

Eliciting the barriers and enablers towards anaesthetists giving penicillin-based antibiotic prophylaxis to low-risk patients who have had their penicillin allergy label removed as part of a preoperative delabelling process

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Background: Some penicillin allergy labels can be removed by non-allergy specialists by direct oral challenge, but there is reluctance amongst anaesthetists to give penicillin to these patients. We aimed to assess anaesthetist beliefs about giving penicillin to patients delabelled by direct oral challenge.

Methods: A survey, developed using the Theoretical Domains Framework, was circulated to anaesthetists within a regional research network in England. Domains were rated using 5-point Likert scales. Overall and group medians were used to dichotomize domains rated by group into ‘relatively important/unimportant’ and ‘relative enabler/barrier’.

Results: We received 257 responses from six hospitals (response rate 49.7%). Seven domains were rated as important for all stakeholder groups and hospitals: *Knowledge, Skills, Belief in Capabilities, Belief in Consequences, Memory/Attention/Decisions, Environmental Context and Resources, and Emotions*. *Social and Professional Role* was also important to all respondents except those in one hospital. *Intentions* and *Optimism* were rated as important for some groups/hospitals and unimportant for others. All four other domains were rated as unimportant for all groups/hospitals. All domains rated as important were enablers for all groups/hospitals, with the exception of *Memory/Attention/Decisions* and *Emotions*, which were rated as discordant barriers/enablers between groups. This means they were acting as a barrier for some staff groups/hospitals and an enabler for others. Barrier domains (*Reinforcement, Goals, Social Influences, Behavioural Regulation*) were all rated unimportant.

Conclusions: Behavioural influences on giving penicillin prophylaxis to a delabelled patient are complex and nuanced. These findings could inform targeted interventions, both across and within hospitals and staff groups.

Introduction

Penicillin allergy records prevent many patients from receiving first-line prophylaxis with penicillins prior to surgery. Over 90% of the 6% of the UK population who report a penicillin allergy do not actually have a penicillin allergy after formal allergy assessment.^{1,2} Patients with a penicillin allergy record are often prescribed glycopeptides, like teicoplanin, as an alternative, but teicoplanin is now reported to be the most common cause of

severe perioperative anaphylaxis in the UK.³ Moreover, alternatives to penicillin are associated with future MDR infections, treatment failure, adverse drug reactions, longer length of stay, higher readmission rates and increased surgical site infections.⁴ Delabelling of penicillin allergy has been shown to reduce use of vancomycin and hence intraoperative time.⁵ There are potentially significant benefits to patients and healthcare systems in using first-line penicillin for perioperative prophylaxis instead of non-penicillin alternatives.⁶

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In the UK, and elsewhere, patients with a penicillin allergy have traditionally been allergy assessed and delabelled via formal review by allergists. Testing in this way is resource intense and access to such services is limited.⁷ There are moves, therefore, to set up delabelling services for patients outside of allergy services, using less resource intense diagnostic methods such as decision support tools, to identify appropriate low-risk patients, and to delabel via oral challenge testing without prior skin testing, termed direct oral challenge.⁶ After a negative penicillin test the patient has the same baseline population risk for penicillin allergy, and as such, can safely be administered penicillin.⁸

A survey found 47% of UK anaesthetists were willing to administer penicillin to patients who have been delabelled via direct oral challenge, but 13% said they would not, and 38% were unsure.³ Reported reasons for uncertainty/unwillingness included lack of hospital guidance and a misunderstanding of allergy testing.³ Clinician prescribing practice is a behaviour, and as such can be investigated using behavioural theory. Theoretical approaches to explaining clinician behaviour, such as the Theoretical Domains Framework (TDF), have been applied in multiple healthcare scenarios, including blood transfusion and sepsis.^{9,10} The TDF presents 14 domains representing individual, socio-cultural and environmental influences on behaviour (Figure 1).¹¹ The domains represent 83 more specific constructs summarizing multiple earlier behaviour change theories. TDF domains can be used to identify the most relevant influences on a target behaviour and to select associated behavior change techniques, which can be used to design tailored interventions.^{12,13} Identification of factors affecting anaesthetist prescribing behaviour are vital to designing theory-informed interventions to improve prescribing of penicillin when an incorrect allergy label has been removed.

