مجلة الدراسات التربوية والعلمية - كلية التربية - الجامعة العراقية
العدد الرابع والعشرون - المجلد الخامس - علوم الحياة - كانون أول 2024 م
doi.org/10.52866/esj.2024.05.24.13

Detection of Some Toxin Genes in Methicillin-resistant *Staphylococcus aureus* (MRSA) Isolates

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Abstract :

Three fundamental syndromes caused by a variety of invasive diseases include bacteria. Methicillin-resistant *Staphylococcus aureus* (MRSA) play a significant role on public health challenge due to its resistance to beta-lactam antibiotics and its association with severe infections. The virulence of MRSA linked to the presence of specific toxin genes, which can enhance its pathogenicity and ability to evade host immune responses. Strains are resistant to the antibiotic especially in nosocomial conditions. These bacteria have a higher risk can cause sepsis or death and resistance against several antibiotics in the form of a boil and pus. *Staphylococcus aureus* produces a number of toxins that distinguish it in food circles under certain conditions. It is considered a high resistance factor for antibiotic therapy in areas where it is considered chronic or persistent. MRSA is resistant to penicillin and became known as Methicillin-Resistant *Staphylococcus aureus* (MRSA) Those at risk for MRSA infection are patients in hospitals and other health facilities, especially the elderly, those with reduced immunity and those with an open wound. In certain people, MRSA is present and is mostly located in the membranes of the mucosa. No signs are caused by it, but it can cause a skin bump or ulceration. Infection of fever also follows it. Bacteria of *Staphylococcus aureus* are immune to standard antibiotics. Toxin genes in MRSA isolates must be found in order to improve patient care and conduct epidemiological surveillance. To handle the growing threat of MRSA and its related virulence factors, further investigation and observation are required. MRSA does not respond to traditional therapy but to different forms of antibiotics. In previous research, the prevalence of MRSA and its history of resistance are an indicator that health and public care workers are at risk.

Key words: Toxin Genes, Methicillin-resistant *Staphylococcus aureus*, Antibiotics, bacteria.

الكشف عن بعض جينات السموم في عزلات المكورات العنقودية الذهبية المقاومة للميثيسيلين (MRSA)

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مستخلص:

ثلاث متلازمات أساسية تسببها مجموعة متنوعة من الأمراض الغازية تشمل البكتيريا. تلعب المكورات العنقودية الذهبية المقاومة للميثيسيلين (MRSA) دورًا مهمًا في تحدي الصحة العامة بسبب مقاومتها للمضادات الحيوية بيتا لاكتام وارتباطها بالالتهابات الشديدة. ترتبط شدة جرثومة MRSA بوجود جينات سمية محددة، والتي يمكن أن تعزز قدرتها المرضية وقدرتها على تجنب الاستجابات المناعية للمضيف. سلالات مقاومة للمضادات الحيوية وخاصة في ظروف المستشفيات. هذه البكتيريا لها خطورة عالية يمكن أن تسبب تعفن الدم أو الوفاة ومقاومة ضد العديد من المضادات الحيوية في شكل صديد. تنتج المكورات العنقودية الذهبية عددًا من السموم التي تميزها في الأوساط الغذائية في ظل ظروف معينة. تعتبر عامل مقاومة عالية للعلاج بالمضادات الحيوية في المناطق التي تعتبر فيها مزمنة أو مستمرة. المكورات العنقودية الذهبية المقاومة للميثيسيلين مقاومة للبنسلين وأصبحت تعرف باسم المكورات العنقودية الذهبية المقاومة للميثيسيلين (MRSA) المعرضون لخطر الإصابة بعدوى المكورات العنقودية الذهبية المقاومة للميثيسيلين هم المرضى في المستشفيات والمرافق الصحية الأخرى، وخاصة كبار السن، وأولئك الذين يعانون من انخفاض المناعة وأولئك الذين يعانون من جرح مفتوح. توجد MRSA لدى بعض الأشخاص، وتتواجد في الغالب في أغشية الغشاء المخاطي. ولا تسبب أي علامات، ولكنها قد تسبب نتوءًا أو تقرحًا في الجلد. كما تتبعها عدوى الحمى. تتمتع بكتيريا المكورات العنقودية الذهبية بمناعة ضد المضادات الحيوية القياسية. ويجب العثور على جينات السموم في عزلات MRSA من أجل تحسين رعاية المرضى وإجراء المراقبة الوبائية. وللتعامل مع التهديد المتزايد لـ MRSA وعوامل الضراوة المرتبطة بها، هناك حاجة إلى مزيد من التحقيق والمراقبة. لا تستجيب MRSA للعلاج التقليدي ولكن لأشكال مختلفة من المضادات الحيوية. كان انتشار MRSA وتاريخ مقاومتها مؤشرًا على أن العاملين في مجال الصحة والرعاية العامة معرضون للخطر.

