

Pathways to improved antibiotic allergy and antimicrobial stewardship practice: The validation of a beta-lactam antibiotic allergy assessment tool



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Clinical Implications

- The validation of a beta-lactam antibiotic allergy assessment allows nonallergists to effectively phenotype patient-reported antibiotic allergies and direct them to appropriate delabeling strategies.

TO THE EDITOR:

Although patient-reported antibiotic allergies (so-called antibiotic allergy labels [AALs]) are encountered in up to 1 in 4 hospitalized patients, they are frequently “unknown” and not clarified by clinicians.¹ The high prevalence of potentially misleading AALs is further confounded by poor clinician understanding of beta-lactam prescribing in penicillin allergy and underutilization of appropriate delabeling strategies.^{2,3}

Antibiotic allergy assessment tools have been used previously to aid phenotyping,⁴ and screening algorithms used to guide appropriate antibiotic allergy prescribing.⁵ The assessment of penicillin allergy is a recommended component of antimicrobial stewardship (AMS), considering the established links between AALs and inferior patient outcomes.^{6–8} What remains absent is a validated point-of-care tool that can be used by a spectrum of health care workers to accurately assess and record AALs and enable referral to specialized testing services. Therefore, we validated a beta-lactam antibiotic allergy assessment tool (AAAT) to aid nonallergists in the phenotyping and management of patients with reported beta-lactam AALs.

The AAAT was developed at Austin Health (Melbourne, Australia), a tertiary referral hospital with specialist antibiotic allergy services. The tool was primarily designed for use by health care providers who frequently encounter AALs when reviewing adult inpatients with infective episodes that require antibiotics. The AAAT uses patient-reported symptoms and signs associated with an index beta-lactam AAL (Figure 1), to assign an accurate (1) phenotype and (2) management recommendation. The phenotypic outcomes of the AAAT were classified as follows:

1. Severe immediate hypersensitivity (IgE-mediated),
2. Nonsevere immediate hypersensitivity (IgE-mediated),
3. Severe delayed hypersensitivity (T-cell-mediated),
4. Nonsevere delayed hypersensitivity (T-cell-mediated),
5. Potential immune-mediated (eg, acute interstitial nephritis), or

6. Unlikely to be significant/non-immune-mediated (eg, gastrointestinal upset and unknown history).

Each phenotype was allocated a corresponding management recommendation of either

1. Direct delabeling with removal from medical record,
2. Oral rechallenge (provocation),
3. Antibiotic allergy skin testing followed by oral rechallenge, or
4. Outpatient antibiotic allergy assessment, potentially including skin testing and oral rechallenge, only after detailed specialist consultation.

The tool underwent an internal review for content and usability, using hypothetical case scenarios representing immune and nonimmune phenotypes. This initial review was performed by specialists in antibiotic allergy care, including adverse drug reaction committee pharmacists, allergists, and infectious diseases physicians specializing in antibiotic allergy. Following modifications to the AAAT postinternal review, the primary validation involved a range of health care workers using the AAAT, using real-patient case studies from the Austin Health Antibiotic Allergy Database. The real patient case studies formed the reference criterion standard as all “phenotypes” were confirmed by specialist review and confirmed *in vivo* methods (skin prick testing and/or oral challenge) and such “management” followed either a local or international guideline.^{9,10} A secondary validation was undertaken in a group of specialist hematology/oncology nurses. The real-patient cases studies were prepared by study investigators (J.A.T., M.D.), reviewed by additional investigators (S.K., K.U., A.D., E.P., and O.S.) and were forwarded to respondents who were able to answer questions anonymously (see Figures E1 in this article’s Online Repository at www.jaci-inpractice.org). This project received approval from the Austin Health Ethics Committee (CD 17/005).

In the primary validation, 8 antibiotic allergy real-patient case studies (immune-mediated [5] and non-immune-mediated [3]) were evaluated by 40 participants (317 total responses). The respondents included 19 junior doctors (48%), 11 pharmacists (28%), 8 (20%) senior doctors (infectious diseases doctors [consultants and fellows]), and 2 (5%) specialist nurses. The secondary validation used the same case studies in a group of 11 specialist hematology/oncology nurses. In the primary validation, the AAAT demonstrated an overall sensitivity of 91.8% (95% CI, 88.9–94.0) for assigning the correct phenotype and 85.2% (95% CI, 80.8–88.7) for the appropriate management. The performance of the AAAT was improved for senior doctors (sensitivity, 93.8%; 95% CI, 84.8–98.3; specificity, 85.9%; 95% CI, 75.0–93.4) and pharmacists (sensitivity, 92.9%; 95% CI, 85.4–97.4; specificity, 96.5%; 95% CI, 90.0–99.3). In the primary validation, sensitivity and specificity varied for phenotype (Table I). The overall sensitivity in secondary validation by hematology/oncology nurses was 97.8% (95% CI, 92.0–99.7) for phenotype and 96.6% (95% CI, 92.0–99.72) for management.

