

Microbe of the month

Breaking The Chain of Infection

**FEATURED
THIS
MONTH:**

Staphylococcus aureus (S. aureus)

A master amongst microbes!

15-minute read + QUIZ

Hello readers!

Microbe of the Month aims to provide a concise clinical resource, to help you keep up to date about pathogens of importance, in an easy-to-read and understand format.

Each issue covers the aetiology (sources) and epidemiology of topical bacteria, viruses or fungi - their mode/s of transmission and the infections they cause; alerts on any antimicrobial resistance (AMR) capability they may have; and the relevant Infection Prevention and Control measures which should be routinely implemented for the safety of patients and healthcare personnel.

There is a quick quiz at the end of the newsletter to test your grasp of the content – please use this newsletter as a teaching tool in your workplace and start an ‘infectious dialogue’ about topical issues in infection control!

Staphylococcus aureus (pronounced ‘staf-ill-oh-KOK-us AW-ree-us’) is the obvious choice for this month’s issue, as we commemorate **World MSRA Day** (2nd October), **World Hand Hygiene Day** (15th October), **International Infection Prevention Week** (15th - 21st October) and **International Stop Wound Infection Day** (19th October).

S. aureus does not normally cause infection in healthy, intact skin; however, if it enters the tissues through a break in the skin, or is introduced into the bloodstream (e.g., via an intravenous catheter, or an endotracheal tube in ventilator-associated pneumonia), it becomes a highly successful **opportunistic pathogen** responsible for a large spectrum of infections, from superficial abscesses, boils and complicated wound infections to life-threatening infections such as osteomyelitis, pneumonia and septicaemia.

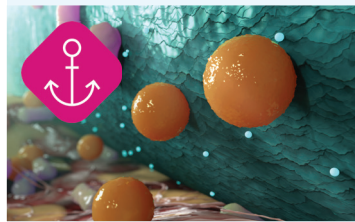
S. aureus is transmitted person-to-person by direct contact (‘skin to skin’ contact, especially via hands) **or by contaminated objects** (fomites) **and surfaces**.¹⁻³

Close contact, such as shared living quarters, playgrounds, gyms, and communal showers, increases the risk of exposure to MRSA, particularly if you share personal items, such as towels or razors. The spread of MRSA can be minimized by thorough and proper handwashing, either with soap and water, or with a waterless cleanser, and by not sharing personal items.

Any break in the skin should be cleaned thoroughly and kept covered until healed.

Key words: commensal, colonised, reservoir, carrier, contact transmission, healthcare-associated infection (HAI), antibiotic resistance, antimicrobial stewardship (AMS), infection control.

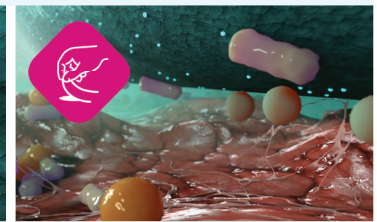
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Staphylococcus aureus is major bacterial human pathogen and the most frequent cause of wound and healthcare-associated infections (HAIs)^{1,2}



EPIDEMIOLOGY OF STAPHYLOCOCCUS AUREUS INFECTION

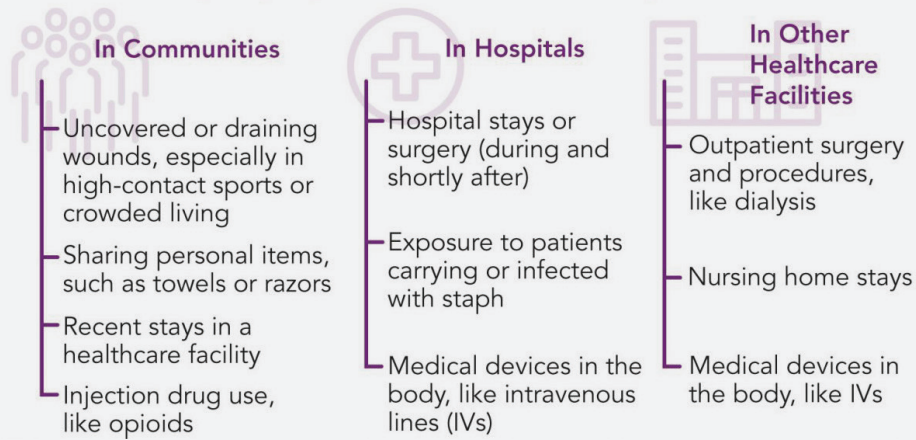
Staphylococcus aureus is a Gram-positive bacterium found on the skin, mucous membranes and in the nares (nostrils) of healthy people and animals, who are generally referred to as 'carriers'. However, humans are the major **reservoir** – it is estimated that up to half of all adults are colonised with *S. aureus*, and at least 15% of the population persistently carry *S. aureus* in the anterior nares.²

It possesses significant virulence characteristics which can promote cellulitis, local tissue destruction, biofilm production, severe systemic inflammatory immune response (SIRS), organ failure, and antimicrobial resistance (AMR) mechanisms.