Our objective was to assess the views of anaesthetists in giving penicillin perioperatively to a patient who had been delabelled via direct oral challenge, using a survey based on the TDF, to identify the most important influences on prescribing behaviour.

Methods

This project was undertaken in anaesthetic departments in the six hospital trusts that form a regional anaesthetic trainee research network in the UK. Hospital size ranged from a small district general hospital (293 beds) to a large tertiary centre (1000 beds).

All anaesthetists [consultants, Staff and Associate Specialist (SAS) grades, specialty trainee/registrar, core trainee/Senior House Officers (SHOs)] were identified from departmental rotas at each site. Consent was obtained for participation and publication. There was no requirement for formal ethics committee approval under Health Research Authority criteria.

We developed a questionnaire that included 28 questions (Supplement 1, available as Supplementary data at JAC-AMR Online) based on the 14 domains of the TDF. It was trialled on expert stakeholders and minor changes to wording were made. A scenario was provided to participants where they were asked to consider administering a dose of IV penicillin as perioperative antibiotic prophylaxis to an elective surgical patient who had been identified as low risk for genuine penicillin allergy via a decision support tool and had a negative response to a direct oral penicillin challenge (DOC) in preassessment clinic. Participants were asked to rate each domain based on whether it currently acts as a barrier or enabler to them giving penicillin in the scenario (agreement), and on overall importance to their decision (as important or unimportant). Participants rated domains on a Likert scale 1 to 5, with 1 being 'very

unimportant, strongly disagree' to 5 being 'very important, strongly agree'. The questionnaire was completed on GoogleForms (<https://docs.google.com>).

Data collection took place over an 8 week period from February to April 2021. Participants were invited by e-mail and text message to complete a linked questionnaire. Weekly reminders were sent, and comparative site response rates were shared in order to encourage completion.

Median scores for each domain were calculated. Domains were ranked for agreement and importance: agreement as to whether the domain was considered a barrier or an enabler to the intervention (administering IV penicillin to a patient recently delabelled via DOC in pre-op clinic); and importance of the domain to enabling the behaviour to occur. Likert scales carry no guarantee that participants have the same baseline, or the same intervals between points. However, one can use relative importance and agreement compared with a sample average, to identify practical targets for intervention design.¹⁰ Median agreement and importance were therefore calculated for the questionnaire as a whole to give a sample baseline and allow dichotomization of domains into relative important/unimportant and relative barrier/enabler when compared with this median, for each group/hospital.¹⁰ This aimed to identify the domains that were most important to address in any subsequent intervention, and to elicit whether they should be addressed for all, or only for certain groups/hospitals.

Results

Participant characteristics

We received 257 responses from 517 potential participants in six hospitals. The overall response rate was 49.7% (range between hospitals 33.3%–66.2%). Response rates were as follows: 155/296 (52.4%) consultants; 38/81 (46.9%) registrars; 33/90 (36.7%) SHOs; and 31/49 (63.3%) SAS grades.

Barriers and enablers (Figure 2)

There were eight domains that were considered to be enablers for penicillin administration, when grouped overall, as well as across all staff groups. Respondents reported they have the knowledge (*Knowledge*) and skills (*Skills*) to administer penicillin in the described scenario and believed it to be part of their role (*Social and Professional Role*). Respondents reported themselves to be capable of giving penicillin to these patients (*Belief in Capabilities*), believed it is possible to successfully delabel these patients (*Optimism*) and that doing so would lead to positive outcomes for the patient (*Belief in Consequences*). Respondents reported that they have the resources they need to administer penicillin to these patients (*Environmental Context and Resources*), and expressed an intention to administer penicillin to these patients in the future (*Intentions*).

There were four domains with negative responses overall, as well as across all staff groups. Respondents reported they would not be rewarded (*Reinforcement*) for giving penicillin to these patients and that they would not receive feedback about this practice (*Behavioural Regulation*). Respondents reported that their colleagues' opinions would be more of a barrier towards giving these patients penicillin (*Social Influences*) and that currently this is not a goal for respondents (*Goals*).

