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CLINICAL PRACTICE

DALES, Drug Allergy Labels in Elective Surgical patients: a prospective multicentre cross-sectional study of incidence, risks, and attitudes in penicillin de-labelling strategies

Louise Savic[1,*], Caroline Thomas[1,†], David Fallaha[2,†], Michelle Wilson[3], Philip M. Hopkins[1], Sinisa Savic[3], Samuel H. Clark[4,†] on behalf of the RAFT group[‡]

[1]Department of Anaesthesia, Leeds Teaching Hospitals NHS Trust, Leeds, UK, [2]Department of Anaesthesia, Golden Jubilee National Hospital NHS Trust, Clydebank, UK, [3]Leeds Institute of Rheumatic and Musculoskeletal Medicine, University of Leeds, Leeds, UK and [4]Departments of Anaesthesia and Critical Care Medicine, University College London Hospital, London, UK

*Corresponding author. E-mail: Louise.savic@nhs.net

[†]Research and Audit Federation of Trainees (RAFT) committee member.
[‡]Research and Audit Federation of Trainees.

Abstract

Background: Penicillin allergy is associated with a range of poor health outcomes. Allergy testing can be made simpler by using a direct drug provocation test in patients at low risk of genuine allergy. This approach could allow population-level 'de-labelling'. We sought to determine the incidence and nature of penicillin allergy labels in UK surgical patients and define patient and anaesthetist attitudes towards penicillin allergy testing.

Methods: A prospective cross-sectional questionnaire study was performed in 213 UK hospitals. 'Penicillin allergic' patients were interviewed and risk-stratified. Knowledge and attitudes around penicillin allergy were defined in patients and anaesthetists.

Results: Of 21 219 patients, 12% (n=2626) self-reported penicillin allergy; 27% reported low-risk histories potentially suitable for a direct drug provocation test; an additional 40% reported symptoms potentially suitable for a direct drug provocation test after more detailed assessment. Of 4798 anaesthetists, 40% claimed to administer penicillin routinely when they judged the label low risk. Only 47% of anaesthetists would be happy to administer penicillin to a patient previously de-labelled by an allergy specialist using a direct drug provocation test; perceived lack of support was the most common reason for not doing so.

Conclusions: At least 27% of patients with a penicillin allergy label may be suitable for a direct drug provocation test. Anaesthetists demonstrated potentially unsafe prescribing in patients with penicillin allergy labels. More than half of anaesthetists lack confidence in the results of a direct drug provocation tests undertaken by a specialist. Our findings highlight significant barriers to the effective implementation of widespread de-labelling in surgical patients.

Keywords: allergy; allergy testing; anaesthesia; de-labelling; drug provocation test; patient safety; penicillin

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Editor's key points

- Allergy testing involving a direct drug provocation test in patients at low risk of genuine allergy can allow population-level 'de-labelling'.
- The authors sought to determine the incidence and nature of penicillin allergy labels in UK surgical patients and to define patient and anaesthetist attitudes towards penicillin allergy testing.
- Fewer than half of anaesthetists were confident in administering penicillin to a patient who had been de-labelled by an allergy specialist using drug provocation testing.
- Reasons including misunderstanding of allergy testing and perceived lack of hospital guidance appear to be major barriers to systematic de-labelling in surgical patients.
- There are opportunities for education and hospital guidance if anaesthetists are to take ownership of the problem of incorrect penicillin allergy labels.

Around 2.7 million people in the UK self-report penicillin allergy, but the label is incorrect in up to 95% of cases.[1,2] The label is associated with harm, including increased risk of infection with methicillin-resistant *Staphylococcus aureus*, *Clostridium difficile*, and vancomycin-resistant enterococcus, longer hospital stays, and more admissions to critical care.[3,4] A 50% increase in surgical site infections (SSIs) has been demonstrated,[5,6] and in the UK there is also an increased risk of perioperative anaphylaxis attributable to teicoplanin use.[7] The overuse of alternative broad-spectrum antibiotics contributes to emergence of resistant bacterial strains.

