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ETIOLOGY, PATHOGENESIS AND TREATMENT OF MRSA INFECTION

Annotation: MRSA infection is a disease caused by methicillin-resistant Staphylococcus aureus, which is characterized by multiple antibiotic resistance. Nosocomial infections include nosocomial pneumonia, osteomyelitis, infections of the skin, urinary tract, and bloodstream. Identification of the microorganism is carried out using molecular genetic and bacteriological methods. Antimicrobial drugs are used to treat MRSA infections: cyclic lipopeptides, glycopeptides, cephalosporins, etc.

Key words: Methicillin-resistant Staphylococcus, practical health care.

Methicillin-resistant Staphylococcus (MRSA) is one of the pathogens that cause nosocomial infections that are difficult to treat with antimicrobial therapy. Among all staphylococcal infections registered in hospitals, the proportion of MRSA strains is 50-60%. Pathological processes caused by methicillin-resistant staphylococcus are accompanied by prolonged hospitalization and high mortality, which makes the problem of the spread of MRSA very relevant for practical health care.

Reasons

Characteristics of MRSA

Methicillin-resistant staphylococci are various strains of Staphylococcus aureus that have evolved insensitivity to beta-lactam antibiotics: penicillins (in particular, methicillin and oxacillin), carbapenems, cephalosporins, and monobactams.

Antibiotic resistance of MRSA is caused by the synthesis of penicillin-binding protein 2a-PBP2a. Other isolates of Staphylococcus spp. also have methicillin resistance: S. Epidermidis, S. Haemolyticus, S. Saprophyticus, S. Hominis, etc., but MRSA is the most widespread and epidemiological significance.

Sources of infection

Sources of MRSA are bacterial carriers (transient, permanent), sick people, and infected animals. Carriers of Staphylococcus can be both patients of hospitals, guests of nursing homes, and the medical and service personnel working in them. In bacterial carriers, Staphylococcus most often colonizes the nasal cavity, pharynx, axillary and perineal skin, and rectum.

Among patients, the incidence of Staphylococcus aureus is higher in people with diabetes, skin diseases, receiving hemodialysis, HIV-infected and AIDS patients. In community-acquired settings, MRSA infection is possible when visiting endemic regions, contact with animals (dogs, guinea pigs, pigeons, horses, pigs, etc.).

Ways of infection

MRSA infection occurs through aerogenic, fecal-oral, and contact mechanisms. Transplacental transmission is less common. The main ways of transmission of methicillin-resistant staphylococcus: airborne, alimentary, contact-household. Factors of transmission of MRSA infection are the hands of medical personnel, medical instruments and equipment, dressings, various contaminated surfaces.

Risk groups

Nosocomial MRSA infections are more common in patients in burn (22%), surgical (21%), intensive care (20%), ophthalmology (15%), and obstetric departments (13%). Risk factors include:

- surgical procedures, especially those complicated by bleeding;

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- availability of vascular catheters and implants in patients;
- connecting to a ventilator;
- efferent therapy;
- permanent urinary tract catheterization;
- availability of postoperative drains;
- large wound surface;
- conducting massive antibacterial therapy in the recent past.

Children under 2 years of age, athletes engaged in contact sports, people who use ophthalmic lenses, people who live in closed groups (boarding houses for the elderly, military barracks, prisons), people who come into contact with animals (veterinarians, pet farm workers, pet owners), as well as injecting drugs are more susceptible to out-of-hospital MRSA infection. drug addicts, homosexuals.

Pathogenesis

Beta-lactam antibiotics are the most widely used class of drugs for the treatment of bacterial infections. These include penicillin and its derivatives, such as methicillin and amoxicillin. The beta-lactam ring part of these antibiotics targets penicillin-binding proteins that are involved in the formation of the bacterial cell wall.

A distinctive feature of MRSA is its insensitivity to all beta-lactam and a number of other antibiotics. The mechanism of antimicrobial multiresistance is mediated by the mecA gene, which is located in the staphylococcal chromosomal cassette SC SCCmec. This gene can undergo horizontal transfer and be introduced into any type of staphylococcus, transferring its properties to it.

The mecA gene encodes the penicillin-binding protein PBP2a. PBP2a has a low affinity for beta-lactams and does not bind to the beta-lactam ring in their structure, so these antibiotics lose their ability to destroy the cell wall of the microorganism and cause its death.

In addition to specific pathogenicity factors, MRSA produces other factors that contribute to the development of the infectious process and evade the action of antibiotics. These include adhesins (various proteins), enzymes (neuraminidase, hyaluronidase, staphylokinase), and toxins (hemolysins, Panton-Valentine leukocidin, etc.). They provide colonization of the skin and mucous membranes of the macroorganism, invasion of epithelial cells and endothelial cells, cell destruction, biofilm formation, and evasion of immune responses.

Classification

By origin, methicillin-resistant strains of Staphylococcus aureus are divided into:

- nosocomial infections (HA-MRSA) – cause an infectious process more than 48 hours after hospitalization;
- community-acquired (CA-MRSA – - causes infection in outpatients or less than two days after admission to the hospital;
- zoonotic diseases (LA-MRSA) – transmitted from animals to humans.

Among HA-MRSA, there are several most common clones: Brazilian, Portuguese, Japanese-American, pediatric, and others.

Symptoms of MRSA infection

In the structure of nosocomial pathology associated with MRSA, wound infections are the leaders (17%). These are followed by nosocomial pneumonia (12%). Urinary tract infections (6%), sepsis (5%), and soft tissue abscesses (4%) occur in approximately the same proportions. Bacterial endocarditis, septic arthritis, osteomyelitis, and CNS damage are also associated with MRSA infection.