Regarding management recommendations the AAAT demonstrated a sensitivity and specificity highest for *direct delabeling* (nonsignificant/nonimmune phenotypes) (Table I).

Dermatological			Respiratory or Systemic			Unknown reaction					
Clinical manifestation		Recommendation & Resultant allergy type		Clinical manifestation		Recommendation & Resultant allergy type		Clinical manifestation		Recommendation & Resultant allergy type	
Childhood exanthem (unspecified) <i>Details of rash timing unknown and no severe features or hospitalisation</i>		☐	Unlikely to be significant (non-severe)	Laryngeal involvement ("throat tightness" or "hoarse voice")		☐	Immediate hypersensitivity (severe)	Unknown reaction ≤ 10 years ago		☐	Unlikely significant (non-severe)
Immediate diffuse rash ("itchy immediate rash") <i><2 hours post dose</i>		☐	Immediate hypersensitivity (non-severe)					Unknown reaction > 10 years ago or family history of penicillin allergy only		☐	Unlikely significant (non-severe, low risk)
Diffuse rash or localized rash with no other symptoms	≤ 10 years ago	☐	Delayed hypersensitivity (non-severe)	Respiratory compromise ("wheeze or shortness of breath")		☐	Immediate hypersensitivity (severe)	Renal			
	> 10 years ago	☐	Delayed hypersensitivity (non-severe, low risk)	Fever ("high temperature") - <i>Not explained by infection or other cause</i>		☐	Delayed hypersensitivity (severe)				
> 24 hours post starting antibiotic				Anaphylaxis or unexplained hypotension or collapse		☐	Immediate hypersensitivity (severe)	Renal failure or severe injury (>50% reduction in eGFR from patient's baseline or absolute serum creatinine increase of ≥26.5µmol/L, or transplantation, or dialysis)		☐	Potential immune mediated (severe, if AIN)
Rash & mucosal ulceration ("mouth, eye or genital ulcers") <i>Be alert for history of SCAR</i>		☐	Delayed hypersensitivity (severe)					Renal impairment (Does not meet criteria for renal failure or severe injury [see box above])		☐	Unlikely immune mediated (non-severe, low risk)
			Haematological					Liver			
Pustular, blistering or desquamating ("skin shedding") rash <i>Be alert for history of SCAR</i>		☐	Delayed hypersensitivity (severe)	Platelets < 150 x10 ⁹ /L or unknown		☐	Potential immune mediated (severe)	Liver failure or severe liver injury (≥5x upper limit of normal (ULN) for ALT or AST, or ≥3x ULN for ALT with ≥2x ULN for bilirubin, or ≥2x ULN for ALP, or decompensation, or transplantation)		☐	Potential immune mediated (severe, if DILI)
Angioedema ("lip, facial or tongue swelling")		☐	Immediate hypersensitivity (severe)	Neutrophils < 1x10 ⁹ /L or unknown		☐	Potential immune mediated (severe)	Hepatic enzyme derangement (Does not meet criteria for liver failure or severe injury [see box above])		☐	Unlikely immune mediated (non-severe, low risk)
Swelling (outside of angioedema)		☐	Potential immediate hypersensitivity (severe)	Haemoglobin < 100 g/L or unknown		☐	Potential immune mediated (severe)	Neurological or gastrointestinal			
Urticaria ("wheals and hives")		☐	Immediate hypersensitivity (non-severe)	Eosinophilia (>0.7 x 10 ⁹ /L or unknown) <i>Examine history for DRESS</i>		☐	Delayed hypersensitivity (severe, if DRESS)	Gastrointestinal symptoms ("nausea, vomiting, diarrhoea")		☐	Unlikely immune mediated (non-severe, low risk)
Appropriate for direct de-labelling - removal of allergy label without testing [oral rechallenge] if required									Neurological or CNS manifestation ("headache, optic neuritis, confusion, depression, mood disorder, low mood, psychosis")		
Appropriate for supervised direct oral rechallenge *											
Appropriate for skin testing followed by oral rechallenge †											
Appropriate for outpatient antibiotic allergy assessment +/- testing											