Current penicillin allergy testing guidelines recommend a stepwise approach.[8–11] A detailed history helps delineate immediate hypersensitivity reactions from side-effects; skin testing is then performed to look for evidence of immunoglobulin E (IgE) sensitisation. Where negative, the patient undergoes a drug provocation test (DPT), the gold standard test. Patients who tolerate a DPT are 'de-labelled' and can receive penicillins with no risk above that of the baseline population.

This is labour-intensive and expensive. In addition, skin tests have variable sensitivity and specificity and require expert interpretation.[12,13] A critical shortage of trained allergists makes it impossible to provide this expertise widely.[14] There is growing interest in de-labelling pathways that risk stratify patients to identify those at low risk of true allergy, who can proceed directly to DPT without prior skin testing.[15–19] The definition of low-risk varies considerably between studies. In some, patients with symptoms suggestive of IgE-mediated reactions were considered suitable for direct DPT providing the reaction occurred more than 5 yr ago.[20] In others, IgE-mediated symptoms that developed >1 h after the first dose were deemed suitable.[2] More commonly, only symptoms suggestive of minor side-effects are considered low risk. In one study, the label could be removed on the basis of the history alone if side-effects with no pathophysiological clinical features of allergy were present, with de-labelling performed by a pharmacist.[15] A key feature in the risk assessment of patients is the length of time elapsed since the index reaction, as penicillin allergy is thought to wane over time.[12,21]

There are several potential barriers to widespread de-labelling, and uncertainty about whether de-labelling translates into future penicillin use.[22] We sought to determine the scale of self-reported penicillin allergy labels in the UK elective surgical population, to risk stratify these labels, and to examine attitudes to de-labelling. We also sought to understand anaesthetists' knowledge and attitudes towards penicillin allergy and de-labelling.

Methods

A UK-wide cross-sectional observational study was conducted across 213 NHS hospitals, on three site-selected data collection days. The study comprised a patient questionnaire administered by data collectors, an anaesthetist questionnaire, and a validation survey for sites. For full inclusion and exclusion criteria, see Supplementary Table S1. The study was conducted through the Research and Audit Federation of Trainees (RAFT), a UK-wide network of anaesthetic trainees collaborating with local research teams.[23] The study gained ethics approval (REC reference 17/LO/2106) and Health Research Authority (HRA) approval (IRAS ID 232512). The STROBE (Strengthening The Reporting of OBservational Studies in Epidemiology) checklist for cross-sectional studies was used to guide reporting of this study. We present here only the penicillin allergy data; data on non-penicillin allergies and other aspects of the work are to be presented separately.

Patient survey

The patient questionnaire (see Supplementary Materials: Patient Survey) was administered via an electronic device (usually a mobile phone or tablet) held by the data collector. The data collector asked the questions as prompted by the electronic form, and ticked the response box accordingly. The questions were logic-gated so that further questions appeared (or not) according to the previous answer. Consenting patients provided data on age, sex, history of atopy or urticaria, and any drug allergies. Patients reporting penicillin allergy were asked about this in more depth. We included patients who reported either 'allergy' or 'sensitivity' to penicillin because these terms are used interchangeably. For patients reporting rash, detailed questions about the nature of the rash were asked including timing in relation to the first dose of penicillin. Pictures of urticarial and maculopapular rashes, and of oral thrush were shown to these patients.

Patients labelled as penicillin allergic and for whom the first-line choice for antimicrobial prophylaxis was penicillin were followed up on the day of surgery to determine which antibiotic was used. The anaesthetic chart was examined postoperatively by a member of the local study team for evidence of possible anaphylaxis using a structured proforma. Specifically, the unplanned use of epinephrine, steroid or antihistamine, mast cell tryptase sampling, unplanned admission to intensive care, or a comment on the chart that anaphylaxis may have occurred.

