

ENHANCING KNOWLEDGE AND ATTITUDES TOWARDS PENICILLIN
ALLERGY LABELS AND AMOXICILLIN CHALLENGES

by

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As members of the DNP Project Committee, we certify that we have read the DNP project prepared by Riley Oberholtzer, titled Enhancing Knowledge and Attitudes Towards Penicillin Allergy Labels and Amoxicillin Challenges, and recommend that it be accepted as fulfilling the DNP project requirement for the Degree of Doctor of Nursing Practice.

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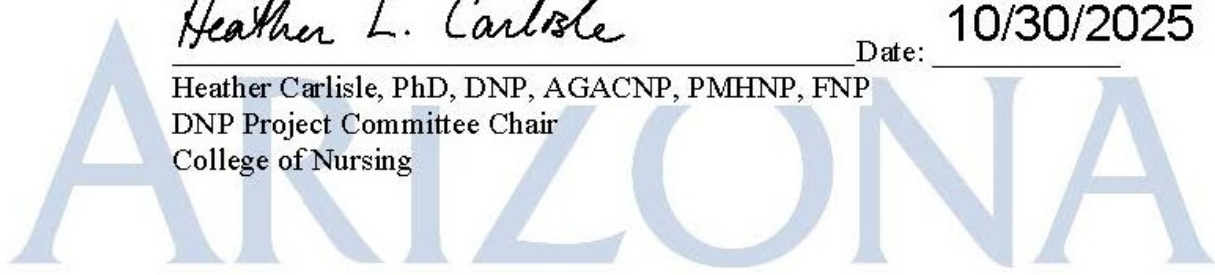


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Abstract

Background: Nearly 15 percent of hospitalized patients report a penicillin allergy; however, 90 percent are not truly allergic (Patterson & Stankewicz, 2023). Inaccurate penicillin allergies are associated with second-line antibiotic selection, prolonged hospitalization, and adverse patient outcomes (Powell et al., 2022). Oral amoxicillin challenges are proven to be an extremely safe and effective way to de-label inaccurate low-risk penicillin allergies (Providencia et al., 2024). Nurses are essential stakeholders and should be involved in patient allergy assessment and education (Hoffman et al., 2025).

Purpose: This DNP project aimed to educate inpatient nurses on allergic reactions, penicillin allergy delabeling, and oral amoxicillin challenges. This project also aims to evaluate and improve nursing knowledge and attitudes towards allergy assessments and amoxicillin challenges to guide further nursing education, hospital-wide. This QI project was developed to prepare nurses and nurse educators for the upcoming nurse protocol change, which prompts bedside nurses to ask their patients further questions about penicillin allergy symptoms.

Methods: The Institute for Healthcare Improvement (IHI) Model for Improvement was utilized as a framework to implement the project in the clinical setting. This model consists of the three fundamental questions and the Plan-Do-Study-Act (PDSA) cycle (Frankel et al., 2017). Pre and post-education session surveys were created to gather data from inpatient nurses who participate in the education session.

Results: This DNP project utilized descriptive statistics to calculate t-tests and p-values to assess for statistical significance of the quantitative data (Jones et al., 2021). The education session yielded a 16.8% increase in pre- and post-survey scores with a statistically significant p-value of

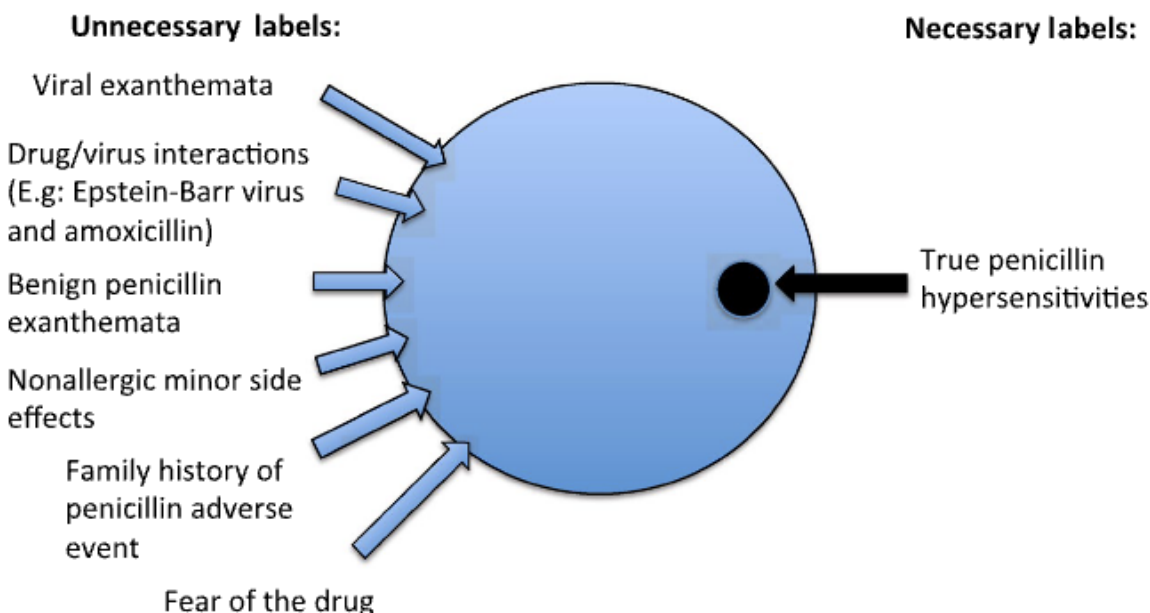
less than 0.05. The feedback and insights from the open-ended survey questions were summarized and presented to the nurse protocol workgroup to guide further education.

Conclusions: The results of this DNP project confirmed the need for nursing education on penicillin allergy topics before the hospital-wide launch of the nurse protocol. Likewise, the project demonstrated the benefit of a formal education session in increasing nursing knowledge and attitudes toward these topics.

Background

Penicillin is a class of antibiotics in the beta-lactam group that includes numerous medications, including penicillin G, amoxicillin, oxacillin, ampicillin, and piperacillin-tazobactam (Letourneau et al., 2024). These antibiotics are first-line medications for multiple bacterial infections, including throat, respiratory, urinary, and abdominal infections, and surgical prophylaxis. Nearly 15% of hospitalized patients report an allergy to penicillin antibiotics (Powell et al., 2023). However, the incidence of penicillin allergy in the general population is less than 1%, and only 10% of people with a recorded penicillin allergy have a true allergy (Patterson & Stankewicz, 2023). A clinically significant penicillin allergy is an IgE-mediated or T lymphocyte-mediated hypersensitivity (Shenoy et al., 2019). These reactions include angioedema, anaphylaxis, immune-mediated organ injuries, and severe cutaneous adverse reactions, such as Stevens-Johnson syndrome (SJS), Toxic Epidermal Necrolysis (TEN), and drug rash with eosinophilia and systemic symptoms (DRESS) (Centers for Disease Control, 2024a). Patients with these reactions should not undergo skin testing or challenges, as they have a true hypersensitivity to the drug.

In contrast to true penicillin allergies, most penicillin allergy labels on medical records are inaccurate, as seen in Figure 1, and do not meet the criteria to be considered a hypersensitivity or allergy. Reasons for these inaccurate labels include patient intolerances, adverse drug reactions, medication-disease interaction, family history of a penicillin allergy, and unspecified or unknown reactions (Stone et al., 2020). Blumenthal et al. (2019) highlight the significant amount of unknown symptoms and reactions that are not remembered by the patient, particularly those from childhood, without knowledge of the response.

Figure 1*Events That Lead to the Application of a Penicillin Allergy Label*

Note: Stone, C. A., Trubiano, J., Coleman, D. T., Rukasin, C. R. F., & Phillips, E. J. (2020). The challenge of de-labeling penicillin allergy. *Allergy (Copenhagen)*, 75(2), 273–288. <https://doi.org/10.1111/all.13848>

There is a knowledge deficit among many patients and healthcare workers regarding what constitutes a drug allergy versus an adverse effect. Often, adverse effects are reported as allergies, which present limitations in medications that clinicians can prescribe to a patient. Pichler et al. (2023) classify adverse drug reactions into two types: Type A and Type B. Type A reactions account for the majority of drug reactions and are predictable based on the pharmacologic actions of the drug. These include side effects, indirect effects, drug interactions, and overdose. Regarding penicillin, common adverse reactions are nausea, diarrhea, and epigastric discomfort, as seen with many classes of antibiotics due to the disruption of gastrointestinal bacteria with antibiotic use (Turner, 2024).

Whereas, Type B reactions account for approximately 10 percent of adverse drug reactions and consist of hypersensitivity reactions (Pichler et al., 2023). These reactions are unpredictable because they are not related to the pharmacological mechanisms. Type B reactions include anaphylaxis, immune-mediated thrombocytopenia, and Stevens-Johnson Syndrome (SJS). These hypersensitivity reactions are classified into type I, II, III, and IV (Pichler et al., 2024). Type I reactions are immunoglobulin E (IgE) mediated and typically occur within several minutes to an hour of exposure to the offending allergen. Type I features include angioedema, anaphylaxis, bronchospasm, and hives.