الكلمات المفتاحية: جينات السموم، المكورات العنقودية الذهبية المقاومة للميثيسيلين، المضادات الحيوية، البكتيريا.

Introduction

For a long time, *Staphylococcus aureus* has been considered to be an important human disease pathogen. It is involved in three basic syndromes caused by a variety of diseases that are invasive. The bacterium continues to show its ability to establish resistance and has a large range of antimicrobial classes[1].

The Significance of Toxin Genes:

The pathogenicity of MRSA is mostly dependent on its toxin genes, which include entero-toxins, alpha-toxin, and Panton-Valentine leukocidin (PVL). Understanding the epidemiology and clinical consequences of MRSA infections depends on the identification of these genes [2], Studies have shown a variable prevalence of toxin genes among MRSA isolates from different geographical regions and clinical settings. For instance: **PVL Genes**: More prevalent in community-acquired MRSA strains, often associated with skin and soft tissue infections. **Alpha-toxin**: Found in both community and hospital-acquired MRSA, contributing to severe conditions such as pneumonia and sepsis. **Enterotoxins**: Their presence is linked to foodborne outbreaks and toxic shock syndrome[3]. The techniques for Identifying genes in MRSA are[4]:

1. Molecular Techniques: The most used technique for identifying toxin genes is PCR (Polymerase Chain Reaction). It provides quick findings, sensitivity, and specificity.

2. Genomic sequencing: Comprehensive information on the existence of toxin genes and their variations is provided by next-generation sequencing.

3. Culture-Based Methods: To verify the existence of toxin genes in MRSA isolates, molecular techniques can be used in conjunction with conventional microbiological techniques[4,5].

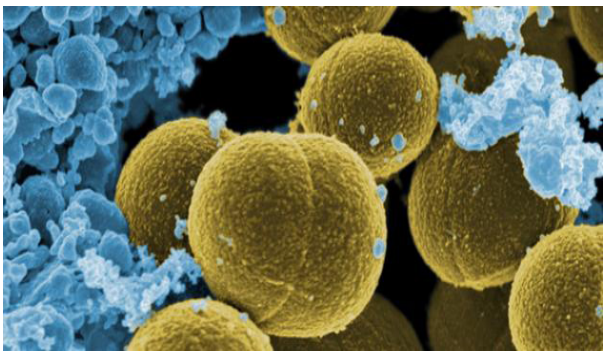

Figure (1) *Staphylococcus aureus* Methicillin-resistant [2].