The data collected on the day were stored and retrospectively risk stratified during data analysis by the study team (Fig. 1). Patients were defined as low risk of allergy when describing side-effects such as nausea or thrush, or where they recalled having subsequently received penicillin without issue. Patients were categorised as high risk if their symptoms were suggestive of an immediate type 1

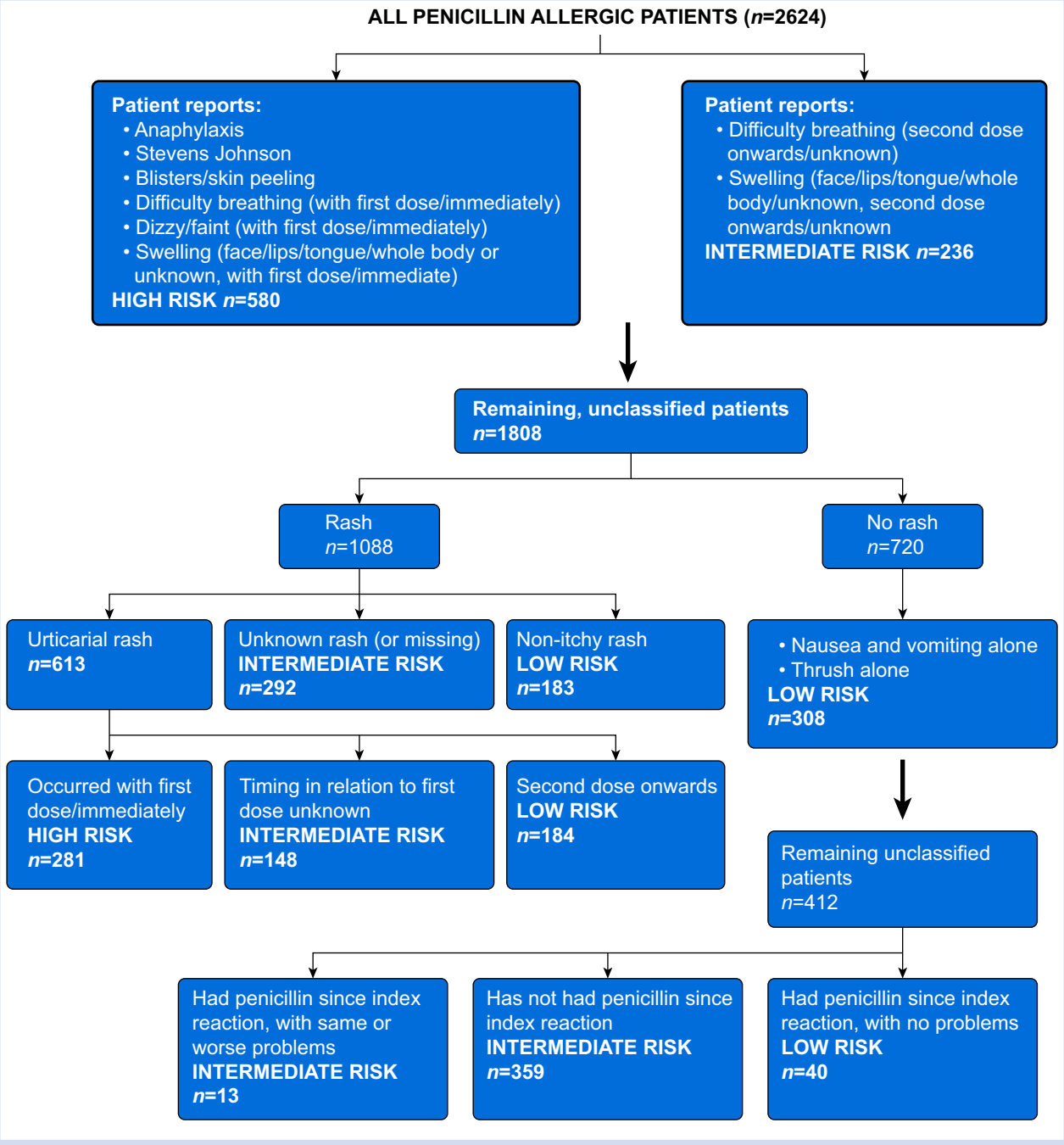

Fig 1. Risk stratification of penicillin allergic patients.

hypersensitivity reaction such as swelling or shortness of breath occurring with the first dose. The remaining patients were categorised as 'intermediate risk'. This included patients whose symptoms were severe but which did not occur with the first dose of penicillin, and patients who could not remember what happened. All patients were asked when the index 'allergic' reaction happened, with the options of within the past 6 months, within the last 10 yr, or more than 10 yr ago.

