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Penicillin Allergy Delabeling in a German University Hospital – Implementation in Inpatient Settings: the PenGuin Pilot Study

Hannah Nürnberg

Hannah.nuernberg@med.uni-heidelberg.de

University Hospital Heidelberg

Katrin Hörth

University Hospital Heidelberg

Kristin Egenberger

University Hospital Heidelberg

Stefanie Amelung

University Hospital Heidelberg

Elena Jaszkowski

University Hospital Heidelberg

Julia Bauer

University Hospital Heidelberg

Carolin Deiß

University Hospital Heidelberg

Ute Chiriac

University Hospital Heidelberg

Alexandra Weber

University Hospital Heidelberg

Anne Wiesner

University Hospital Heidelberg

Britta Kölking

University Hospital Heidelberg

David Martin

University Hospital Heidelberg

Miriam Pasinato

University Hospital Heidelberg

Tilman Schöning

University Hospital Heidelberg

Claudia Maria Denkinger

University Hospital Heidelberg
Benedict Morath
University Hospital Heidelberg
Elham Khatamzas
University Hospital Heidelberg

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Abstract

Background

Penicillin allergy (PenA) is reported in up to 15% of hospitalized patients, although true IgE-mediated hypersensitivity is rare. PenA delabeling is an important antimicrobial stewardship intervention, as mislabeling is associated with adverse clinical outcomes. While structured delabeling interventions are safe and effective, their translation into routine care across different healthcare settings remains unclear.

Methods

This prospective implementation study was conducted on four wards of a 2600-bed German tertiary care center. All adult inpatients with reported PenA underwent structured allergy assessment and risk stratification by clinical pharmacists. Low risk patients were delabeled directly, while moderate-risk patients were evaluated for direct oral challenge (DOC). Outcomes included delabeling rate at discharge, ward-specific differences, and implementation barriers and facilitators assessed by staff questionnaires. Sustainability was evaluated by primary care follow-up 32 weeks after discharge.

Results

Among 2890 screened patients, 179 (6.2%) reported a PenA. Of 162 eligible patients, 54 (33.3%) were successfully delabeled. DOC was well tolerated, with only one mild skin reaction observed. Ward-specific environments influenced the use of different delabeling strategies. Key barriers included staffing shortages, short hospital stays, and patient-related factors, whereas facilitators included easy integration into pharmacist workflows and interprofessional collaboration. Follow-up showed limited transfer of delabeling outcomes to primary care, reducing long-term sustainability.

Conclusion

Pharmacist-led PenA delabeling can be safely integrated and is feasible within existing clinical workflows. However, real-world implementation barriers and incomplete transfer to primary care limited its full potential. Improve standardized documentation and cross-sector communication are essential for sustainable and widespread implementation of delabeling strategies.

INTRODUCTION

Penicillin allergy (PenA) labels affect up to 15% of hospitalized patients, although most of these labels are not confirmed as true immune-mediated allergies [1]. Mislabeling has significant consequences for patient care, including increased use of second-line antibiotics, higher rates of antimicrobial resistance,

longer hospital stays, as well as higher treatment costs [2–6]. Consequently, penicillin allergy delabeling (i.e. removing false penicillin allergy labels) has become part of antimicrobial stewardship programs worldwide [7]. International data, primarily from the United States, the United Kingdom, and Australia, have shown that structured delabeling interventions are both safe and effective, even when performed by non-allergists such as pharmacists and ward physicians [8–12]. Within interprofessional antimicrobial stewardship programs, pharmacists are well positioned to initiate and coordinate structured penicillin allergy assessments and delabeling [13]. Studies on delabeling demonstrate that standardized risk stratification with tools like the PEN-FAST score, combined with direct oral provocation testing for selected patients, can successfully remove incorrect penicillin allergy labels [14–17]. However, despite growing evidence, knowledge gaps remain such as the sustained translation and implementation of penicillin allergy delabeling strategies into different healthcare systems. A recent systematic review demonstrated variability in delabeling strategies and effectiveness across settings, suggesting that successful delabeling depends on local structures and available resources [18]. Within the German healthcare setting it is however unclear how such interventions can be effectively integrated into clinical inpatient routine without additional staffing or structural resources. Prospective implementation studies are missing in non-prescribing pharmacists setting, and documentation practices, clinical responsibilities, and availability of allergy services vary across institutions [19]. In addition, the long-term sustainability of delabeling, particularly for the time after discharge into primary care remains unexplored for Germany. Thus, this study aimed to address these knowledge gaps by providing the first real-world data on the implementation of a pharmacist-led structured delabeling intervention in a German university hospital. This study focuses on impact of interprofessional collaboration, intersectoral communication, as well as barriers and facilitators of implementation.

