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Case Study

Analysis of the Treatment Plan for Q-T Interval Prolongation Caused by Moxifloxacin in One Case

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Abstract

This case report presents the clinical treatment process of a 65-year-old female patient who experienced Q-T interval prolongation following the administration of moxifloxacin for a pulmonary infection. Upon hospital admission, the patient was initially treated with a combination of moxifloxacin and ceftazidime as part of an empirical anti-infective regimen. However, shortly after treatment commenced, the patient developed a skin rash accompanied by a significant prolongation of the Q-T interval as observed on the electrocardiogram (ECG), raising concerns about potential cardiac risks. In response, the clinical pharmacist conducted a timely medication review and recommended discontinuing both moxifloxacin and ceftazidime due to their possible adverse effects. Based on the pharmacist's recommendation, the medical team revised the anti-infective regimen and substituted biapenem, a carbapenem antibiotic with a lower risk of cardiac side effects. Supportive symptomatic treatments were also provided to address the patient's condition holistically. As a result of these adjustments, the patient's rash gradually subsided, her Q-T interval normalised, and her overall symptoms significantly improved. She was eventually discharged in stable condition. This case highlights the potential cardiac risks associated with fluoroquinolone antibiotics like moxifloxacin, particularly in elderly patients who may be more susceptible to adverse drug reactions. Moreover, it underscores the essential role of clinical pharmacists in ensuring medication safety and optimising individualised treatment plans through active participation in multidisciplinary care teams.

Keywords: *Individualised Medication; Moxifloxacin; Pulmonary Infection; Q-T Interval Prolongation*

Introduction

Pulmonary infection is one of the common diseases in the elderly and is also one of the important causes of death in the elderly. Senile pneumonia has the clinical characteristics of acute onset, severe illness, and poor prognosis. Moreover, the immune function and respiratory defense ability of the elderly gradually decline. The elderly often have multiple concurrent diseases, are repeatedly hospitalised, and use multiple antibiotics in combination, resulting in complex drug interactions and a high incidence of adverse reactions. Therefore, individualised pharmaceutical care should be provided for elderly patients with pulmonary infections. The Q-T interval prolongation is manifested as an elongated QT interval on the electrocardiogram, and it is prone to be accompanied by malignant arrhythmias such as torsades de pointes (TdP) and ventricular fibrillation, leading to sudden death (Khan *et al*., 2018). Common drugs that cause Q-T interval prolongation include quinidine, amiodarone, cisapride, azithromycin, quinolones, haloperidol, etc. It is crucial to understand the common adverse reactions of these drugs and their interactions to ensure the safety of patients' medication. The above drugs all have the effect of prolonging the QT interval and have the risk of causing TdP. Especially in the presence of other risk

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factors, more vigilance is required. Through the analysis of the treatment plan for a patient with Q-T interval prolongation caused by moxifloxacin in this case, a systematic study of the mechanism of action, high-risk factors, etc. that cause Q-T interval prolongation is carried out, reflecting the value of pharmacists in the rational use of drugs by patients.

Case Presentation

Physical Condition at Admission

The patient is an elderly female, 65 years old, with a height of 150 cm and a weight of 40 Kg. She was admitted to the hospital due to "fever for 3 days".

The patient developed a fever 3 days ago after getting cold, with the highest body temperature reaching 38°C, accompanied by chills but no rigors. There was occasional cough and expectoration, with a small amount of white phlegm that was difficult to expectorate. There was no dyspnea. After taking "cephalosporin and Pudilan" by herself, the effect was not good, and there was still intermittent fever, mainly low fever. She visited the fever clinic of the hospital on June 20, 2024. Chest CT showed: possible scattered infectious lesions in both lungs, and the local lesion in the upper lobe of the right lung showed a nodular change. The blood routine showed: WBC 11.7×10^9g /L, N 76.8%, CRP 23.3m1/L. The three influenza antibody tests were negative, and the nucleic acid test for the novel coronavirus was negative. After receiving anti-infection treatment with moxifloxacin, the patient's body temperature returned to normal. Now, she was admitted to the Department of Respiratory Medicine for further diagnosis and treatment, but her overall condition remained stable.