Anaesthetist survey

Data collected included grade and age range. Knowledge was explored using closed questions and clinical scenarios. Participants were asked what they would prescribe for a patient previously labelled as penicillin allergic but subsequently delabelled by an allergy specialist using a direct DPT to amoxicillin (see Supplementary Materials: Anaesthetist Survey). The anaesthetist survey was anonymous. Anaesthetists were not given any advice about prescribing penicillin to patients

Table 1 Patient characteristics. ENT, ear, nose, and throat; HPB, hepato-pancreato-billiary; UGI, upper gastro-intestinal.

Characteristic		All (*n*=21 281)	No PenA label (*n*=18 657)	PenA label (*n*=2624)	P-value (χ^2)
Age range, yr	18–25	1111 (5.2)	1014 (5.4)	97 (3.7)	<0.01
	26–50	6040 (28.4)	5321 (28.5)	719 (27.4)	
	51–75	9879 (46.4)	8610 (46.1)	1269 (48.4)	
	>75	4251 (20)	3712 (19.9)	539 (20.5)	
Sex	Female	11 939 (56.1)	10 146 (54.4)	1793 (68.3)	<0.01
	Male	9342 (43.9)	8511 (45.6)	831 (31.7)	
Type of surgery	Breast	334 (4.3)	248 (4.9)	86 (3.3)	<0.01
	Cardiac	75 (1)	45 (0.9)	30 (1.1)	
	Chronic Pain	227 (3)	155 (3.1)	72 (2.7)	
	Colorectal	242 (3.1)	165 (3.3)	77 (2.9)	
	Dental	153 (2)	90 (1.8)	63 (2.4)	
	ENT/Head & neck	633 (8.2)	406 (8)	227 (8.7)	
	General surgery (including UGI/HPB)	702 (9.1)	491 (9.7)	211 (8)	
	Gynaecology	893 (11.6)	574 (11.3)	319 (12.2)	
	Neurological	107 (1.4)	80 (1.6)	27 (1)	
	Non-theatre	66 (0.9)	42 (0.8)	24 (0.9)	
	Obstetrics	199 (2.6)	127 (2.5)	72 (2.7)	
	Ophthalmology	1102 (14.3)	699 (13.8)	403 (15.4)	
	Orthopaedics	1527 (19.9)	1040 (20.5)	487 (18.6)	
	Plastics	284 (3.7)	183 (3.6)	101 (3.8)	
	Spinal	104 (1.4)	66 (1.3)	38 (1.4)	
	Thoracics	57 (0.7)	41 (0.8)	16 (0.6)	
	Transplant	7 (0.1)	6 (0.1)	1 (0)	
	Urology	801 (10.4)	498 (9.8)	303 (11.5)	
	Vascular	176 (2.3)	109 (2.2)	67 (2.6)	
	Not recorded	13 592 (–)	13 592 (–)	0 (–)	

labelled as penicillin allergic during the study period, and individual anaesthetist responses were not linked to any patient they later anaesthetised.

Site survey

This determined local guidelines for antimicrobial prophylaxis (see Supplementary Materials: Site Survey).

Data handling and statistical analysis

Study data were collected and managed using REDCap (Research Electronic Data Capture) hosted at Anaesthesia.Audit on Scotland's Health on the Web (www.scot.nhs.uk) secure servers.[·] REDCap is a secure, web-based software platform designed to support data capture for research studies.[24,25] For detailed data handling, see Supplementary Figure S1.

Patient characteristics were summarised and differences between pertinent groups (patients with and without penicillin labels, risk stratification groups) compared using χ^2 tests. Where appropriate, univariable logistic regression was used to assess associations between predictor variables and binary outcome, with multivariable logistic regression used to assess independence of predictors. All statistical analyses were carried out in R, significance tests were two-sided, and *P*-values <0.05 were considered significant.

