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A Review Article on Staphylococcus Aureus

N. Usha Sree

Department of MSc Microbiology Siddhartha Women's Degree and PG College, Kukatpally, Hyderabad

Abstract:
Staphylococcus is a genus of gram-positive bacteria. More than 30 species of gram-positive bacteria are present. Under a microscope, their shape is normally spherical(cocci) clusters that resemble grapes. As facultative anaerobes, staphylococcus species may grow in both aerobic and anaerobic conditions. Greek terms *"staphylo" which means grapes and "coccus" which means spherical bacterium* were combined to name the genus in 1880 by Scottish surgeon **Alexander Ogston**. It is a frequently occurring bacteria in humans and causes various illnesses, such as sepsis, pneumonia, and skin infections. With this bacterium, it can infect patients who have low immunity power such as in cases when the patient is in critical condition and those who have medical implants equipped in their body, they can also create toxins that lead to food poisoning. It creates post-surgery infection.

Introduction:
Staphylococcus aureus is a primary human pathogen that can cause many great infections. It is a leading reason for bacteremia, infective endocarditis, as well as osteoarticular, skin and soft tissue, pleuropulmonary, and device-associated infections.
Staphylococcus aureus is a Gram-effective bacterium that typically colonizes the human pores skin and nasal passages, with around 30% of the population being asymptomatic providers. However, when the microorganism inputs the inner tissues or bloodstream, it can cause intense and potentially life-threatening infections.
The epidemiology of Staphylococcus aureus infections has shifted in current many years. There has been a rise in healthcare-associated infections, specifically in infective endocarditis and prosthetic tool infections. Additionally, there was an endemic of network-related pores and skin and gentle tissue infections driven with the aid of lines with certain virulence factors and resistance to beta-lactam antibiotics, along with methicillin-resistant Staphylococcus aureus (MRSA).
Staphylococcus aureus expresses plenty of virulence factors that assist it set up the infection by facilitating tissue attachment, invasion, and evasion of the host immune reaction. The capability of Staphylococcus aureus to acquire resistance to multiple antibiotic classes, together with the development of MRSA, has made it a hard pathogen to treat.
The management of Staphylococcus aureus infections remains a full undertaking, with a paucity of first-rate evidence to manual clinical decision- making in many instances. Vancomycin has been the gold widespread treatment for MRSA; however, the emergence of resistance has limited its software. Newer anti-MRSA antibiotics have supplied some comfort, but the persevered improvement of the latest treatment options and non-antibiotic techniques is essential, as Staphylococcus aureus has an excellent capability to fast acquire resistance to newly delivered capsules.
Vancomycin-resistant Staphylococcus aureus (VRSA) infections are uncommon but have been suggested, with the first case recognized within the United States in 2002. These infections are related to excessive mortality prices and pose a tremendous risk, as treatment alternatives are extraordinarily constrained. The emergence of VRSA is notion to be pushed via the transfer of the vanA gene from vancomycin-resistant Enterococcus species to Staphylococcus aureus.
In addition to antibiotic resistance, Staphylococcus aureus has additionally evolved resistance to different antimicrobial marketers, such as antiseptics and disinfectants. This in addition complicates the control of Staphylococcus aureus infections, as those agents are often used as part of contamination management

measures in healthcare settings.

Classification of Staphylococcus aureus:

S. Aureus is classified as a facultative anaerobe, which means it can grow inside the presence or absence of oxygen. It is nonmotile and does now not shape spores. On agar media, S. Aureus paperwork massive, round, convex colonies that might be yellow or white in shade because of carotenoid pigments. The colonies regularly exhibit zones of clear beta-hemolysis on blood agar. Biochemically, S. Aureus is catalase-effective, meaning it can produce the enzyme catalase which converts hydrogen peroxide to water and oxygen. This helps distinguish it from streptococci and enterococci.

Domain: Bacteria Phylum: Firmicutes Class: Bacilli

Order: Bacillales

Family: Staphylococcaceae Genus: Staphylococcus Species: S. aureus

Morphology:

Cocci bacteria that are spherical and are classified as gram-positive upon magnification are seen to group themselves in clusters like grapes. It is an exclusively parasitic structure as it is accompanied by some distinctive characteristics such as; Cells are non-motile, non-sacculiferous, individual, and very small in size and measures between 0. and undefined. On agar media S. aureus forms large round-shaped colonies with elevation or convex surface, colour of these colonies is yellow or white due to the formation of carotenoid substances. The colonies may be surrounded by zones of beta-clear hemolysis on blood agar; however, there presents weak or no hemolysis in the methicillin- resistant strains (MRSA). On plasma onto the base, S. aureus creates irregular, aggregated biofilms while creating smooth flat biofilms.