Physical Examination

Body temperature: 36.3°C, respiration: 17 times/min, pulse: 85 times/min, blood pressure: 125/85 mmHg. Normal development, moderate nutrition, clear consciousness, spontaneous body position, walked into the ward, and cooperative with the examination. There was no jaundice or purpura on the skin and mucous membranes all over the body, and no swelling of superficial lymph nodes all over the body was detected. The head was normal, there was no edema of the upper and lower eyelids, the sclera was not jaundiced, the pupils of both eyes were equal in size and round, and the light reflex was sensitive. The nasal cavity was unobstructed, there was no deformity in the external auditory canal, and there was no purulent secretion. The lips were not cyanotic, the pharynx was not congested, and the tonsils were not enlarged. The neck was soft without resistance, the jugular veins on both sides were not distended, the trachea was in the middle, and the thyroid gland was not enlarged. The thoracic cage was not deformed, the respiratory movements on both sides were symmetrical, the tactile fremitus was neither increased nor decreased, the percussion of both lungs was voiceless consonant, the breath sounds were clear on auscultation, and no dry or wet rales were heard. There was no prominence in the precordial area, the apex beat was located 0.5 cm inside the midclavicular line at the fifth intercostal space on the left side. The cardiac dullness boundary was not large on percussion, the heart rate was 85 times/min, the rhythm was regular, no premature beats were heard, and no pathological murmurs were heard in each valve area. The abdomen was flat and soft, there was no obvious tenderness or rebound tenderness all over the abdomen, the liver and spleen were not palpable under the costal margin, the hepatojugular reflux sign was (-), the shifting dullness was negative, and the bowel sounds were not hyperactive. The physiological curvature of the spine was present, the limbs moved freely, there were no clubbed fingers (toes), and there was no edema in the lower extremities. Physiological reflexes were present, and pathological reflexes were not elicited.

Past Medical History

On March 8, 2023, due to a fall injury resulting in "pelvic fracture (fracture of the upper and lower branches of the left pubic bone)", she was hospitalised in the Orthopedics Department. After conservative treatment, her condition improved and she was discharged. She denied the history of infectious diseases such as hepatitis, typhoid fever, and tuberculosis, and denied the history of chronic diseases such as hypertension, diabetes, and chronic bronchitis. She denied other trauma and surgical history, denied a history of drug allergy and blood transfusion history, and the history of vaccination was unknown.

Auxiliary Examinations:

Chest CT showed: possible scattered infectious lesions in both lungs, and the local lesion in the upper lobe of the right lung showed a nodular change (June 20, 2024).
Blood routine showed: WBC 11.7×10^9g/L, N 78.8%, CRP 23.3ml/L (June 20, 2024).
The three influenza antibody tests were negative, and the nucleic acid test for the novel coronavirus was negative (June 20, 2024).

Diagnosis at Admission:

1. Pulmonary infection
2. Old pelvic fracture

Treatment Process:

Day 1 (Admission Day)

- Symptoms: The patient was admitted to the hospital due to fever for 3 days. The body temperature was 36.3°C, with cough and expectoration, and a small amount of white phlegm that was difficult to expectorate.
- Examinations:
  Blood routine: WBC 11.7×10^9/L, N 76.8%, CRP 23.3 mg/L.
  Chest CT: Scattered infectious lesions in both lungs, local nodular change in the upper lobe of the right lung.
- Diagnosis: Pulmonary infection.
- Treatment: Given moxifloxacin + ceftazidime for anti-infection and symptomatic treatment for relieving cough and reducing sputum.

Day 2

- Symptoms: The body temperature was normal, and the cough and expectoration continued.
- Examinations:
  Blood routine: WBC 8.5×10^9/L, N 66.7%, CRP 49.6 mg/L.
  Chest X-ray: Scattered infectious lesions in both lungs, local nodular change in the upper lobe of the right lung.
- Treatment: Continue moxifloxacin + ceftazidime for anti-infection.
- Pharmacist's suggestion: According to the guidelines, it is recommended to use moxifloxacin alone, but the doctor did not adopt it.

Day 3

- Symptoms: Red rashes appeared on the limbs, chest and abdomen, accompanied by itching; the electrocardiogram showed Q-T interval prolongation.
- Examinations: Influenza B virus antibody (IgM) was positive.
- Pharmacist's evaluation: Both moxifloxacin and ceftazidime may cause rashes. Moxifloxacin is contraindicated in patients with Q-T interval prolongation, and the correlation evaluation is possible.
- Treatment adjustment: Discontinue moxifloxacin and ceftazidime, change to biapenem for anti-infection, cetirizine dihydrochloride for anti-allergy, Qiangli Pipa Lu for relieving cough and reducing sputum, and oseltamivir for antiviral treatment.

Day 4-6

- Symptoms: No chills or fever, the cough and expectoration were relieved compared with before, and the rash did not improve significantly.
- Consultation of the Department of Dermatology: Considered allergic dermatitis, and compound calamine lotion was added for relieving itching.
- Treatment adjustment: Discontinue biapenem, oseltamivir and other possibly allergenic drugs.

Day 7 (June 27)

- Examinations: Chest CT showed that the local original lesion was more consolidated than before, and new lesions were seen, considering organising pneumonia.
- Treatment: Add prednisone tablets for anti-inflammation, calcium carbonate D3 for preventing osteoporosis, and esomeprazole for inhibiting acid and protecting the stomach.