Regarding penicillin, these type I hypersensitivity IgE-mediated reactions may present with any of the following signs of anaphylaxis: dyspnea, tachycardia, stridor, loss of consciousness, urticaria, and pruritus (Turner, 2024). Types II, III, and IV are typically delayed, meaning the reactions commonly occur days after exposure. Hemolytic anemia is an example of a type II reaction to penicillin, and serum sickness-like reactions are type III (Knol et al., 2022). Type IV reactions are T cell-mediated, and for penicillin allergic individuals, these include severe dermatologic conditions, including SJS, TEN, and DRESS (Pichler et al., 2024).

Regarding penicillin, rash and gastrointestinal discomfort are common adverse drug effects that patients report as allergies (Turner, 2024). These adverse effects are often mistaken for allergies due to a slight overlap in symptoms and syndromes between adverse reactions and allergies, particularly in cases of gastrointestinal discomfort and skin rashes. However, a thorough allergy history taken by a trained healthcare provider can distinguish these symptoms. Sudden gastrointestinal distress, such as sudden onset abdominal cramping, nausea, or vomiting, can represent anaphylaxis when it occurs abruptly and with other systemic symptoms (Turner et

al., 2019). However, if an individual experiences gradual nausea, vomiting, or diarrhea throughout the course of taking a penicillin antibiotic, this is an expected adverse drug reaction related to the mechanism of action of antibiotics and is not an immunologic allergic response.

Rashes are another common symptom reported as an allergy, primarily due to a misconception that all rashes represent an allergic response. Benign rashes typically occur in the trunk area, are a single tone erythema, and do not have vesicles, pustules, or bullae (Yan et al., 2025). Whereas, higher risk rashes occur across the face, mucosa, genitals, and trunk, and have a dusky appearance with pustules and vesicles. This distinction is helpful to stratify the risk associated with the reported rash and clarify if the rash was a true allergy or not.

Another issue with patient-reported penicillin allergies is that detailed symptoms and occurrences are often missing from the medical record, and healthcare providers do not always verify or question the allergy (Copaescu et al., 2023). This risks patient safety because unverified penicillin allergies automatically label patients as intolerant to penicillin antibiotics. Inaccurate penicillin allergies are associated with increased broad-spectrum antibiotic use, prolonged hospitalizations, mortality, drug resistance, and second-line antibiotic use (Shankaran et al., 2025). Patients with a penicillin allergy label who have infections that respond best to penicillin antibiotics often receive second-line antibiotics. Second-line antibiotics for these infections, like aminoglycosides and glycopeptide antibiotics, are less effective, more toxic, and associated with multidrug-resistant infections (Blumenthal et al., 2017). Not treating infections with first-line medications increases the risk of treatment failure, cost of antibiotics, and extended hospitalizations with complications (Kan et al., 2023; Powell et al., 2020).

In response to extensive research on penicillin allergies and adverse outcomes associated with inaccurate penicillin allergies, the Joint Task Force on Practice Parameters published an updated practice parameter in 2010 regarding drug allergies (Solensky et al., 2020). This practice update emphasized the importance and effectiveness of skin testing to evaluate penicillin allergies and de-label inaccurate allergies. The term de-labeling refers to the process of removing a penicillin allergy from a patient's medical record. In 2016, the *Infectious Disease Society of America and the Society for Healthcare Epidemiology of America* encouraged the development of antimicrobial stewardship programs that promote optimal antimicrobial use, including assessing penicillin allergies (Barlam et al., 2016). In 2019, the Centers for Medicare and Medicaid (2019) required affiliated hospitals to implement antimicrobial stewardship teams to promote infection prevention and control. The World Health Organization (2021), American Academy of Allergy Asthma & Allergy (2023), and the Centers for Disease Control (2024b) recommended antibiotic allergy de-labeling as part of hospital antimicrobial stewardship programs. These national guidelines and recommendations encouraged further research and expansion of penicillin allergy delabeling, apart from allergy skin testing in a specialized outpatient setting.

The prior standard of care for evaluating penicillin allergies was to refer patients to an allergen specialist for skin testing before completing a direct oral amoxicillin challenge (Copaescu et al., 2023). However, not all institutions have allergist specialists or the resources to refer patients for this testing. Likewise, numerous studies have established the safety and efficacy of general clinicians to assess and manage low-risk penicillin allergies via direct

challenges without allergist consultation (Blumenthal et al., 2019; Liviya et al., 2022; Trubiano et al., 2023).

Another barrier of skin testing is that it does not have a 100 percent negative predictive value (NPV) and requires an amoxicillin challenge after a negative result to confidently remove a penicillin allergy (Copaescu et al., 2023). Thus, the need for identifying inaccurate penicillin allergies and performing direct amoxicillin challenges arose.

Direct oral amoxicillin challenge is a graded challenge that provides a smaller dose of the antibiotic to observe for any immediate allergy symptoms to remove the inaccurate allergy label (Blumenthal & Solensky, 2024). Oral amoxicillin challenges are performed on patients with low-risk penicillin allergy and have demonstrated equal efficacy and safety to skin tests in ruling out a penicillin allergy (Piotin et al., 2022; Powell et al., 2023). These challenges do not require skin testing to be done beforehand for appropriate low-risk patients (Khan et al., 2022). As more research arose supporting direct challenges, patient tolerance after a direct challenge became the gold standard to assess for immediate hypersensitivities and remove the allergy label without the need for skin testing beforehand for low-risk patients (Stone et al., 2019).

Of note, skin testing remains the standard of care for high-risk patients who have anaphylaxis-like symptoms to rule out IgE-mediated severe reactions (Liviya et al., 2022). However, for patients not in the high-risk category determined by a validated assessment tool, like PEN-FAST, the amoxicillin challenge should be done by general medical providers to promote penicillin delabeling and improve patient outcomes (Dore et al., 2025). Liviya et al. (2022) found that even in acutely ill hospitalized patients, amoxicillin challenges are safe and recommended.

As mentioned, the direct amoxicillin challenge is safe for patients with a low-risk penicillin allergy. To determine the risk status of patients, Trubiano et al. (2020) developed and validated the PEN-FAST clinical decision tool. PEN-FAST is a mnemonic outlining the four features of a potentially severe penicillin allergy, including five or fewer years ago (F), anaphylaxis/ angioedema (A), severe cutaneous adverse reaction (S), and the treatment (T) needed. As seen in Figure 2, each feature is associated with a numeric point. The score of the PEN-FAST tool is grouped into risk categories, including very low risk (0 points), low risk (1-2 points), moderate risk (3 points), and high risk (>4 points). Scores of 0, 1, and 2 can exclude severe penicillin allergies as they correspond with a very-low or low risk of positive skin test allergy. Depending on the institution, challenges are given for PEN-FAST scores of 0, 1, and 2.

Figure 2

PEN-FAST Screening Tool

PEN	Penicillin allergy reported by patient	
F	Five years or less since reaction†	2 points
A	Anaphylaxis or angioedema	2 points
	Or	
S	Severe cutaneous reaction†	
T	Treatment required for reaction†	1 point
		Total points
Interpretation		
0 point	Very low risk of positive penicillin allergy test	
1 or 2 points	Low risk of positive penicillin allergy test	
3 points	Moderate risk of positive penicillin allergy test	
4 or 5 points	High risk of positive penicillin allergy test	

Note: From “Predictive factors of amoxicillin immediate hypersensitivity and validation of PEN-FAST clinical decision rule” by Piotin, A., Godet, J., Trubiano, J. A., Grandbastien, M., Guénard-Bilbault, L., de Blay, F., & Metz-Favre, C. (2022).

Scores of 4 or 5 are associated with a high risk of penicillin allergy, and these patients should be referred to allergy specialists for further testing. Trubiano et al. (2020) found a 96.3% NPV of the PEN-FAST tool, and it has since been tested and validated by numerous researchers at large healthcare institutions across different patient populations (Copaescu et al., 2023; Piotin et al., 2022). Su et al. (2023) found a 100 percent NPV of this tool and encourage its use across hospitals and various clinical sites. The American Academy of Allergy, Asthma, and Immunology (2023) recommends, and the CDC (2023) validates the PEN-FAST tool. Overall, many reputable organizations recommend its use for determining eligible patients for the direct amoxicillin challenge without the need for skin testing.

The American Nurses Association and the CDC (2017) published a white paper describing the role nurses have in identifying low-risk penicillin allergies. Nurses have the opportunity to educate patients on accurate antibiotic allergy history and assess for potential inaccurate allergy labels. The CDC (2024b) highlights the critical role nurses have in promoting antimicrobial stewardship and improving penicillin allergy assessments.

Hoffman et al. (2025) compared PEN-FAST assessments completed by bedside nurses versus pharmacists across hundreds of EHRs. The researchers found strong performance of nurses completing PEN-FAST assessments and determined that nursing assessments upon admission are effective to stratify allergy risk and promote antimicrobial stewardship.

Needs Analysis

Quality Assurance Performance Improvement (QAPI) is a systematic method to improve healthcare safety and quality (Centers for Medicare and Medicaid, 2024). MCA has annual QAPI measures and goals for various categories. One of the 2025 to 2026 QAPI goals is to increase the

average number of monthly patients with a listed penicillin or aminopenicillin allergy who are administered an oral amoxicillin challenge by 100%. The current average of challenges performed every month is 4, and the QAPI goal is to complete at least 8 per month.

