 2010 for both the USA and Europe. Most importantly, these authors reported that MRSA-colonized patients had an eightfold increased risk of developing an MRSA infection. In a recent US experience, institution of daily chlorhexidine bathing in an ICU resulted in a decrease in the transmission of *S. aureus*, including MRSA [8]. The implication of these trials is that universal decolonization prevented infection, may obviate the need for surveillance testing, and could reduce the need for contact isolation. A V710 vaccine directed against *S. aureus* compared with placebo did not reduce the rate of serious postoperative *S. aureus* infections in patients undergoing cardiothoracic surgery and was associated with increased mortality among patients who developed *S. aureus* infections [9]. Hence, these findings waive the support of generally using such a vaccine in patients undergoing surgical intervention. In another study, which reported a 28-day all-cause mortality of 36 %, independent predictors of 28-day mortality included MDR isolate, uncontrolled infection source, and timing to adequate treatment. MDR and XDR bacteria (especially gram-negative) were common in hospital-acquired BSIs (HA-BSIs) in critically ill patients and associated with increased 28-day mortality. Hence, intensified efforts to prevent HA-BSIs and optimize their management through adequate source control and antibiotic therapy were suggested to improve outcomes [10]. A meta-analysis of quality-improvement initiatives demonstrated the successful reduction of CLABSI rates. Effects were greater with quality-improvement initiatives that included bundle or checklists [11].

Antibiotic prophylaxis timing was also recently shown to not be associated with the risk of postoperative skin and soft tissue infection in patients undergoing hip or knee arthroplasty, colorectal surgical procedures, arterial vascular surgical procedures, and hysterectomy, while procedure type and antibiotic class were predictors of such infections [12].

Razazi et al. reported that upon ICU admission, transfer from another ICU, hospital admission in another country, surgery within the past year, prior neurologic disease, and prior administration of third-generation cephalosporin (within 3–12 months before ICU admission) were independent predictive factors of colonization by extended spectrum β-lactamase-producing *Enterobacteriaceae* (ESBL-PE). It was suggested that identifying risk factors for ESBL-PE colonization may help in identifying which patients may warrant empiric ESBL-targeted therapy to limit carbapenem use [13].

Regarding full selective decontamination of the digestive tract, regimens using parenteral and enteral antimicrobials were found to reduce lower airway infection by 72 %, bloodstream infection by 37 %, and mortality by 29 %. Resistance was also controlled. Parenteral cefotaxime was found to eradicate overgrowth of 'normal' bacteria in the throat, enteral polyenes to control 'normal' *Candida* species, and enteral polymyxin and tobramycin to eradicate or prevent gut overgrowth of 'abnormal' aerobic GNB. Enteral vancomycin was found to control overgrowth of 'abnormal' MRSA [14].

Finally, procalcitonin-guided treatment was found to have no difference in mortality compared to conventional treatment regimens, but duration of antibiotic therapy for the first infectious episode was reduced and antibiotic-free days were increased within the first 28 hospitalization days [15]. A summary of the included studies may be found in Table 1.

**Table 1** Prevention of infection 2014: what's new?

| Infection | Ref | Prevention |
|---|---|---|
| VAP | [1] | No evidence that routine brushing of teeth in addition to mouthwashes reduce VAP risk |
| | [2] | The risk of VAP was not different in patients that were not monitored for residual gastric volumes vs. patients in which residual volumes were checked every 6 h |
| | [3] | A bundle to prevent VAP reduced VAP rates from 24 to 14/1,000 ventilation days |
| | [4] | VAP development and the presence of additional intravascular devices were the major risk factors for CR-GNB. In the absence of VAP, prior use of carbapenems was the only independent risk factor |
| HACV | [5] | A bundled approach reduced the rate of external cerebral drainage-associated ventriculitis from 28 % (pre-intervention period) to 10.5 % (intervention) period |
| IFI | [6] | Oral nystatin reduced significantly *Candida* colonization without a benefit in terms of *Candida* infection prevention |

**Table 1** continued

| Infection | Ref | Prevention |
|---|---|---|
| BSI | [7] | 6–8 % of ICU patients are colonized at admission with MRSA presenting an eightfold increased risk of developing an MRSA infection |
| | [8] | The daily chlorhexidine bathing resulted in a decrease in the transmission of*S. aureus* including MRSA |
| | [9] | A V710 vaccine directed against *S. aureus* vs. placebo did not reduce the rate of postoperative *S. aureus* infections and was associated with increased mortality among patients who developed *S. aureus* infections |
| | [10] | MDR and XDR bacteria (especially gram-negative) are common in hospital-acquired BSIs in critically ill patients and are associated with increased 28-day mortality |
| CLABSI | [11] | Meta-analysis: quality-improvement initiatives reduced CLABSI rates |
| SSI | [12] | Antibiotic prophylaxis was shown to not be associated with the risk of SSI while procedure type and antibiotic class were predictors of SSI |
| ESBL-PE | [13] | High prevalence of extended spectrum β-lactamase-producing *Enterobacteriaceae* colonization on admission to the ICU, even in the subgroup admitted from the community |
| SDD | [14] | Full SDD regimens using parenteral and enteral antimicrobials were found to reduce lower airway infection by 72 %, bloodstream infection by 37 %, and mortality by 29 % |
| PCTGT | [15] | Procalcitonin-guided antibiotic therapy algorithms could help in reducing the duration of antimicrobial administration without having a negative impact on survival |

*Ref* reference, *BSI* bloodstream infections, *CLABSI* central line associated BSI, *HACV* healthcare-associated cerebral ventriculitis, *IFI* invasive fungal infections, *SSI* skin and soft tissue infection, *ESBL-PE* extended spectrum β-lactamase-producing *Enterobacteriaceae*, *VAP* ventilator-associated pneumonia, *SDD* selective decontamination of the digestive tract, *PCTGT* procalcitonin-guided treatment, *CR-GNB* carbapenem-resistant gram-negative bacilli, *MDR* multidrug-resistant, *XDR* extensively resistant

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