Infection prevention and control

Table of Contents

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Intended Learning Outcomes

Infection prevention and control

General concepts

1. Define healthcare-associated infections (HAIs) and explain their epidemiological burden in the ICU.
2. Distinguish between colonisation and true infection, and explain clinical implications of this distinction for diagnostic and therapeutic decision-making.
3. Describe the multimodal approach to HAI prevention, including hand hygiene, environmental disinfection, care bundles, staff education, and surveillance.
4. Explain the relationship between nurse-to-patient ratios, staffing levels, and HAI risk.

Ventilator-associated pneumonia (VAP)

1. Describe the epidemiology of VAP.
2. Explain the pathobiological mechanisms underlying VAP development.
3. Apply the diagnostic criteria for VAP and recognise the limitations of current diagnostic approaches.
4. Implement evidence-based essential prevention strategies for VAP, including avoidance of intubation, sedation minimisation, semi-recumbent positioning, oral care, and enteral feeding.

Catheter-related bloodstream infections (CRBSI)

1. Describe the epidemiology of CRBSI across different catheter types.
2. Explain the main routes of catheter contamination and the role of insertion technique and hub care in infection pathogenesis.
3. Apply the key elements of CRBSI prevention (insertion site selection, barrier precautions, chlorhexidine skin antisepsis, and post-insertion care).
4. Describe best practices for blood culture sampling to minimise false-positive results and avoid unnecessary antimicrobial therapy.

Catheter-associated urinary tract infections (CAUTI)

1. Identify modifiable and non-modifiable risk factors for CAUTI.
2. Apply diagnostic criteria for CAUTI.
3. Implement appropriate catheter insertion technique and closed-system maintenance practices to reduce CAUTI risk.
4. Evaluate the role of nurse-driven protocols in reducing inappropriate catheter use and CAUTI incidence.

eModule Information

Relevant Competencies from CoBaTrICE

Infection prevention and control

- **2.5** Obtains appropriate microbiological samples and interprets results
- **3.9** Recognises and manages the septic patient
- **4.2** Manages antimicrobial drug therapy
- **4.6** Initiates, manages and weans patients from invasive and non-invasive ventilatory support
- **5.13** Performs central venous catheterisation
- **11.2** Complies with local infection control measures
- **11.3** Identifies environmental hazards and promotes safety for patients and staff
- **11.4** Identifies and minimises the risk of critical incidents and adverse events, including complications of critical illness

1. Introduction

Healthcare-associated infections (HAIs) are serious complications encountered in intensive care medicine, as ICU patients are uniquely vulnerable: they are frequently elderly, carry significant comorbidities, and are often immunocompromised. Many life-sustaining interventions that define ICU care — mechanical ventilation, central venous catheterisation, and urinary catheterisation — inherently compromise the body's natural defence barriers and create direct conduits for microbial invasion. The resulting "device-associated infections" constitute the dominant infectious complications in this setting and are the primary focus of this ACE course.

The three infections that carry the greatest relevance for the ICU are ventilator-associated pneumonia (VAP), catheter-related bloodstream infections (CRBSI), and catheter-associated urinary tract infections (CAUTI). Despite their frequency and severity, a substantial proportion of HAIs are preventable. Evidence consistently demonstrates that up to 65–70% of CRBSI and CAUTI cases, and approximately 55% of VAP cases, can be avoided through the consistent application of evidence-based prevention strategies. This underscores a fundamental principle: while HAIs are not an inevitable consequence of ICU care, their prevention demands deliberate, sustained, and system-wide efforts.

2. Healthcare-associated infections in the ICU

2. 1. General considerations

In contrast to “community acquired infections”, the defining characteristic of healthcare-associated infections (HAIs) is that they occur in association to medical care in health care facilities, including the ICU. By definition, HAIs are not present or incubating at the time of admission. Also, HAIs can become apparent after discharge. HAIs are among the most serious complications in intensive care medicine. The epidemiological burden of HAIs is substantial, causing excess mortality and increased healthcare costs. Driven by the rising average age of patients, a growing comorbidity burden, increasing immunosuppression from underlying disease or therapy, and the extended access to supportive therapies, the complexity of HAIs in the ICU has increased continuously over recent decades. Furthermore, depending on the local epidemiology, multidrug-resistant organisms (MDROs) are often causative pathogens of such infections, making management even more challenging.