Results

Patient study

A total of 21 219 patients (see Table 1 for patient characteristics) consented to the study. Of these, 2626 (12%) self-reported 'allergy', 'sensitivity', or both to penicillin; two of these patients were excluded from further analysis as their records were incomplete. Among penicillin allergic patients, 274 (10%) also described allergy to at least one other antibiotic and 955 (36%) described allergy to at least one other non-antibiotic drug. In the penicillin allergic group, 68% were female compared with 54% of patients without this label and 56% of all patients. In univariable logistic regression, males were less likely to have a penicillin allergy label than females (odds ratio [OR]=0.55; 95% confidence interval [CI], 0.51–0.60; *P*<0.01). There was evidence of an increasing risk of having a penicillin allergy label with increasing age; for example patients in the 51–75 yr age group were more likely to report allergy than those in the 18–25 yr group (OR=1.54; 95% CI, 1.20–1.90; *P*<0.01) (Supplementary Table S2).

Rash was the most commonly reported feature (*n*=1445, 55%), occurring as a sole sign in 63% of those reporting it. Of patients with a rash, 795 (55%) stated it resembled a maculopapular rash (picture B in Appendix 3). See Table 2 for all symptoms reported.

Using the stratification model (Fig. 1), we determined that 27% (*n*=715) reported low-risk histories, 33% (*n*=861) high-risk histories, and 40% (*n*=1048) intermediate-risk histories. There was a greater likelihood of women having a high-risk label than men (OR=0.81 [for men]; CI, 0.68–0.97; *P*=0.02).

As the utility of skin testing to risk stratify patients decreases significantly over time, we determined the proportion of historic reactions (>10 yr) in our cohort. In the low-risk group 68% reported the index reaction as being >10 yr, 88% in the intermediate-risk group, and 73% in the high-risk group.

A minority (*n*=141, 5.4%) recalled having had undergone previous allergy testing; the nature of this testing was not elucidated. Most recalled a positive result (*n*=95, 67%), but 25%

Table 2 Nature of penicillin allergy: absolute numbers for each symptom, and relative incidence of each symptom. *Patients with only symptom summarized in column 1 (e.g. 1446 people had a rash, of whom only 912 had a rash and 543 also experienced another symptom). AGEP, acute generalised exanthematous pustulosis; DRESS, drug reaction with eosinophilia and systemic symptoms.

Characteristic	All (n=2624)	Patients with only each symptom*
Rash	1446 (55.1)	912 (63.1)
Blisters/skin peeling	173 (6.6)	47 (27.2)
Difficult to breathe, became wheezy, or both	219 (8.3)	21 (9.6)
Swelling	529 (20.2)	172 (32.5)
Dizzy or faint	146 (5.6)	33 (22.6)
Sick/vomited/had a sore stomach/had diarrhoea	482 (18.4)	241 (50)
Thrush	55 (2.1)	33 (60)
Anaphylaxis or a serious reaction	131 (5)	64 (48.9)
Stevens–Johnson syndrome/DRESS/AGEP	1 (0)	0 (0)
Other side-effect	175 (6.7)	95 (54.3)
Unknown	304 (11.6)	289 (95.1)

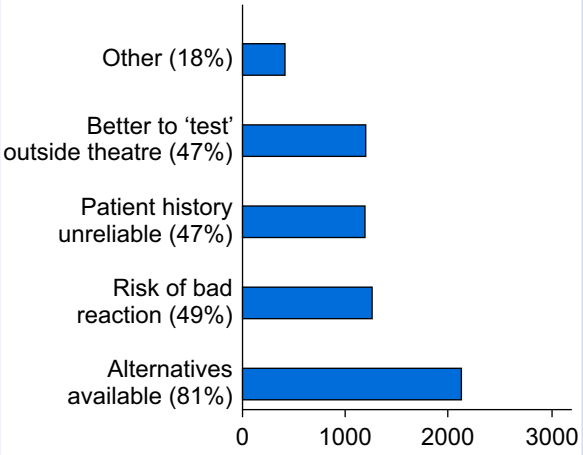

Fig 2. Why do 60% of anaesthetists 'always avoid' giving penicillin to a patient labelled as penicillin allergic?.

