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Research and Progress in the Review of Commonly Used Antimicrobial Drug Prescriptions

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Abstract: This paper reviews the key points of commonly used antimicrobial prescriptions and comprehensively analyzes the key links of antibiotics in clinical use. From the background introduction, the importance of prescription review and review, analysis of people, antibacterial, bacteria, combing commonly used antimicrobial classification and matters needing attention, discusses the antimicrobial safety, effectiveness, rational drug use audit knowledge, and according to the classification of antibacterial activity, perioperative preventive drug points, and combined with penicillin drug skin test, cephalosporin skin test and disulfur problem typical case is analyzed. Through the in-depth study of these key points, it aims to provide a comprehensive and in-depth reference basis for improving the level of antimicrobial prescription review and promoting the rational clinical use.
Keywords: Antimicrobial drugs; Prescription review; Rational drug use; Drug safety; Effectiveness

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1. Introduction

1.1. Antimicrobial use background

Since their emergence, antimicrobial drugs have been of great significance in the treatment of infectious diseases. They have significantly reduced the infection mortality rate and improved human health. However, during clinical applications, the problem of irrational drug use has become increasingly prominent. The WHO report indicates that antimicrobial drugs' global irrational use rate ranges from 30% to 50%. In China, the irrational use rate of antibiotics in hospitals is between 20% and 40% [1]. Irrational use not only wastes medical resources but also leads to the escalation of bacterial drug resistance, an increase in patients' adverse reactions, and a rise in medical costs.

1.2. The importance of prescription opinions and prescription reviews

Prescription review and evaluation are crucial for ensuring rational clinical drug use. A review can promptly identify and correct potential mistakes in drug selection, dosage, administration route, and drug interactions when a prescription is being issued, thus safeguarding patients' medication safety assesses their rationality and standardization, provides directions for improving subsequent clinical medication, and promotes the rational use of antibiotics [2]. The two work in tandem to ensure rational drug use [2].

1.3. The relationship among humans, antibiotics and bacteria

The human body is a complex micro-ecosystem where bacteria play an important role. Under normal circumstances, there is a symbiotic balance between the human body and bacteria, and the immune system controls bacterial growth. Antimicrobial drugs disrupt this balance to treat infectious diseases. However, irrational use disrupts the normal flora, reducing beneficial bacteria and fostering the growth of drug-resistant bacteria. Drug-resistant bacteria can multiply within an individual and spread to others, rendering antimicrobial drugs ineffective and threatening public health [3].

1.4. Classification and precautions of commonly used antibacterial drugs

1.4.1. Antibiotics

1.4.1.1. β-lactam class

(1) Penicillin: Commonly used in clinical practice, it exerts antibacterial effects by inhibiting the synthesis of the bacterial cell wall. Allergic reactions can be severe. Before use, the patient's allergy history should be carefully inquired about, and a skin test is required. Those with a history of allergy are prohibited from using it.

(2) Cephalosporins: They have a broad antibacterial spectrum and strong bactericidal power, with fewer allergic reactions compared to penicillin. For patients with a history of allergy or a high-sensitivity constitution, a skin test is necessary. For some cephalosporins, alcohol consumption should be strictly avoided during medication and within 7 days after withdrawal to prevent the disulfiram-like reaction [4].

(3) Atypical β-Lactams: Carbapenems are highly antibacterial but prone to resistance, and should be used with caution in patients with epilepsy. Cephalomycins are effective against anaerobic bacteria, and attention should be paid to drug interactions.

1.4.1.2. Macrolides and lincomycin class

(1) Macrolides: Such as erythromycin, they inhibit bacterial protein synthesis. Common adverse reactions are gastrointestinal discomfort, and attention should be paid to drug interactions when used in combination with other drugs.

(2) Lincomycin class: Their antibacterial mechanism is similar to that of macrolides, and they are effective against gram-positive bacteria and anaerobic bacteria. Long-term or high-dose use may lead to pseudomembranous enteritis. If intestinal symptoms occur, the drug should be discontinued and relevant examinations should be carried out [5].

(3) Aminoglycosides: For example, gentamicin acts on bacterial ribosomes to inhibit protein synthesis. They have strong ototoxicity and nephrotoxicity. Elderly people, children, and patients with renal insufficiency should use them with caution and require monitoring of hearing and renal function.

(4) Polypeptides: Polymyxin has strong antibacterial activity against gram-negative bacteria but significant

nephrotoxicity and neurotoxicity. Vancomycin is effective against gram-positive bacteria, especially drug-resistant Staphylococcus aureus, but may cause ototoxicity, nephrotoxicity, and red man syndrome. Blood concentration monitoring is required.