FIGURE 1. Beta-lactam antibiotic allergy assessment tool. If more than 1 clinical manifestation selected, default to the most likely or severe. *A/N*, Acute interstitial nephritis; *DILI*, drug-induced liver injury; *DRESS*, drug reaction with eosinophilia and systemic symptoms; *SCAR*, severe cutaneous adverse drug reactions; *ULN*, upper limit normal. Patients classified as an "immediate hypersensitivity" are appropriate for desensitization if the patients have a beta-lactam allergy history and require urgent penicillin-based therapy. *In the appropriate setting, a direct oral rechallenge may be performed under specialist guidance. †Skin testing followed by oral rechallenge can be performed in the outpatient or inpatient setting. Those patients with features of severe life-threatening allergy are those marked for "outpatient assessment" rather than inpatient setting to ensure a (1) detailed collateral history is obtained, (2) presence of specialist allergy oversight, and (3) resolution of acute illness. If the aforementioned can be achieved in the acute setting, then testing may proceed with caution.

Regarding potentially hazardous recommendations, defined as a less restrictive management recommendation (eg, oral rechallenge in case of severe immune-mediated reaction), the highest number was seen in the *skin testing ± oral rechallenge* recommendations where 5 of 15 incorrect responses were considered potentially hazardous. For the *outpatient assessment* recommendation, 4 of 16 incorrect responses were potentially hazardous, whereas 0 were identified from the 9 incorrectly given responses for the *direct delabelling* option. All potentially hazardous recommendations were made by junior medical staff respondents.

When examining the proportion of correct responses per group, there was no significant difference between senior and junior doctors overall for phenotyping (137/152 vs 60/64; $P = .60$) or management recommendations (116/152 vs 55/64; $P = .14$). When comparing pharmacists to doctors, there was no difference for phenotyping (79/85 vs 197/216; $P = .82$), but there was for management (82/85 vs 171/216; $P = .0001$). Nurses (hematology/oncology, specialist nurses) performed better than doctors overall for phenotyping (101/104 vs 197/216; $P = .059$) and management (100/104 vs 171/216; $P = .0001$).

The beta-lactam AAAT proved useful to a range of non-allergist health care workers who frequently encounter AALs, in the identification of antibiotic allergy phenotypes and designating appropriate management. The study was limited by the validation in a retrospective cohort of patient cases and small number of respondents. However, our tool demonstrated good overall sensitivity and performed best for assigning the correct phenotype and management in nonsignificant beta-lactam allergy phenotypes, which would aid direct oral rechallenge protocols, an approach increasingly performed as part of AMS programs.¹¹ Good sensitivity was also noted for immediate hypersensitivities, where skin prick and intradermal penicillin testing is increasingly being performed by trained nonallergists.³ We propose that the AAAT could be integrated into the workflow of health care workers who frequently encounter AALs (eg, infectious diseases physicians, hematology/oncology nurses, and AMS pharmacists), enabling patient referral to supervised testing programs, to reduce the significant public health issue of beta-lactam allergy.⁸

The lower sensitivity for severe delayed hypersensitivity phenotyping, by junior medical staff, highlights the need for greater

TABLE I. The sensitivity and specificity of the beta-lactam AAAT

Validation	Phenotype			Management		
	Immediate hypersensitivity (cases 3, 5, and 7)	Delayed hypersensitivity (cases 4 and 8)	Nonsignificant (cases 1, 2, and 6)	Direct delabeling or oral rechallenge* (cases 1, 2, and 6)	Skin prick testing $\pm$ OC† (cases 7 and 8)	Outpatient assessment‡ (cases 3, 4, and 5)
<i>Primary validation—Doctors, pharmacists, specialist nurses ($n_{\text{respondents}} = 40$)</i>						
Sensitivity % (95% CI)	97.5 (91.3-99.7)	84.8§ (76.0-91.9)	96.7 (91.7-99.1)	92.5 (86.2-96.5)	79.2 (68.5-87.6)	87.5 (80.2-92.8)
Specificity % (95% CI)	97.9 (94.9-99.5)	97.5 (94.4-99.2)	97.9 (94.9-99.5)	94.4 (90.2-97.2)	93.8 (89.9-96.46)	93.4 (89.0-96.4)
<i>Secondary validation—Hematology/oncology nurses ($n_{\text{respondents}} = 11$)</i>						
Sensitivity % (95% CI)	96.9 (84.2-99.2)	95.5 (77.1-99.9)	98.2 (90.3-99.5)	100 (89.42-100)	95.5 (77.2-99.8)	93.9 (79.9-99.2)
Specificity % (95% CI)	100 (93.5-100)	98.2 (90.3-99.5)	98.2 (90.3-99.9)	96.4 (87.5-99.6)	98.5 (91.8-99.6)	100 (91.9-100)

