Healthcare-associated infections

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Abstract

Healthcare-associated infections (HCAIs) are a serious cause of healthcare-related preventable harm. Infections occur from exposure to healthcare-related microbes in combination with reductions in the host's physical and immunological barriers to infection through illness, treatments and medical devices and procedures. Infection prevention and control care bundles are essential to reduce the risk of infection and should be overseen at hospital executive level. Failure to reduce HCAIs can result in fines for the healthcare provider.

Keywords *Clostridioides difficile*; *Enterobacterales*; hospital-acquired pneumonia; infection prevention control; methicillin-resistant *Staphylococcus aureus*

Key points

- Healthcare-associated infections (HCAIs) are infections acquired during medical care in hospitals, long-term care facilities, primary care or even at home under healthcare supervision
- By definition, HCAIs are new infections that appear ≥48 hours after healthcare contact and were not incubating at the time of admission; for surgical site infections, the window extends to 30 days after the procedure
- Common causative organisms include *Escherichia coli*, methicillin-sensitive *Staphylococcus aureus*, methicillin-resistant *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Clostridioides difficile*; antimicrobial resistance is more frequent in HCAIs than community infections
- HCAIs contribute significantly to morbidity, mortality, prolonged hospital stay and healthcare costs, but 50–70% are preventable through evidence-based infection prevention and control (IPC)
- IPC measures such as care bundles, hand hygiene, antimicrobial stewardship and executive-level oversight are essential; failure to control HCAIs can lead to financial penalties for healthcare providers

Definition

Healthcare-associated infections (HCAIs) refer to infections that are acquired from medical care or treatment in hospital, primary care, a long-term care facility or the patient's own home.

HCAIs are defined as an infection that becomes apparent >48 hours after the healthcare contact that was not present or incubating at the time of contact. The 48-hour rule does not hold for some viral infections because of prolonged incubation times. For skin and soft tissue infections (SSI) an HCAI is defined as an SSI within 30 days of surgery. HCAIs may be referred to as nosocomial infections.

Epidemiology

HCAIs occur frequently. Point prevalence surveys from the USA, Europe and the UK suggest a prevalence of around 4–8% in acute care settings.[1] The rates are lower in long-term care facilities (3–4%) and higher in intensive care settings (around 15–20%).

Urinary tract infections (17–30%) and chest infections (20–30%) account for most HCAIs, followed by SSIs, including surgical site infections (15–20%), disseminated infections (10%) and diarrhoea. Only around 20% of HCAI have microbiological confirmation; *Escherichia coli* (15–30%) is the most common organism, followed by *Staphylococcus aureus* (7–10%), *Pseudomonas aeruginosa* (7%) and *Clostridioides difficile* (1–7%).

The rates of HCAIs are higher in low-income countries. Organisms associated with HCAIs are more likely than community-acquired organisms to be associated with antimicrobial resistance.

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The consequences of HCAIs

HCAIs can be fatal and are a major cause of delayed recovery, prolonged disability and functional or cosmetic complications that can have lifelong consequences. Their management often necessitates extended hospitalization, repeated investigations, surgical procedures and prolonged antimicrobial therapy, all significantly increasing healthcare costs.

Beyond the clinical impact, HCAI rates are increasingly regarded as a key indicator of healthcare quality, with regulators viewing most cases as preventable through robust infection prevention and control (IPC). Internationally, funders and insurers are limiting or refusing reimbursement for the costs of HCAIs, placing financial pressure on healthcare providers. In England, mandatory surveillance exists for high-profile infections, and trusts face financial penalties if the incidence exceeds national thresholds, for example, in cases of nosocomial *C. difficile* infection.

Globally, the burden of HCAIs is highest in low- and middle-income countries, where limited resources, inadequate staffing and suboptimal infection control infrastructure contribute to higher prevalence and greater morbidity and mortality. This highlights the need for scalable, context-specific IPC strategies.

Pathophysiology of HCAIs

HCAIs are driven by a combination of microorganism exposure, impaired patient host defences and medical procedures, which further impair the host defence.

Exposure

Microorganisms colonize both patients and hospital environments. Physical contact with other patients, shared equipment (blood pressure cuffs, commodes, etc.), large respiratory droplets (>5 micrometres) and the environment (sinks, showers, baths) can lead to colonization with new bacteria, viruses or *Candida* on the skin or in the respiratory or alimentary tract (Figure 1). In addition, aerosolized pathogens spread on small droplets (<5 micrometres; tuberculosis, influenza, coronavirus disease (COVID-19) measles, chickenpox) can be inhaled in shared environments.

Because of pressure from exposure to antibiotics, bacteria in hospital environments can be more resistant than those in the community. The proximity between patients, and thus bacteria, also provides ample opportunity for resistance to cross between Gram-negative organisms on mobile genetic elements called plasmids.