Adaptation of Staphylococcus aureus:

According to the given text, Staphylococcus aureus is highly adaptable to its host environments through several ways:

Serological and phage typing: Various serological types of S. aureus have different antigenic structures while also susceptibility to bacteriophages differs among them with their bacterial components respectively. This helps it in eluding the immunity from the hosts. Biofilm production: It shows varying levels of biofilms which help in its persistence by preventing immune defense mechanisms and antibiotics from reaching it.

Genome evolution: The infection by S. aureus leads to selective adaptation which causes this organism to suffer genetic changes enriched in genes responsible for antibiotic resistance, evasion of the immune system, and pathogenesis. Some key examples of these genes are *agrA, agrC, stp1, and sucA.*

Metabolic adaptation: When in a particular host niche where nutrients get limited as well as use different carbon sources, this organism adapts its metabolism such as *CcpA* regulator regulation.

Development of antimicrobial resistance in Staphylococcus aureus:

AMR is a process through which measures that were previously used in the elimination of pathogens like bacteria, viruses, fungi, and parasites are rendered less effective. Mental illness is a severe and pressing problem on a global scale. Overuse and misuse of antimicrobials: This is because diseases- causing microbes are under pressure due to abuse and excessive use of antibiotics, antiviral, antifungal as well as antiparasitic agents. Genetic adaptation of microbes: It induces genetic fluctuation in the bacteria and other microorganisms like mutations that enable them to resist the antibiotics and other antimicrobial compounds. Environmental factors: AMR can also be explained as a result of the abuse of antimicrobial residues, heavy metals, and other pollution. Human conflict and infrastructure disruption: It also affects the delivery of health care services, sanitation, and the facility leading to the emergence of resistant microbes. The most familiar of these bacteria are the methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant Enterococcus (VRE), and multidrug-resistant Mycobacterium tuberculosis. Strengthening of infection prevention and control measures enhancement of surveillance and monitoring of resistance Strengthening of research gaps for development of new antibiotics decreasing factors that may fuel the development of AMR.

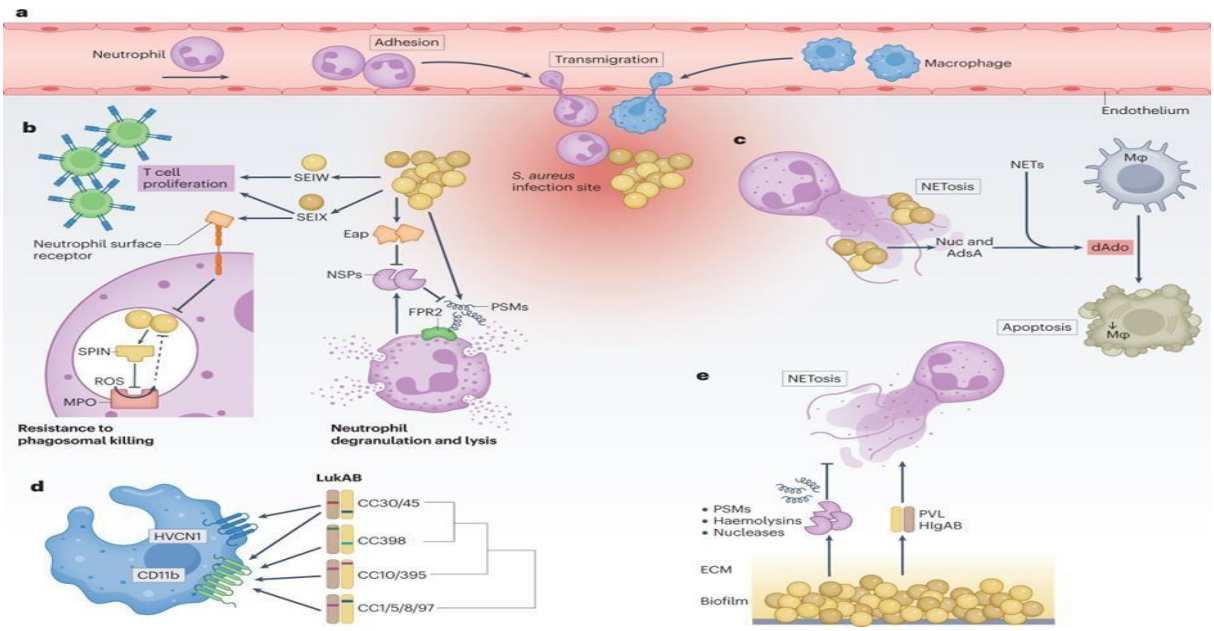


Figure: Staphylococcus aureus host interactions and adaptation.