The development of many HAIs is inseparably linked to invasive life-sustaining interventions routinely employed in intensive care units, e.g. endotracheal intubation for mechanical ventilation, vascular catheters and urinary catheters. Thus, many of these infections are “device-associated infections”, where a causative association exists with the invasive “foreign body” that is inserted during ICU care. Important examples for this type of infection are “ventilator-associated pneumonia” (VAP), “catheter-related bloodstream infections” (CRBSI) and “catheter-associated urinary tract infections” (CAUTI).

Besides the more general category “healthcare-associated infections”, the term “ICU-acquired infections” is often used to describe these complications. Although the occurrence of infectious complications in the ICU might seem unavoidable, studies indicate that up to 65-70% of CRBSI and CAUTI cases, and up to 55% of VAP cases could be prevented through consistent application of current evidence-based prevention strategies.

2. 2. Diagnosis of HAIs – colonisation versus infection

Colonisation is the presence of multiplying pathogens with no overt tissue damage, host immune response or clinical symptoms. Common examples of this are bacterial

colonisation of the tracheobronchial system in invasively ventilated patients or bacteriuria during urinary catheterization.

A colonisation with potentially pathogenic microorganisms (mostly bacteria and fungi) occurs readily in hospital environments, where colonisation pressure is high. Factors facilitating colonisation are identical to those predisposing to infection. However, while every infection is preceded by colonisation with the pathogens involved, not every colonisation will subsequently cause true infection. Therefore, clinicians are often faced with the challenge of distinguishing between them. This circumstance is more often a problem in HAIs than in community-acquired infections, where colonisation is not as easily detected compared to hospitalized patients who have a low threshold of receiving microbiologic tests. Additionally, a growing use of molecular diagnostic techniques potentially leads to over-documentation of colonisation.
Colonisation has the potential to become “critical”, when host defences are unable to control the colonizing pathogen, and dysbiosis (shift in microbiota with the emergence of pathogen-dominant microbiomes) can occur, increasing the risk of infection. Unfortunately, systemic antimicrobial therapy does not positively affect colonisation or prevent infection, and on the contrary, has an impact on the selection of antimicrobial resistant organisms. Thus, prevention needs to find other ways to improve patient outcomes.

2. 3. Prevention strategies for HAIs

Prevention of HAIs in the ICU rests on a multimodal approach encompassing the following pillars:

- Strict hand hygiene as a non-negotiable baseline requirement
- Use of regular and thorough environmental disinfection
- Implementation of evidence-based care bundles targeting specific infections (CRBSI bundle, VAP bundle, etc.) with daily reassessment of invasive device necessity
- Structured education programmes for all ICU staff with direct patient contact, who are key actors in prevention and surveillance
- Surveillance of HAI rates for early detection of increasing prevalence

Beyond these measures, overarching organisational aspects of individual ICUs and hospitals have implications for infection prevention. An unfavourable nurse-to-patient ratio is independently associated with a significantly increased risk of healthcare-associated infections, underlining the critical role of adequate staffing levels.

In Chapter References

(Blot et al. 2022; Jeffrey et al. 2023; Kollef et al. 2021; Mazzeffi, Galvagno and Rock. 2021; Medioli et al. 2025)

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3. Ventilator-associated pneumonia

3. 1. Epidemiology and diagnostic considerations

Ventilator-associated pneumonia (VAP) is the most frequent ICU-acquired infection. VAP affects up to 50% patients under invasive mechanical ventilation, with an acquisition rate of 3% per day for the first week, 2% per day for the second, and 1% thereafter. It prolongs ICU stay and increases relative mortality risk by around 25% and attributable mortality of about 3-10%. Differences in mortality might be influenced by false positive diagnosis in up to 20-30% of VAPs. The diagnosis requires a combination of clinical and microbiological data. Due to the “low” attributed mortality, randomised trials aiming to demonstrate reductions in mortality resulting from prevention strategies need a high recruitment target, compromising feasibility. Early identification of VAP is critical to start antimicrobial therapy, but the risk should be balanced against that of using unnecessary antibiotics. Finding this balance is challenging because there is no gold standard for VAP diagnosis. Diagnostic criteria used in randomized clinical trials rely on variable combinations of clinical, radiographic and laboratory indicators (Figure 1). Guidelines recommend to re-evaluate pneumonia diagnosis after 72 hours. In children a similar combination of clinical score and microbiological data has been proposed.