(n=35) could not remember the result. In those with positive test results, the majority (58, 61%) had a high-risk index reaction history. Of all those who had not previously received testing, 62% (n=1541) stated that they would like to be tested. Among those who did not (n=940, 38%), the most common reason was 'I would never take penicillin again, whatever the result' (n=408, 43%; see Supplementary Table S3). The risk category of the patient did not appear to influence likelihood of wanting to be tested (58% low-risk *vs* 62% intermediate-risk *vs* 55% of high-risk patients). Multivariable analysis showed an effect of age on whether the patient wished to be tested, with those in the >75 yr age range less likely to want this (OR=0.34; CI, 0.2–0.55; P<0.01). There was also an association with other patient characteristics; those reporting atopy were more likely to want testing (OR=1.21; CI, 1.01–1.45; P=0.03), and those reporting nausea and vomiting as their presenting 'allergic' feature were less likely to (OR=0.64; CI, 0.51–0.81; P<0.01). Among patients who wanted testing (n=1541), the majority (68%, n=1060) would be happy to have the label removed by an allergy specialist on the basis of history alone.

In those with a penicillin allergy label, 526 (20%) required penicillin for first-line antimicrobial prophylaxis. Penicillin was administered despite the allergy label in 34 of these (6%). It is not possible to know from our data whether these administrations were accidental or deliberate. Among those given penicillin despite the label, seven had a high-risk history, eight had an intermediate-risk history, and 19 a low-risk history. Second-line prophylaxis was given to 52% of the penicillin-allergic patients (n=251), whereas 39% (n=203) were given no antibiotics or an antibiotic non-standard for that hospital. Included in this latter group were an unidentified number of patients for whom antibiotic use was contingent on intraoperative events and may not have been required (e.g. antibiotic use in laparoscopic cholecystectomy only if the bile duct is injured). Two patients receiving alternative antibiotics suffered potential anaphylaxis (Supplementary Table S4); this was confirmed as anaphylaxis to a glycopeptide antibiotic in one, with no further details for the second. None who received penicillin had an adverse intraoperative event.

Anaesthetist study

A total of 4978 anaesthetists participated, of whom 64% (n=3051) were consultant grade, 12% associate specialists or staff grades, the remainder junior grade doctors (n=1158, 24%) or physician assistants (n=23, 0.5%). There was generally good understanding of which symptoms/signs were likely to reflect true allergy *vs* side-effect. For example, 94% (n=4492) stated that a history of 'anaphylaxis' was likely/highly likely to represent true allergy but a minority believed this to be unlikely/highly unlikely (5%, n=214). Although 72% (n=3425) believed nausea/diarrhoea were unlikely/very unlikely to represent true allergy, 7% (322) thought this was likely/highly likely to be an allergic problem (Supplementary Table S5).

When prescribing antibiotics to patients with penicillin allergy labels, 40% (n=1934) of anaesthetists stated they would give penicillin if they felt the label was 'highly unlikely to represent true allergy'; 60% (n=2829) stated they would always avoid penicillin in this situation. In the group who thought it appropriate to overrule the allergy label, we asked what actions they would take after an uneventful administration of penicillin, to inform other healthcare providers or the patient. Among responders, the majority (n=1357, 72%) would amend the anaesthetic chart, but few other reported actions would be taken, with 14% (n=266) telling the general practitioner and 65% (n=1235) telling the patient (Supplementary Table S6). Among anaesthetists who would always avoid penicillin in patients with a penicillin allergy label, there were multiple reasons with the single most common being the understanding that (non-inferior) alternatives to penicillin are available (Fig. 2).