This organizational goal to increase oral amoxicillin challenges requires support from multiple disciplines, including pharmacy, providers, nurses, and educators. Thus, there is a dedicated penicillin allergy nurse protocol workgroup at Mayo Clinic Arizona (MCA). The project developer (PD) of this DNP project was a member of this penicillin allergy workgroup. This workgroup plans to launch a hospital-wide nurse protocol by the end of 2025. This protocol will instruct bedside nurses to ask low-risk penicillin allergy patients a series of questions based on the PEN-FAST tool. Completing these questions will generate a nursing order to consult the pharmacy team. A pharmacist will receive this order stating the patient is eligible for an amoxicillin challenge based on the completion of the nursing penicillin assessment screening tool. As a subset of this workgroup, this DNP project focused on creating nursing educational material and evaluating perceived barriers and knowledge gaps among bedside nurses regarding amoxicillin challenges and penicillin allergies.

Before launching the nurse protocol, all bedside nurses need to receive the required education regarding the protocol and perform an amoxicillin challenge. Thus, the purpose of this QI project was to create and evaluate education on a smaller scale in one nursing unit and assess the perceived barriers to the protocol and topics of allergy assessment, penicillin de-labeling, and amoxicillin challenges. The PD shared results with the general penicillin screening workgroup members to enhance their preparation for the launch of this protocol initiative and ensure nursing education is ready for dissemination on a hospital-wide basis.

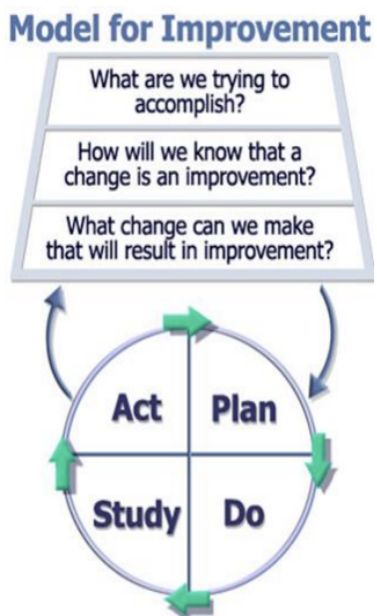
Implementation Model

Model for Improvement

The Institute for Healthcare Improvement recommends the Model for Improvement as a systematic approach to generate the proposed improvement (Frankel et al., 2017). This model incorporates aim, measurement, change, and the Plan-Do-Study-Act (PDSA) cycle (Lee & Larson, 2014). As seen in Figure 3, the researcher must first complete the initial three questions to determine the change idea goals. Then, the team completes the PDSA cycle to test and refine the proposed change (Lee & Larson, 2014). This process is cyclical, as depicted in Figure 3, there are arrows between the three questions and the PDSA cycle to emphasize the iterative nature of this model and the goal of further refining changes.

Figure 3

Model for Improvement Methodology



Note: From “ A Framework for Safe, Reliable, and Effective Care: White Paper” by A. Frankel, C. Haraden, F. Federico, and J. Lenoci-Edwards, 2017, Institute for Healthcare Improvement and Safe & Reliable Healthcare (<https://tinyurl.com/mr36tn9a>). Copyright 2017 by the Institute for Healthcare Improvement and Safe & Reliable Healthcare.

Fundamental Questions

In response to the first question of this model, “What are we trying to accomplish?”, the project aimed to educate nurses on an upcoming practice change and assess potential barriers. The goal of this project was to improve the knowledge and attitudes of bedside nurses regarding penicillin allergies and amoxicillin challenges. According to the IHI (n.d.-d), practical aims statements are specific, clear, and concise with measurable numerical goals. The aim statement for this project was to increase nursing knowledge on penicillin allergies and amoxicillin challenges by at least 15 percent via an educational session. Another goal is to assess nursing concerns about these topics and share recommendations with the penicillin allergy workgroup.

The PD addressed the second question, “How will we know that a change is an improvement?”, by evaluating data from pre- and post-education surveys. The PD used descriptive statistics via paired t-tests to test the difference between mean scores of the pre- and post-surveys (Bradshaw et al., 2024a). The PD utilized a 95% confidence interval to calculate a p-value of less than 0.05 to determine statistical significance. Participant feedback and attitudes were also assessed to ensure both quantitative and qualitative data were measured (IHI, n.d.-a).

The third fundamental question, “What change can we make that will result in improvement?”, was addressed by providing the penicillin de-labeling workgroup with feedback and results from this project. This enabled them to utilize the data and recommendations to enhance further nurses' knowledge and attitudes towards these essential topics.

The IHI (2019) provides various change concepts for approaching change in QI projects. This project addressed a work environment issue by providing inpatient nurses with readily accessible, standardized education on allergy assessments and amoxicillin challenges. To address

this issue, the PD provided nurses with access to educational resources and training materials.

Conducting education sessions and providing tangible feedback to the project team improved the work environment by establishing a baseline for nursing education on these topics and offering recommendations for future implementation.

Plan-Do-Study-Act (PDSA) Cycle

Plan

The plan phase of the project consists of forming the team and planning to test the change (IHI, n.d.-b). As mentioned, the PD joined the hospital-wide penicillin allergy protocol workgroup. The team consisted of the Project Developer (PD), who is a bedside RN at the Mayo Clinic, an Infectious Disease Pharmacist, a Nurse Education Specialist (NES), two Clinical Nurse Specialists (CNS), and a nurse Information Technology (IT) specialist. This team has met bi-weekly to discuss and plan for the nurse protocol build and bedside nurse education material. These meetings enabled key stakeholders to share new developments, concerns, and solutions for the project, ultimately optimizing the launch of the nurse protocol by the end of 2025. However, nurse education must be ready to disseminate before this protocol is active so that nurses are comfortable with the protocol and able to implement it successfully. Thus, the focus of this DNP project was on the nurse education aspect. The workgroup agreed to serve as team members for this DNP project, given that the PD is also a member of the overall workgroup.

The PD created educational content via PowerPoint slides, and the other team members reviewed the content for accuracy and provided approval. The PD utilized content from the Evidence table, seen in Appendix A, which included various peer-reviewed journals, medical textbooks, and *UpToDate*. The PD recorded a fifteen-minute voiceover presentation of the slides

as the recorded education session. The PD drafted survey questions based on knowledge assessment content and screening intent questions. The NES advised the PD to include various levels of the Kirkpatrick model for training evaluation, including the following categories: reaction, learning, behavioral, and results (Alsalamah & Callinan, 2022). The peer-reviewed survey questions were imputed to Qualtrics, an intuitive survey software utilized by many universities and institutions (Dugger & Kelli, 2024).

Before disseminating this education and conducting this QI project, the PD submitted materials to both the University of Arizona Institutional Review Board (IRB) and Mayo Clinic IRB. Both review boards approved conducting this QI project, as seen in appendices B and C, because it does not meet the criteria for research, but rather for a QI project.

Do

The Do phase consists of carrying out the proposed change, collecting the data, documenting observations, and starting to analyze the data (IHI, n.d.-e). The recorded education session and Qualtrics survey links were sent via email to all nurses on the Cardiovascular Progressive Care Unit (CVPCU) on September 9, 2025, as seen in Appendix D. The recruitment email included a disclosure form, as seen in Appendix E, and links to the surveys and recorded presentation. The PD also played the recorded presentation at the monthly Unit-Based Council meeting on September 9th, 2025. This meeting is voluntary for CVPCU staff and includes leadership and education updates by unit managers and NES. The PD decided to present at the September 2025 UBC meeting because it reaches multiple levels of CVPCU nurses, including bedside nurses, charge nurses, and supervising nurses. The same video and links for surveys were given to all voluntary participants. The PD left the surveys

open for the entire month of September to allow for maximum participation of nurses, with the goal of 15 participants.

Study

The study phase entails analyzing the data and comparing it to predictions (IHI, n.d.-e). This phase started on October 1, 2025, after the education intervention window ended. The pre-education survey collected nursing demographic information and assessed baseline knowledge via five knowledge questions. The post-education session survey assessed knowledge retention from the education intervention, collected feedback on the education, and gathered suggestions for the project team. Paired t-tests were utilized to analyze the difference between the pre- and post-intervention data (Bradshaw et al., 2024a; Johnson et al., 2023).

Act

After studying and analyzing the data, the team moved to the Act phase that optimizes the change based on what was learned (IHI, n.d.-e). If the PD identified issues with the project or the proposed goal was not met, the team would have returned to the plan phase to refine changes. However, the goals were met and no problems were identified, thus the team confidently recommended that this educational material continue throughout hospital-wide dissemination. Likewise, the PD shared the survey results with the workgroup to further enhance the nurse protocol build. The workgroup reflected on the survey results during weekly meetings, utilizing the feedback to improve nursing education and prepare for potential barriers before implementing hospital-wide. This signified the final implementation of the project as it resulted in a change within the organization (IHI, n.d.-c).