Outbreaks of *legionella pneumophila*, resistant *Pseudomonas* and other *Enterobacterales* have been linked to wastewater outflow systems and have required the redesign of sinks, dead legs in pipe systems and whole wards. *Candidozyma auris* (previously called *Candida auris*) and carbapenem-resistant organism (CRO) colonization of clinical areas has lead to the closure of whole wards for cleaning and redesign.

Host defences and medical procedures

Hospitalized patients are at increased risk of infection because illness often impairs cognition, mobility and protective reflexes. Reduced airway protection predisposes to aspiration and the development of hospital- or ventilator-acquired pneumonia, while immobility and the inability to perform self-care increase the risk of pressure sores that can become secondarily infected. Medical procedures further compromise host defences by breaching natural barriers such as skin and mucosa.

Prosthetic materials, including urinary catheters, vascular lines and neurosurgical drains, provide a direct conduit for bacterial entry and a surface for biofilm formation. Biofilms shield bacteria from antibiotics and host immunity, making infections on devices such as central lines, prosthetic joints or shunts difficult to eradicate without removal.

In addition to these structural vulnerabilities, many patients are immunocompromised by chemotherapy, chronic disease or critical illness, leaving them more susceptible to severe and persistent HCAIs.

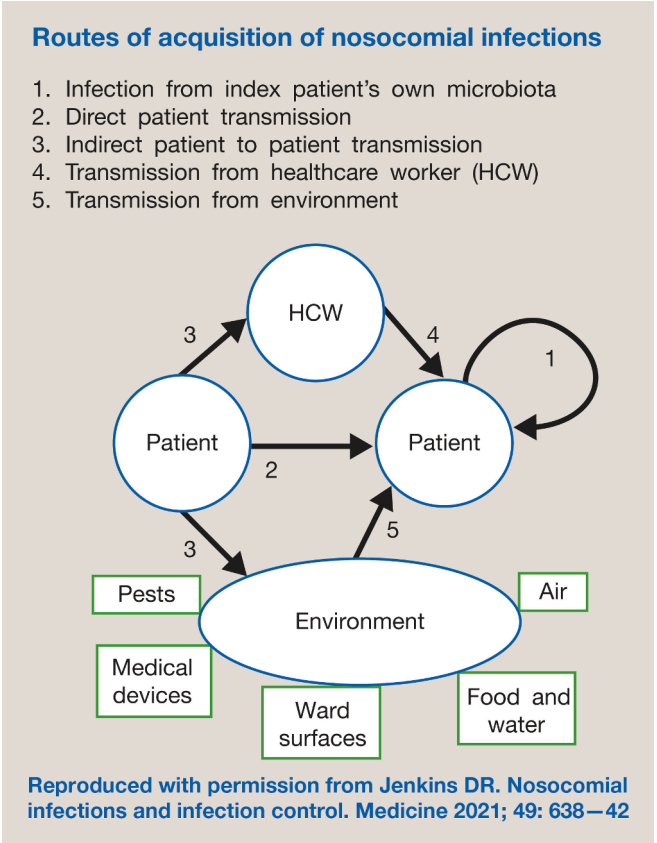

Figure 1

Infection prevention

Good IPC is essential to prevent HCAIs and to provide safe and effective care. In the UK a code of practice for IPC was established under the 2008 Health and Social Care Act, compliance with which is monitored by the Care Quality Commission. The National infection prevention and control manual (NIPCM) for England summarizes all standard practices and approaches.[2]

The implementation of NIPCM policies should be overseen at an executive level in the hospital management structure to ensure processes are prioritized. Prevention of HCAIs often takes a bundle approach to actions that, if implemented as a group, have been shown to improve care. Although it is unlikely that a total reduction is possible, reviews suggest that 50–70% of infections can be prevented and the length and cost of hospital stays can be reduced.

Exposure to hospital pathogens requires multiple approaches. The environment can be improved through well-designed sinks, outflow systems and choice of furnishing and furniture.[3] Antimicrobial stewardship is essential to ensure a reduction of antibiotic pressure in people and the environment. Contact with other patients can be reduced through home-based care, early discharge, bed spacing and appropriate side room isolation and personal protective equipment (PPE) for infectious patients, as well as ward cleaning, shared device disinfection and hand hygiene.

Hand hygiene is one of the most important ways to prevent infection HCAIs and is one of the 10 elements of the standard infection control precautions (SICPs) laid out in the NIPCM.[4] Hands should be cleaned with soap and water if they are visibly dirty, when caring for patients with vomiting and diarrhoea or for patients with known gastrointestinal infections including norovirus or *clostridioides* difficile. Apart from these situations alcohol-based hand rubs are appropriate. Hand hygiene should be performed before touching a patient, before clean or aseptic procedures, after body fluid exposure, after touching a patient or a patient's surroundings and before and after glove use. The WHO has referred to the first 5 of these as 'My 5 moments of Hand Hygiene'.