OC, Oral rechallenge.

*Direct delabeling or oral rechallenge was considered the correct management option for cases designated as unlikely significant or delayed (nonsevere, low risk) hypersensitivity only.

†Skin prick testing $\pm$ OC were considered the correct management option for cases designated as immediate hypersensitivity (not anaphylaxis) or delayed hypersensitivity (nonsevere) only.

‡Outpatient assessment was considered the correct management option for cases designated as delayed hypersensitivity (severe) anaphylaxis or severe potential immune-mediated adverse drug reactions only.

§Lowest sensitivity noted for severe delayed hypersensitivities: 77.5% (95% CI, 61.6-89.2), while retaining high specificity 99.6% (95% CI, 97.7-99.99).

education, because this group is at risk of represcribing implicated antibiotics in severe hypersensitivity without formal assessment. Also, there remains a risk of misclassification with any clinical assessment tool, and site-specific validation, auditing, and clinical oversight must remain *in situ*. However, considering that the primary targets of this tool would be AMS pharmacists and infectious diseases physicians, the AAAT is likely to aid effective beta-lactam allergy assessment, appropriate allergy delabeling of spurious beta-lactam allergy, and referral to specialist-run antibiotic allergy services. Importantly, the tool performed particularly well in the hands of hematology nurses, working in units where the AAL burden is known to be greatest,¹² which could significantly benefit delabeling programs that improve prescribing in vulnerable patients.

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Introduction to antibiotic allergy

1. Antibiotic allergies can be either *immune mediated* or *non-immune mediated*.
 - (a) *Immune mediated* include both immediate (IgE) and delayed (T-cell) hypersensitivities.
 - (b) *Non-immune mediated* are typically drug side effects (e.g. diarrhoea) - not true allergies.
2. This tool aids in the assessment of patient-reported beta-lactam allergies, by pharmacists, nurses, and doctors, to determine:
 - (a) antibiotic allergy type (phenotype)
 - (b) appropriate testing and follow-up (management)
3. Documentation of the allergy type is vital, as many allergies can be immediately removed from the medical history using this information alone. Whilst other allergies may be amenable to inpatient or outpatient specialist testing.

Beta-lactam antibiotic allergy assessment questions

1. Do you have any allergies that you know of?
2. Do you remember the details of the reaction?
3. How many hours after having your first dose of the antibiotic did the reaction occur?
4. How many years ago did the reaction occur?
5. How was the reaction managed? What was the outcome?
6. Which other antibiotics have you tolerated post reaction?

Beta-lactam antibiotic allergy assessment tool post reaction (See Figure 1)

1. Use the introductory key [allergy assessment questions](#) above and the [allergy assessment tool](#) (Figure 1) to determine the likely allergy type, severity and approach to management.
2. If more than one allergy type is selected, please default to the most likely OR severe type.

FIGURE E1. Survey provided to respondents to complete regarding beta-lactam antibiotic allergy assessment tool.

Respondent occupation (choose the single most appropriate) **Date:** _____

- | | |
|---|--|
| ☐ Pharmacist [< 5 years experience] | ☐ Doctor - resident |
| ☐ Pharmacist [> 5 years experience] | ☐ Doctor – registrar [medical] |
| ☐ Pharmacist - Infectious diseases/Austin Health | ☐ Doctor – registrar [infectious diseases (ID)] |
| ☐ Pharmacist – Adverse drug reaction committee | ☐ Doctor – consultant [ID or allergy] |
| ☐ Doctor - intern | ☐ Specialist nurse |

Case 1

A 28-year-old female, with a history of anxiety, recalls a childhood history of rash associated with oral penicillin therapy when she was under the age of 5. She can not recall what she was being treated for at the time. However, she does recall her mother telling her that she had a red rash all over her body. No treatment was required, and the rash went away over a couple of days. She has subsequently tolerated cephalexin therapy. Her listed allergy is to penicillin.