Skin and Soft tissue infections (PKI)

Nosocomial HA-MRSA infections are mainly represented by post-injection abscesses, suppuration of postoperative wounds. Community-acquired MRSA infection in healthy individuals usually manifests

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itself as a skin infection: boils, carbuncles, abscesses, recurrent furunculosis. Less common are folliculitis and impetigo.

Abrasions, wounds, and cuts serve as the entry gate for ICMTS caused by CA-MRSA. It is characterized by the sudden appearance of local hyperemia of the skin, painful swelling, which in the initial stages often resembles an insect bite. In the future, a fluctuation appears in the focus, there may be a yellowish thick pus that has a sour smell.

Skin MRSA infection is complicated by phlegmon, necrotizing fasciitis, and fulminant purpura. With contact or hematogenic spread of infection, purulent thrombophlebitis, infectious arthritis, pyomyositis, and osteomyelitis occur.

Staphylococcal pneumonia

Community-acquired staphylococcal pneumonia usually develops after acute respiratory viral infections, in patients with immunosuppression, and chronic bronchopulmonary diseases. Nosocomial pneumonia can occur against the background of mechanical ventilation (ventilator-associated), as a result of hematogenic infection.

Characteristic symptoms of staphylococcal pneumonia: severe general condition, temperature above 39°C, severe shortness of breath, hemoptysis, chest pain. Typical laboratory signs are leukopenia and high CRP levels. Complications of MRSA pneumonia include lung abscesses, pleural empyema, abscessing pneumonia, and acute respiratory distress syndrome.

Bloodstream infections

They are accompanied by febrile fever, chills, and signs of severe general intoxication. With catheter-associated infections, both local manifestations (phlebitis, abscesses) and systemic reactions (sepsis) occur. Bacteremia caused by MRSA is accompanied by the development of metastatic infection in various organs (pneumonia, endocarditis, etc.), which significantly increases the risk of mortality.

ODE Infections

Staphylococcal arthritis and osteomyelitis can be caused by direct (during trauma, surgery) or hematogenous infection. Chills, fever, and pain in the affected joint or bone are common. Soft tissues above the focus of infection become hyperemic and swollen. Often there is an articular effusion. MRSA infection of the musculoskeletal system can lead to ankylosis and joint contractures, deformity/shortening of the limb, and systemic septic complications.

Diagnostics

Laboratory diagnostics

Patients infected with MRSA, depending on the location of the infection, can be supervised by various specialists: surgeons, pulmonologists, traumatologists, cardiologists, ophthalmologists, urologists, etc. Laboratory methods play a leading role in the diagnosis of MRSA infections:

- Molecular genetic (PCR) diagnostics is used for carrier screening and detection of Staphylococcus aureus in biological samples without isolation of its pure culture. Getting a positive test quickly is critical for isolating the patient and making decisions about choosing a course of antibiotic therapy.
- Microbiological diagnostics. Allows not only to grow a culture of S. aureus on a nutrient medium, but also to determine methicillin resistance, to identify sensitivity to antimicrobial drugs.

The clinical material used may include nasopharyngeal mucus, wound discharge, blood, sputum, urine, feces, as well as catheters, drains, and implants. In addition to examining a patient with MRSA infection, the sanitary and epidemiological situation in the department is monitored: environmental objects, materials used, and the hands of medical personnel are examined.

Instrumental methods

In parallel with laboratory monitoring, instrumental diagnostics is carried out to assess the severity and dynamics of the infectious process. For this purpose, the methods of X-ray (X-ray and CT of the lungs,

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X-ray of bones and joints) and functional diagnostics (ECG, echocardiography, monitoring of vital functions) are used.

Treatment of MRSA infection

Conservative therapy

The main direction of treatment of MRSA infections is the use of antibiotics that are active against methicillin-resistant Staphylococcus aureus. These include drugs of the following pharmacological groups: tricyclic glycopeptides, oxazolidinones, cyclic lipopeptides, fifth-generation cephalosporins, and lincosamides. Sometimes drugs of the main groups are combined with aminoglycosides, ansamycins.

The duration of the course and dosage depend on the location of the infection, the age and condition of the patient. Other treatment options include infusion therapy (detoxification, CBS correction), anti-staphylococcal plasma and immunoglobulin administration.

Surgical treatment

ICCT may require treatment of infected wounds, necrectomy, and opening of boils and abscesses. When purulent processes in the lungs resort to drainage of abscesses and pleural cavity. In case of damage to the bone and joint system, arthrocentesis and joint rehabilitation, arthrotomy, sequestrectomy for osteomyelitis are performed. Patients with infectious endocarditis undergo valve replacement/reprosthetics.

Prognosis and prevention

Given the multiple antibiotic resistance of the microorganism, a large range of pathologies caused and their complicated course, the prognosis of MRSA infections is extremely serious. Clinical outcomes largely depend on the timing of initiation and adequacy of therapy, as well as the immunoreactivity of the macroorganism. The mortality rate from MRSA infections in the Russian Federation is 14%.

The following anti-epidemic measures can prevent the spread of MRSA infections: examination of patients and medical staff entering the hospital, isolation of patients with confirmed staphylococcal infection, disinfection measures in the hearth, compliance with aseptic and antiseptic standards during medical manipulations.

Prevention of community-acquired and zoonotic MRSA infection consists in observing personal hygiene measures when communicating with animals and traveling to endemic regions, conducting screening in closed groups, and primary treatment of wounds received in everyday life.

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