There were two domains with positive overall responses, but responses differing between the staff groups. Overall, respondents reported they would not find it difficult to make the decision to give penicillin to these patients (*Memory, Attention and*

| Domain | Content | Sample question |
|-------------------------------|--|---|
| Knowledge | An awareness of something | I do (not) have enough knowledge to give penicillin to this patient |
| Skills | Ability or proficiency acquired through practice | I do (not) have the required skills to manage penicillin administration in this patient |
| Social/Professional Role | Set of behaviours and qualities of an individual in social or work setting | It is (not) part of my role to give penicillin in this situation |
| Beliefs about Capabilities | Views about one's ability/talent/capability to perform the target behaviour(s) | I would find it easy/difficult to give penicillin to this patient |
| Optimism | Confidence that things will happen for the best or that desired goals will be attained | I do (not) believe that this group of patients can be successfully de-labelled |
| Beliefs about Consequences | Acceptance of the truth, reality or validity about outcomes of a behaviour in a given situation | I believe that giving penicillin to these patients (instead of an alternative) would lead to positive/negative outcomes |
| Reinforcement | Increasing the likelihood of a behaviour being performed by establishing an association between performing a behaviour and a given stimulus or cue | I will (not) get rewarded for giving penicillin to this patient |
| Intentions | Conscious decision to perform a behaviour or resolve to act in a certain way | I (do not) intend to give penicillin to this group of patients in the future |
| Goals | Mental representation of outcomes or states that an individual wants to achieve | I do (not) have a goal to give penicillin to this patient |
| Memory/Attention/Decisions | The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives | I would find it easy/difficult to make the decision to give penicillin to this patient |
| Environment/Context/Resources | Circumstances of a person's situation/environment that affect behaviour | I (do not) have the resources I need to give penicillin to this patient |
| Social Influences | Interpersonal processes that can cause individuals to change thoughts/feelings/behaviours | My colleagues would have a positive/negative opinion about giving penicillin to this patient |
| Emotions | Complex reaction pattern by which individual attempts to deal with a personally significant matter or event | I am worried or concerned/happy and relaxed about giving penicillin to this patient |
| Behavioural Regulation | Anything aimed at managing or changing objectively observed or measured actions | I will (not) receive feedback after giving penicillin to this patient |

Figure 1. Theoretical Domains Framework.¹¹

Decisions), with consultants and SAS reporting the same. However, Specialty Trainees (ST)/registrars and Core Trainees (CT)/SHOs reported that they would find it difficult to make that decision. Overall, respondents reported not being worried or concerned (*Emotions*) about giving penicillin to these patients, with consultants responding the same. However, the other staff groups would be concerned about giving penicillin to these patients.

Importance (Figure 3)

There were eight domains that overall were considered important in relation to penicillin prescribing in a delabelled patient with positive responses overall, as well as and across all staff groups. Having enough knowledge (*Knowledge*) and the skills (*Skills*) to give penicillin to these patients, whether doing so was part of their role (*Social and Professional Role*), how difficult or

| Group | Overall | Consultants | ST/Registrar | CT/SHO | SAS |
|-------------------------------------|---------|-------------|--------------|--------|------|
| Knowledge | 4.50 | 4.59 | 4.49 | 4.12 | 4.50 |
| Skills | 4.72 | 4.83 | 4.69 | 4.21 | 4.77 |
| Social and Professional Role | 4.53 | 4.57 | 4.49 | 4.33 | 4.57 |
| Belief in Capabilities | 4.33 | 4.53 | 3.92 | 3.79 | 4.43 |
| Optimism | 4.63 | 4.67 | 4.56 | 4.48 | 4.67 |
| Belief in Consequences | 4.41 | 4.52 | 4.15 | 4.33 | 4.27 |
| Reinforcement | 2.43 | 2.37 | 2.41 | 2.21 | 2.97 |
| Goals | 3.54 | 3.53 | 3.41 | 3.45 | 3.90 |
| Memory, Attention and Decisions | 4.23 | 4.45 | 3.85 | 3.64 | 4.23 |
| Environmental Context and Resources | 4.49 | 4.62 | 4.31 | 4.12 | 4.47 |
| Social Influences | 3.83 | 3.91 | 3.77 | 3.64 | 3.73 |
| Emotions | 4.08 | 4.28 | 3.77 | 3.52 | 4.03 |
| Behavioural Regulation | 2.88 | 2.81 | 2.77 | 2.61 | 3.70 |
| Intentions | 4.44 | 4.52 | 4.21 | 4.24 | 4.60 |
| Group Mean | 4.07 | 4.16 | 3.91 | 3.76 | 4.20 |