1) What is the most likely allergy type? (Choose the most appropriate utilizing [assessment tool](#))

- ☐ Immediate hypersensitivity (non-severe)
- ☐ Immediate hypersensitivity (severe)
- ☐ Delayed hypersensitivity (non-severe)
- ☐ Delayed hypersensitivity (severe)
- ☐ Immune mediated (other)
- ☐ Unlikely to be significant or immune mediated

2) What is the corresponding testing recommendation (Choose the most appropriate)

- | | |
|--|---|
| ☐ Direct de-labelling | ☐ Supervised direct oral rechallenge |
| ☐ Skin testing followed by oral rechallenge | ☐ Outpatient antibiotic allergy assessment |

Case 2

A 50-year-old female with multiple myeloma has been avoiding piperacillin-tazobactam (Tazocin) therapy during episodes of febrile neutropenia due to a reported amoxicillin allergy. She describes developing profuse watery diarrhoea, nausea and dizziness following amoxicillin therapy, 10-15 years ago. Her doctor told her that she was allergic to penicillins and should continue to avoid. She cannot recall any other systemic or cutaneous features. She did not require any treatment and the diarrhoea stopped following cessation of amoxicillin. Her listed allergy is to penicillins.

1) What is the most likely allergy type (Choose the most appropriate utilizing [assessment tool](#))

- ☐ Immediate hypersensitivity (non-severe)
- ☐ Immediate hypersensitivity (severe)
- ☐ Delayed hypersensitivity (non-severe)
- ☐ Delayed hypersensitivity (severe)
- ☐ Immune mediated (other)
- ☐ Unlikely to be significant or immune mediated

2) What is the corresponding testing recommendation (Choose the most appropriate)

- | | |
|--|---|
| ☐ Direct de-labelling | ☐ Supervised direct oral rechallenge |
| ☐ Skin testing followed by oral rechallenge | ☐ Outpatient antibiotic allergy assessment |

Case 3

A 74-year-old female with multiple medical comorbidities reports a history of allergy to amoxicillin from 1 year previous. She developed lip tingling, dizziness, nausea and central chest pain 5 minutes following the ingestion of oral amoxicillin, which was being used to treat a dental infection. She called for an ambulance, however on their arrival was noted to have a very low blood pressure (60/20) and full body erythema, which they treated with 2 intramuscular injections into her thigh. She was transferred to hospital and stayed in the intensive care unit for 24 hours before being discharged home. Her listed allergy is to amoxicillin.

1) What is the most likely allergy type (Choose the most appropriate utilizing [assessment tool](#))

- ☐ Immediate hypersensitivity (non-severe)
- ☐ Immediate hypersensitivity (severe)
- ☐ Delayed hypersensitivity (non-severe)
- ☐ Delayed hypersensitivity (severe)
- ☐ Immune mediated (other)
- ☐ Unlikely to be significant or immune mediated

2) What is the corresponding testing recommendation (Choose the most appropriate)

- ☐ Direct de-labelling
- ☐ Supervised direct oral rechallenge
- ☐ Skin testing followed by oral rechallenge
- ☐ Outpatient antibiotic allergy assessment

Case 4

A 38-year-old female with a history of Type 2 Diabetes and cardiovascular disease developed a surgical site infection following coronary artery bypass grafting 3 years ago. She was treated with both piperacillin-tazobactam (Tazocin) and vancomycin, and nine days into therapy developed fever, rash and eosinophilia. She also recalls that her kidney function was abnormal during this time. Her listed allergies are for Tazocin, penicillins and vancomycin.

1) What is the most likely allergy type (Choose the most appropriate utilizing [assessment tool](#))

- ☐ Immediate hypersensitivity (non-severe)
- ☐ Immediate hypersensitivity (severe)
- ☐ Delayed hypersensitivity (non-severe)
- ☐ Delayed hypersensitivity (severe)
- ☐ Immune mediated (other)
- ☐ Unlikely to be significant or immune mediated

2) What is the corresponding testing recommendation (Choose the most appropriate)

- ☐ Direct de-labelling
- ☐ Supervised direct oral rechallenge
- ☐ Skin testing followed by oral rechallenge
- ☐ Outpatient antibiotic allergy assessment

Case 5

A 39-year-old mother of two with no relevant past medical history has a history of allergy following varicose vein surgery 1 year previously. Soon after induction of anaesthesia for the planned surgery she developed profound hypotension, which required aggressive pharmacological blood pressure support. She subsequently went into cardiac arrest and required resuscitation. At induction she was given propofol, fentanyl, lignocaine, dexamethasone, ondansetron, cefazolin, parecoxib and clexane. Her listed allergies are all the aforementioned drugs and penicillins.