METHODS

Setting

This prospective quality improvement study was conducted at a German tertiary care center with 2.600 beds. The study involved four wards where clinical pharmacists routinely perform medication reconciliation and are members of the interprofessional team. Participating wards included cardiac and vascular surgery, ear-nose-throat (ENT), and radio-oncology.

Study design

This prospective implementation study was conducted in accordance with the Standards for Quality Improvement Reporting Excellence (SQUIRE) guideline between July 8th and November 30th, 2024 [20]. The study was designed to provide a basis for future multicenter implementation. Adult patients (18 years and older) with a reported penicillin allergy were eligible for inclusion and were identified during routine care on participating wards. The delabeling intervention was integrated into existing clinical workflows without additional personnel or financial resources. Participation of patients and healthcare professionals was voluntary.

Intervention description

Figure 1: Penicillin allergy delabeling process
Abbreviations: ID: Infectious diseases

The penicillin allergy delabeling process is shown in Figure 1. Clinical pharmacists identified eligible patients during daily routine (medication reconciliation, ward rounds) and performed allergy history assessment and risk stratification using the local guideline of the antimicrobial stewardship team (Supplementary 1). Based on this assessment, clinical pharmacists carried out direct delabeling for patients classified as low risk. All patients classified as moderate risk were referred to infectious disease specialists for evaluation for direct oral challenge (DOC). Eligible patients were prescribed a single dose of Amoxicillin 500 mg orally by ward physicians after informed consent following standardized protocols (supplementary 2). Ward physicians and nurses were educated on the benefits of delabeling and advised to monitor for signs and symptoms of allergic reactions for one hour after DOC. Delabeling outcomes were documented in medical records by clinical pharmacists. Discharge documentation had to be updated by ward physicians using documentation aids provided by the local guideline.

Outcomes and data collection

The primary effectiveness outcome of this study was the proportion of patients who were successfully delabeled either by direct delabeling or successful DOC resulting in a removed PenA label at discharge following the intervention. Secondary clinical outcomes included the characterization of reported index reactions and the categorization of patients into risk groups according to the internal guideline (supplementary 1). Data were collected using the structured questionnaire of the internal guideline, which were completed paper-based by clinical pharmacists during routine care (supplementary 3). Implementation outcomes focused on barriers and facilitators influencing the PenA delabeling process. These were assessed by structured questionnaires distributed to healthcare professionals (i.e. clinical pharmacists, ward physicians, infectious disease specialists, nurses) (supplementary 4). Sustainability was evaluated by assessing whether the PenA label remained removed in primary care documentation systems. For this purpose, primary care physicians were contacted after patient consent via telephone and fax and were asked to completed a standardized follow-up questionnaire (supplementary 5). All data were pseudonymized and stored securely in institutional databases in accordance with data protection regulations.

Statistical analysis

Categorical variables were presented as counts and percentages, continuous variables using median and interquartile range (IQR). Statistical significance was defined as $p < 0.05$. Analyses were performed using Microsoft Excel 2021 (version 2108). Differences in prevalence and delabeling outcomes between participating wards were evaluated using Chi-square tests. Barriers and facilitating factors of implementation were categorized according to the Consolidated Framework for Implementation Research (CFIR) [21]. Sample size was calculated to estimate the prevalence of reported PenA with

adequate precision. Assuming a prevalence of 7.5 %, a 95 % confidence level (Z = 1.96), and a desired absolute precision (half-width of the CI) of 0.02, a minimum of 666 screened patients was required. As a quality improvement study, the sample size was pragmatic and based on the number of eligible inpatients during the study period on participating wards. The delabeling rate is reported with 95 % confidence intervals using the exact Clopper-Pearson method.

Ethics approval and consent to participate

The ethics committee of Heidelberg University Hospital approved the study (positive vote S-512/2023). All procedures were in accordance with the declaration of Helsinki.

RESULTS

Admission and prevalence

During the study period, 179 of 2890 screened patients, admitted to the participating wards, reported a PenA during medication assessment, resulting in an overall prevalence of 6.2 % for the included wards. The highest prevalence was detected in cardiac surgery (35/391, 9.0 %), followed by radio-oncology (37/474, 7.8 %). ENT wards and vascular surgery showed lower prevalence of reported penicillin allergy (ENT: 90/1564, 3.7 %; vascular surgery: 17/461, 3.7 %) (p = 0.005).