The rising incidence of S. Multiresistant. An additional concern has been Aureus. Staphylitis Aureus is well rec-

ognized as a human pathogen. Bacteria are microorganisms consisting of a single cell discovered by scientist Anthony van Leeuwenhoek in the year 1,676 AD[3]. It is considered to be the first living organism on earth, and bacteria are studied in their own research, called bacteriology, Bacteriology and bacteria are classified into two specific groups, Gram-positive and Gram-negative bacteria, and the classification is achieved by applying the pigment to the bacteria and looking at it under a microscope[4]. It is considered positive if it appears in the color of the dye and if it does not bear the color of the dye, it is considered negative[5]. It is part of the high-energy and pathogenic form of staphylococcus. An significant pathogen is found in it: coagulase. Coagulation experiments will reveal its existence: the bacteria to be detected are applied with plasma citrate to a physiologically concentrated table salt solution. An example of this type is: *Staphylococcus aureus*, meaning *Staphylococcus aureus* bacteria. Those in the above test that do not have coagulability [6]. It is located without pathological concern on the skin and mucosal membranes, With the exception of individuals that have been immunocompromised (see: immunodeficiency) or in cases of plastic surfaces that have been present in the body for a long time (such as catheters, heart valves and plastic joints)[7]. *Staphylococcus epidermidis*, which means *Staphylococcus epidermidis* or *Staphylococcus albus*, which is responsible for a large proportion of endocardium inflammation, and *Staphylococcus capitis*, which is responsible for a large proportion of endocardium inflammation on the scalp, *Staphylococcus haemolyticus*, *Staphylococcus saprophyticus*. A particular pathological syndrome, which is urinary retention, is associated with the latter and affects males and females, particularly lower urinary tract infections. In horses and dogs, *staphylococcus intermedius* is present[8].

Basic *S. aureus* - Related Syndromes:

Infections of the skin and soft tissues (SSTIs) Description: *S. aureus* is frequently linked to infections such as folliculitis, cellulitis, and abscesses.

Pathogenesis: Localized infections can result from the bacteria's ability to pierce skin cracks. Its pathogenicity is increased by elements like the synthesis of toxins (such alpha-toxin and

PVL) [6,9].

Clinical Manifestations: From minor swelling and redness to serious necrotizing infections that necessitate surgery.

Invading Pathogens Description: Systemic infections such osteomyelitis, endocarditis, and bacteremia can be brought on by *S. aureus*.

Pathogenesis: If the germs get into the bloodstream, they can spread far and damage several organs. The danger of invasive infections is increased by the potential for biofilms to grow on medical equipment[8,10]. Such as catheters and prosthetic joints.

Clinical Manifestations: Signs of organ malfunction, fever, chills, and possibly fatal consequences are among the symptoms.

Diseases Mediated by Toxins Description: *S. aureus* produces a variety of toxins that can cause different symptoms, including food poisoning and toxic shock syndrome (TSS). Pathogenesis: Enterotoxins induce gastrointestinal problems, while superantigen toxins (such TSST-1) can generate an inflated immunological response.

Clinical Manifestations: Food poisoning usually causes nausea, vomiting, and diarrhea to appear quickly, but TSS can present with fever, rash, and multi-organ failure[9,10].

Toxin Genes And MRSA

Toxin Genes : Genetic harmful process disruption that affects the integrity and function of a cell called Genotoxicity. It is known that genetic (or gene) toxic substances may be mutagenic or carcinogenic, particularly those that are capable of causing genetic mutations and contributing to tumor growth[9]. Genotoxins are like aromatic amines and it is suspected that the cause of mutations is that they are powerful nucleophilic and form covalent bonds with DNA, leading to the formation of DNA-aromatic affinity, preventing the process of replication. This requires certain chemical compounds and some forms of radiation. Genetic toxins the sperm and eggs are affected by. Particularly when they are not exposed to the genetic toxin, genetic variations can be passed on to the offspring. This is because of the truth of the problem. The image was the prescription of antibiotics for colds , flu, and other viral infections that did not respond to them. That’s right, there are antibacterials; you drop any microbe you’re target-

ing[10]. The bacteria live fast, which is why these numbers that live the treatment learn how to fight afterwards against others.