Mode of Transmission:

The main mode of transmission for Staphylococcus aureus is through direct contact or indirect contact with infected items or surfaces:

- Direct touch: Transmission can arise via direct contact with wounds, discharge, or soiled regions of an inflamed person.
- Indirect touch: Transmission can arise via indirect contact with contaminated environments, devices, or gadgets.

Other much less not unusual modes of transmission include:

- Airborne transmission: This can arise in sufferers with S. Aureus pneumonia or big burn wounds, as well as from colonized individuals with higher respiration tract infections who might also shed S. Aureus into the air.
- Sexual transmission: This has been described and can occur as folliculitis or abscesses within the pubic, vaginal, or perineal regions.

Pathogenicity:

Staphylococcus aureus is a highly pathogenic bacterium which can cause a huge range of substantial infections: S. Aureus is one of the maximum common international causes of morbidity and mortality because of an infectious agent. It can cause sicknesses starting from slight pores and skin infections to deadly pneumonia and sepsis. S. Aureus has an in-depth arsenal of virulence factors, consisting of a plethora of toxins and immune evasion elements, that permit it to initiate and maintain infections. These virulence elements permit host colonization and immune evasion. The emergence of community-related methicillin-resistant S. Aureus (CA-MRSA) lines in the early 2000s, which integrate antibiotic resistance with high virulence, has been a high pressure of prolonged research into S. Aureus pathogenicity. S. Aureus can produce virulence factors much like the golden pigment staphyloxanthin that act as antioxidants to help the micro-organism live far from the host immune machine. Mutant traces lacking this pigment are greater vulnerable to immune defenses. The excessive plasticity of the S. Aureus genome and its capacity to accumulate foreign genetic material contribute to its pathogenicity and the emergence of recent virulent traces.

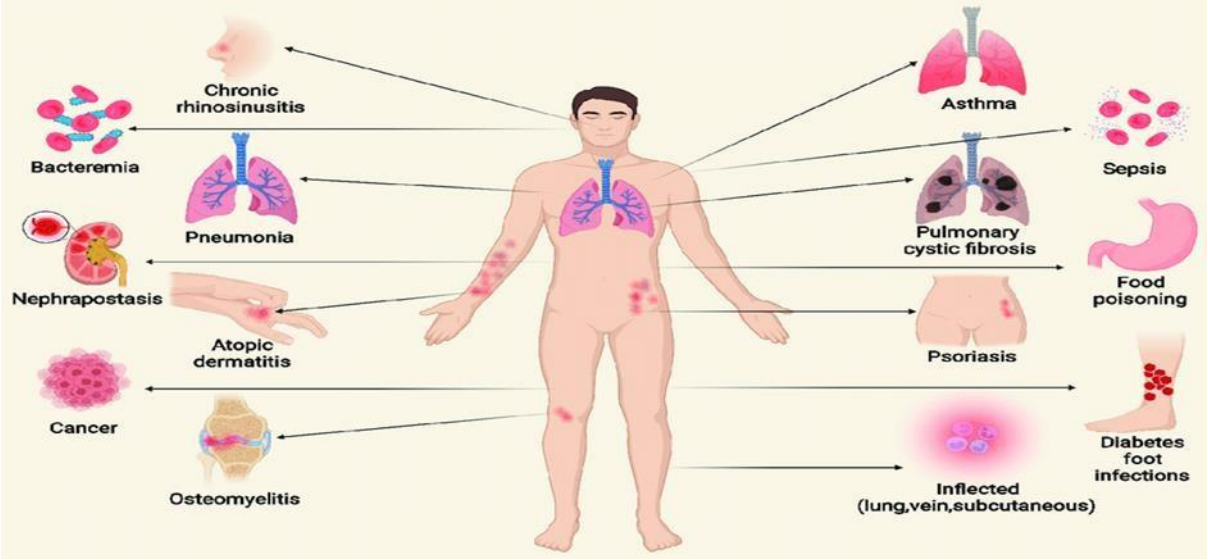
Mechanism:

AMR in the S. aureus strains is a severe issue from the public health standpoint since it hampers the use of the available drugs and results in the worsening of diseases and deaths. S. aureus has tended to become resistant to multiple classes of antibiotics through different mechanism of genetic and biochemical. The best-known multi-resistant sub-species is the methicillin- resistant Staphylococcus aureus (MRSA), which

has developed resistance against the beta-lactam-antibiotics methicillin, oxacillin, and cephalosporin. MSSA strains are positive for the mecA gene that Codes for a modified PBP2a with low affinity for beta-lactams. Beta-lactams typically inhibit PBP2a's ability to catalyze peptidoglycan synthesis through blending with the terminal D-alanyl-D-alanine peptide chain of the lipid II precursor; however, PBP2a can accomplish the formation of peptidoglycan in the existence of beta-lactams and therefore MRSA. S. aureus has also the ability to develop resistance to a class of antibiotics known as glycopeptides such as vancomycin through stepwise mechanisms. VISA is an intermediate level of resistance that is attained through changes in the structure of the bacterial cell wall, which retains vancomycin before it gets to the peptidoglycan layer. VRSA on the other hand involves complete resistance and this is achieved by obtaining the vanA gene from VRE which alters the target of the antibiotic. Other resistance mechanisms in S. aureus include: Other resistance mechanisms in S. aureus include: Enzymatic inactivation: resistance mechanisms as the production of beta-lactamases capable of breaking the beta- lactam ring or acetyltransferases that alter aminoglycosides. Target modification: Alterations in the genes that encode the targets DNA gyrase and topoisomerase IV can provide fluoroquinolone resistance. By methylating the 23S rRNA subunit with the help of the erm gene the binding of macrolides decreases. Efflux pumps: Some membrane transporters such as NorA can expel many classes of antibiotics from the cell if their levels are too high. Biofilm formation: EPS in biofilms themselves prevent antibiotics from penetrating due to the EPS 'matrix and additionally alter the metabolic state of cells to a slow-growing, dormant-like, phenotype that is highly tolerant to antibiotics. Also, some MRSA strains are developing resistance to the more recent antibiotics such as linezolid and daptomycin through these mechanisms. Resistance can arise where there is the exchange of plasmids and transposons through horizontal gene transfer. Preventing further development of AMR requires a multi-pronged approach: This case entails the proper prescription of antibiotics so that it reduces selective pressure. Borrowed infection prevention measures to slow down the spreading of resistant strains. Creation of new antibiotics and other approaches. Reduced time to accurate diagnosis to allow for prompt appropriate antibiotic therapy. Synergistic Global monitoring of eyeglasses and research.

Diseases caused:

Staph bacteria affect the human body in different ways since there are many of them; it is categorized in different forms. Staphylococcal infection can affect the: Staphylococcal infection can affect the: Skin: More often, the bacterium that is responsible for skin infection is Staphylococcus aureus bacteria. Can cause the formation of boils, blisters, and redness on your skin. The infections can be anywhere on the body, head, and face especially on the area around the mouth and the nose. Breasts/chest: Breastfeeding (chestfeeding) people can develop mastitis, which causes inflammation (swelling) and/or abscesses (fluid-filled pockets of infection). Digestive system: Perhaps, if you consume foods containing bacteria, you will fall sick with a sore throat, vomiting, and diarrhea. Bones: The bacteria can invade your bones hence causing inflammation and pain r Fisher and Scott-Fleming 2000. Osteomyelitis is the name of this infection. Lungs and heart: Once inside the lungs, one can get pneumonia and other respiratory complications resulting from abscess formations. It also becomes possible that Staph bacteria cause inflammation of the heart valves and result in heart failure. Bloodstream: When bacteria secrete something into your body that is toxic to you, you can get what is known as septicemia or blood poisoning.



Prevention:
Here are the key factors in the prevention of Staphylococcus aureus infections:

Hand hygiene:
Thorough handwashing with soap and water or the use of alcohol-primarily based hand sanitizers is critical to saving you from the transmission of S. Aureus, as its miles spread via direct and oblique touch. Proper hand hygiene ought to be practiced by using healthcare employees, sufferers, and the overall public.

Environmental cleaning and disinfection:
Cleaning and disinfecting surfaces, systems, and healthcare surroundings can assist reduce the unfold of S. Aureus, such as antibiotic-resistant strains like MRSA. Regular cleaning of high-touch surfaces is critical in each healthcare and community setting.