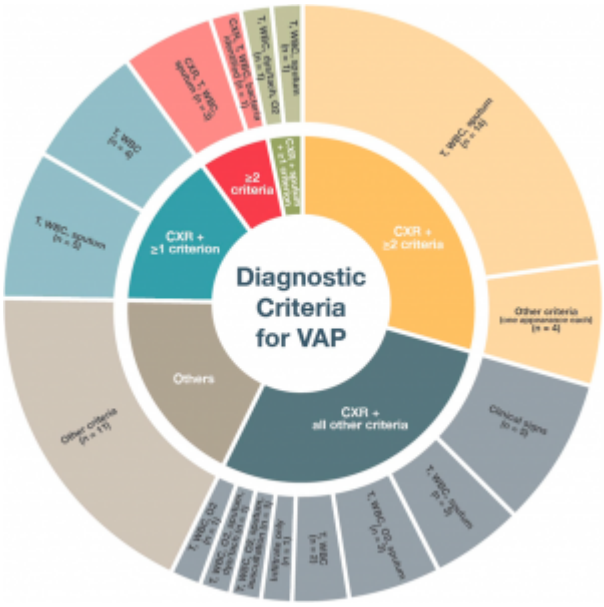

Figure 1: The different combinations of diagnostic criteria used in VAP randomized clinical trials. CXR radiological evidence of a new infiltrate; T temperature criterion; WBC white blood count criterion; dys/tach dyspnoea and/or tachypnoea; O2 hypoxia; auscultation auscultation abnormalities. Taken from: Fally M et al. Critical Care 2024.

The pathobiology of VAP is multi-factorial (Figure 2). External factors associated with ICU therapies (Figure 2.1), the placement of the endotracheal tube (Figure 2.2), and the associated alterations in patients physiologic microbiome, as well as activation of immune responses (Figure 2.3), are currently key predisposing mechanisms of VAP.

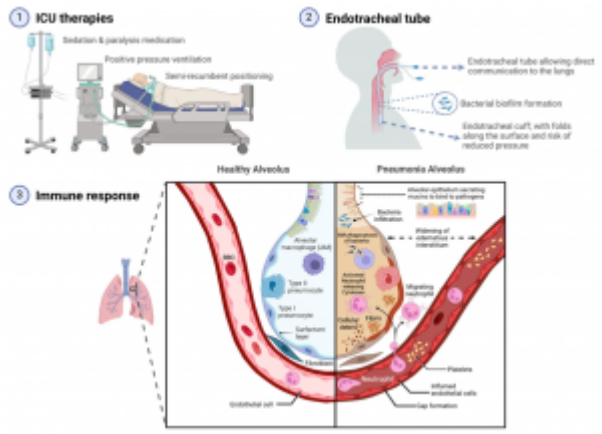

Figure 2: Mechanisms of ventilator-acquired pneumonia. CU = intensive care unit; AM = alveolar macrophages. Taken from: Howroyd F et al. Nature communications 2024.

Beyond VAP, current guidelines promote the surveillance and bundled prevention of Ventilator Associated Events (VAE). VAE was created by the CDC to overcome the complexity of VAP surveillance based on its subjective definitions. VAEs comprise 3 categories:

- Ventilator Associated Condition (VAC): an increase in the daily minimum positive end expiratory pressure (PEEP) of ≥3 cm H_2O sustained for ≥2 calendar days after ≥2 days of stable or decreasing daily minimum PEEP, or an increase in the fraction of inspired oxygen (FiO_2) of ≥20 points sustained for ≥2 days after ≥2 days of stable or decreasing daily minimum FiO_2 levels.
- Infection-related ventilator associated complications (IVAC): a VAC with concurrent signs of possible infection, e.g. abnormal temperature (38°C), white blood cell count (≤4,000 or ≥12,000 cells/mm3), and new antibiotic therapy for ≥4 days, all beginning within 2 days before or 2 days after VAC onset.
- Possible VAP: IVAC with indications that infection might be localized to the lungs. It requires respiratory secretion cultures positive for potentially pathogenic organisms, positive cultures from 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.

In children and neonates, pediatric VAE is defined as an increase in the daily minimum mean airway pressure of ≥4 cm H_2O sustained for ≥2 calendar days after ≥2 days of stable or decreasing daily minimum mean airway pressure, or an increase in FiO_2 of

≥25 points sustained for ≥2 days after ≥2 days of stable or decreasing daily minimum FiO_2s.