Day 8 (June 28)

- Examinations: The blood routine, liver and kidney function, and electrolytes showed no abnormalities.
- Symptoms: The cough and expectoration were relieved, and the body temperature was normal.
- Discharge: Granted to be discharged with medications.

Mind Map

Mind Map of the Treatment Process

Day 1 (Admission Day)

- Symptoms: Fever, cough, expectoration
- Examinations: Blood routine, Chest CT
- Treatment: Moxifloxacin + ceftazidime for anti-infection

Day 2

- Symptoms: Normal body temperature, continuous cough
- Examinations: Blood routine, Chest X-ray
- Pharmacist's suggestion: Use moxifloxacin alone (not adopted)

Day 3

- Symptoms: Rash, Q-T interval prolongation
- Examinations: Influenza B virus antibody (IgM) positive
- Treatment adjustment: Discontinue moxifloxacin + ceftazidime, change to biapenem + anti-allergy + antiviral

Day 4-6

- Symptoms: Cough relieved, rash not improved
- Consultation of the Department of Dermatology: Allergic dermatitis
- Treatment adjustment: Discontinue biapenem, oseltamivir, add compound calamine lotion

Day 7 (June 27)

- Examinations: Chest CT (Organising pneumonia)
- Treatment: Add prednisone tablets, calcium carbonate D3, esomeprazole

Day 8 (June 28)

- Examinations: Blood routine, liver and kidney function, electrolytes normal
- Discharge: Discharged with medications

The doctor accepted these suggestions. After active treatment, the patient's cough and expectoration were relieved, and the body temperature was normal. His condition was stable and he could be discharged from the hospital.

Treatment Outcome

The doctor accepted these suggestions. After active treatment, the patient's cough and expectoration were relieved, the body temperature was normal, the QT interval returned to normal, and the reexamination of the blood routine and inflammatory indicators was significantly improved compared

with before. However, the chest CT showed that the original lesion was more consolidated than before, and new lesions were seen, considering organising pneumonia. The blood routine, liver and kidney function, and electrolytes showed no abnormalities, and the patient was discharged from the hospital with medications.

Discussion

Admitted to Respiratory Medicine for Further Evaluation; Assess Need to Adjust Anti-Infection Plan

According to the "Expert Consensus on the Clinical Diagnosis and Treatment of Senile Pneumonia (2024 Edition)" (Ozbay *et al*., 2023), the results of multiple domestic epidemiological surveys on adult CAP in China currently show that Mycoplasma pneumoniae and Streptococcus pneumoniae are important pathogens of adult CAP in China. Other common pathogens include Haemophilus influenzae, Chlamydia pneumoniae, Klebsiella pneumoniae, and Staphylococcus aureus; but Pseudomonas aeruginosa and Acinetobacter baumannii are rare.

The risk factors for Pseudomonas aeruginosa infection include the colonisation of Pseudomonas aeruginosa in the airway and the repeated use of antibacterial drugs or glucocorticoids due to chronic airway diseases. Another literature pointed out that bronchiectasis, lung abscess/empyema, chronic obstructive pulmonary disease, type 2 diabetes, and alcohol use disorder are also risk factors for Pseudomonas aeruginosa infection (Yiyu *et al*., 2025). After the patient received anti-infection treatment with moxifloxacin in the fever clinic of the hospital, the body temperature returned to normal, and the patient had no risk factors for Pseudomonas aeruginosa infection after evaluation. According to the "Expert Consensus on the Response Strategy for Infections Caused by Enterobacteriaceae Bacteria Producing Extended-Spectrum β-Lactamases in China" (周华 et al., 2014), the risk of ESBL-producing bacteria infection is low (the effect of oral cephalosporin outside the hospital is not good). The literature shows that the independent risk factors for the treatment failure of moxifloxacin include age, the presence of 2 or more chronic diseases, electrolyte disorders, renal insufficiency, and multilobar pneumonia (Tulkens, Arvis & Kruesmann, 2012). Considering that the patient has no other above-mentioned risk factors except for being older and moxifloxacin can already cover the common pathogenic bacteria of CAP, there is no need to add ceftazidime to resist Pseudomonas aeruginosa. Therefore, the clinical pharmacist suggested using moxifloxacin alone for anti-infection.