The main mode of *S. aureus* transmission is primarily via hands, from 'high touch surfaces', and in crowded environments where the skin is exposed.

Some populations tend to have higher rates of *S. aureus* (and even MRSA) colonisation (as much as 80%), such as healthcare workers, individuals who use needles on a regular basis (i.e., diabetics and intravenous (IV) drug users), hospitalised patients, people living in communal accommodation (e.g., prisons, boarding schools, care homes), gym-goers and immunocompromised individuals.^{1,2,4}

What puts people at risk for serious staph infection?



CLINICAL MICROBIOLOGY

Staphylococcus aureus ('*Staphylus*' is from the ancient Greek for 'grape cluster', and '*aureus*' – from the Latin for 'gold' – refers to the golden yellow colour of *S. aureus* colonies) is a Gram-positive (i.e., stained purple by Gram stain) bacterial **commensal**, commonly found in warm, moist areas of the body, particularly the nose, axilla, skin folds and perineum.



S. aureus possesses many **virulence factors** – including defensive proteins attached to its cell wall which interfere with the attack and phagocytosis by macrophages and neutrophils (white blood cells), as well as the production of highly toxic enzymes which cause acute physiological reactions (e.g., renal failure in septic shock).^{2,3}

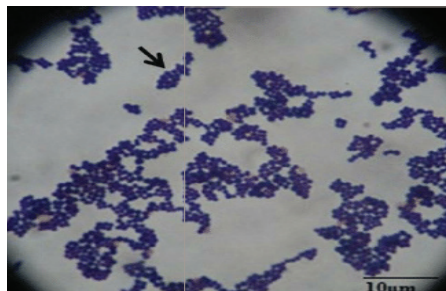
Historically, certain strains of *S. aureus* quickly became resistant to penicillin until an alternative antibiotic – **methicillin** – was introduced in 1960. However, it wasn't long before resistant strains were again reported in 1962, which were associated with many serious hospital outbreaks.

Methicillin-resistant *Staphylococcus aureus* (MRSA) refers to a group of *Staphylococcal* bacteria that are genetically distinct from other strains of *S. aureus*. MRSA is any strain of *S. aureus* that has developed (through horizontal gene transfer and natural selection) multiple drug resistance to **beta-lactam antibiotics** (β -lactam antibiotics are a broad-spectrum group of penicillin derivatives such as Ampicillin and Amoxicillin, as well as the cephalosporins and carbapenems).

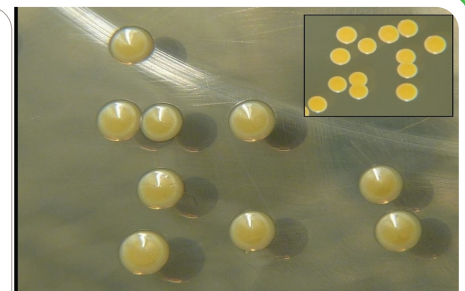
Methicillin (or cloxacillin) is therefore used as a screening tool in the microbiology laboratory for sensitivity / susceptibility testing – hence the acronym **MRSA**.^{3,4}



Electron microscope image depicting the grape-like clusters of *Staphylococcus aureus* (*S. aureus*).



Laboratory microscopy illustrating a positive Gram's stain (i.e., the purple clusters of *S. aureus*).



The golden yellow colonies of *Staphylococcus aureus* (*S. aureus*) growing on laboratory nutrient agar.



THE SPECTRUM OF SERIOUS INFECTIONS CAUSED BY S. AUREUS^{1,2}

- **Bacterial exotoxin mediated:** infectious endocarditis, sepsis, gastroenteritis, toxic shock syndrome.
- **Skin and soft tissue infections:** impetigo, boils, carbuncles, cellulitis, 'scalded skin syndrome' (newborn infants), severe wound and burns infections – all types.
- **Musculoskeletal complications:** osteomyelitis, septic arthritis, devastating prosthetic device infections.
- **Respiratory infections:** chronic rhinosinusitis, pneumonia, empyema.
- **Catheter / device-related infections:** urinary, central line associated bloodstream infections (CLA-BSI), ventilator associated pneumonia (VAP).