Anaesthetists were asked whether they would administer a penicillin to a patient who had previously been de-labelled by an allergy specialist after an uneventful direct DPT with amoxicillin. About half (47%, n=2240) stated that they would administer a penicillin, with the remainder responding 'no' (n=633, 13%) or 'unsure' (n=1828, 38%). The two most common

reasons were that they would require formal guidelines from their hospital to support this action (*n*=1379, 56%), and that patients should undergo skin testing in order to be de-labelled (*n*=1247, 51%). There was concern that an oral DPT was an insufficient test for a patient subsequently requiring intravenous penicillin (*n*=667, 27%; Table 3). Of those anaesthetists confident to give penicillin to a patient whose label was 'highly unlikely' to be correct, only about half (*n*=1038, 54%) would be happy to give penicillin to a patient de-labelled using direct DPT by a specialist. Among anaesthetists not happy to give penicillin for 'highly unlikely' labels, 42% (*n*=1193) would be happy to give penicillin if the patient was de-labelled by a specialist. Among those anaesthetists who would accept the results of an oral DPT the majority (*n*=1856, 83%) stated that if the allergy specialist had 'de-labelled' the patient on the basis of history alone (no skin testing or DPT), they would still be confident to administer a penicillin.

When asked about the use of test doses for antibiotics, 49% (2319) stated they 'never' gave them, the remainder giving test doses routinely, or in selected patients. Anaesthetists who avoid penicillin in anyone with a penicillin allergy label were more likely to give a test dose routinely than anaesthetists who are happy to administer penicillin to someone with a label they judged to be incorrect (31% *vs* 24%; Supplementary Table S7).

Anaesthetists were not always aware of whether their site had guidelines on prescribing in patients with a penicillin allergy label. Of 203 sites, 63 had specific guidelines for how to assess risk of true penicillin allergy in patients with the label and prescribe accordingly. Expressed as the median range percentage, anaesthetists thought that such guidance existed in 30%. Conversely, where guidance did not exist, anaesthetists thought it did in 27% of sites. Among anaesthetists, 52% (*n*=2474) would avoid cephalosporins in patients with a label of penicillin allergy; 17% (*n*=804) would routinely prescribe a cephalosporin, and a further 25% (*n*=1154) would follow local guidelines on cephalosporin use. Of 203 sites, 97 had guidelines on prescribing of cephalosporins to patients with the label.

Discussion

This is the largest prospective multicentre study to date examining penicillin allergy in an unselected elective surgical population combined with detailed risk stratification. We have demonstrated a high incidence of reported penicillin allergy in this population, especially in older and female patients. In 27% of patients with the label, a direct DPT is likely to be suitable because the symptoms are low-risk for true allergy. This approach would significantly reduce the time and cost burden of testing and allow widespread testing. In a further 40%, the symptoms were not typical for a true allergic reaction because they did not appear immediately after taking the first dose; nevertheless, these symptoms warrant further detailed risk assessment by an allergy specialist before consideration for direct DPT. A notable finding in the intermediate group was that in 88% of these patients the reaction occurred >10 yr ago. It is important to note this is a population-based study; all patients require individualised assessment before testing.

Our study defines several key patient attitudes. A subgroup would never take penicillin again irrespective of the test result. Overall there was high demand for testing, largely unaffected by the severity of the index reaction. Patients do not appear to have preconceived ideas about how testing should be performed and would be happy to be de-labelled without formal testing if appropriate.

We have also determined the key attitudes and behaviours among anaesthetists in relation to penicillin allergic patients. Previously, the only large-scale work to examine anaesthetists' views on allergy was the 6th National Audit Project (NAP6) study.[26] One of this study's key findings was of flawed understanding around which drugs were most likely to cause allergic reactions, with penicillin perceived to be more likely to cause allergy than is the case in reality. In Drug Allergy Labels in Elective Surgical patients (DALES), we sought to gain a comprehensive understanding of anaesthetists' understanding of penicillin allergy and de-labelling, and to define real-life prescribing behaviours. We found that the majority of anaesthetists were able to appropriately categorise allergy histories that were clearly low or high risk. Apparent discrepancies in this understanding may simply reflect error in using the 0–5 scale.

We also demonstrated mixed prescribing habits in penicillin allergic patients with up to 40% of anaesthetists stating that they would administer penicillin to a patient with a label they judged to be incorrect. In the absence of training or specialist drug allergy knowledge this represents a potential

Table 3 Reasons for anaesthetists who stated 'no' or 'unsure' to whether they would give penicillin to a patient who had been de-labelled by a specialist using a direct oral drug provocation test. *n* (%). Multiple selections allowed.