3. 2. Prevention strategies for VAP

The latest guidelines classify recommendations as essential practices (those that improve outcomes such as duration of mechanical ventilation, length of stay, mortality, VAEs, antibiotic utilization and/or costs with little risk of harm, and cost-saving, outcome-neutral interventions) and additional approaches (those that improve objective outcomes but carry some risk of harm, or that lower VAP rates but where insufficient data exist to determine their impact).

Essential practices:

Avoiding intubation and preventing reintubation

As intubation and mechanical ventilation are the main risk factor of VAP, non-invasive respiratory support strategies using high-flow nasal oxygen and non-invasive positive pressure ventilation are associated with lower rates of HAP/VAP in critically ill patients. However, this must be balanced against the increased risk of VAP from failed trials of extubation and re-intubation, as well as the potentially life-threatening consequences of delaying endotracheal intubation and invasive mechanical ventilation (IMV) when non-invasive respiratory support strategies fail.

Minimizing sedation

Interventions which promote earlier liberation of the patient from the ventilator may also reduce exposure to risk of infection; this includes preferring other agents over benzodiazepines, using targeted sedation protocols coupled with weaning protocols and inclusive daily assessment of readiness of extubation through spontaneous breathing trials.

Semi-recumbent body positioning and early mobilisation

Positioning patients at 30-45° to the horizontal had been demonstrated to reduce passive regurgitation and VAP. A meta-analysis of 8 randomized trials reported that elevating the head of the bed was associated with significant reduction in VAP rates but had no difference in duration of mechanical ventilation or mortality. Early exercise and mobilization programs may shorten IMV duration, ICU length of stay, lower VAP rats and increase the rate of return to independent function.

Provide oral care with tooth brushing without chlorhexidine

Daily tooth brushing is associated with significantly lower VAP rates, shorter duration of mechanical ventilation, and shorter ICU length of stay. Meta-analyses of randomized trials and observational studies suggest that oral care with chlorhexidine may increase mortality rates.

Enteral feeding

Early enteral nutrition (usually withing 48 – 72 hours after onset of critical illness when enteral feeding is possible) is associated with a lower risk of nosocomial pneumonia, shorter ICU length of stay, and shorter hospital length of stay compared to early parenteral nutrition.

Maintain ventilator circuits

Change the ventilator circuit only if visibly soiled or malfunctioning, rather than on a fixed schedule, unless instructed otherwise by the manufacturer.

Additional approaches:

Selective decontamination of the oral or digestive tract

The rationale behind selective decontamination of the oral (SOD) or digestive (SDD) tracts is that colonisation of the gastrointestinal (GI) tract with potentially pathogenic Gram-negative micro-organisms causes VAP by direct translocation from gut to oropharynx. The principle is to abolish pathogenic microorganisms while preserving the normal colonic Gram-negative anaerobes (e.g. Bacteroides sp.).

Oral agents used for SDD include colistin, tobramycin and amphotericin B, parenteral agents include cefotaxime,

A meta-analysis of 6 clustered randomized trials performed in countries with low antimicrobial resistance (AMR) levels reported that SOD was associated with a 16% reduction in hospital mortality, that increased to 18% when combined with SDD.

There's good evidence that this intervention decreases VAP rates, but may confer an increased risk of AMR selection, and a clustered randomized trial performed in ICUs with higher levels of AMR showed no benefit of the intervention. Therefore, SOD and SDD are recommended only in ICUs and countries with low prevalence of antibiotic-resistant organisms (defined as <5% bloodstream infections caused by Extended-Spectrum Beta-Lactamase producing pathogens).

Aspiration of subglottic secretions

Pooling of secretions around the cuff leads to micro-aspiration, main mechanism of VAP (Figure 2.2). Endotracheal tubes with a subglottic secretion drainage port are recommended for patients with expected IMV of >48-72h. Subglottic secretion aspiration may reduce VAP rates but there is insufficient data to determine the impact on duration of mechanical ventilation, length of stay in ICU, or mortality.

Early tracheostomy

Tracheostomy might be effective to produce better endotracheal tube tolerance resulting in reduction of analgesics and sedatives and might maintain host defence. A meta-analysis of 17 randomized trials suggests that early tracheostomy (within 7 days of intubation) may be associated with a 40% decrease in VAP rates, less time on mechanical ventilation, and fewer ICU days but no difference in mortality.