Isolation in separate rooms with negative pressure ventilation and PPE for staff is required for aerosolized infections. Helping host defences after exposure to pathogens includes rolling and use of pressure mattresses for immobile patients, sitting patients up, encouraging them to sit out of bed as much as possible and a reduction of sedation in ventilated individuals. Intravenous catheters should be used for as short a time as possible to prevent catheter-related bloodstream infections.

Common HCAI pathogens

Clostridioides difficile

Clostridioides difficile is a cause of hospital-acquired antibiotic-associated diarrhoea. Hospital surfaces and shared equipment (e.g. commodes) can become colonized with *C. difficile* spores if patients with diarrhoea are not isolated, staff do not use PPE and the environment is not cleaned with a chlorine-based cleaning product.

Spores are spread between patients via the faecal–oral route. After colonization the use of broad-spectrum antibiotics leads to disruption of the native intestinal flora and overgrowth of *C. difficile*, leading to disease. The disease can range from mild diarrhoea to systemic upset with fevers and toxic megacolon. Recurrent disease is common, with up to 25% of individuals experiencing a relapse within 30 days of finishing treatment.

As well as the NIPCM requirements an effective antibiotic stewardship programme is essential to drive down antimicrobial prescribing where not required. Mandatory reporting of *C. difficile* infections is required in England.

Methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-sensitive *Staphylococcus aureus*

During contact with healthcare services, patients can become colonized with MSSA or MRSA. MSSA is part of the normal nasal flora in 20–30% of the population and can colonize skin and mucosal surfaces. MRSA colonization in the UK is as low as 1% but can be higher in other countries. Hand hygiene plays a large part in the control of the spread of colonization.

MSSA and MRSA are significant pathogens in intravenous catheter-related bloodstream infections and surgical site infections. Mandatory surveillance of staphylococcal bacteraemia is required in England, with post-infection reviews for all MRSA bacteraemias. MRSA screening of all in patients is no longer required but NHS trusts should undertake screening in high-risk areas (surgical, haematological and augmented care settings).

Enterobacterales and *Pseudomonas aeruginosa*

Escherichia coli is the most common cause of catheter-related urinary tract infection (CUTI). Reducing catheter use and duration is the key to reducing infection. Mandatory reporting exists for *E. coli*, *Klebsiella* and *Pseudomonas* bacteraemias as a marker of poor hospital care as they are common causes of CUTI and catheter-related bloodstream infections.

Infections with CROs are particularly hard to treat, with limited antibiotic options. For this reason environmental contamination with these organisms and spread between patients is particularly troublesome, leading to ward closures and increased mortality. In England screening of patients for CRO via, as a minimum, a rectal swab should be undertaken for all patients in augmented care areas as well as all those with inpatient stays or repeated hospital exposure in the previous 12 months either in the UK or abroad.[5]

Legionella pneumophila

Legionella pneumophila is the cause of legionnaires disease a potentially fatal pneumonia. Hospital water systems can become colonized with the organism and patients may be exposed to aerosolized droplets in the air through showers, taps, spa pools etc. Severe pneumonia is more common in people over the age of 45, in those with alcohol excess and those with impaired immune system. Conditions that increase the risk from *legionella* include biofilm and sludge in pipes as well as slow flow in redundant pipework (dead legs) and water temperatures between 20-45 °C. When there is doubt about *legionella* water control regimens, regular water testing is required monthly. If *legionella* is found at high levels then a risk assessment, and remedial action is required. Action may include closing a ward or clinical area, putting filters on taps, remedial work on plumbing systems to remove dead legs and changes to water heating systems. ◆

KEY REFERENCES

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TEST YOURSELF

To test your knowledge based on the article you have just read, please complete the questions below. The answers can be found at the end of the issue or online here.

Question 1

A 55-year-old man presented with fever, low blood pressure and a blocked urinary catheter. He was diagnosed with a catheter-related urinary tract infection and the catheter was changed.

Why are infections involving prosthetic material particularly difficult to eradicate?

A. They always involve multidrug-resistant organisms
B. Biofilm formation protects bacteria from host immunity and antimicrobials
C. Prosthetic material prevents neutrophil migration
D. Prosthetic devices are usually inserted in immunocompromised hosts
E. Antibiotics cannot penetrate the bloodstream near prostheses

Question 2

A hospital is preparing a guidance document on the prevention of ventilator-associated pneumonia (VAP) on the intensive therapy unit.

What is the most important advice for preventing VAP?

A. Daily chest X-rays to detect pneumonia early
B. Use of broad-spectrum antibiotic prophylaxis
C. Elevating the head of the bed and reducing sedation where possible
D. Placing patients in negative-pressure isolation rooms
E. Routine chlorhexidine mouthwash