Reported reactions

Table 1: Reported reaction types

Reaction types	Number of patients (n = 179)
Non-immune mediated reactions	**n = 24 (13.4 %)**
Isolated nausea/ vomiting/ diarrhoea	n = 12
Others	n = 7
In *combination* with other symptoms	n = 5
Unknown/ not memorable	**n = 24 (13.4 %)**
Rash and Urticaria	**n = 108 (60.3 %)**
Isolated diffuse rash	n = 79
Delayed rash	n = 9
Rash with blistering	n = 7
In *combination* with other symptoms	n = 13
Respiratory swelling/ bronchospasm	**n = 16 (8.9 %)**
Isolated respiratory symptoms	n = 8
In *combination* with other symptoms	n = 8
Hypotension	**n = 10 (5.6 %)**
Isolated Hypotension	n = 3
Unexplained collapse	n = 3
In *combination* with other symptoms	n = 4
Diffuse swelling	**n = 5 (3.0 %)**
Prick-test positive	**n = 2 (1.1 %)**
Angioedema	**n = 1 (0.6 %)**
Anaphylactic shock	**n = 1 (0.6 %)**
Combinations	n = 2
Rash + gastrointestinal symptoms	n = 3
Rash + bronchospasm	n = 1
Rash + bronchospasm + hypotension	n = 7
Rash + diffuse swelling	n = 2
Bronchospasm + hypotension	n = 1
Bronchospasm + vomiting	n = 1

Bronchospasm + vomiting + Fever	n = 1
Hypotension + diarrhea + vomiting	

Reaction types assessed during allergy assessment are shown in Table 1. The most reported reactions to penicillin antibiotics were skin rash (108/179; 60.3 %), followed by non-immune mediated reactions like isolated nausea (24/179; 13.4 %) and respiratory symptoms (16/179, 8.9 %). A minor proportion of patients reported diffuse body swelling (5/179, 3.0 %), prior positive prick-test (2/179, 1.1. %), angioedema (1/179, 0.6 %) and anaphylactic shock (1/179, 0.6 %). Twenty-four patients (13.4 %) were unable to characterize the nature of their reaction. Combinations of reaction types were reported in 18 patients (10.0 %).

Risk stratification

Patients were risk stratified according to the local penicillin allergy management guideline. Sixty-two patients (34.6 %) were classified as low risk, 100 patients (55.9 %) as moderate risk, and 17 patients (9.5 %) as high risk of true penicillin allergy (Figure 2). Time since index reaction was more than five years ago in 138 patients (77.1 %), 38 (21.2 %) of the reactions occurred during childhood. Overall five patients (2.8 %) could not remember the time of the allergy reaction. The PEN-FAST score supported the clinical risk stratification, details can be found in the supplemental material 6.

Delabeling outcomes

Overall, 54 of 162 eligible patients (33.3 %, 95 % CI 26.1-41.2 %) were delabeled following the delabeling intervention (Figure 2). Based on allergy history, 34 of 62 (54.8 %) low risk patients were directly delabeled without further testing. The remaining 21 patients underwent DOC. Of these, six patients were classified as low risk and 15 as moderate risk according to the local guideline. DOC was well tolerated in all but one patient, who developed an immediate, non-severe rash not requiring treatment. This patient had been classified as moderate risk by the local guideline and following the reaction retained the allergy label. Delabeling outcomes were documented in discharge letters for 47 of 54 delabeled patients (87.0 %).

Ward differences

Stratification by ward demonstrated differences in the relative use of delabeling strategies (Figure 3). On ENT and radio-oncology wards, a larger proportion of patients were directly delabeled based on allergy history alone (ENT: 15/24, 62.5 %; radio-oncology: 9/10, 90.0 %), while in cardiac surgery a higher proportion of patients underwent direct oral challenge (8/14, 57.1 %). In vascular surgery, both approaches were used less frequently, reflecting the smaller overall number of eligible patients. Delabeling rate was highest in cardiac surgery (14/35, 40.0 %) and lowest in ENT (24/90, 26.7 %). Differences in delabeling rates across participating wards were not significant (p = 0.473).

Figure 2: Risk stratification according to local guideline and delabeling outcomes
Abbreviations: DOC: Direct oral challenge; Directly delabeled: Delabeled by allergy history without testing;
Sustained delabeling: Patients without penicillin allergy label in primary care follow up according to 13 returned questionnaires.

Figure 3: Use of delabeling strategies stratified by ward
Abbreviations: ENT: Ear Nose Throat

Barriers and Facilitators

Implementation of PenA delabeling was influenced by a combination of facilitating and limiting factors. All identified barriers, including reasons for unsuccessful delabeling, as well as facilitators are summarized and mapped to the CFIR framework in Table 2.