Figure 2. Numerical agreement ratings for each domain, sorted by stakeholder group. Green/bold = relative enabler; red/standard = relative barrier.

easy they found doing so (*Belief in Capabilities*), a belief that doing so improved patient outcomes (*Belief in Consequences*), whether it was easy to decide whether to give these patients penicillin (*Memory, Attention and Decisions*), whether the required resources were available (*Environmental Context and Resources*), and how comfortable or concerned respondents were about administering penicillin to these patients (*Emotions*) were all rated as important.

How optimistic respondents felt that these patients can be successfully delabelled in this way (*Optimism*) was rated as important overall, and by consultants and ST/registrar, but both the CT/SHO and SAS groups reported *Optimism* was not important when considering giving penicillin to a patient delabelled in the described way.

Four domains were rated as unimportant across all staff groups. Staff felt that it was unimportant that they were rewarded (*Reinforcement*), that giving penicillin to delabelled patients was a personal goal (*Goals*), their colleagues' opinion (*Social Influences*) and whether they received feedback (*Behavioural Regulation*).

Overall results by staff group

When read together overall, the following domains were both important and enablers (i.e. respondents felt that these domains are important and that they are already met): *Knowledge*; *Skills*; *Social and Professional Role*; *Belief in Capabilities*; *Optimism*; *Belief in Consequences*; *Memory, Attention and Decisions*; *Environmental Context and Resources*; *Emotions*; and *Intentions*.

Overall, and by all staff groups, *Reinforcement*, *Goals*, *Social Influences* and *Behavioural Regulation* were reported to be barriers but also reported to not be important, i.e. not meeting these domains would be unlikely to impede the intervention.

There were no domains that, for the overall sample, were classed to be both important, and a barrier.

Memory, Attention and Decisions, and *Emotions*, although rated as an enabler overall, demonstrated discordance between

| Domain | Overall | Consultants | ST/Registrar | CT/SHO | SAS |
|-------------------------------------|---------|-------------|--------------|--------|------|
| Knowledge | 4.71 | 4.66 | 4.74 | 4.64 | 4.97 |
| Skills | 4.70 | 4.70 | 4.54 | 4.67 | 4.93 |
| Social and Professional Role | 4.04 | 3.95 | 4.21 | 3.97 | 4.40 |
| Belief in Capabilities | 4.07 | 4.01 | 4.15 | 4.03 | 4.27 |
| Optimism | 3.98 | 3.99 | 3.92 | 3.79 | 3.85 |
| Belief in Consequences | 4.32 | 4.26 | 4.38 | 4.42 | 4.37 |
| Reinforcement | 1.93 | 1.95 | 1.85 | 1.82 | 2.07 |
| Goals | 3.07 | 3.08 | 3.13 | 3.00 | 3.00 |
| Memory, Attention and Decisions | 4.08 | 4.05 | 4.00 | 3.97 | 4.47 |
| Environmental Context and Resources | 4.39 | 4.26 | 4.46 | 4.39 | 4.93 |
| Social Influences | 3.18 | 3.01 | 3.31 | 3.30 | 3.73 |
| Emotions | 4.30 | 4.22 | 4.23 | 4.58 | 4.53 |
| Behavioural Regulation | 3.04 | 2.78 | 3.15 | 3.30 | 3.93 |
| Intentions | 3.86 | 3.83 | 3.79 | 3.76 | 4.23 |
| Group Mean | 3.83 | 3.77 | 3.85 | 3.83 | 4.15 |

Figure 3. Numerical importance ratings for each domain, sorted by stakeholder group. Green/bold = relatively important; red/standard = relatively unimportant.

staff groups. ST/registrar and CT/SHOs reported that they would find it difficult to make the decision to give these patients penicillin, and both staff groups rated this an important domain. Likewise, ST/registrar, CT/SHOs and SAS rated *Emotions* a barrier and rated this domain important, i.e. they reported that they have concerns about giving these patients penicillin and these concerns would be a barrier.