Purpose

This project aimed to enhance CVPCU nurses' knowledge and attitudes of penicillin allergy delabeling and amoxicillin challenges. This project provided education to nurses and assessed learning and attitudes towards the topics. This was done to better prepare for the planned launch of the nursing protocol throughout the hospital later in the calendar year. This project aimed to enhance nursing knowledge and attitudes towards the nurse protocol topics, guiding further hospital-wide education. This project supported the MCA QAPI goal of increasing the amount of oral Amoxicillin challenges by 100% in the inpatient population so that more inappropriate penicillin allergies are removed from the EHR. The outcome of this project was to increase nursing knowledge and attitudes towards penicillin allergy de-labeling, thereby promoting the QAPI goal and preparing for hospital-wide dissemination.

Project Question

The PD developed the project question with emphasis on the patient population, intervention, and outcome (Bradshaw et al., 2024b). The question for this project was: "Does implementing an education session improve nursing knowledge and attitudes of penicillin de-labeling topics?".

Project Objectives

The objectives of a DNP project refer to specific actions to achieve the project aims and should be specific, measurable, and achievable (Bradshaw et al., 2024a). The goals of this project were to enhance nursing knowledge and attitudes towards penicillin delabeling topics. The objectives for this QI project were:

1. Evaluate the literature and develop a nursing education PowerPoint presentation, recruitment material, and pre- and post-education surveys that assess knowledge and attitudes towards this topic.
2. Implement an evidence-based educational presentation on penicillin allergies and amoxicillin challenges for CVPCU nurses at MCA.
3. Analyze pre- and post-education survey results to assess the education material's impact on enhancing nursing knowledge and attitudes towards penicillin allergy topics.
4. Provide survey results and suggestions to the project workgroup to guide future implementation.

Project Rationale

At MCA, there is no system-wide process to identify low-risk penicillin allergy patients who are eligible for an amoxicillin challenge while hospitalized. This prompted the penicillin allergy workgroup to create a nurse protocol for inpatient nurses to ensure all inpatients are screened for penicillin allergies. This protocol includes questions based on PEN-FAST for the RN to ask patients who have a low-risk penicillin allergy. When the RN completes these questions with the patient, the EHR will generate an order to consult the pharmacy department. The pharmacy order will state that the patient completed the allergy screening questions and may be eligible for an amoxicillin challenge. This nurse protocol provides a systematic way for all admitted patients to be screened for inappropriate penicillin allergies. Since the workgroup plans to submit this protocol at the end of 2025, the PD created this QI project to develop and assess nursing education regarding penicillin allergies and amoxicillin challenges.

Amoxicillin challenges are within the scope of RNs at MCA; however, it is not an everyday occurrence in many nursing units. Thus, there is a knowledge gap among nurses regarding penicillin allergy de-labeling and amoxicillin challenges. The PD created this project in preparation for this launch to develop and assess nursing education on a smaller unit level before hospital-wide dissemination. The PD also developed questions to ask nurse participants to determine their attitudes and perceived barriers towards this topic. Trialing nurse education on a smaller scale will provide insight into knowledge gaps and attitudes before launching the hospital-wide initiative.

Methods

Site

This DNP project occurred at the MCA Hospital in Phoenix, Arizona. This hospital has 368 beds, an emergency department, thirty-three operating rooms, and is a licensed transplant center (Mayo Clinic, n.d.-b). This QI project occurred specifically on the 42-bed CVPCU unit. The PD presented the recorded education session in person at the September monthly CVPCU Unit-Based Council (UBC) meeting. The same recorded presentation was emailed to all CVPCU nursing staff to reach those who were not at the UBC meeting.

Stakeholders are individuals who are directly interested in the topic and outcome of the project (Boaz et al., 2018). For this project, the stakeholders were people involved in the allergy assessment and/ or penicillin allergy de-labeling initiatives. The stakeholders of this project include the pharmacy team, allergy department, Information Technology (IT), nurse education specialists, and bedside nurses.

Participants and Recruitment

The PD recruited participants via MCA email that included an introduction to the project and a request for voluntary participation (Appendix D). The email included the estimated time commitment and links to the recorded presentation, pre- and post-surveys. The email contained a disclosure statement with informed consent and University of Arizona faculty contact information (Appendix E). The intended participants were CVPCU nurses who were likely to encounter patients with penicillin allergies in the near future.

Intervention

This project's intervention was to educate CVPCU nurses on penicillin topics. The PI created a 27-slide PowerPoint presentation, seen in Appendix F, and recorded a voiceover video 15 minutes in length. The presentation covered several key topics, including penicillin allergy background information, the classification of allergies versus adverse drug reactions, oral amoxicillin challenges, hypersensitivity reactions, components of allergy history, PEN-FAST, upcoming nurse protocols, and nurse responsibilities.

The PD emailed the presentation along with links to the Qualtrics pre- and post-surveys. The pre-survey, seen in Appendix G, included consent to participate, demographic information, and attitude and knowledge assessment questions. The demographic questions asked about years of nursing experience and the number of amoxicillin challenges performed as an RN at MCA. The survey asked participants to rate their familiarity and comfort level with penicillin de-labeling and amoxicillin challenges on a Likert scale to assess their baseline attitudes towards these topics. Likert scales allow participants to rank their attitudes towards a statement from on a scale of strongly agree to strongly disagree (Taherdoost, 2019).

The five knowledge questions aimed to assess baseline knowledge of penicillin allergy topics in the pre-survey and to assess for knowledge acquisition and retention in the post-survey. These questions and correct answers are seen in Appendix H. The PD utilized evidence-based resources on penicillin allergy de-labeling, including Blumenthal et al. (2019), Centers for Disease Control (2024a), Knol et al. (2022), Pichler et al. (2023), and Turner et al. (2019), as seen in the literature review in Appendix A. The workgroup reviewed these questions before submission to ensure accuracy.

The first question was: Which of the following is true regarding penicillin allergies? The correct answer was that the majority of penicillin allergies are inaccurate. The correct answer for the second question is that symptoms such as nausea, GI upset, and rash without systemic symptoms after penicillin administration are examples of adverse reactions or side effects. The third knowledge question asked participants to classify hypotension, blisters, and sudden GI distress after penicillin administration as either an immunologic drug reaction or an adverse effect. The correct answer was immunologic drug reaction or allergy. The fourth question asked participants to select the incorrect statement regarding anaphylaxis, including that treatment includes an albuterol inhaler, symptoms include dyspnea, chest tightness, and wheezing, treatment includes intravenous epinephrine, or that there is a nursing protocol available for anaphylaxis management. The correct answer for this exception question was treatment with intravenous epinephrine, as anaphylaxis is treated with intramuscular epinephrine (Picheler et al., 2024). The final knowledge question asked participants to select the correct statement about oral amoxicillin challenges. The correct answer was oral amoxicillin challenges are given to low-risk patients with frequent vital signs.

The post-education survey included the same five knowledge questions, Likert scale statements on knowledge and attitudes towards these topics, and free text responses to provide suggestions for the workgroup to improve this education and protocol before dissemination hospital-wide (Appendix I). The QI selected the pre-post method because it corresponds to the educational objectives, nature of the education session, and DNP project criteria (Wykowski & Starks, 2024).

The recruitment materials, including the disclosure form, pre-survey, education video, and post-survey, were presented at the UBC meeting and sent by email on September 9, 2025. The links were available for three weeks to allow sufficient time for nurses to watch the education video and complete the surveys. Data was collected by Qualtrics survey software.

Evaluation Measures

DNP projects need to evaluate the outcomes and processes of the intervention. The PD developed surveys to capture data relevant to the QI project. The surveys were developed in alignment with the project team's goals to validate the importance of nurse involvement in penicillin allergy de-labeling and to document knowledge gaps, attitudes, and advice for further improvement of the QI initiative (Bradshaw et al., 2024a). As detailed in the above intervention section, survey questions were meticulously created to include knowledge assessment multiple choice questions and Likert scales to assess attitudes and advice regarding the QI project topic. The PD inputted the survey questions into Qualtrics software and extracted data after the intervention window completed on October 1, 2025.

Analysis

The results of pre- and post-education surveys were compared to assess knowledge, and information was collected to gather beliefs and attitudes. The PD extracted survey response data from Qualtrics and analyzed it via Microsoft Excel. The PD utilized descriptive statistics by performing t-tests in Excel to calculate the statistical significance of the mean difference of scores (Bradshaw et al., 2024a). The calculated p-value allowed the PD to determine if there were statistically significant changes after the intervention. Data was displayed in bar graphs to demonstrate the findings visually (Jones et al., 2021).

Content analysis methods were applied to the open-ended question responses to generate qualitative insights (Aracharya, 2022). The PD analyzed the responses from Likert scale questions to understand participant attitudes and beliefs towards penicillin allergy topics and assess their satisfaction with the educational material. Common words and themes were summarized from the participant feedback of the qualitative open-ended questions.

Ethical Considerations

The project was implemented safely and ethically. This project had no direct patient involvement, and the nurse participant's answers remained confidential. Participants were not asked to disclose their name or any demographic information except for the range of years worked as a nurse. Regarding consent, the first question on the pre-survey asked participants if they agreed to participate in the QI project, and they were informed that this served as consent. A detailed disclosure form was included in the recruitment email, as seen in Appendix D, that explained the project intentions, components, and voluntary participation. This form explained that there were no foreseeable risks associated with participation and that participants had the

right to withdraw at any time from the project. The PD provided contact information for the PD and the University of Arizona faculty advisor. The pre- and post-surveys collected an individualized 4-digit code that participants created for the PD to associate responses while keeping all data anonymous. The PD collected and securely stored survey results in Qualtrics. This followed the recommended ethical considerations for QI projects and informed consent (Bradshaw et al., 2024a; Hunt et al., 2021).