Key facilitators included the relative advantage of direct delabeling compared with DOC, the availability of a standardized allergy assessment, and easy integration of delabeling into routine medication assessment led by clinical pharmacists. In addition, education of ward physicians improved acceptance and confidence in the delabeling process. Major barriers were related to limited medical staffing resources, high workload, short length of stays, and patient-related factors such as language barriers, patient insecurity, or refusal. Structural and process-related challenges, particularly during the early implementation phase, further affected feasibility.

Overall, 125 patients (69.8 %) could not be delabeled. Seventeen of them (13.6 %) were classified as high risk according to the internal guideline and therefore not eligible for delabeling. Reasons for unsuccessful delabeling varied between wards. On the ENT ward, delabeling most often failed due to short hospital stays with discharge before completion of evaluation, combined with a high patient turnover and overall high workload. In radio-oncology, delabeling was frequently not pursued for clinical reasons (palliative situation, systemic corticosteroid therapy, critical clinical condition). In addition, ward physicians were initially partly sceptical towards delabeling, citing inexperience with assessing and managing allergic reactions. Acceptance of delabeling increased among ward physicians after targeted education. Across all wards, however, the most frequent reasons preventing delabeling were high-risk classification and staffing shortages among the involved pharmacists and infectious disease specialists, which limited the ability to provide patient education and perform testing.

Table 2: Barriers and facilitators mapped to the Consolidated Framework for implementation research (CFIR)

CFIR Domain	CFIR Construct	Facilitators	Barriers
Intervention characteristics			
	Relative Advantage	Direct delabeling based on allergy history easier than oral challenge	
	Design Quality & Packaging	Standardized questionnaire for allergy assessment Easy identification of eligible patients during medication reconciliation	
	Complexity	Easy Integration in allergy assessment into medication reconciliation Uncomplicated consultation of infectious disease specialists (email/ telephone)	Infectious disease specialist not continuously present on the ward (consult required) Longer duration of medication assessment
Outer Setting			
	Patient Needs & Resources	Patients are grateful for evaluation and time Patients understand purpose after education Positive perception of delabeling process in general	Language barriers Patient refusal (fear of allergic reaction, lack of understanding delabeling purpose, patient's conviction of having a true allergy, uncertainty about allergy history) Critical medical conditions Palliative care setting (radio-oncology)
	External Policies & Incentives		Pharmacists are not allowed to prescribe and perform oral provocation testing
Inner Setting			
	Structural Characteristics		Admission/Discharge during weekends Staffing shortages (pharmacists, infectious disease specialists) High additional workload

	Networks & Communication		Lack of clear referral guidance from pharmacists to infectious disease specialists during the early implementation phase, resulting in over-referral and information overload
	Implementation Climate	Low turnover settings with longer hospital stays (e.g. Cardiac surgery) – more time for delabeling	High turnover settings with short hospital stay (ENT)
	Readiness for Implementation		Lack of initial education on penicillin allergy delabeling purpose and management for ward physicians
Characteristics of individuals			
	Knowledge & Beliefs	Ward physicians trusted pharmacists' allergy assessment and risk stratification	Refusal or skepticism among clinical staff to perform delabeling (lack of understanding relevance or importance)
	Self-Efficacy	Acceptance of delabeling increased among ward physicians after targeted education	
Process			
	Planning		
	Engaging	Pharmacist-led coordination of the process Consulting infectious disease specialists Education of ward physicians to support infectious disease specialists in times of staffing shortage	
	Executing		Discharge prior to evaluation or testing Postponed or cancelled surgical procedures
Abbreviations: CFIR: Consolidated Framework for implementation research; ENT: Ear Nose Throat			

Follow up

Out of 54 delabeled patients, 33 (61.1 %) agreed to follow-up with their primary care physician after eight months. A total of 13 questionnaires (39.4 %) from primary care physicians were returned to the study

team. In 10 of 13 patients (77.0 %), the penicillin allergy status was “no penicillin allergy” in the primary care documentation. In nine of these 10 cases (90.0 %), the primary care physician previously did not know about the patient’s penicillin allergy. Three patients (23.1 %) had already been prescribed a penicillin antibiotic after hospital discharge. One patient reported a mild allergic reaction characterized by unspecific body swelling. However, the patient stated that they would take penicillin in the future if medically indicated.