MRSA:- MRSA is the name for *S. aureus* resistant to methicillin, and this type of bacteria is distinguished by its tolerance to several forms of recognized antibiotics, and this type of bacteria normally exists in the nose and on the skin and does not affect humans, And a wound or surgical procedure can greatly multiply the bacteria and cause infection, and the signs of infection depend on the location of the infection, often causing skin sores and boils, and can in some cases cause some of the more severe health problems when they are moved to the bloodstream, or lungs, or urinary system, and this type of bacteria is highly [11].

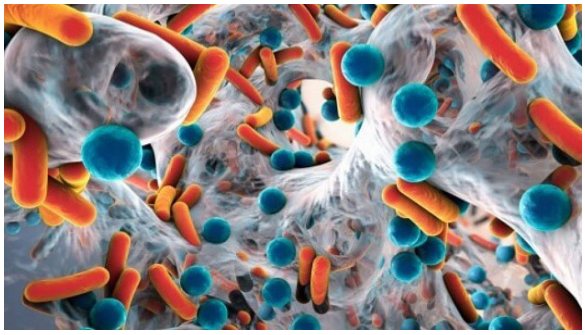

Figure (2) MRSA bacteria [12] .

While some cases of MRSA infection which pose a risk to the life of the patient, or contact with surfaces containing bacteria transmitted from the infected individual, *Staphylococcus aureus* or Methicillin-resistant *Staphylococcus aureus* is a bacterium called *Staphylococcus aureus*, but it is not susceptible to methicillin[13]. This infection is immune to many antibiotics, including often methicillin, in the form of a boil and pus, and is often spread by handshaking and contact. The infection can be spread to someone outside hospitals from any infected person, and children are more likely than adults to pass on the infection with that infection[14].

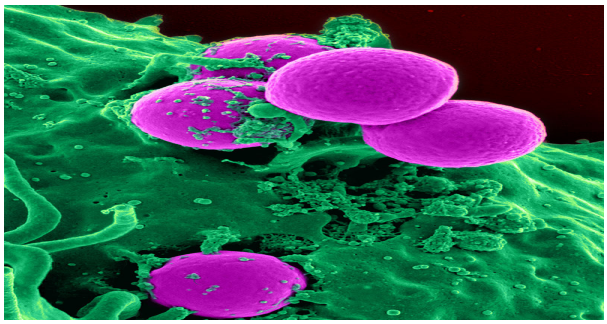

Figure (3) Scanning electron microscope image of a neutral cell engulfing methicillin-resistant *Staphylococcus aureus*[15]

Staphylococcus aureus Associated Infections

These bacteria are transmitted by direct contact with an infected person or a bacteria-contaminated substance or by inhaling droplets containing the bacteria from coughing or sneezing[16]. Skin infections are normal, but bacteria may spread and invade distant organs via the bloodstream. A skin infection in the infected area can cause blisters, abscesses, and redness and swelling. Diagnosis is based on the appearance of the skin or the detection of bacteria in the infected tissue samples. Washing your hands well with soap and water will prevent infection from spreading. Antibiotics are selected based on their potency against the infection-causing strain[17]. Staphylococcus aureus is present (usually temporarily) in 30 percent of healthy people's noses and 20 percent of healthy people's eyes. Bacteria are more likely to be found in sick patients or health care workers[18]. People who carry the infection without displaying signs are considered carriers. When exposed to injections regularly, a individual is more likely to be a carrier of the infection, as in the following cases: Patients infected with hemodialysis, or chronic outpatient peritoneal dialysis, diabetics in need of daily insulin doses, opioid addicts taken through injection[19]. People with a skin infection, AIDS, or prior staphylococcal infection in the bloodstream. People who use their hands to move bacteria from their noses to other areas of the body, Which often leads to infection. While undergoing surgery, infected carriers may become infected with the disease or are treated with hemodialysis, chronic outpatient peritoneal dialysis, The infection can spread from individual to individual through direct touch, either through infected objects (such as exercise equipment, phones, door handles, remote controls, or elevator buttons), or through contaminated objects[20]. Or also by droplet inhalation. Bacterial sneezing or coughing. Infections with Staphylococcus aureus vary from mild to serious. Bacteria appear to invade the skin, often causing abscesses (see Overview of dermatological bacterial infections) [21]. Bacteria can pass through the bloodstream (bacteremia) and invade any part of the body, in particular the valves of the heart (endocarditis) and the bones (osteomyelitis). Bacteria often appear to accumulate within the