IRB Review and Approval

The PD submitted this project proposal to Mayo Clinic's Institutional Review Board (IRB) for exemption approval (Mayo Clinic, n.d.-a). This application was approved, as seen in Appendix C. Likewise, MCA Academic Affairs provided a site approval letter for this project, as seen in Appendix J. The University of Arizona IRB approved this project as QI and not human research (Appendix B).

Results

The PD collected and analyzed Qualtrics pre- and post-survey data to assess nursing knowledge and attitudes toward penicillin allergy topics. The survey answers were extracted from Qualtrics and inserted into Excel to apply descriptive statistical tests. Twenty-three participants completed the pre-survey, and eighteen completed the post-survey. The PD included the demographic and screening intent answers from all participants in the pre-survey to assess baseline beliefs. However, to ensure accurate statistical findings, the PD removed the five participants who did not complete the post-survey from the knowledge question results. Only the 18 participants who completed both pre- and post-surveys were included in the statistical analysis of knowledge retention. Participant retention and drop-off data are seen in Table 1.

Table 1*Participant Drop Out Rate*

	Number of Participants	Percentage Rate
Completed Pre-Survey	23	100%
Completed Post-Survey	18	78.2%
Drop-Off	5	21.7%

Participant Demographics

The majority of participants had three to five years of nursing experience. Of the 23 participants who completed the pre-survey, 52.2% (n=12) had three to five years of nursing experience, 21.7% (n=5) had over 10 years of experience, 17.3% (n=4) had six to ten years of experience, and 8.6% (n=2) had less than 2 years of experience. This data is visualized in Figure 4. In addition to years of nursing experience, the pre-survey asked participants how many amoxicillin challenges they had performed as nurses at MCA. 70% of participants (n=16) have never performed an amoxicillin challenge. 30% (n=7) have performed 1 of 2 challenges. No participants answered the options of performing 2 to 5 or 5 or more challenges (Figure 5).

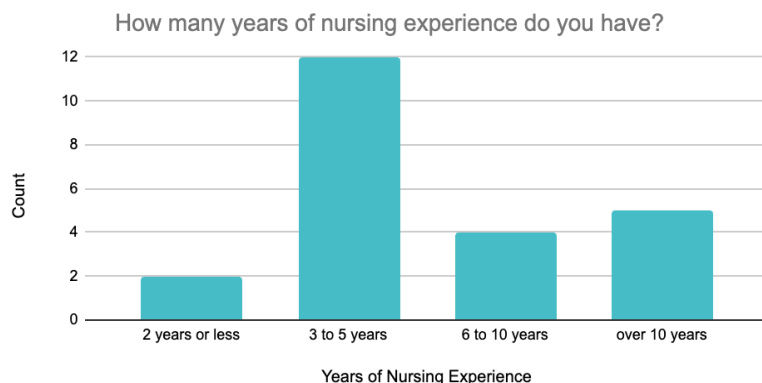
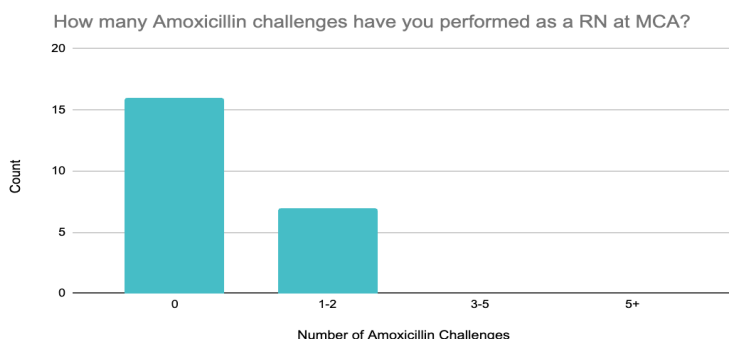
Figure 4*Participant Demographics*

Figure 5*Amoxicillin Challenges Performed***Pre-Intervention Screening Intent**

The pre-education survey also included questions about participants' comfort levels with the topics of penicillin allergy de-labeling, amoxicillin challenges, and allergy assessments. The PD included these questions to assess participants' beliefs and attitudes toward the issues and gather a sense of baseline perceptions. Participants were asked to rank their level of comfort on a Likert scale for three questions. The first screening intent question asked participants to respond to "How familiar are you with the topic of penicillin allergy delabeling?". As seen in Figure 6, 52% (n=12) of participants responded with slightly familiar, 26% (n=6) felt not familiar at all, and 22% (n=5) felt moderately familiar. No participants responded with very familiar or extremely familiar. This aligns with the project's intent and purpose, which is that nurses at MCA require additional education on these topics before the hospital-wide nursing order set initiative is launched. Participants were asked to respond to "How comfortable are you performing oral amoxicillin challenges?" The responses were as follows: 17% (n=4) responded with extremely uncomfortable, 35% (n=8) with somewhat uncomfortable, 26% (n=6) neither comfortable nor uncomfortable, 22% (n=5) with somewhat comfortable, and no participants responded with

extremely comfortable. The third screening intent question asked patients to respond to “How important are allergy assessments to your job as an RN.” This question aimed to gather baseline attitudes towards the importance of performing allergy assessments as an RN with patients at MCA. 17% (n=4) responded with moderately important, 48% (n=11) with very important, and 35% (n=8) with extremely important. No participants responded with not at all important or slightly important.

Knowledge Assessment Questions

The pre- and post-surveys included the same five knowledge questions to assess baseline and post-intervention knowledge of penicillin allergy topics. These questions and answer choices are seen in Appendix H. The mean score among all 18 participants was 75.79 on the pre-intervention survey and 92.63 on the post-intervention survey, yielding a 16.8 point difference. The PD utilized the paired two-sample t-test function in Excel to generate a paired T-test and calculate a p-value with a 95% confidence interval ($\alpha = 0.05$), based on the null hypothesis that there is no significant difference between the means. As shown in Table 2, the P value was calculated to be 0.0041. Since the p-value is less than 0.05, we can reject the null hypothesis and conclude that there is a significant difference in the pre- and post-test mean scores (Wadhwa & Marappa-Ganeshan, 2023).

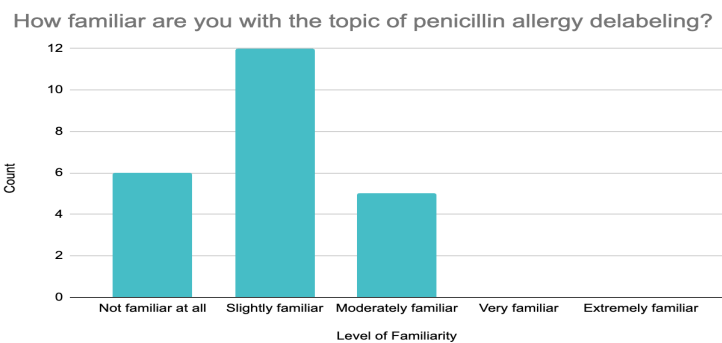
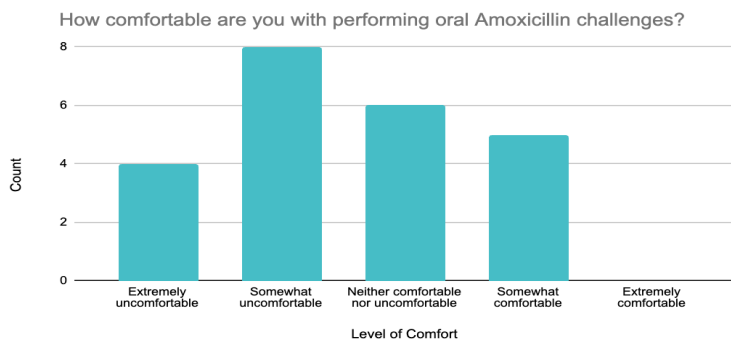
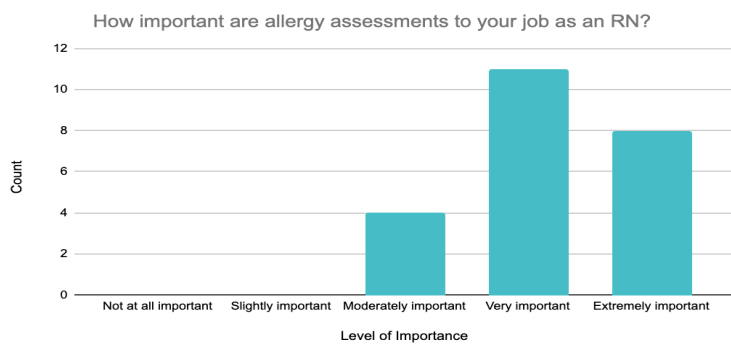
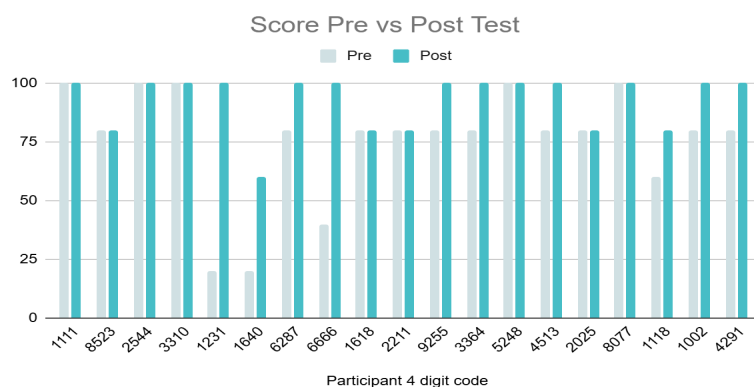
Figure 6*Participant Screening Intent Questions***A****B****C**