Nine of 13 (69.2 %) primary care physicians stated that they would be willing to prescribe a penicillin antibiotic to the patient in the future. Regarding discharge documentation, 3 of 13 (23.0 %) primary care physicians reported that the delabeling was documented in the hospital discharge letter, whereas five physicians (38.5 %) reported not having received a discharge letter, and another five (38.5 %) reported that the delabeling was not documented. On review, the absent of documentation regarding the delabeling intervention could be confirmed in only one hospital record, suggesting that four of the five physicians likely did not receive or read the discharge letter. One physician stated that the patient herself reported on the delabeling.

Discussion

This pilot study represents the first real-world evaluation of a pharmacist-led penicillin allergy delabeling program implemented in inpatient clinical routine in Germany. The findings of this study demonstrate that penicillin allergy delabeling can be embedded into routine patient care. However, implementation under routine conditions was influenced by context-specific factors including personnel resources, duration of hospital stay, and patient-related aspects, which varied across participating wards. As a pilot study, it provides an important foundation for future multicenter studies and broader implementation within antimicrobial stewardship (AMS) programs.

The prevalence of reported penicillin allergy in our cohort was 6.2 %, which was lower than in a separate point-prevalence analysis conducted at our institution (8.1 %). This difference is presumably explained by the selected wards in this study without general internal medicine, where patients may have more comorbidities. Overall, the prevalence aligned with international data (5 -15 %) and highlights the relevance of delabeling initiatives in the German healthcare setting [1, 22].

The overall delabeling rate observed in our study was 33 %, with 63 % of these patients being directly delabeled based on structured allergy history alone by pharmacists and 37 % following direct oral challenge (DOC). When considering only patients eligible for history-based delabeling, more than half (55 %) could be successfully delabeled. International pharmacist-led programs have reported wide ranges of delabeling rates (37-80 %), reflecting differences in patient selection and clinical setting [23-25]. Nevertheless, a substantial proportion of patients in our study could not be delabeled despite low risk stratification (20/62, 32 %). This is likely because our program was implemented entirely within clinical routine without any additional personnel and financial resources, dedicated research staff and controlled conditions. The results may therefore better reflect realistic expectations for real-world implementation.

Barriers identified in this study align with those reported in international studies, including high clinical workload, limited staffing and time resources, clinical concerns regarding safety of delabeling, and lack of confidence to perform PenA delabeling [26, 27]. Patient related barriers included critical illness, cognitive or emotional overload during hospitalization, and fear of an allergic reaction [18, 28]. In contrast, key facilitators for successful delabeling included productive interprofessional collaboration, mutual trust between professional groups, clear task allocation, and targeted education for both staff and patients. International expertise also suggests that involving clinical pharmacists, expanding non-allergist-led programs, and integrating structured education and training into established AMS workflows may enhance feasibility of PenA delabeling in clinical routine [26, 29, 30].

A key finding of our study was the substantial difference in employed delabeling strategies across participating wards, which can be explained by ward-specific patient characteristics and workflows. While direct delabeling based on allergy history was more frequently used in radio-oncology and ENT wards, DOC was more commonly performed in primarily surgical wards. On radio-oncology, a higher proportion of palliative patients limited the feasibility and acceptance of DOC, whereas the short length of hospital stay in high turnover ENT wards posed logistical challenges. In contrast, longer hospital stays on surgical wards facilitated the planning and conducting of DOC. These findings indicate that penicillin allergy delabeling strategies require adoption to local clinical environment, including patient populations and workflow [18]. Direct delabeling was easier to implement than DOC and required less resources, suggesting that prioritizing direct delabeling in low-risk patients may be an effective strategy for high workload settings.

Consistent with previous studies, a high proportion of patients reported unknown or poorly described index reactions [1, 31]. These findings support the growing evidence that a significant proportion of penicillin allergy labels can be safely removed without additional testing after appropriate risk stratification and therefore represented an ideal target population for pharmacist-led interventions [2, 8, 32].

In this setting, clinical pharmacists played a major role in the delabeling process supporting their potential role within delabeling programmes imbedded within AMS-teams. This is particularly relevant for the German healthcare system where pharmacists have no independent prescribing authority. While pharmacists can initiate and coordinate delabeling processes and perform direct delabeling in accordance with local guidelines, clinical decision making, prescribing of antibiotics for DOC and diagnostic procedures such as skin testing remain the responsibility of physicians and infectious disease or allergy specialists.