body on medical instruments, such as heart valves or artificial joints, heart pacemakers, and vascular catheters. In particular places, certain forms of staph infections can be common: Endocarditis: as is the case with injection drug use, transmission of the infection to the catheter of the blood vessel or artificial heart valve[22]. Osteomyelitis: If infection with Staphylococcus aureus spreads from the bloodstream or surrounding soft tissue into the bone, as may occur in people with deep pressure ulcers or diabetic foot ulcers[23]. Lung infection (pneumonia): when the patient has an influenza (especially) or bloodstream infection, or when the patient is admitted to corticosteroids or immunosuppressants, or when the patient is admitted to hospital due to the need for endotracheal intubation and artificial respiration Having regard to the acceleration of the production of bacterial strains that are almost entirely or completely resistant to antibiotics, Efforts are organized and local and global health players have recently been very involved in developing strategies that would maintain the great human antibiotic success by which the individual has been able to preserve and save the lives of millions of people. In this sense, in 2017 , the World Health Organization released a list of 12 bacteria that pose a high global risk due to their high antibiotic resistance capabilities[24]. For each bacterium, we will assign an article in this series of articles in which we will display some of its attributes, locations, how it spreads / transmits, the diseases it causes, the antibiotics used and their resistance[25]. Gram positive , non-motile bacteria, in addition to details on the whereabouts of resistant species. It was named after that name (*staphylococcus*) because when viewed under a microscope, it is organized in irregular balls that resemble a cluster of grapes, As for the name (golden) because, when grown on blood agar, they appear in the form of yellow colonies and can completely examine red blood cells that are optional anaerobes (can live in the presence and absence of oxygen). In general, *Staphylococcus aureus* lives naturally on human skin, in the nasal cavity or in the respiratory tract[26]. However, minor skin infections such as pimples, impetigo, boils, cellulitis, folliculitis, scalded skin syndrome and abscesses can cause a variety of diseases, Life-threatening conditions such as the following: influenza, men-

ingitis. Septicemia, Osteomyelitis and. It is one of the most prominent causes of hospital-acquired disease[27]. The bacterium *Staphylococcus aureus* is an opportunistic pathogen responsible for many purulent infections in both humans and animals. Under some circumstances, the bacterium *Staphylococcus aureus* generates a variety of toxins that differentiate it in food circles, including Hemolysin Alpha, which breaks down red blood cells in rabbits[28]. And hemolysin beta toxins that break down red sheep blood cells, as well as leukocidin-degrading toxins. In addition, *Staphylococcus aureus* develops enterotoxins that are responsible for a significant number of cases of food poisoning. The existence of adhesion factors and their ability to build biofilms that help bacteria thrive within the atmosphere of the host and are responsible for chronic or recurrent infections are among the variables of virulence factors. It is known to be a high resistance factor for the treatment of antibiotics[29]. They serve as a barrier to avoid antibiotic penetration because of their existence, and likely because they contain antibiotic enzymes, such as beta-lactamases.