Table 2*Overall Score Pre- and Post-Intervention*

t-Test: Paired Two Sample for Means with 95% Confidence Interval ($\alpha=0.05$)			
	<i>PRE</i>	<i>POST</i>	<i>Difference</i>
Mean	75.7894737	92.63157895	-16.8421052
Variance	603.508772	142.6900585	
Standard deviation	24.566415	11.94529441	12.62112112
Observations	18	18	
Pearson Correlation	0.41848947		
Hypothesized Mean Difference	0		
df	18		
t Stat	-3.2812124		
P(T<=t) one-tail	0.00207491		
t Critical one-tailed	1.73406361		
P(T<=t) two-tail	0.00414983		
t Critical two-tailed	2.10092204		

As seen in Figure 7, there was an overall increase in participant scores from pre-test to post-test. Four participants scored the same on both pre- and post-tests. However, 77.7% (n = 14) of participants scored higher on the post-test, and no participant's scores decreased from the pre-test to the post-test. Several participants had significant increases in knowledge; for example, participant 1231 increased their score by 80%, and participant 6666 by 40%. These increases correspond with the statistical significance demonstrated in the p-value of 0.004 seen in Table 2.

Figure 7*Pre- and Post-Score by Participant ID*

The PD performed further statistical analysis on individual questions. Table 3 depicts the statistical data from the T-test with a 95% confidence interval ($\alpha=0.05$). Overall, all the questions yielded a p-value of 0.0075, which is less than 0.05, indicating statistical significance. The standard deviations were all less than 0.2, indicating that the results are clustered closely to the mean (Khan, 2025).

Table 3

Statistical Analysis of Five Knowledge Questions

Question	Pre-intervention percent answered correctly	Post-intervention percent answered correctly	Difference	Standard Deviation
Which of the following is true regarding penicillin allergies	0.77	1	0.23	0.1626345
Symptoms such as nausea, GI upset, and rash without systemic symptoms after penicillin administration are examples of	0.88	1	0.12	0.0848528
Hypotension, blisters, and sudden GI distress after penicillin administration are examples of	0.94	1	0.06	0.0424264
All of the following statements regarding anaphylaxis are true except	0.5	0.72	0.22	0.1555634
Oral Amoxicillin challenges are:	0.66	0.88	0.22	0.1555634
		T-Test P Value	0.0075363	

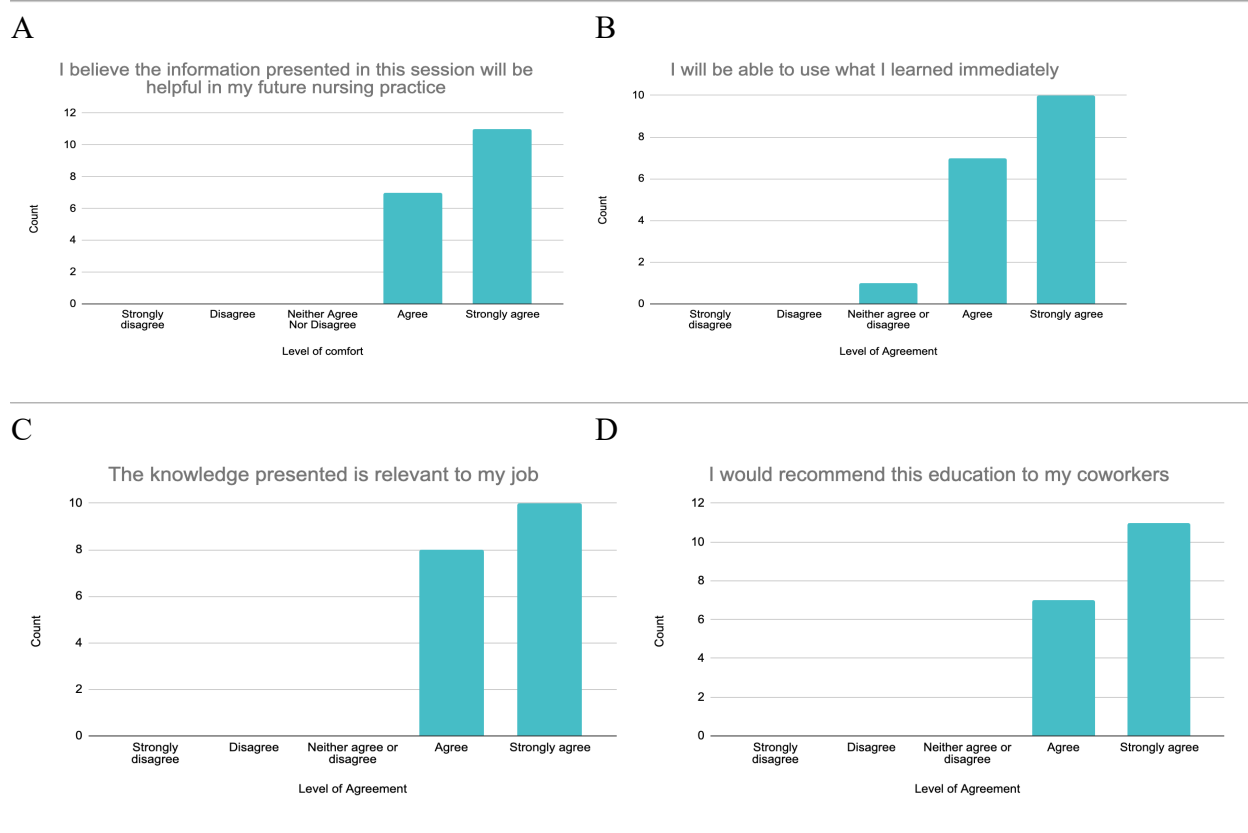
Post-Intervention Screening Intent

After the knowledge assessment questions on the post-survey, participants were asked to respond to a series of statements with Likert scale responses, as seen in Figure 8. These questions served to assess participant satisfaction and attitudes towards the education intervention, as well as their likelihood of incorporating what they learned into practice. In response to “I believe the information presented in this session will be helpful in my future practice”, 39% (n=7) responded with agree, and 61% (n=11) strongly agree. No participants responded with strongly disagree,

disagree, or neither agree nor disagree. In response to “I will be able to use what I learned immediately”, 6% (n=1) responded with neither agree nor disagree, 39% (n=7) with agree, and 56% (n=10) with strongly agree. There were no responses of strongly disagree or disagree. “The knowledge presented is relevant to my job” had the following responses: 44% (n=8) responded with agree, and 56% (n=10) with strongly agree, and no participants responded with strongly disagree, disagree, or neither agree nor disagree. In response to “I would recommend this education to my coworkers,” 39% (n=7) responded with agree and 61% (n=11) strongly agree. Likewise, no participants answered with strongly disagree, disagree, neither disagree nor agree.

Figure 8

Post-Education Screening Intent



Participants were asked to rank their level of confidence in performing oral amoxicillin challenges before and after the intervention. As seen in Figure 9, an overwhelming majority of participants felt confident after the education, compared to not confident before the intervention. In response to “Prior to this education, my confidence level regarding amoxicillin challenges was”, 17% (n=3) felt extremely not confident, 50% (n=9) responded with not confident, 17% (n=3) with neutral, 11% (n=2) with confident, and 6% (n=1) felt extremely confident. In response to “After this education, my confidence level regarding amoxicillin challenges is,” 61% (n=11) responded with “confident,” 28% (n=5) with “extremely confident,” 11% (n=2) with “neutral,” and no participants responded with “extremely not confident,” or “not confident.” This data is depicted in Table 4.