Post-pyloric feeding

Consider post-pyloric rather than gastric feeding for patients with gastric intolerance (e.g. reflux and vomit) or at high risk for aspiration.

Finally, the following recommendations that were given in previous guidelines have been re-classified as “not recommended” as they are inconsistently associated with lower VAP rates or have no impact or negative impact in the duration of mechanical ventilation, length of stay or mortality.

- Oral care with chlorhexidine and chlorhexidine bathing
- Probiotics
- Ultrathin polyurethane endotracheal tube cuffs and silver-coated endotracheal tubes
- Tapered endotracheal cuffs, automated control of endotracheal tube cuff pressure, frequent cuff-pressure monitoring
- Use of kinetic beds
- Prone positioning
- Stress-ulcer prophylaxis
- Monitoring residual gastric volumes
- Early parenteral nutrition
- Closed endotracheal suctioning systems

In Chapter References

(Babcock et al. 2004; Fally et al. 2024; Howroyd et al. 2024; Kalil et al. 2016; Klompas et al. 2022; Melsen et al. 2013; Segal, Rom and Weiden. 2014; Torres et al. 2017; Torres et al. 2021; Weiss et al. 2019)

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4. Catheter-related bloodstream infections

4. 1. Epidemiology and diagnostic considerations

Catheter-related bloodstream infections (CRBSIs) are an important nosocomial infection in the ICU. The CDC estimates a median rate of 1.8 to 5.2 bloodstream infections per 1000 catheter days, and it is likely that these cause a substantial number of deaths amongst hospitalised patients each year. CRBSIs are associated with a high mortality and long-term burden. CRBSIs are not only related to central venous catheters (CVCs) but also to arterial catheters (AC) and peripheral venous catheters (PVC) – despite the low incidence of PVC-related BSI, their higher frequent use promotes a high quantity of infections, which has been showed in a prospective study.

4. 2. Prevention strategies for CRBSI

Location of insertion

Evidence-based interventions to reduce CRBSIs include avoiding femoral cannulation, as the incidence of CRBSIs is lower with subclavian CVCs versus femoral CVCs.

Aseptic technique during insertion

The inoculation of bacteria from the skin along the subcutaneous tract during insertion is likely the most common route of infection, followed by contamination and colonisation of the catheter hub via exogenous sources. Meticulous hand hygiene and maximal barrier precautions (gloves, gown, large drapes) reduce the incidence of CRBSIs when compared with more basic precautions (e.g. just gloves and a small drape). Chlorhexidine 2% is a more effective skin antiseptic than povidone-iodine. The assisting nurse should be empowered to stop unsafe practice.

Use of ultrasound

Ultrasound may reduce complication rates such as misplacement and haematoma, and could therefore reduce subsequent infection. If used during catheter insertion, proper maximum barrier precautions must be taken to prevent contamination of the skin site including a sterile cover for the probe and cable and the use of sterile gel.

Tunnelling catheters

Evidence supports the use of tunnelled CVCs for longer-term vascular access. For shorter term access such as in the ICU, the evidence is less definite and benefit varies

between studies and sites of CVC insertion. This finding does not apply to paediatrics. No significant difference has been found between long-term femoral and internal jugular catheters in some studies.

Antimicrobial catheters

Catheters may be impregnated with minocycline-rifampicin or silver sulfadiazine-chlorhexidine. They are recommended for longer-term cannulation, in high-risk patients and for reduction in CRBSIs rates when other methods of infection control have been maximised. Some studies indicate minocycline-rifampicin impregnation was much more effective and long-lasting (more than three weeks) in prevention of infection than silver sulfadiazine impregnated. The primary concern in relation to their broad introduction to clinical practice is not cost but the potential to drive multi-drug antimicrobial resistance.

Post-insertion care

CRBSIs can be reduced by minimising handling, maximal hand hygiene before preparing infusion / medication and manipulating the catheter, proper care of connections and taps, and reducing catheter manipulation or movement. Specialised CVC nursing teams with sole responsibility for CVCs contribute to reduced CRBSIs, and to medical and nursing staff education. The importance of catheter hub care is noted in a number of reviews. CVC hubs with antiseptic chamber and other modifications have been reported. Chlorhexidine washing significantly reduces BSI in relation to the length of the catheter insertion and is most effective on medical ICU compared with surgical.

