Ceftaroline Desensitization Procedure in a Pregnant Patient With Multiple Drug Allergies

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Validated skin testing is lacking for many drugs, including ceftaroline. The cross-reactivity between ceftaroline and other β-lactam antibiotics is unknown. We report a case of a pregnant patient with cystic fibrosis and multiple drug allergies who required ceftaroline for methicillin-resistant Staphylococcus aureus pneumonia and underwent an uncomplicated empiric desensitization procedure.

Keywords. β-lactam, ceftaroline, cross-reactivity; desensitization procedure; drug allergy.

Adverse drug reactions (ADRs) account for 3%–6% of all hospital admissions and occur in 10%–15% of hospitalized patients [1]. Adverse drug reactions can be costly, life-threatening, and result in morbidity, prolonged hospitalization, and increased risk of mortality [1]. Approximately one quarter of all ADRs are attributed to drug hypersensitivity [2], with antibiotics representing the most frequently reported class of drugs causing hypersensitivity reactions (HSR). Penicillin (PCN) allergy alone is documented in up to 15% of hospitalized patients [3–5]. When evaluating an inpatient with a history of multiple drug allergies to antibiotics, exonerating a reported drug allergy is challenging. Validated skin testing for immediate, type I HSR exists only for PCN, where the antigenic determinants have been identified [3–5]. Skin testing to most other drugs, although not validated, may be performed using a nonirritating concentration (NIC) [5, 6] when this value has been previously established. A drug graded challenge, or test dose, can be performed when the reaction is unlikely to have an immunoglobulin (Ig)E-mediated mechanism or if skin testing is negative [5–7]. A desensitization protocol can be used to safely administer a drug if there is a history of IgE-mediated HSR, positive skin testing, or if cross-reactivity within a drug class is unknown and no reasonable alternative treatment options are available [5, 6, 8, 9].

Given the lack of validated tools available to evaluate drug allergies, we report the case of a patient with history of multiple β-lactam antibiotic allergies and methicillin-resistant Staphylococcus aureus (MRSA) pneumonia treated with ceftaroline. She reported a history of HSR to both PCN and an advanced-generation cephalosporin and was managed safely using a desensitization procedure to ceftaroline. We discuss the chemical structure of ceftaroline and how this might result in cross-reactivity with PCN and other cephalosporins.

CASE PRESENTATION

A 29-year-old female G1P0 in her 12th week of pregnancy with a history of cystic fibrosis (CF) presented with cough and increased sputum production. She reported dyspnea on exertion, productive cough, sore throat, nasal congestion, and postnasal drip. In addition to CF, her medical history was notable for allergic rhinitis, chronic rhinosinusitis with nasal polyposis, diabetes mellitus, gastroesophageal reflux disease, pancreatic insufficiency, and vitamin D deficiency. She had documented drug allergies to amoxicillin, piperacillin-tazobactam, cefepime, and vancomycin. On exam, she was tachycardic and hypoxic but hemodynamically stable. Auscultation identified crackles over the bilateral upper lung fields; radiographic images were not obtained given the patient’s pregnancy. Laboratory evaluation included normal renal function. A sputum Gram stain revealed abundant polymorphonuclear lymphocytes and few squamous cells with a culture growth of few Pseudomonas aeruginosa and abundant MRSA. The Infectious Diseases service was consulted and recommended ceftaroline as the optimal
Ceftaroline: Indications, Adverse Reactions, and Cross-reactivity

Ceftaroline is a third-generation cephalosporin with a broad antimicrobial spectrum, demonstrating activity against organisms including MRSA, MSSA, and PCN-resistant S. pneumoniae. It is approved in the United States for the treatment of S. aureus infections (SSTIs) and community-acquired pneumonia. Although ceftaroline has been reported to be less likely to cause a reaction when administered in patients allergic to β-lactam antibiotics like PCNs, there is cross-reactivity with other cephalosporins. Cross-reactivity with β-lactam antibiotics is mediated by development of IgE antibodies against antigenic determinants that are unique to cephalosporins (side chains or R groups) or to determinants that are shared with other β-lactam drugs (β-lactam ring) [12]. In general, patients who react to one cephalosporin are less likely to react to a different cephalosporin due to the presence of R groups and other determinants that are shared with other β-lactam drugs [12].

Ceftaroline contains a bicyclic ring with a 4-member β-lactam ring joined to a 6-member cephem ring (Figure 1) [12]. Ceftaroline’s R1 group is defined by 2 parts: the 7-alpha-iminoethoxy group and an iminohydantoin group [12]. Ceftaroline’s R2 group is a 1,3-thiazole ring [12]. Structurally, ceftaroline’s R groups are less likely to be cross-reactive with other cephalosporins [12]. Ceftaroline, containing 1 less carbon (7-α-iminomethoxyl group as opposed to iminoethoxy group), is less likely to cause a reaction when administered in patients with reported allergy to any of these antibiotics.

Although this structural information suggests that the patient would have likely tolerated ceftaroline, because of her poor response to previous cephalosporin treatments and her known cross-reactivity to PCNs, a desensitization procedure was conducted. The patient tolerated the desensitization procedure without adverse effects. She completed 14 days of intravenous ceftaroline (600 milligrams twice daily) without complications and returned to her baseline pulmonary status. A full-term healthy male child was born 6 months after her admission.
respiratory status and pregnancy, we determined that the safest approach was administration of ceftaroline by desensitization.

**CONCLUSIONS**

We report a case of ceftaroline desensitization in a patient with multiple β-lactam antibiotic allergies. The patient’s antibiotic treatment plan was complicated by a well documented PCN and cephalosporin allergy, lack of validated skin testing to ceftaroline, poor respiratory status, and need for aggressive therapy with no reasonable alternative treatment options. Ceftaroline was considered the optimal therapy given the patient’s diagnosis of MRSA pneumonia. Although the literature supports the safety of vancomycin in pregnancy despite its class C classification [19–23], our patient additionally had a reported allergy to vancomycin, which led to the selection of ceftaroline as the preferred therapy. Without knowing the cross-reactivity of ceftaroline and cefepime or ceftaroline and PCN, drug desensitization was recommended and tolerated. Similar to another recent report of ceftaroline desensitization [15], we were unable to tell whether the patient’s tolerance of ceftaroline was due to lack of cross-reactivity or the result of a successful desensitization procedure.

The patient’s desensitization protocol was similar to previously published desensitizations [5, 8, 9], using a 12-step protocol beginning with a dilution of 1:100,000 of the therapeutic dose (for ceftaroline, 0.0002 mg/mL). The only other published ceftaroline desensitization protocol used 14 steps, initiated at 0.0004 mg/mL, and took 3.75 hours to complete [15]. Protocols are chosen based on a patient’s risk of HSR, with the slowest protocols recommended for patients at highest risk of HSR.

Based on its structural properties, we hypothesize that ceftaroline may be tolerated in patients with a PCN or cephalosporin allergy, although clinical data are needed to confirm these hypotheses. In addition, more research to define a skin-testing protocol should be established and validated to improve the care of patients with multiple allergies to PCN and cephalosporin antibiotics.

**Supplementary Material**

Supplementary material is available online at Open Forum Infectious Diseases (http://OpenForumInfectiousDiseases.oxfordjournals.org/).

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