Figure 9

Comparison of Pre- and Post-Education Level of Confidence

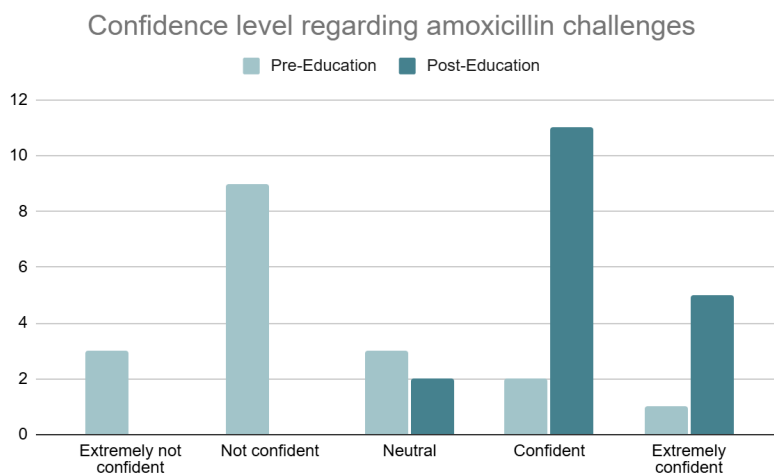


Table 4*Pre and Post Level of Confidence Data*

Pre	Count	Percentage
Extremely not confident	3	17%
Not confident	9	50%
Neutral	3	17%
Confident	2	11%
Extremely confident	1	6%
Post	Count	Percentage
Extremely not confident	0	0%
Not confident	0	0%
Neutral	2	11%
Confident	11	61%
Extremely confident	5	28%

Post-Intervention Feedback Themes

After the knowledge assessment questions in the post-survey, participants were asked three open-ended questions to gather feedback and recommendations for future use of this education. In response to, “After receiving this education, what barriers do you anticipate from a nursing perspective regarding the penicillin allergy screening tool protocol?”, eight participants wrote none or not applicable, as seen in Table 5. The remaining 10 participants wrote specific phrases expressing potential barriers they anticipate with the launch of the upcoming nurse protocol. Content analysis principles were applied to the responses to identify common themes (Vaismoradi & Snelgrove, 2019). The common themes identified include patient willingness to participate, patient refusal, time restraints, and nursing workflow.

Table 5*Participant Written Feedback on Anticipated Barriers of Nurse Protocol*

Response	Number of responses
n/a	2
none	6
Patient not willing to participate	1
Patient refusal	2
time to complete	1
It is not something that occurs often on our floor, so I worry that retention will be low when staff encounter this situation on the floor.	1
I anticipate that nursing will have a lack of time to complete the screening protocol or consider it less important compared to other admission tasks.	1
Patient continued reluctance to participate. Unknown reactions as a child.	1
if you dismiss the OPA will it come back to fill out?	1
making it fluent in their workflow since it will be new	1
Nurses being nervous about challenging allergies	1
Total	18

The subsequent open-ended question was “Please share any suggestions for the penicillin allergy screening group as they are preparing to launch this tool and anticipate more amoxicillin challenges”. As seen in Table 6, 13 participants wrote none or n/a, while 5 participants wrote feedback. Common themes in the suggestions included continuing this education and sharing it on the nursing webpage. One participant expressed concern regarding patient hesitancy to have an allergy removed and to provide extensive patient education to address these concerns.

Table 6*Qualitative Data on Participant Suggestions*

Response	Number of responses
none	7
n/a	6
I anticipate that patients may express extreme hesitancy to complete the amoxicillin challenge and that the team and nursing staff should be prepared to deliver extensive patient education to help reassure them.	1
Have everyone learn about this tool to create successful monitoring for every patient performing the challenge.	1
make information available on MyNursing page	1
video demo once this launches on how to use	1
continue this excellent education!	1
Total	18

The final post-survey question was “Any other thoughts or knowledge gaps you would like to share?”. As seen in Table 7, 16 participants either left the response blank or wrote "none" or "n/a." One participant responded with positive accolades regarding the presentation, and one participant asked if nurses or doctors are the ones who will remove the allergy from the chart.

Table 7

Participant Final Feedback

Response	Number of responses
none	6
left blank	7
n/a	3
great work and info!	1
who can remove allergies- nurse or doctor? what is the process?	1
Total	18

Discussion

The PD developed this project based on the MCA local need for nursing education before launching a hospital-wide nurse order set for assessing patient penicillin allergies. The goal was to increase nursing knowledge and attitudes towards penicillin allergy topics, preparing nurses for an upcoming policy change. The project evaluated baseline knowledge, level of confidence, and experience with these topics, provided education, and then tested knowledge comprehension and asked for feedback. The data collected and analyzed demonstrate how the objectives of improving nursing knowledge and attitudes were met.

Improving Nursing Attitudes

The pre-survey screening questions validated the need for this project, as most participants reported being somewhat uncomfortable or neutral about performing amoxicillin challenges. Likewise, all participants indicated moderate familiarity or less on the Likert scale

when asked about their familiarity with penicillin allergy de-labeling. When asked about the importance of allergy assessments towards their job as an RN, all participants indicated they were moderately, very, or extremely important. These findings support the project's intention and rationale for improving attitudes towards these topics by educating and empowering nurses. The responses highlight nurses' perceptions that allergy assessments are important to their job as a RN at MCA.

Although amoxicillin challenges are ordered periodically at MCA, the workgroup anticipated a significant increase in the number ordered after the hospital-wide nurse protocol is active. The workgroup anticipated that nurses did not have substantial experience performing amoxicillin challenges. This was validated in the data as 70% of participants (n=16) indicated they had never performed an amoxicillin challenge while an RN at MCA, and 30% (n=7) had performed one or two challenges. Given that all participants had performed two or fewer amoxicillin challenges throughout their nursing career at MCA, these results align with the project's purpose and rationale.

The post-survey screening questions asked participants about their thoughts on the content presented in the education session. All participants responded with "agree" or "strongly agree" to statements about the information being relevant to their future nursing practice, their job as an RN, and recommending this education to their coworkers. In response to being asked to rate their immediate use of the information on a Likert scale, one participant responded with "neither agree nor disagree". While the other 17 participants responded with agree or strongly agree. These questions were asked in the post-survey to gather attitudes towards the education material and penicillin allergy topics after receiving education. Participant responses were

encouraging regarding the educational material and its potential applications in nursing practice at MCA.

Regarding overall confidence performing amoxicillin challenges, participants were asked to rank their level of confidence before and after the education session. There was an overwhelmingly significant increase in participant confidence after the education session. Before the education, 83% (n=15) felt either neutral, not confident, or extremely not confident. While 17% (n=3) felt confident or extremely confident. 50% (n=9) felt not confident. However, after the education, all participants ranked their confidence as neutral, confident, or extremely confident. No participants responded with not confident or extremely not confident. The majority, 61% (n=11), felt confident, 28% (n=5) extremely confident, and 11% (n=2) neutral after the education session. This data is reassuring that the education increased participant attitudes toward the topics, given the significant increase in confidence.

Participants were asked to provide feedback on the education session and to state any barriers they anticipate as the workgroup plans to launch the new nursing protocol. These questions served to assess nursing attitudes towards the upcoming protocol and empowered nurses, as their opinions and suggestions are essential to the team. The common themes identified regarding potential barriers to the nurse protocol and suggestions to the team were mainly regarding patient participation and incorporating the protocol into nursing practice. These findings were shared with the project workgroup to improve the protocol and anticipate questions and concerns. The responses were encouraging, indicating nurses' interest in these topics and supporting the importance of further education on them.

Improving Knowledge

The pre- and post-surveys assessed baseline knowledge and comprehension after the education session, respectively. The overall pre-test score of 75.8% indicates a knowledge deficit among nurses regarding these topics. Whereas the post-education survey mean score was 92.6%, indicating a strong understanding of the material. The 16.8% increase indicates retention of the material and overall increased knowledge regarding these topics after receiving formal education. The statistical t-test yielded a p-value of less than 0.05, which demonstrates significance.

All participants had a 100% correct response rate for the post-education questions regarding penicillin allergy facts and differentiating symptoms of adverse reactions versus anaphylaxis. However, only 72% of participants answered correctly in the post survey to the question regarding anaphylaxis treatment and protocols. Although this increased from an average of 50% correct answers in the pre-survey, there is still room for improvement. This indicates a continued knowledge gap and an area to focus future nursing education.

This data demonstrates that the initial project aim statement of increasing nursing knowledge on penicillin allergies and amoxicillin challenges by at least 15 percent via an educational session has been met. The data and summarized results were shared with the penicillin workgroup. This met the project objective of providing suggestions to the workgroup to guide future implementation.

An essential aspect of the DNP project is to make connections between the findings in the literature and the project (Bradshaw et al., 2024c). The results from this QI project confirmed findings in the literature regarding the need to distinguish between allergies and adverse

reactions, educate healthcare professionals on amoxicillin challenges, and the benefits of penicillin allergy de-labeling. Overall, the participants felt that allergy assessments were essential to their jobs; however, the majority did not feel confident with penicillin allergy de-labeling prior to the education session. After education, nurses demonstrated strong retention of concepts and increased confidence. This confirms the literature findings that with the proper education, nurses are capable of performing allergy assessments, educating patients, and promoting antimicrobial stewardship through advocating for penicillin-delabeling (CDC, 2017; Hoffman et al., 2025).

Alignment with DNP Essentials

The American Association of Colleges of Nursing (AACN) published eight Essentials of Doctoral Education for Advanced Nursing Practice to describe the essential competencies of DNP program graduates (AACN, 2006). This QI project incorporated DNP Essentials II, III, and VI into its planning, implementation, and evaluation.

DNP Essential II states: Organizational and Systems Leadership for Quality Improvement and Systems Thinking (AACN, 2006). The PD addressed this essential by utilizing the IHI Model for Improvement to design and implement the project change. The PD identified the lack of a system-wide process to assess admitted patients for inaccurate penicillin allergy labels. The PD collaborated with nursing, pharmacy, and education leaders across MCA to develop an intervention aimed at improving this process to meet the current and future needs of MCA hospitalized patients (AACN, 2006). The PD meticulously reviewed MCA's current policy and literature on penicillin allergies and recommended incorporating this intervention into the

organization after demonstrating success with this QI project. These processes demonstrate organizational and systems leadership for quality improvement at MCA.