(5) Tetracyclines: For instance, tetracycline inhibits bacterial protein synthesis. It can cause yellow teeth and abnormal bone development, so it is prohibited for pregnant women, lactating women, and children under 8 years old. Long-term use may lead to double infections.

(6) Chloramphenicol: It has an inhibitory effect on both gram-positive and gram-negative bacteria, especially typhoid and paratyphoid. However, its adverse reactions are serious, and it is only used cautiously when other antimicrobial agents are ineffective or contraindicated.

(7) Antifungal-Antibiotics: Amphotericin B is used for deep fungal infections. It acts by destroying the fungal cell membrane, but has many adverse reactions. Slow intravenous infusion is required, and renal function and electrolyte balance should be closely monitored [6].

1.4.1.3. Synthetic antimicrobial agents

(1) Sulfonamides: They interfere with bacterial folic acid metabolism and are prone to form crystals in the urine. Patients should be instructed to drink more water, and those allergic to sulfonamides are prohibited from using them.

(2) Quinolones: They inhibit bacterial DNA gyrase and can affect cartilage development, so they are prohibited for pregnant women, lactating women, and children under 18 years old. They may also cause arrhythmia and abnormal blood sugar, and relevant symptoms should be closely monitored.

(3) Nitroimidazoles: They are used for anti-anaerobic bacteria and anti-trichomonas infections. Common adverse reactions are gastrointestinal reactions, and alcohol consumption should be avoided during medication to prevent the disulfiram-like reaction.

(4) Synthetic antifungal drugs: Fluconazole is used for Candida and cryptococcal infections with few adverse reactions. Itraconazole has good antibacterial activity but may interact with some drugs, such as statins, increasing the risk of rhabdomyolysis [7]. Attention should be paid to drug interactions and liver and kidney function when using it.

Clinicians' understanding of these can facilitate rational drug selection to ensure the safe and effective use of drugs for patients. Patients must also strictly follow the doctor's advice when taking medications.

1.5. Aspects of safety, efficacy and rational use of antibiotics that require attention

1.5.1. Efficacy points

1.5.1.1. Indication judgment

Doctors need to comprehensively consider patients' symptoms (such as fever, cough, etc.), signs (such as lung rales, etc.) and laboratory test results (such as elevated blood cells, positive bacterial culture, etc.) to judge the presence of bacterial infection and the type of infection. Blind use of antibiotics should be avoided. For example, the common cold is mostly a viral infection and usually does not require antibiotics, while for bacterial pneumonia, appropriate antibacterial drugs should be used promptly after diagnosis.

1.5.1.2. Antimicrobial spectrum matching

Different antibacterial drugs have different antimicrobial spectra. Penicillin is mainly effective against Gram-positive bacteria, and some cephalosporins and aminoglycosides are effective against Gram-negative bacteria. Clinically, drugs should be selected according to the type and source of pathogenic bacteria to prevent treatment failure due to inconsistent antimicrobial spectra [8].

1.5.1.3. Consideration of tissue distribution

The distribution of antibacterial drugs in different tissues varies. Fluoroquinolones and metronidazole are suitable for bone infections, and sulfadiazine can be used for central nervous system infections. When choosing drugs, it is necessary to ensure that the drug can reach an effective concentration at the infection site.

1.5.1.4. Application of bacterial epidemiological characteristics

The epidemiological characteristics of bacteria (common pathogens, drug resistance) vary in different regions and medical institutions. For example, in some hospitals, methicillin-resistant *Staphylococcus aureus* (MRSA) infection is common. For suspected skin and soft tissue infections, drugs effective against MRSA should be considered in empirical treatment. Mastering the dynamic changes of bacterial epidemiological characteristics is conducive to adjusting the drug-use strategy.

1.5.2. Safety points

1.5.2.1. Precise usage and dosage

Different antibacterial drugs have appropriate dosages, frequencies and courses of treatment. Aminoglycosides can reduce toxicity with once-daily dosing, while β-lactams usually require multiple doses. At the same time, the dosage should be adjusted according to age, liver and kidney function. Elderly people and patients with renal insufficiency often need to reduce the dosage [9].

1.5.2.2. Correct solvent selection

The solvent affects the stability and effectiveness of antibacterial drugs. Penicillin is unstable in glucose solution and 0.9% sodium chloride injection should be selected. Amphotericin B needs to be diluted with 5% glucose injection and solutions containing electrolytes should be avoided.