The exploratory primary care follow-up revealed a number of challenges in the sustainability of PenA delabeling after hospital discharge, in keeping with previously published studies: While PenA labels are updated correctly in hospital records, documentation in primary care often remains inconsistent, with many patients still carrying their PenA label after being delabeled or avoiding penicillin antibiotics despite negative testing [33]. In this study, discharge letters were not received by some of the patients'

primary care physicians. In recent studies incomplete discharge communication and absence of shared documentation systems between hospital and primary care have also been identified as possible contributors [34]. These findings indicate that loss of information between healthcare sectors may compromise the long-term effectiveness of inpatient delabeling interventions. Strategies such as standardized patient-held delabeling documentation and integration of delabeling into electronic patient records may help ensure visibility of delabeling outcomes beyond hospitalization. In this context, the recent nationwide rollout of the electronic patient record in Germany may offer an opportunity to improve cross-sector documentation in the future.

Our findings have several implications for broader implementation in Germany. First, standardized training programs, delabeling algorithms and documentation practices are needed. Further, penicillin allergy delabeling should be formally integrated into AMS programs, with clear definition of responsibilities, prioritization strategies, and a central role for pharmacists in allergy assessment, interprofessional coordination and targeted education. In settings with limited resources, prioritizing patients classified as low-risk and eligible for direct delabeling without further testing may be beneficial as this approach is less time and resource intensive. Alternatively, prioritizing patients who are currently receiving or require antibiotic therapy may maximize clinical benefit.

Future research should focus on multicenter studies to confirm generalizability, assess clinical outcomes, and evaluate long-term sustainability. Integration in electronic patient records and follow-up beyond hospital discharge will be crucial to ensure positive impact.

Limitations and strengths

This study has several limitations. First, the sample size of this study was limited, and the exploratory design did not include confirmatory analyses or formal sample size calculation. Additionally, ward-specific differences may limit generalizability. Second, this was a single-centre study conducted in a tertiary care university hospital with access to infectious disease specialists and clinical pharmacists. Therefore, transferability to smaller hospitals without on-site infectious disease specialists or clinical pharmacists may be limited. Implementation strategies may need to be adapted to local structures and available expertise. Third, parts of this intervention and follow-up required patient consent and willingness of primary care physicians to provide information, which may lead to selection and response bias. As a result, patients who are more open towards delabeling, as well as perspective of physicians interested in AMS and PenA delabeling may be overrepresented. These limitations as well as small sample size should be considered when interpreting the follow-up findings. Finally, this intervention was planned involving pharmacists and physicians and not solely infectious diseases specialists. The role of other professional groups like nursing staff, medical students or outpatient allergy services was not evaluated and may present an area for future research.

Despite these limitations, this study has several strengths. To our knowledge, this is the first study evaluating the implementation of pharmacist-led penicillin allergy delabeling in Germany. It provides relevant real-world insights into the implementation of pharmacist-led penicillin allergy delabeling in

routine inpatient care. Furthermore, the follow-up after hospital discharge enabled assessment of the sustainability of the intervention and highlighted the importance of intersectoral communication. The multidisciplinary approach involving pharmacists and physicians specialists also reflects practical clinical conditions and supports broader implementation in Germany.

CONCLUSION

This real-world implementation study demonstrated that pharmacist-led penicillin allergy delabeling can be safely integrated into routine inpatient care in Germany. Structured allergy assessment enabled efficient identification and direct delabeling of low-risk patients within existing clinical workflows. However, delabeling rates and long-term sustainability were limited by real-world implementation barriers and challenges in communication beyond hospital discharge. Pharmacists can play a crucial role in coordinating delabeling and supporting interprofessional collaboration. To fully realize the potential of pharmacist-led interventions institutional support, standardized documentation, and integration into AMS programs will be essential. Overall, this study provides an important foundation for multicenter and widespread implementation of standardized, scalable penicillin allergy delabeling strategies in German healthcare settings.

Declarations

Authors' contributions

The study was designed by HN, BM, EK, TS and CMD. The manuscript was written by HN and critically edited and reviewed by all authors. HN, KH, KE, SA, EJ, JB, CD, UC, AW, AW, BK, DM, MP, BM, and EK participated in screening, evaluation and documentation. The final manuscript was approved by all authors.

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interest.

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Patient Consent statement

Informed consent was obtained from all individual participants included in the study.

Ethics approval

The ethics committee of Heidelberg University Hospital approved the study (positive vote S-512/2023). All procedures were in accordance with the declaration of Helsinki.

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None to declare.