Upon its discovery, Penicillin demonstrated high efficacy against *Staphylococcus aureus*, as Penicillin acts to prevent the formation of peptidoglycan bonds that "provide the bacterial cell wall with stiffness and strength" and influence the formation of cell walls, leading to its death[30]. In spite of this, in most countries of the world, the issue of penicillin resistance has become widespread and has risen in recent times, taking the resistance rate close to 100%. There is a wide group of antibiotics, including erythromycin, cephalosporin, clindemycin, linomycin, erythromycin, methicillin, naphicillin and vancomycin, which have been used to treat infections caused by *Staphylococcus aureus*. Methicillin resistance was demonstrated by Staphylococcus aureus and became known as Methicillin-Resistant *Staphylococcus Aureus* (MRSA)[31]. Patients in hospitals and other health care facilities, particularly the elderly, those with diminished immunity and those with an open wound or body catheter, are at risk for MRSA infection. These bacteria, sadly, breached the boundaries of health facilities to constitute a high percentage of population isolates. This methicillin resistance was caused by gene expression of the β-lactamase5

methicillin-hydrolysing complex and by gene expression of the protein associated with the defective PBP2 protein. Staphylococcus aureus (including MRSA) bacteria are typically transmitted by direct contact between individuals and by the exchange of personal objects or the touching of infected equipment and tools. Pets may be responsible for transmitting the infection. The bacteria are transmitted into the hands of staff in health care. The introduction of bacteria into the bloodstream can lead to several complications, such as endocarditis and menigitis, and it can cause sepsis if it spreads widely. Virulence Genes Prevalence as show in table 1the right methods of hand washing, hygiene management and wound cleaning, this can be prevented. Employees use masks and protective gloves to minimize skin-to - skin touch, thus reducing the risk of transmission. In the 1990s, anti-vancomycin resistant strains of Staphylococcus aureus bacteria that could cure infections resulting from MRSA were reported. These bacteria are known as Staphylococcus aureus (VISA), which is immune to vancomycin. This is due to many gene modifications and several gene mutations responsible for forming the biosphere of the cell[32].

Table (1): The Virulence Genes in MRSA isolates in previous study.

Virulence Gene	Total Isolates (n)	Positive Isolates (n)	Pooled Prevalence (%)
Enterotoxin B	1,500	225	15%
Alpha-toxin	1,500	1,050	70%
PVL	1,500	450	30%
Enterotoxin A	1,500	375	25%

History of MRSA

In 1961, MRSA was first identified in Britain. Penicillin, methicillin, tetracycline, and erythromycin are immune to certain bacteria. Vincomycin is widely known to be the only antibiotic that can combat aureus, although it was found in Japan that vancomycin could not withstand a methicillin resistant form of aureus. Since antibiotics are so commonly used in hospitals , medical staff also bear antibiotic-resistant strains of bacteria. The bacteria that cause the infection are often immune to many forms of antibiotics when a health care worker gets infected in a health care

facility, including all penicillins (beta-lactam antibiotics)[33]. Methicillin-resistant Staphylococcus aureus (MRSA) are the bacterial strains resistant to the beta-lactam antibiotic. If the infection is contracted from a health care facility, MRSA strains are normal, and an growing number of these infections are now being contracted within the population, including simple abscesses and skin infections[34].

Transmission methods:

As it has the potential to survive long enough in non-living organisms (such as: pillowcases or towels), it is transferred from person to person[35]. It is also capable of surviving in dry areas, at high temperatures, with acid from the stomach or high salt levels, and is transmitted by: Communication with an infected person. Crowded locations. Sharing the use of instruments (such as razors, etc). Polluted surfaces (such as handles for doors, etc.) Dealing with pathogen-carrying species[36,37,38].

The Reasons

Rapidly evolving MRSA is the major cause of this infection. In the United States of America, there are two clones of MRSA, these two clones are USA400 (MW2 strain, ST1 strain) which USA300, and are responsible for population rampant diseases[39]. And soft fabrics. In the prison population, sports teams, armed forces, children born in nurseries and homosexuals, cases of methicillin-resistant Staphylococcus aureus infection have been identified. A new antibiotic was discovered in Turkey in 2009, which is secreted by filamentous bacteria containing Clotonic plants from the soil covering the roots, but this finding is still under investigation. Total resistance to vancomycin (VRSA) was documented in 2002 and is acquired or transferred to plasmids via genes called Van-A[40]. In view of the number and nature of infections caused by Staphylococcus aureus, whether in the population or in health facilities, and when care options are out of reach or in villages, humanity is at the threshold of a dangerous time reminiscent of the pre-antibiotic era in which people died of minor wound infections[39]. Therefore, making the robust and urgent production of new antibiotics a top priority for drug manufacturers, researchers and graduate students worldwide is crucial[40]. Measures and precautions against the spread of these strains need