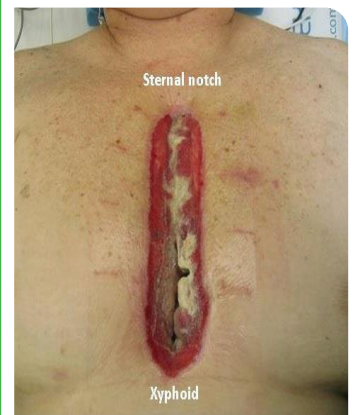
Boil, with surrounding painful cellulitis.



A carbuncle (a cluster of boils).



Septic thrombophlebitis (from IV infusion).



Deep sternal surgical site infection (SSI).



WHY DOES ANTIBIOTIC RESISTANCE MATTER?

Bacterial resistance occurs through 'selective pressure' when antibiotics are overused or abused. Antibiotic pressure 'selects' for bacterial genetic mutations (which are permanent), so it is clear that **a 'One Health' approach to antibiotic stewardship in healthcare, veterinary and livestock farming applications is fundamental to the prevention and management of antimicrobial resistance (AMR)**.^{4,5}

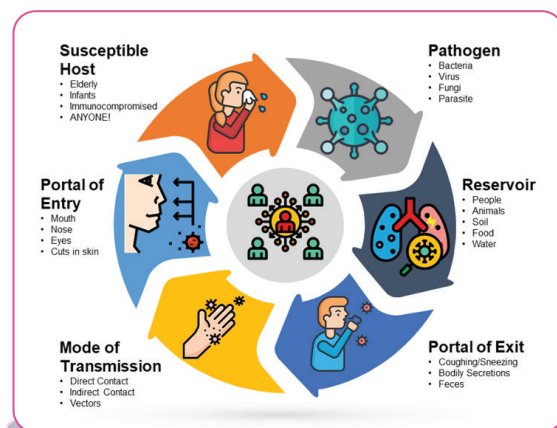
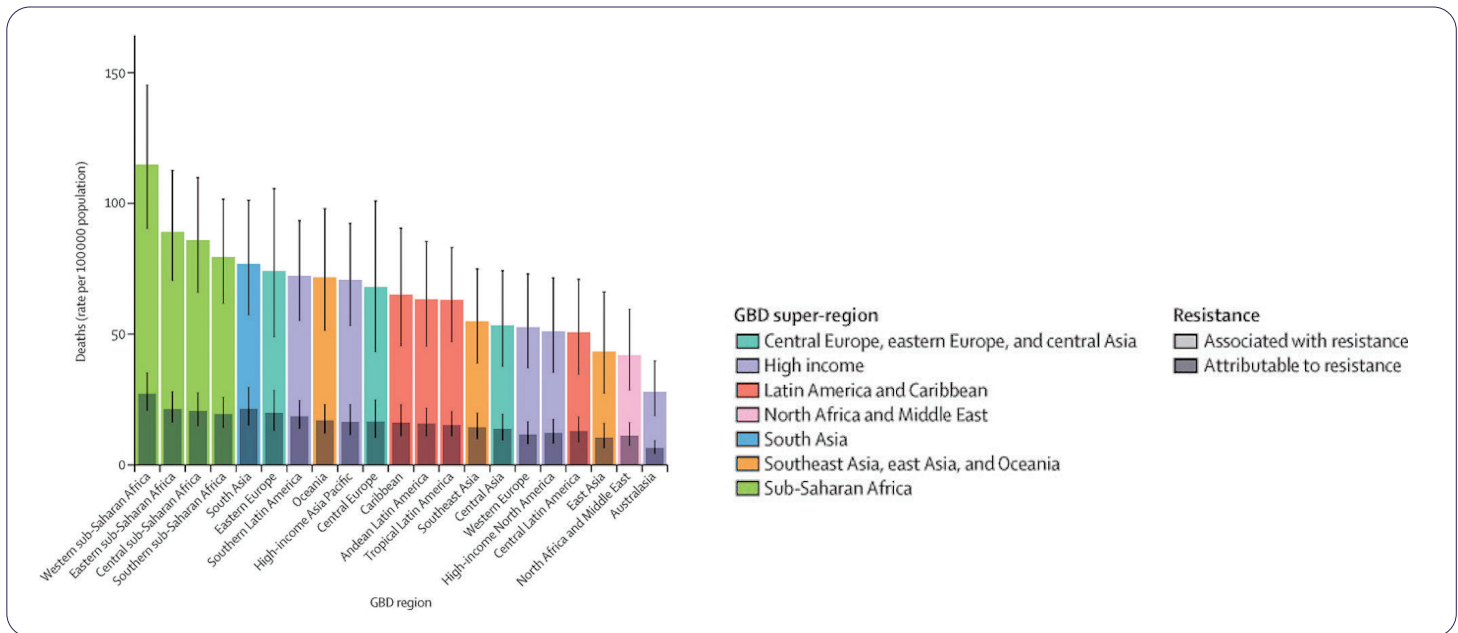
It is important to recognise that **multiple strains of MRSA exist**, and that MRSA colonisation and infection can be acquired from healthcare facilities as well as in **the community setting**.^{1,4,7}