Analysis of the Adverse Reaction of Q-T Interval Prolongation Caused by Moxifloxacin

The patient had no previous cardiovascular-related diseases, and the electrocardiogram showed no abnormalities when the patient was hospitalised in the hospital in March 2023. The influence of self-diseases can be basically excluded. On the second day of this admission, the electrocardiogram suggested that QT/QTc was 385/482ms. By consulting the initial treatment drugs, which were moxifloxacin, ceftazidime, carbocisteine, and Suhuang Zhike Capsules, except for moxifloxacin, there were no reports of relevant adverse reactions for the other drugs, and there was no drug interaction or dysfunction of the patient's metabolic organs. Therefore, according to the ADR correlation evaluation principle of the Ministry of Health (Wu *et al*., 2020), the patient developed Q-T interval prolongation 2 days after using moxifloxacin hydrochloride and sodium chloride injection, which has a time correlation; the instruction manual of moxifloxacin and relevant literatures (Junping, 2019; Wu *et al*., 2013; 药飞, & 王东晓. 2020) suggest that Q-T interval prolongation is a known type of adverse reaction of it; the patient did not have an electrocardiogram examination after stopping the drug, and moxifloxacin was not used again during the hospitalisation; so the correlation evaluation of this adverse reaction is possible.

High-Risk Factors

The physical functions of the elderly are declining. With the increase of age, physiological and pathological changes occur in the body. The glomerular filtration rate, the excretion and reabsorption functions of the renal tubules of the elderly decline. The renal function of the elderly is only half of that of young people, resulting in a slower excretion of drugs and a higher likelihood of adverse reactions.

The high-risk factors for the cardiotoxicity caused by moxifloxacin include: advanced age (≥65 years old), female gender, electrolyte disorders (hypokalemia, hypomagnesemia, and hypocalcemia may all increase the risk of TdP, among which hypokalemia is the most common), a history of underlying diseases (hypokalemia, hypomagnesemia, and hypocalcemia may all increase the risk of TdP, among which hypokalemia is the most common), blood drug concentration (the risk of QTIP is high within the 2-4 h window period when moxifloxacin reaches its peak), and drug interactions (the combination of drugs that can cause Q-T interval prolongation such as amiodarone, sotalol, and macrolides is more likely to cause Q-T interval prolongation) (Tulkens, Arvis & Kruesmann, 2012).

Mechanism of Action

The prolongation of the QT interval caused by moxifloxacin may be due to its blocking of the rapidly activating delayed rectifier potassium current (Ikr) on the ventricular myocyte membrane. This current is an important outward current in the three phases of the ventricular myocyte action potential. The inhibition of this current prolongs the myocardial repolarisation time and the action potential time, which is manifested as the prolongation of the QT interval and a decrease in heart rate. Some studies have pointed out electrolyte disorders. Patients with hypokalemia are more likely to be induced to have a prolonged QT interval and even more severe arrhythmia, torsades de pointes, when moxifloxacin is used in combination. The patient is an elderly female (65 years old), and the serum potassium level was 3.5 mmol/L upon admission, which is at the lower limit of the normal value. There are high-risk factors for inducing a prolonged QT interval, making it more likely to induce a prolonged QT interval.

Treatment Measures

For the treatment of QT interval prolongation caused by drugs, the suspected drug should be discontinued first (or an alternative drug should be used). When there are drug interactions, discontinuation or dosage reduction should be considered simultaneously, and relevant drugs that can delay its metabolism should be used. If the patient has risk factors such as hypokalemia, bradycardia, heart failure, myocardial ischemia, liver and kidney diseases, etc., these should be actively corrected. When the patient has already developed torsades de pointes (TdP), magnesium sulfate should be administered intravenously for treatment. The patient should be transferred to a specialised ward with complete in-hospital monitoring equipment as soon as possible, and external cardiac defibrillation should be ensured to be available at any time. For elderly patients with a history of coronary heart disease and arrhythmia, when using moxifloxacin, the electrocardiogram and electrolyte levels should be monitored, and other drugs that affect the QT interval should be used in combination with caution. Once abnormal changes in the electrocardiogram are found, the drug should be discontinued immediately to avoid more severe arrhythmias that may endanger life. In this case, after considering that moxifloxacin caused the prolongation of the QT interval, treatment measures such as discontinuing moxifloxacin were taken, and these treatment measures were reasonable.

Conclusion

In conclusion, the comprehensive management of this case highlights the crucial role of clinical pharmacists in optimising antibiotic therapy and ensuring patient safety. This case is a patient with pulmonary infection complicated by old pelvic fracture. When selecting antibacterial drugs, the possible pathogenic bacteria of the patient should be analysed, and the resistance risk of ESBL-producing bacteria should be fully evaluated. When the patient has a prolonged Q-T interval, it is necessary to actively assist the doctor in sorting out the medications and adjust the antibacterial drugs in a timely manner. Only in this way can objective and comprehensive suggestions be provided for clinical practice, and the value of clinical pharmacists can be truly realised.

Conflict of Interest

The authors affirm that there is no conflicting objectives.

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