to be taken in hospitals, and medical personnel need to be checked to ensure that they are free of these strains and, if they are present, prohibit them from carrying out their duties until they are fully eliminated so that they do not constitute a source of infection for in-patients, especially those with low immunity[41,42].

Symptoms of a MRSA infection.

MRSA is present in many people and is mostly located in the mucous membranes and does not cause any symptoms in them, and in the case of a skin infection with this form of bacteria, a skin bump or ulceration may occur and may look like an insect bite, and the region of infection is differentiated, As for cases of severe infection with MRSA bacteria in which the infection occurs in the deep tissues of the body or in the blood, and it is often followed by infection with fever, there are a variety of symptoms, including the following: non-healing wounds. The likeness of a rash. They have a fever. Headaches. Headache. Feeling frozen[43].

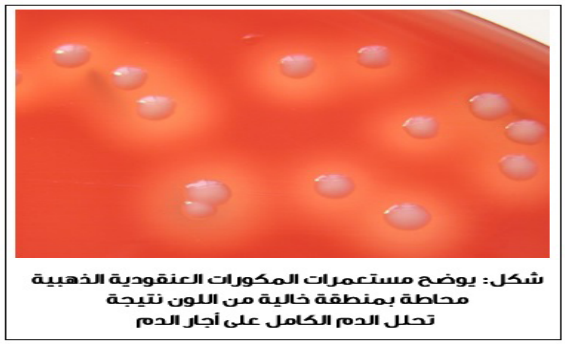

Figure (4) Staphylococcus aureus colonies are surrounded by a discolored region as a result of complete hemolysis on blood agar[43]

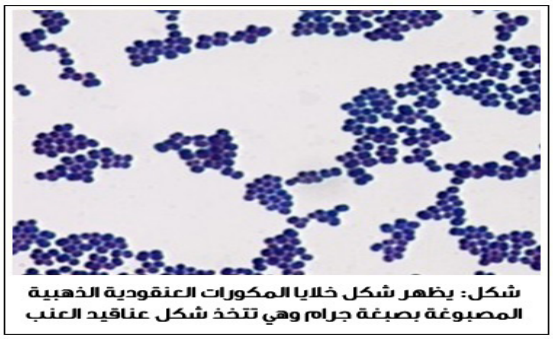

Figure (5) Gram-stained Staphylococcus aureus cells form grape clusters[44].

Sick feeling. Getting dizzy. Breath shortages. You've got a cough. The sense of pain in the chest area[45,46,47]. Feeling bewildered. The sense of muscle pain. The region affected is swollen and, when squeezed, painful. The production of antibiotic resistance can

be promoted by repeated or incorrect antibiotic use. Since certain kinds of antibiotics are unable to combat bacteria and operate against them. The rate of excessive or incorrect use of antibiotics ranges from a third to half, according to the Center for Disease Control and Prevention, and 47 million excessive antibiotic prescriptions are administered annually in clinics in the United States of America. Rooms for emergencies, among others. The types of bacteria that cause skin infections, meningitis, sexually transmitted diseases, and pneumonia, among others, that can be transmitted to other people, are examples of groups of bacteria that cause antibiotic resistance. The failure of antibiotics to function raises the length and difficulty of the disease, the patient's use of strong and expensive antibiotics, the rise in hospital visits, and the increased risk of death from bacterial infections. It should be remembered that there are a limited number of bacteria that have shown resistance to all forms of antibiotics at the moment[48,49,50].