1.5.2.3. Reasonable route of administration

The route of administration should be selected according to the degree of infection and the characteristics of the drug. Mild infections can be treated orally, while severe or non-oral infections need intravenous administration, but intravenous administration has risks such as phlebitis.

1.5.2.4. Control of administration speed

The administration speed affects safety and efficacy. For example, rapid intravenous infusion of vancomycin can cause red man syndrome, and β-lactams are generally required to be infused within 0.5–2 hours, which should be strictly followed.

1.5.2.5. Special precautions

Quinolones and tetracyclines can affect the bone development of children, so pregnant women, lactating women and children should use them with caution or avoid them. Chloramphenicol can cause bone marrow suppression and the blood routine should be monitored. Cephalosporins and nitroimidazoles should be avoided with alcohol during and after use to prevent disulfiram-like reactions [10].

1.5.2.6. Awareness of compatibility taboos

Combining antibacterial drugs with other drugs may cause precipitation and other changes, such as cephalosporins with calcium-containing solutions and penicillin with acidic drugs. Information should be consulted before the combination.

1.5.2.7. Consideration of interactions

There are pharmacokinetic (affecting absorption, etc.) and pharmacodynamic (synergistic or antagonistic) interactions between antibiotics and other drugs. For example, rifampicin accelerates the metabolism of contraceptives, and the combination of bactericides and bacteriostatic agents may be antagonistic, so the treatment plan needs to be adjusted for combined use.

1.5.2.8. Strict grasp of contraindications

Patients allergic to drug ingredients should be prohibited from using the drug. Patients with severe liver and kidney function impairment should use drugs metabolized by the liver or kidney with caution or avoid them. Doctors should inquire about the patient's medical history in detail before prescribing.

1.5.3. Dimensions of rational drug use

1.5.3.1. Treatment plan formulation

(1) Accurate diagnosis and indication grasp

Judge bacterial infection and its type through symptoms, signs, and test results, avoid misusing antibiotics for viral infections, and accurately grasp indications to prevent abuse.

(2) Drug selection based on characteristics

Understand the antimicrobial spectrum and local bacterial epidemiological characteristics. For example, select drugs according to the MRSA infection situation to improve treatment pertinence.

(3) Consideration of tissue distribution

Select drugs according to the infection site to ensure that the drug reaches an effective concentration in the infected tissue, such as choosing fluoroquinolones for bone infections.

1.5.3.2. Medication process

(1) Appropriate usage and dosage

Adjust the dosage according to the drug characteristics and individual conditions to ensure efficacy and safety.

(2) Reasonable selection of solvent, route and speed

Select the solvent as required, choose the route according to the condition, and control the speed as specified to ensure the effect and safety of the medication.

1.5.3.3. Combined medication and risk avoidance

(1) Cautious combination

Clarify the purpose of the combination and avoid unreasonable combinations leading to antagonism or increased adverse reactions.

(2) Attention to taboos

Pay attention to compatibility taboos, interactions, and contraindications to ensure medication safety.

1.5.3.4. Treatment monitoring and adjustment

(1) Process monitoring

Monitor the efficacy (improvement of symptoms and indicators) and adverse reactions (such as the ototoxicity and nephrotoxicity of aminoglycosides).

(2) Timely adjustment

Adjust the treatment plan in a timely manner when the efficacy is poor or severe adverse reactions occur to ensure treatment effect and patient safety.

The rational use of antibiotics requires comprehensive consideration from multiple aspects to ensure effectiveness and safety, and reduce drug resistance and adverse reactions.

1.6. Commonly used antimicrobial drug audit knowledge points

(1) Indications for Use

Ascertain whether the patient has indications of a bacterial infection. Avoid administering antibacterial drugs for non-indications such as viral infections. Make judgments based on the patient's symptoms, physical signs, and examination results.

(2) Route of administration

Select the appropriate route according to the infection status and drug characteristics. For mild infections, oral administration is preferred. For severe infections or patients who are unable to take oral medications, intravenous injection should be used [11].

(3) Solvent

Different antibacterial drugs have specific requirements for solvents. For instance, penicillin should be dissolved in 0.9% sodium chloride solution.

(4) Concentration

Precisely control the drug concentration. Dilute it as per the instructions to avoid concentrations that are either too high or too low.

(5) Dosage

Determine the dosage based on factors such as the patient's age, weight, and liver and kidney function. For children, the dosage is often calculated based on body weight or body surface area.