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Figures

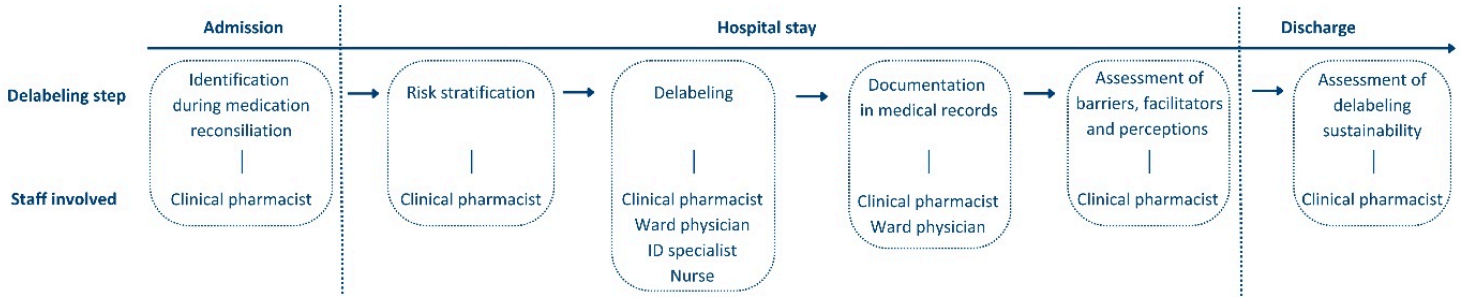


Figure 1

Penicillin allergy delabeling process
Abbreviations: ID: Infectious diseases

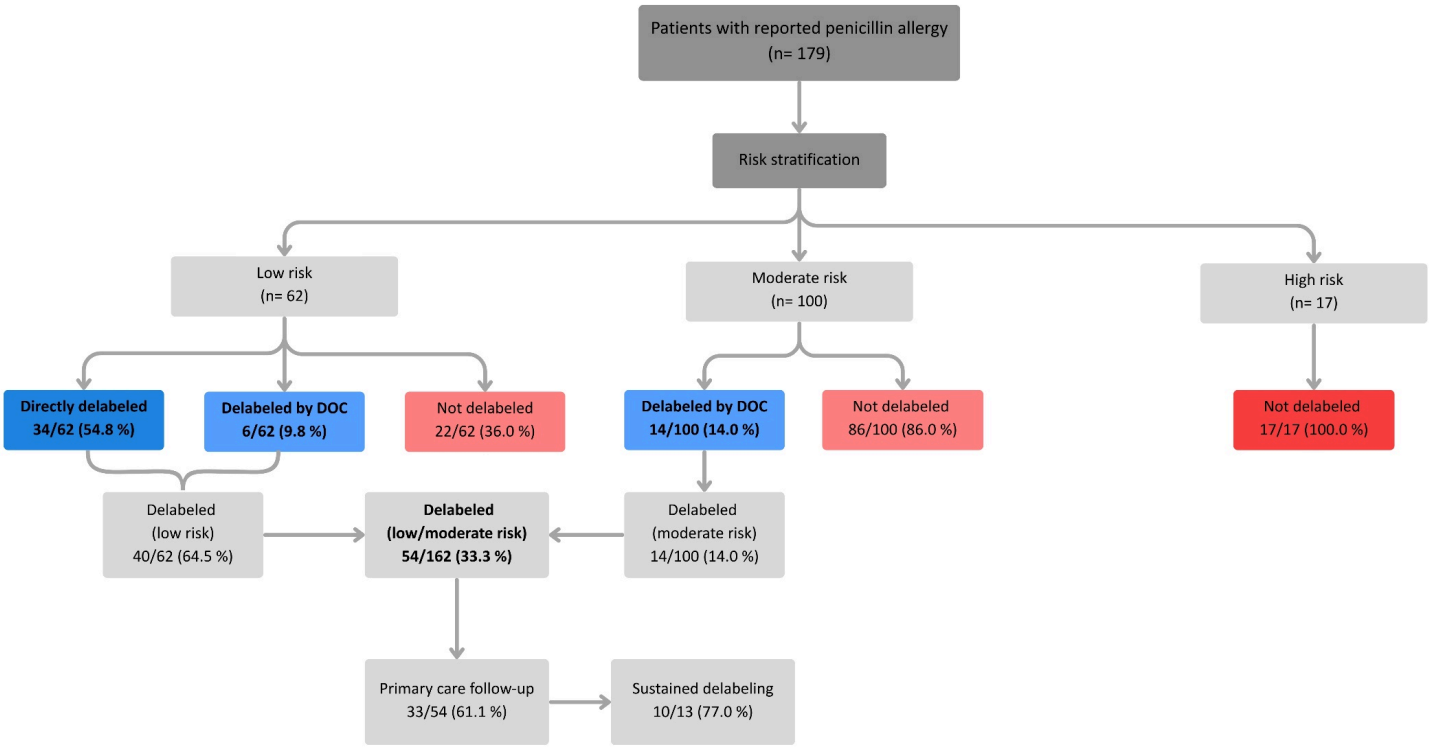


Figure 2

Risk stratification according to local guideline and delabeling outcomes
Abbreviations: DOC: Direct oral challenge; Directly delabeled: Delabeled by allergy history without testing; Sustained delabeling: Patients without penicillin allergy label in primary care follow up according to 13 returned questionnaires