Removal of CVCs

Guidelines do not recommend routine replacement of CVCs to prevent CRBSIs. However, the probability of colonisation and infection increases with time, particularly after 5-7 days, so CVCs should always be removed at the earliest opportunity. A daily review and documentation of the indication of the inserted CVC is recommended and might reduce the duration of insertion, which is one of the risk factors for CRBSI. Guide wire exchanges are not recommended and should not be performed for CRBSIs or for catheter-related insertion site infections. If CVCs are inserted under unsterile circumstances, their exchange should be performed as soon as possible.

Parenteral feeding

The risk of CRBSIs increases when a CVC lumen is utilised for parenteral nutrition. Meticulous infection control procedures must be undertaken when handling catheter connections, and one lumen should be dedicated to total parenteral nutrition.

Reduction of false positive blood-culture samples

False positive blood cultures should be avoided because of their potential misleading consequences and harm to the patient - like antimicrobial therapy and resulting costs for the health care system.

Microbes with low pathogenicity proven in a single blood culture (BC) sample might be a hint for a contamination, whereas the detection of staphylococci, gram negative

Enterobacteriaceae and candida should always be taken as a serious infection even if only reported in one BC sample. Moreover, the patient's immune status should be taken into account, as immunocompromised individuals are at increased risk of bacteraemia caused by pathogens that are not typically isolated in immunocompetent patients. Garcia et al. published a systematic investigation about the best practice of blood culture sampling. The IDSA recommends the blood culture sampling out of inserted CVCs in terms of suspicious CRBSI simultaneously with two pairs of BCs out of a peripheral vein. An approach to minimise BC contaminations could be achieved with:

- Antiseptic approach before blood culture sampling (disinfection of the sampling site, hands, sterile gloves, mask)
- Alcohol disinfection of the sample bottle rubber diaphragm
- Number of samples and adequate volume of blood (8-10 ml of blood per bottle)
- Tip of the catheter culture in patients at risk of BSIs
- BC -kits, -teams, education and teaching of BC sampling technique
- Time to incubation < 12h

A six-step strategy combining several of these elements has been shown to reduce CRBSI effectively to zero:

- Antiseptic handwashing including alcohol rub disinfection
- Full aseptic precautions
- Chlorhexidine 2% skin preparation
- Avoid the femoral route
- Minimise duration of placement
- Empower the nurse to stop unsafe practice.

> **Note**
>
> The key aspects of reducing CRBSIs are strict aseptic technique on insertion and daily review of the need for the CVC.

The use of prophylactic antibiotics to prevent CRBSI and nosocomial infections at other sites is generally not advised. Concern exists that use of prophylactic antibiotics routinely on ICU, for example prior to intubation or re-intubation, will promote antibiotic resistance rather than just reducing the incidence of HAIs.

In Chapter References

(Bates, Goldman and Lee. 1991; Alahmadi et al. 2011; Cassini et al. 2016; Climo et al. 2013; Garcia et al. 2015; Lamperti et al. 2012; Lucet et al. 2010; Pronovost et al. 2006; Stuart et al. 2013)

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5. Catheter-associated urinary tract infection

5. 1. Epidemiology and diagnostic considerations

Catheter-associated urinary tract infection (CAUTI) carries a lower direct mortality in the ICU in comparison to VAP and CRBSI. A number of risk factors are known, some of which are potentially modifiable, while others cannot be changed.

The most important modifiable risk factor is likely catheter dwell time. A number of studies report a close association between the duration of catheterization and bacteriuria, which approaches a 100% likelihood after 30 or more days. Other factors in this category include unnecessary catheter placement, poor insertion technique, improper maintenance care and delayed removal.
Non-modifiable (or host-level) risk factors are patient age, sex and anatomy (easier ascension of bacteria in the shorter female urethra), diabetes mellitus, immobility and structural urologic abnormalities including urinary tract instrumentation.