Reason		No (n=633)	Unsure (n=1828)
My understanding is that patients should also be skin tested	Yes	372 (58.8)	875 (47.9)
	No	261 (41.2)	953 (52.1)
The penicillin received during testing might not be the same one I give in theatre	Yes	162 (25.6)	362 (19.8)
	No	471 (74.4)	1466 (80.2)
I will be giving intravenous penicillin during surgery but the testing was oral	Yes	201 (31.8)	466 (25.5)
	No	432 (68.2)	1362 (74.5)
I would never give penicillin to someone previously labelled as allergic, whatever the result of testing	Yes	70 (11.1)	57 (3.1)
	No	563 (88.9)	1771 (96.9)
I would require clear local guidelines to support the use of penicillin in this situation	Yes	298 (47.1)	1081 (59.1)
	No	335 (52.9)	747 (40.9)
Other reason(s)	Yes	35 (5.5)	145 (7.9)
	No	598 (94.5)	1683 (92.1)

patient safety issue. We found that anaesthetists, having given penicillin uneventfully, would not then cascade this information to other healthcare professionals or the patient, negating any long-term benefits from de-labelling. This also raises the issue of whether patients are appropriately consented for what is in effect a DPT. There is potential discrepancy between what anaesthetists say they will do and what they actually do; 40% claimed they would prescribe penicillin to low-risk label patients, whereas only 13% of low-risk patients who required penicillin on the study days received it. It is possible that study participation inflated the number of anaesthetists who stated they would prescribe penicillin to low-risk label patients (on the basis that participation in the study raised awareness about the issue) without greatly influencing the number who had the confidence to put it into practice. However, this discrepancy might also be explained by low-risk patients coincidentally not being cared for on the study days by those anaesthetists who would give penicillin to low-risk patients. Because the anaesthetist survey was anonymous, we could not link individual anaesthetist responses to actual prescribing during the study.

Our most significant finding was that fewer than half of anaesthetists would be confident administering penicillin to a patient who has previously been de-labelled by an allergy specialist using direct DPT. Key reasons include misunderstanding of allergy testing and perceived lack of support from their hospital. These are likely to be the greatest barrier to any effective programme of systematic de-labelling in surgical patients and could potentially be addressed with greater education and structured guidance within hospitals.

Other findings of note include the high incidence of penicillin allergic patients receiving non-standard antibiotics for surgery, or no antibiotics at all. We cannot determine from our data what the reasons were for this or what impact this had on surgical outcomes.

There are several limitations to this study. Firstly, data collected on symptoms of the index reaction were limited. Secondly, the inclusion of rash pictures in the survey may not have added value to the description and may have been misleading. The quality of these pictures likely varied depending on the electronic device used to display these. Thirdly, because the anaesthetic survey was anonymous, we did not link individual anaesthetists to patients and therefore could not identify differences between stated and actual prescribing habits on the study days for any individual.

Conclusions

Penicillin allergy labels are easy to acquire and difficult to lose. We have identified key attitudes and behaviours among both doctors and patients which might be relevant to this problem. Our findings are likely to be representative of the UK elective surgical population and may translate across different groups of patients. We found a high demand for testing among patients, with at least 27% suitable for direct DPT, and a further 40% potentially suitable for this after detailed assessment by an allergy specialist. Anaesthetists exhibit potentially unsafe prescribing habits in patients with the label, and there are several important misconceptions around penicillin allergy testing. The persistent avoidance of penicillin by clinicians in the face of negative testing is a key problem warranting further exploration; de-labelling is futile if it does not translate to future penicillin use. Some concerns might be allayed with additional guidance from hospitals. However, if anaesthetists are to take ownership of the problem of incorrect penicillin allergy labels as part of perioperative medicine, there is also a significant educational gap to bridge.

Authors' contributions

Statistical analysis: MW
Writing of the manuscript: MW, SS, PH
Study inception and design: SS, PH
Contribution to all aspects of the study: LS, CT, SC, DF

Declarations of interest

The authors declare that they have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2020.07.048.

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