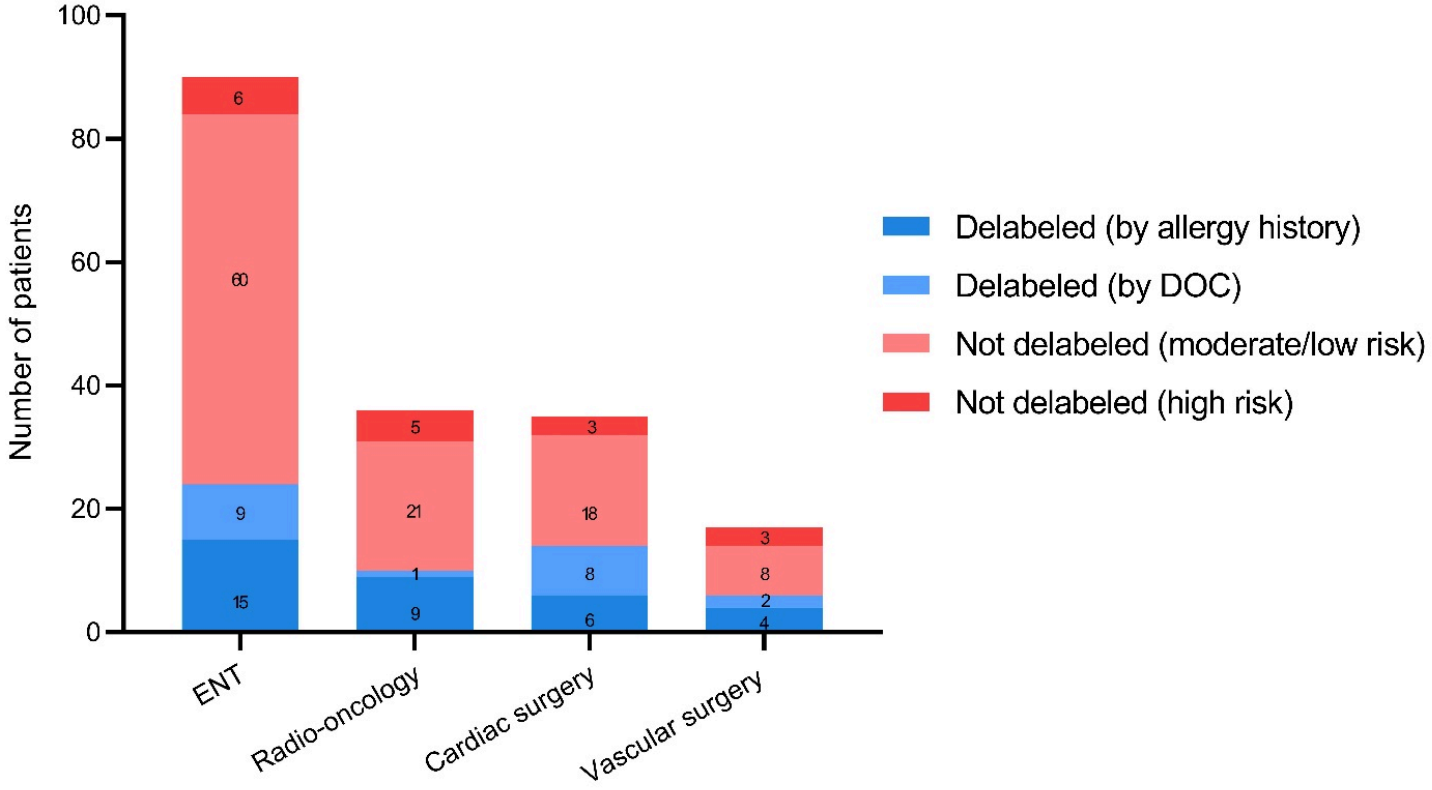


Figure 3

Use of delabeling strategies stratified by ward
Abbreviations: ENT: Ear Nose Throat

Supplementary Files

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