1) What is the most likely allergy type (Choose the most appropriate utilizing [assessment tool](#))

- ☐ Immediate hypersensitivity (non-severe)
- ☐ Immediate hypersensitivity (severe)
- ☐ Delayed hypersensitivity (non-severe)
- ☐ Delayed hypersensitivity (severe)
- ☐ Immune mediated (other)
- ☐ Unlikely to be significant or immune mediated

2) What is the corresponding testing recommendation (Choose the most appropriate)

- ☐ Direct de-labelling
- ☐ Supervised direct oral rechallenge
- ☐ Skin testing followed by oral rechallenge
- ☐ Outpatient antibiotic allergy assessment

Case 6

An 18-year-old male with a history of developmental delay and recurrent respiratory tract infections has a listed penicillin allergy. His mother recalls a strong family history of serious penicillin allergy for all her children and herself. The patient's general practitioner has advised him to avoid all penicillins. He can not recall a personal history of rash or other reactions to penicillin or amoxicillin. His listed allergy is to penicillins

1) What is the most likely allergy type (Choose the most appropriate utilizing [assessment tool](#))

- ☐ Immediate hypersensitivity (non-severe)
- ☐ Immediate hypersensitivity (severe)
- ☐ Delayed hypersensitivity (non-severe)
- ☐ Delayed hypersensitivity (severe)
- ☐ Immune mediated (other)
- ☐ Unlikely to be significant or immune mediated

2) What is the corresponding testing recommendation (Choose the most appropriate)

- ☐ Direct de-labelling
- ☐ Supervised direct oral rechallenge
- ☐ Skin testing followed by oral rechallenge
- ☐ Outpatient antibiotic allergy assessment

FIGURE E1. (CONTINUED).

Case 7

A 53-year-old female with a history of hypertension developed an intensely itchy rash and widespread erythema 30 mins following her second dose of cephalexin therapy a year previously. She was being treated for an upper respiratory tract infection at the time. She called an ambulance and was treated with an oral antihistamine only and taken to hospital for observation but did not require any additional therapy. She had previously tolerated amoxicillin and cephalexin. Her listed allergy is to cephalexin.

1) What is the most likely allergy type (Choose the most appropriate utilizing [assessment tool](#))

- ☐ Immediate hypersensitivity (non-severe)
- ☐ Immediate hypersensitivity (severe)
- ☐ Delayed hypersensitivity (non-severe)
- ☐ Delayed hypersensitivity (severe)
- ☐ Immune mediated (other)
- ☐ Unlikely to be significant or immune mediated

2) What is the corresponding testing recommendation (Choose the most appropriate)

- ☐ Direct de-labelling
- ☐ Supervised direct oral rechallenge
- ☐ Skin testing followed by oral rechallenge
- ☐ Outpatient antibiotic allergy assessment

Case 8

A 40-year-old male with a history of cushings disease was admitted for management of complicated *Staphylococcus aureus* bacteraemia and pyomyositis 6 months previously. He was commenced on intravenous flucloxacillin and on day 18 of treatment developed a widespread itchy rash that predominately involved his thighs, upper torso and trunk. There was no fever, blistering, skin peeling or mucosal involvement noted, however the rash took about 15 days to resolve. He was changed to cephalexin which he tolerated post. He has not listed allergies in his medical record.

1) What is the most likely allergy type (Choose the most appropriate utilizing [assessment tool](#))

- ☐ Immediate hypersensitivity (non-severe)
- ☐ Immediate hypersensitivity (severe)
- ☐ Delayed hypersensitivity (non-severe)
- ☐ Delayed hypersensitivity (severe)
- ☐ Immune mediated (other)
- ☐ Unlikely to be significant or immune mediated

2) What is the corresponding testing recommendation (Choose the most appropriate)

- ☐ Direct de-labelling
- ☐ Supervised direct oral rechallenge
- ☐ Skin testing followed by oral rechallenge
- ☐ Outpatient antibiotic allergy assessment