(6) Administration time

For time-dependent drugs (such as β-lactams), administer multiple doses. For concentration-dependent drugs (such as aminoglycosides), administer once daily.

(7) Treatment course

Determine the treatment course according to the type of infection and the severity of the illness to prevent inappropriate treatment durations.

(8) Contraindications

Check for allergies and contraindications for special populations (such as pregnant women and children).

(9) Drug interactions-substitution

Replace with appropriate drugs when there are severe drug interactions.

(10) Monitoring

Monitor the blood drug concentration for drugs with a narrow therapeutic window.

(11) Adverse reactions

Be aware of the potential adverse reactions of combined medications.

(12) Duplicate medication

Avoid using drugs with similar mechanisms of action and overlapping antibacterial spectra.

1.7. Concepts of antibacterial drugs-audit according to antibacterial activity classification

(1) Concentration-dependent antibiotics

Bactericidal effect depends on peak concentration with a long PAE. Examples include aminoglycosides. During the prescription audit, check if the dose can reach the peak. High-dose and low-frequency administration is preferred. For instance, once-daily aminoglycosides can reduce adverse reactions [12].

(2) Time-dependent antibiotics with short PAE

Antibacterial activity relates to the time above MIC, with little relation to peak concentration. β-lactams belong to this type. The prescription should ensure a proper dosing interval for multiple administrations. For example, penicillin G needs to be given several times a day.

(3) Time-dependent antibiotics with long PAE

Need to maintain drug concentration above MIC and have a long PAE. Azithromycin is an example. During the audit, pay attention to the dosing interval, which can be extended. Azithromycin is usually given once a day and can still work after discontinuation.

1.8. Knowledge points of perioperative preventive medication concern

(1) Drug selection

Choose drugs based on incision type and likely contaminants. For clean surgeries, first-generation cephalosporins like cefazolin are for staphylococcal prevention; clindamycin for cephalosporin-allergic patients. For clean-contaminated surgeries, consider pathogens. In contaminated surgeries, rely on contaminant types and sensitivity results [13].

(2) Medication timing

Administer drugs 0.5–1 hour before incision. Add a dose if surgery exceeds 3 hours or blood loss > 1500 mL.

(3) Course of medication

Clean surgeries: ≤ 24 hours; clean-contaminated surgeries: ≤ 48 hours. Extended appropriately for contaminated surgeries.

(4) Rationality of drug combinations

Combine drugs with clear purposes, like expanding the spectra. Avoid irrational combinations to prevent increased risks [14].

1.9. Typical cases

1.9.1. Penicillin skin test review

Skin test is vital before penicillin use (NHC). Per NHC, those without a penicillin allergy history and rapid-anaphylaxis risk don’t need routine tests. But if there’s a clear anaphylactic reaction or unclear allergy type, testing is a must. Purity once affected the allergy rate, and though improved, it's still a factor in review. Inquire about past meds, food/drug allergies, and family history. Allergic patients should avoid penicillin. A 46-year-old female died from a penicillin skin-test-related immediate-type reaction post-thyroidectomy, with compliant test and rescue, not malpractice [15].

1.9.2. Cephalosporin skin test review

Not all cephalosporins need routine tests (NHC). Tests are required for clear anaphylaxis, multiple drug allergies, or as per instructions. The method, like penicillin's, has a 15–20-minute result-reading time [13]. An 80-year-old male had a ceftazidime-related delayed reaction, maybe from overdose. This alerts staff to check allergies, test when needed, and monitor closely.

1.9.3. Cephalosporin disulfiram-like reaction review

Certain cephalosporins, with a methylthiotetrazole side chain, can cause such reactions.[16] Reviewers should note patients' 7-day post-withdrawal drinking history. Warn patients to avoid alcohol during and after use. A 46-year-old alcoholic had this reaction after taking cephalosporins and drinking, highlighting the need to ask about history and educate patients [16].

2. Discussion

Antimicrobial prescription review points, like indications, usage, interactions, and incompatibilities, are crucial for rational antibiotic use. In practice, reviewers face challenges. Clinical complexity, rapid knowledge updates, and a lack of multidisciplinary cooperation make accurate review tough.

To address these, training reviewers, establishing an info system, and promoting collaboration are essential. Regular training, academic exchanges, and case discussions can enhance review quality.

3. Conclusion

Review points ensure rational drug use. By strict review and case analysis, irrational use can be curbed. However, challenges remain, and solutions lie in training, info systems, and cooperation. Future review work needs innovation for better clinical support.

Disclosure statement

The author declares no conflict of interest.

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