Results by hospital

Broadly, analysing results by individual hospital (Figures 4 and 5) reflects those of the overall findings in Figures 2 and 3. However, there are differences between hospitals as shown in Figures 4 and 5 and when compared with the overall findings in Figures 2 and 3.

In contrast to the overall findings, respondents from Hospital 6 believed themselves not to be capable of giving penicillin to these patients (*Belief in Capabilities*) and reported this as an important domain. Therefore, *Belief in Capabilities* was an important barrier domain to their giving the drug to these patients.

Hospital 5 reported not believing that giving penicillin would have a positive outcome for the patient (*Belief in Consequences*) and reported that this was important to them in giving the drug. Therefore, not believing in the positive consequences is a barrier in this hospital.

Overall, when all staff groups were combined, four of six hospitals reported being worried or concerned (*Emotions*) about giving penicillin to these patients, contrary to the combined findings, which showed that overall, across all staff groups and all hospitals, participants were not worried or concerned. All hospitals identified this an important domain and therefore these concerns are an important barrier in these four hospitals.

Discussion

This study explored anaesthetists' beliefs about administration of penicillin to patients who have had their penicillin allergy label formally removed after being identified as having a low-risk allergy history, and tolerated a direct oral challenge test in a non-allergist-led

| Domain | Hospital 1 | Hospital 2 | Hospital 3 | Hospital 4 | Hospital 5 | Hospital 6 |
|-------------------------------------|------------|------------|------------|------------|------------|------------|
| Knowledge | 4.71 | 4.45 | 4.24 | 4.61 | 4.65 | 4.17 |
| Skills | 4.79 | 4.65 | 4.65 | 4.73 | 4.79 | 4.67 |
| Social and Professional Role | 4.36 | 4.59 | 4.54 | 4.61 | 4.83 | 4.38 |
| Belief in Capabilities | 4.50 | 4.18 | 4.20 | 4.55 | 4.70 | 3.63 |
| Optimism | 4.77 | 4.53 | 4.59 | 4.67 | 4.83 | 4.25 |
| Belief in Consequences | 4.62 | 4.33 | 4.46 | 4.51 | 4.00 | 4.08 |
| Reinforcement | 2.50 | 2.49 | 2.33 | 2.29 | 2.35 | 2.67 |
| Goals | 3.77 | 3.59 | 3.35 | 3.55 | 3.26 | 3.46 |
| Memory, Attention and Decisions | 4.42 | 4.08 | 4.09 | 4.51 | 4.43 | 3.46 |
| Environmental Context and Resources | 4.59 | 4.53 | 4.43 | 4.55 | 4.57 | 4.04 |
| Social Influences | 4.03 | 3.82 | 3.80 | 3.94 | 3.65 | 3.33 |
| Emotions | 4.15 | 3.98 | 3.98 | 4.47 | 4.26 | 3.29 |
| Behavioural Regulation | 2.94 | 2.69 | 2.91 | 2.78 | 3.26 | 2.92 |
| Intentions | 4.64 | 4.35 | 4.22 | 4.61 | 4.57 | 4.08 |
| Group Mean | 4.20 | 4.02 | 3.99 | 4.18 | 4.15 | 3.73 |

Figure 4. Numerical agreement ratings for each domain, sorted by hospital. Green/bold = relative enabler; red/standard = relative barrier.

delabelling service. Domains identified as important to anaesthetists prescribing penicillin to delabelled patients were predominantly domains that anaesthetists also reported as enablers, i.e. these were domains that they considered to be already met, and included: *Knowledge*, *Skills*, *Belief in Capabilities*, *Belief in Consequences*, *Environmental Context and Resources*, and *Social and Professional Role*. These domains would need reinforcing across all groups/hospitals in an intervention, to ensure they remained supported. *Emotions* and *Memory/Attention/Decisions* were two discordant domains that were identified as important, but that were considered barriers for some groups, i.e. domains that are not already met. These would need particular attention within the groups/hospitals for which they were a barrier, in order to transform them to important enablers. Domains currently acting as barriers were not felt to be important overall in terms of whether the anaesthetist would give penicillin or not and therefore any intervention would likely not require these unimportant barrier domains to be addressed for any groups or hospitals.