Public Health Importance of S. aureus:
Staphylococcus aureus is a major public health concern due to its ability to cause a wide range of serious infections and its increasing resistance to antibiotics: Staphylococcus aureus is a major public health concern due to its ability to cause a wide range of serious infections and its increasing resistance to antibiotics:

Staphylococcus aureus is responsible for bacteremia, infective endocarditis, osteoarticular infection, skin and soft tissue infection, and Pleuropulmonary infection and infection associated with devices. These invasive infections are normally related to high morbidity and mortality rates. MRSA, which stands for Methicillin-resistant S. aureus has been on the US public health agenda for over three decades. Data from 2014 shows that invasive MRSA infections were reportedly at 72,444 cases and 9,194 were fatal. Nevertheless, methicillin-resistant S. aureus (MRSA) is not the only significant strain of S. aureus; there is also methicillin-sensitive S. aureus (MSSA). McGee et al have quantified the MSSA invasive infection rates in 2016 as follows: 1. It also pointed out that the BSI infection rate from MRSA was eight times less than the rate of infection from C diff. MSSA accounted for 59. 7% of all HAIs and 60 percent of C. difficile cases could be prevented if heeded. 1% of deaths. Staphylococcus aureus can have multiple antibiotic resistance of multiple classes by genetic material acquisition, enzymatic drug alteration, protein alteration of the targeted site, and drug expulsion. This poses a major problem to the treatment of severe infections because it restricts the chances of seeking effective treatment.

Economic impact:
The economic impact of antimicrobial resistance (AMR) is significant and far-reaching: The economic impact of antimicrobial resistance (AMR) is significant and far-reaching: Healthcare costs: AMR infections delay the length of stay and require more intensive interventions; they entail potentially more costly or potent antibiotics. This in turn raises direct health care costs. Productivity losses: These infections can lead to

longer patient recovery periods, missed school and working days, and deaths in the premature ages. This results in significant other costs that are not direct but their impact on productivity is enormous. Reduced agricultural output: The disease affects the Livestock and crops hence the food chain lowers poor agricultural output. Reduced investment: The risk that the infections are untreatable prejudices capital credit in several industries and geographical zones. Estimates of the economic burden of AMR vary, but studies suggest it is substantial: Estimates of the economic burden of AMR vary, but studies suggest it is substantial: The Annual global Cost of AMR could be up to $100 trillion by the year 2050 as estimated by a review conducted in 2014. According to the OECD analysis, AMR could lead to 2 in the year 2050. An additional 4 million deaths per year in Europe, North America, and Australia amounting to over $3. 5 billion per year. Annually, for the US alone, AMR was estimated to cost more than $20 billion of direct health care costs of which societal costs were estimated to be more than $35 billion. On an economic aspect, the financial effect would be even higher in LMICs, because those countries afford higher morbidity and mortality rates of ID, as well as they have weaker capacities to cope with AMR. Combating the AMR problem entails higher spending on surveillance systems, infection prevention practices, antibiotic stewardship programs, and research and development of new antimicrobials and non-antibiotic treatments. Inaction may lead to disastrous economic outcomes on the world stage which may not be salvaged.

Conclusion:

In the end, Staphylococcus aureus is an incredibly adaptable and pathogenic bacterium that poses a full-size public health risk globally. Key points about S. Aureus:

It is a leading reason for skin and soft tissue infections, invasive diseases like bacteremia and endocarditis, and toxin-mediated illnesses.

S. Aureus employs diverse virulence factors and adaptive mechanisms to stay away from host defenses and purpose persistent infections. These include immune evasion techniques, biofilm formation, and metabolic edition.

The emergence of antibiotic-resistant strains like MRSA has complicated remedies and expanded morbidity and mortality from S. Aureus infections. Resistance arises through genetic changes like obtaining resistance genes and enhancing antibiotic objectives.

S. Aureus is broadly speaking transmitted through direct touch or oblique contact with contaminated surfaces. Airborne and sexual transmission additionally occur but are much less, not unusual.

Addressing the public fitness chance of S. Aureus requires a multi-pronged approach of antimicrobial stewardship, contamination prevention, speedy diagnostics, and persevered studies into new treatment techniques focused on virulence and resistance mechanisms.

In precis, S. Aureus is a very versatile and dangerous pathogen that has adapted to successfully colonize and infect people. Combating this threat calls for a concerted international effort to restrict the unfolding of resistant strains and develop progressive methods to save you and deal with S. Aureus infections.

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