Diagnosis of CAUTI is not trivial and no single laboratory test can reliably confirm true infection. Bacteriuria and pyuria (the detection of leucocytes in urine) alone are insufficient diagnostic markers, particularly in catheterized patients where bacterial colonization is common. CAUTI thus remains fundamentally a clinical diagnosis, where abnormal urine findings, localized symptoms and “systemic” inflammatory markers in patients with indwelling urinary catheters must be integrated into the diagnostic evaluation. This difficulty in diagnosing “true” CAUTI also has implications for attempts at screening for this infection. As bacteriuria has a low specificity for CAUTI, surveillance urine cultures or routine tests for pyuria are not recommended and carry the risk to trigger antimicrobial therapy in situations where true infection is absent. In addition, the appearance and the smell of urine are not suitable diagnostic criteria to guide testing.
If diagnostic work-up for suspected CAUTI is indicated, the following steps should be followed:

- If the catheter is no longer needed, it should be removed before obtaining a midstream urine sample
- If catheterization must continue but the catheter has been in place >10-14 days, it should be replaced before collecting a specimen
- If the catheter must remain and was recently placed, a collection of a sample from the aspiration port of the drainage system after disinfection is possible
- Urine must never be obtained from the catheter collection bag

5. 2. Prevention strategies for CAUTI

Appropriate Indication and Early Removal

Minimizing catheter use is the most fundamental preventive strategy for CAUTI and a frequent reassessment of urinary catheter necessity is needed. However, ICU patients have a variety of specific clinical indications justifying urinary catheterization, e.g. strict fluid monitoring requiring hourly output assessment in shock states or in situations of acute kidney injury. These circumstances will make the “deliberate” removal of urinary catheters for preventive reasons impossible in many situations, as patients simply need their catheters. Still, device removal should be considered daily, as opportunities for prevention might exist and must not be missed. A common example might be the removal of a urinary catheter in surgical patients before discharge from the ICU to the regular ward 24-48 hours after surgery.

A special situation might exist in some patients with acute or chronic kidney dysfunction, who might be oliguric or anuric. This clinical setting might make intermittent catheterization a possible alternative to indwelling catheters. Ultrasound assessment of bladder volume can help guide the timing of catheterization.

Insertion Technique

When urinary catheterization is necessary, insertion requires strict aseptic technique with appropriate equipment, including sterile gloves, draping, and antiseptic cleaning of the periurethral area. The smallest possible catheter size should be used to minimize urethral and bladder trauma, and indwelling catheters must be properly secured to prevent movement and urethral traction. Hand hygiene should be performed before any insertion or manipulation of the catheter.

Catheter Maintenance

Maintaining a “closed” drainage and collection system is essential for prevention. An unobstructed urine flow must be ensured by avoiding kinks in the tubing and positioning the drainage bag below the level of the bladder at all times. The catheter and collection system should only be replaced if sterility is compromised, and routine changes at fixed intervals are not recommended.

Quality Improvement and Surveillance

As with other ICU-acquired infections, an institutional quality improvement program aimed at reducing inappropriate catheter use and ensuring proper catheter insertion and maintenance is an important component of CAUTI prevention. Standardized surveillance methods — such as the number of infections per 1,000 catheter days — are recommended, while routine surveillance for asymptomatic bacteriuria is widely discouraged. A proper documentation of the indication for catheterization, and the date of insertion is an important step in raising “awareness” for the presence of an indwelling device and it´s management.

Nurse-driven protocols for CAUTI prevention

Nurse-driven protocols (NDPs) are effective in reducing both catheter use and CAUTI incidence. Compared to traditional physician-directed catheter management, NDPs offer a clinically meaningful and scalable approach to patient safety. As with many other components of ICU care, it is apparent that nurses are not merely executors of physician orders but active agents in infection prevention. NDPs formalize this role by granting nurses the authority to assess catheter necessity and initiate removal based on predefined clinical criteria — without waiting for a physician's order.

In Chapter References

(Alanazi et al. 2023; Clarke et al. 2020; Huang et al. 2025; Rosenthal et al. 2021; Rosenthal et al. 2025; Scruggs-Wodkowski et al. 2024; Su. 2025)

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6. Conclusions

Despite considerable advances, HAIs remain an important preventable causes of mortality, morbidity, and resource consumption in the ICU. Many HAIs are “device-associated infections”, particularly those associated with ICU-specific treatment. The dominant infections relevant to intensive care medicine are ventilator-associated pneumonia, catheter-related bloodstream and urinary tract infections. The response requires an integrated approach, encompassing hand hygiene, bundle measures for the prevention of specific infections, training of ICU staff as indispensable actors in prevention and surveillance of HAIs.