The DALES (Drug Allergy Labels in Elected Surgical patients) study surveyed anaesthetists' understanding of drug allergy testing and identified misunderstanding of the place for different allergy testing methods, with a high proportion of anaesthetists believing patients should undergo skin testing to rule out penicillin allergy. This belief is cited as a major reason for anaesthetists not being willing to give penicillin to patients delabelled by direct oral challenge.^{6,14} In our study, knowledge was not a barrier, i.e. anaesthetists in our survey believed they have the knowledge required to be able to give penicillin to a patient delabelled by direct oral challenge. Our study explored other important domains that might determine behaviour and need to be addressed in order for delabelled patients to be given penicillin perioperatively. Contrary to DALES' perceived lack of support being the main barrier, our study suggests that *Social Influences* is an unimportant domain affecting anaesthetist behaviour in this situation. DALES reports the need for local guidelines, which may represent support required to meet *Knowledge*, *Skills*, and *Memory, Attention and Decisions* domains, which we identified as important in our study.⁶

| Domain | Hospital 1 | Hospital 2 | Hospital 3 | Hospital 4 | Hospital 5 | Hospital 6 |
|-------------------------------------|------------|------------|------------|------------|------------|------------|
| Knowledge | 4.56 | 4.51 | 4.83 | 4.84 | 4.83 | 4.92 |
| Skills | 4.67 | 4.63 | 4.67 | 4.73 | 4.78 | 4.79 |
| Social and Professional Role | 3.76 | 4.10 | 4.15 | 4.22 | 4.26 | 3.92 |
| Belief in Capabilities | 4.11 | 3.94 | 4.04 | 4.02 | 4.43 | 4.00 |
| Optimism | 3.54 | 3.59 | 3.71 | 3.60 | 3.50 | 3.70 |
| Belief in Consequences | 4.33 | 4.39 | 4.59 | 4.27 | 3.96 | 4.04 |
| Reinforcement | 1.76 | 2.22 | 1.93 | 1.88 | 1.74 | 2.08 |
| Goals | 3.14 | 3.33 | 3.02 | 3.08 | 2.70 | 2.79 |
| Memory, Attention and Decisions | 3.98 | 3.96 | 4.24 | 4.24 | 3.96 | 4.04 |
| Environmental Context and Resources | 4.38 | 4.24 | 4.43 | 4.37 | 4.52 | 4.50 |
| Social Influences | 3.12 | 3.14 | 3.35 | 2.90 | 3.09 | 3.75 |
| Emotions | 4.36 | 4.16 | 4.37 | 4.35 | 4.30 | 4.21 |
| Behavioural Regulation | 2.94 | 2.88 | 3.04 | 3.10 | 2.87 | 3.67 |
| Intentions | 4.03 | 3.71 | 3.91 | 3.73 | 3.96 | 3.79 |
| Group Mean | 3.78 | 3.79 | 3.91 | 3.85 | 3.80 | 3.90 |

Figure 5. Numerical importance ratings for each domain, sorted by hospital. Green/bold = relatively important; red/standard = relatively unimportant.

Our study presents a more nuanced picture than previous research, in particular demonstrating differences between roles and between hospitals. Junior medical staff (ST/registrar and CT/SHO) reported that they would find it difficult to make the decision to give these patients penicillin, and that they would experience negative emotions about giving these patients penicillin. Any intervention would need to address this to enable this staff group to give penicillin to patients delabelled by direct oral challenge. There was also some discordance between hospitals, with some not believing themselves capable of administering penicillin to this patient group, lacking belief in the positive consequences of giving these patients penicillin, and relatively negative emotions about giving these patients penicillin. This may explain the variation in prescribing habits found in DALES and offers insights in to why it may occur.