Symptoms

For this disease, there are two kinds of signs: first: when the patient has an infection and signs are evident, such as the presence of pimples or ulceration on the skin. Second: The patient is a germ carrier, But in a way that can be detected, he does not display any signs, but he remains a carrier of the germ in the skin or in the nose. The symptoms typically start from the skin where some tiny red bumps, full of pus and vesicles, which are followed by extreme pain, begin to appear. More extreme signs occur after the staph has passed into deeper parts of the tissues, including fever , chills, headache, rash, joint pain, and partial shortness of breath[46].

Types of MRSA infection MRSA infection

Groups of MRSA infection Two major types of MRSA infection are classified: hospital-acquired HA-MRSA MRSA infection, MRSA (CA-MRSA) and Community-acquired infection, and a statement is given below[47]. For the variations between the two types: hospital-acquired MRSA infection: In people who have a weak immune system or due to a weak immune system because of certain health problems, the risk of acquiring MRSA infection rises, In health facilities such as hospitals and health care homes, this raises

the risk of infection and the infection is spread by direct contact with an infected wound or by using improperly sterilized surgical instruments during surgery, Infection with this type of bacteria can be followed by the incidence of some health problems, such as pulmonary infection, and the percentage of infection with this type of bacteria has decreased by approximately 50 percent over the past few years, relative to the rate of infection in previous years, based on the findings of some recent studies. MRSA infection acquired by the Community: among these forms of infection, there are cases in which MRSA infection is contaminated outside health care centers and, according to CDC statistics, the prevalence is 14%[48]. the following are among the factors that raise the risk of contracting this form of infection: being exposed to a skin wound or regularly receiving drugs by injection[49]. Communication with surfaces that are contaminated. Prior antibiotic application. Lack of attention to personal health or the use of public installations that are polluted. Being in crowded areas, such as jails, military bases, and accommodation for universities. Doing sports that enable many people to have direct skin touch, such as soccer, football, and basketball[50,51,52].

Prevention of MRSA infection

Some guidelines to help avoid infection with MRSA bacteria are followed, and among these guidelines are the following: Hand washing with soap and water: the only way to avoid infection with MRSA bacteria is to take care of hand hygiene, Use soap and well water for a time of not less than 15 seconds or use a hand sanitizer containing at least 62% alcohol, and you must wash your face. It is advisable for physicians and health care providers to wash their hands during patient visits, too[53,54,55]. Covering wounds: purulent fluid can contain MRSA bacteria for infected skin sores, so washing wounds and covering them with a sterile, dry dressing helps avoid infection, and once they are healed, wounds must be sealed. Do not share personal products: You should avoid sharing personal items such as razors, towels, sheets, garments, or sports equipment, as MRSA bacteria are able to move to a healthy person by sticking to surfaces[56,57,58,59]. Shower after exercise: Make sure to shower with soap and water after playing matches or sports, taking care not to share the

towel with others. Washing sheets and clothes: In the event of a wound or skin sores, make sure to wash and dry all bed linen and towels in a washing machine at high temperatures. Infected patient isolation: precautions must be taken to isolate people from other hospitalized patients with MRSA infection. Ensure the cleanliness of health care facilities by constantly cleaning them and washing surgical supplies, clothing for patients and clothing for health care providers[56,59].

Conclusions

Bacteria of *Staphylococcus aureus* are immune to standard antibiotics. MRSA does not respond to traditional therapy but to different forms of antibiotics. In previous research, the prevalence of MRSA and its history of resistance are an indicator that health and public care workers are at risk. One of the therapies that destroys this form of bacteria is Vancomycin. The prevalence of MRSA and its resistance pattern is noted as an indicator that the population is at risk for health and population care workers. One useful technique for comprehending MRSA activity and enhancing clinical care is gene detection. Medical professionals can improve patient care, customize therapies, and help avoid MRSA infections overall by using genetic technologies to find virulence and resistance genes.

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