The Global Research on Antimicrobial Resistance (Gram) Project is the first global analysis of AMR trends over time.

The researchers used data from 204 countries and regions (from approximately 520 million individual records) to produce estimates of AMR-attributable deaths from 1990 to 2021, and forecasts running through to 2050.

Furthermore, the researchers found that MRSA had the largest increase across **all age groups** (i.e. the number of attributable deaths nearly doubled from 57 200 in 1990 to 130 000 in 2021).

Global leaders will meet in New York this month to discuss antimicrobial resistance, during the UN's general assembly. They are expected to reaffirm a political declaration on stepping up action against antimicrobial resistance, which campaigners hope will include a target to reduce AMR deaths by 10% by 2030.⁸



THE BOTTOM LINE...^{1,3-8}

Implement specific infection prevention and control strategies aimed at 'breaking the chain' of transmission. For example, the use of standard precautions irrespective of patients' diagnosis, contact precautions (gloves and disposable aprons), scrupulous hand hygiene and the application of 70% alcohol-based hand sanitisers, the frequent disinfection of stethoscopes, avoidance of neck ties, long sleeves, the wearing of wrist bands and watches, and loose / uncovered hair and braids.

Avoid sharing patient equipment in high-risk clinical areas.

Use a detergent-based hypochlorite solution for damp-dusting and environmental disinfection – especially 'high touch' surfaces.

Handle and dispose of used linen carefully – never place linen on the floor or on adjacent surfaces, and never carry it against your clothing or through the ward!

Implement the SSI and CLA-BSI prevention bundles and ensure strict adherence to pre-, peri- and post-operative infection prevention measures across multidisciplinary teams.

Place patients who are colonised or infected with MRSA in isolation, or cohort (combined isolation) with other MRSA patients – provided they have no other infection/s.

The routine 'screening' of healthcare workers for MRSA is not recommended. Rather, carry out *S. aureus* surveillance and be on the alert for clusters of *S. aureus* infection.

The use of topical (intranasal) antimicrobials such as mupirocin can be used to eliminate nasal colonisation in some nasal carriers. However, its use is controversial, especially in view of increasing mupirocin resistance.

If the source of MRSA is community-acquired, treating family and close contacts is recommended to prevent recolonisation.

Wash your hands after handling pets.

Monitor and control the inappropriate use of antimicrobial agents!



Supply the correct answer!

Question 1. The main route of transmission of *S. aureus* is via _____.

Question 2. *S. aureus* is commonly found in _____ and _____ areas of the body, particularly the nose, axilla, skin folds and perineum.

Question 3. *S. aureus* is the most common cause of _____ infections.

Question 4. Methicillin-resistant *S. aureus* (MRSA) is resistant to all _____ antibiotics.

Question 5. The wearing of wrist _____ and watches, and loose / uncovered _____ and braids should not be permitted, to prevent the transmission of *S. aureus* in healthcare facilities.

ANSWERS: 1. Hands. 2. Warm and moist. 3. Wound. 4. Beta-lactam. 5. (Wrist) bands and hair.

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¹ Stanirowski J, Bizon M, Cendrowski K, et al (2016b) Randomized controlled trial evaluating dialkylcarbonyl chloride impregnated dressings for the prevention of surgical site infections in adult women undergoing caesarean section. Surg Infect (Larchmt) 17(4): 427-35

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