Strengths and limitations

This was a large multicentre study across all grades of anaesthetists within a region. The DALES study identified that anaesthetists were hesitant to give penicillin to delabelled patients.⁶ We used a theory-based implementation science framework, the TDF, to explore a broader range of potential influences on behaviours around penicillin use post-delabel and in more depth. The use of TDF makes this study replicable in other populations, with the findings used to develop a targeted behaviour change intervention that empowers anaesthetists to give penicillin to delabelled patients. Without addressing this step a delabel service will likely have limited impact on increasing the use of penicillin in more patients perioperatively.

The high response rate provided a good representation of anaesthetists' beliefs across six hospitals in the region. As with all non-mandatory questionnaire studies, participation bias is a risk, with those taking part potentially more likely to be engaged with prescribing in patients with a penicillin allergy or with quality improvement. However, the large sample size may reduce this risk of bias. Overall, the results had a positive skew towards

'important' and 'enabler', but the method used to assess for relative importance/agreement allowed each participant to have a different 'baseline' on the Likert scale, and as such the skew should not affect results in terms of producing practically useful results for intervention design. Regular, iterative, multidisciplinary discussions took place throughout the study to improve consensus and reduce subjectivity of interpretation. Though unusual, the data analysis method used has been used elsewhere in implementation literature to provide practically useful results.¹⁰

Consultants had the greatest representation and as such the overall response was strongly influenced by consultant responses. We did not analyse at the level of individual staff groups within hospitals because the potential small sample size in this case was at risk of compromising internal validity. Consultants play a key role within departmental culture and training and as such hold strong influence over junior staff and are arguably the most important group to consistently influence for any subsequent behaviour change intervention, so this may not be important in practical terms. However, we did analyse separately by staff group and hospital to look for differences, with those found highlighted in the results.

Next steps

Our study included anaesthetists working in one allergy network of hospitals in the UK's National Health Service (NHS), and therefore the findings may not be generalizable to anaesthetists working in other allergy networks or to other healthcare worker groups. Assessing on a larger scale across the country, or within different settings, e.g. another country or comparing private with state-run healthcare. Within the network studied, the data already gathered can be used to design targeted behaviour change interventions through matching behaviour change techniques to the most important domains as per established behavioural science methodology. Further focus groups studying these domains could elicit detail around local barriers and enablers within hospitals and to focus on the domains identified for specific staff groups described earlier. For example, we identified that *Emotion* and *Memory, Attention and Decisions* were important barriers for non-consultant doctors and therefore this group may have specific training needs for decision making and to address the emotional challenges of perioperative drug administration. Intervention design should focus initially on important discordant domains, because an important barrier may be converted to important enabler, as well as other important domains, which in this case are all enablers to be reinforced. Though the barrier domains are described as unimportant by participants, a truly comprehensive intervention could also mitigate against these. An example process could use the Behaviour Change Wheel and Taxonomy v1 to design a full intervention by matching specific Behaviour Change Techniques to domains (e.g. 'Demonstration of the behaviour' to 'Skills' or 'Social Comparison' to 'Social Influences'). This intervention should sit within an implementation process including measured outcomes and Plan-Do-Study-Act cycles.^{15,16}

Conclusions

Influences on the clinical behaviour of an anaesthetist giving perioperative penicillin prophylaxis to a patient who has had a penicillin allergy label removed are complex and nuanced, to a greater

degree than described in existing literature. The findings of this study could be used to inform interventions to improve the use of penicillin in delabelled patients when novel delabelling services are implemented. Improving knowledge and understanding of the delabelling process amongst anaesthetists, as previously described,⁶ is crucial, but there are multiple other important domains. As discordant domains, *Memory/Attention/Decisions* and *Emotions* should be targeted within any proposed intervention, along with important enabler domains *Knowledge, Skills, Belief in Capabilities, Belief in Consequences, Environmental Context and Resources*, and *Social and Professional Role*. Targeting these should make improving penicillin use amongst anaesthetists post delabelling more likely.

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Transparency declarations

There was no other involvement of outside agencies and no influence on any aspect of the study. No other competing interests are declared.

Supplementary data

Supplement 1 is available as [Supplementary data](#) at JAC-AMR Online.

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