DNP Essential III reads as follows: Clinical Scholarship and Analytical Methods for Evidence-Based Practice (AACN, 2006). This project aligned with this DNP Essential because the PD critically analyzed the scholarly evidence and designed a QI project based on the evidence. The PD reviewed the extensive literature available for evidence-based practice on penicillin allergies, amoxicillin challenges, and allergy assessment tools. This detailed review is seen in Appendix A. After summarizing the scholarly literature, the PD applied these principles to the local problem at MCA by creating this QI project to improve current allergy assessment practice. The intervention was evaluated using descriptive statistics and information technology methods before the findings were confidently disseminated to improve outcomes (AACN, 2006).

DNP Essential VI declares: Interprofessional Collaboration for Improving Patient and Population Health Outcomes (AACN, 2006). As a DNP student and current CVPCU RN at MCA, the PD joined the penicillin allergy workgroup to collaborate with interprofessional team members and improve the current penicillin allergy screening process. The PD took leadership of the nurse education aspect of the nurse protocol and collaborated with CNS and NES to understand the scope of practice of RNs at MCA and current education requirements and gaps regarding allergy assessments. The PD consulted with the specialty pharmacist on the team to understand and improve current workflows of determining patient eligibility for amoxicillin challenges. Overall, with support from the workgroup team members, the PD successfully demonstrated strong leadership and interdisciplinary collaboration to improve patient health outcomes.

Sustainability

The PD presented the data and recommendations to the penicillin allergy workgroup, sharing the success of the education intervention and feedback from CVPCU nurse participants. The team was sent an executive summary detailing the findings of the DNP project and feedback from participants (Appendix K). The workgroup was receptive to the feedback and plans to utilize the education content for future nursing education. The workgroup intends to submit the penicillin allergy nurse protocol for IT build in December of 2025. Once the protocol is finalized in the EHR, hospital-wide education will commence so that all nurses are educated on proper penicillin allergy labels and amoxicillin challenges. Given the success of this QI project, the workgroup plans to utilize the content from the education presentation in the future, thus confirming the sustainability of this project.

Limitations

The primary limitation of this QI project was the small sample size, which restricts the generalizability of the findings to populations outside the study. Although the PD attempted to recruit all CVPCU nurses by sending a unit-wide email to all 130 nurses and attending a UBC meeting, only 18 nurses participated in all aspects of the project. Five participants did not complete the post-survey. After reviewing the timestamps of the survey responses, the PD realized that all in-person participants completed both the pre- and post-surveys in real-time. However, the five participants who did not complete the post-survey had completed the pre-survey several days after the email was sent out and were not in attendance at the in-person session. This supports in-person synchronous education over virtual self-paced education in terms of reaching as many nurses as possible and ensuring completion of educational material.

Another limitation is that the project did not conduct a follow-up assessment to assess for knowledge retention and attitudes at a longer interval. Ideally, the PD would send a follow-up survey one month after the participant completed the education session to assess their knowledge of the content questions and solicit their feedback and attitudes towards the topic. This would have evaluated long-term retention and improvement. However, for purposes of this DNP project and as a member of the penicillin allergy workgroup, this project successfully assessed and improved nursing knowledge and attitudes towards penicillin de-labeling.

Conclusion

The findings from this QI project demonstrate the importance of nursing education and empowerment to improve penicillin allergy de-labeling efforts at MCA. The participants were eager to learn more about de-labeling penicillin allergies and oral amoxicillin challenges. Participants shared honest feedback about potential barriers they anticipate when participating in the upcoming nurse protocol, mainly regarding patient willingness to participate and nurses requesting more education before the implementation. The improvement in scores after the nursing education session is reassuring, indicating that with adequate training, nurses can effectively distinguish adverse reactions from allergies and educate their patients on amoxicillin challenges. Overall, this QI project underscored the critical importance of nurses being well-educated in proper allergy assessment techniques and oral amoxicillin challenges to enhance antimicrobial stewardship.

Implications for Future Practice

Penicillin allergy assessments and de-labeling are essential topics in the field of healthcare and antimicrobial stewardship. Currently, many healthcare institutions have

pharmacists or providers perform allergy assessments, like the PEN-FAST. However, nurses can safely and effectively perform such assessments. Hoffman et al. (2025) found similar efficacy among nurses and pharmacists when performing a modified PEN-FAST assessment. After nurses collect information, pharmacists verify the details with the patient and order amoxicillin challenges for these low-risk patients to correct the inaccurate penicillin label. This demonstrates the immense potential of assessing more patients for inaccurate penicillin allergies since nurses are the front line of healthcare, taking care of patients at the bedside. With proper education and training, nurses can safely perform penicillin allergy screening questions with their patients and perform the ordered amoxicillin challenges. This PD is hopeful for more involvement of nurses in penicillin de-labeling and antimicrobial stewardship across MCA and more healthcare institutions.

Appendix A
Evidence Table

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
American Academy of Allergy, Asthma, and Immunology, 2023	Penicillin allergy evaluation should be performed proactively in patients with a penicillin allergy label – A position statement of the American Academy of Allergy, Asthma & Immunology	Position statement	<ul style="list-style-type: none"> - Mislabeling occurs due to reports of side effects being misidentified as allergies, coincidental events, etc. - Poor patient outcomes are associated with mislabeled allergies - Very low reaction rate for direct oral challenges - Defines low-risk allergies as those with a history greater than 5 years and only cutaneous symptoms - Patients with just a family history or side effects like nausea can be de-labeled without a drug challenge - Recommends PEN-FAST as a decision tool for low-risk allergies 	<ul style="list-style-type: none"> - Position statement from the American Academy of Allergy, Asthma, and Immunology recommending inpatient antimicrobial stewardship programs, direct oral challenges without skin tests in low-risk patients, utilizing PEN-FAST - Importance of performing tests in an inpatient setting - Skin testing should only be used if concerned about an IgE-mediated or anaphylaxis reaction
American Nurses Association and the Centers for Disease Control and Prevention (CDC), (2017)	Redefining the antibiotic stewardship team: Recommendations from the American Nurses Association/ Centers for Disease Control and Prevention workgroup on the role of registered nurses in hospital antibiotic stewardship practices.	Recommendation/ guideline	<ul style="list-style-type: none"> - Highlights how nurses can contribute to antimicrobial stewardship: allergy history, collecting blood cultures before antibiotics, timely antibiotic administration, reporting lab results, and patient education - Importance of a thorough allergy history and documentation - Hospital antibiotic stewardship programs should include leadership commitment, accountability, drug expertise, action, tracking, reporting, and education 	<ul style="list-style-type: none"> - Applicable to this project’s focus on nurses assessing for low-risk penicillin allergies - Create nurse-focused tools and education on antimicrobial stewardship - Educate patients on what is considered an allergy versus a side effect
Barlam et al., 2016	Implementing an antibiotic stewardship program: Guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America.	Clinical Guidelines	<ul style="list-style-type: none"> - Provides a series of recommendations regarding antibiotic best practices - Evidence-based recommendations to optimize antibiotic use, improve outcomes, and reduce resistance - Strongly recommends preauthorization and prospective audit and feedback interventions - Institution-specific guidelines - Prescriber education 	<ul style="list-style-type: none"> - Evidence-based guidelines for antibiotic stewardship programs - Defines antibiotic stewardship from the CDC perspective - Detailed guidelines and recommendations for particular antibiotics and patient scenarios - Recommend penicillin allergy assessments and testing

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
Blumenthal et al., 2017	Tackling inpatient penicillin allergies: Assessing tools for antimicrobial stewardship	Quasi-experimental controlled trial without randomization n=625 Level III	<ul style="list-style-type: none"> - Describes the dangers of inaccurate PCN allergies, including less effective medications, increased risk of resistant organisms, adverse events, and treatment failures - 15% - Tested two interventions: a computerized guideline application with clinical decision support and inpatient skin testing compared to the hospital's standard of care, which is not to perform testing or trials inpatient, but instead refer patients to the allergy clinic outpatient - Found that both interventions were successful in increasing appropriate antibiotic use in the hospital and increasing beta-lactam antibiotic use 	<ul style="list-style-type: none"> - Provides strong background information on inaccurate PCN allergies and their harms - The inpatient population, unable to do skin testing, applies to this project. - Yielded significant improvement in antimicrobial stewardship and gold standard antibiotic choice
Blumenthal et al., 2019	Antibiotic allergy	Clinical practice guideline	<ul style="list-style-type: none"> - compares antibiotic hypersensitivity reactions to adverse reactions - Describes non-IgE-mediated symptoms - PCN drugs rarely cause IgE-mediated reactions - Common adverse drug reactions (not allergic symptoms) to this class: rash, drug-viral interactions - Rare but serious ADRs: SCARs, SJS - High prevalence of non-severe ADRs listed as an allergy on the patient's medical record - Declares adverse effects of false allergy labels on patients, cost, and healthcare-associated infections, 	<ul style="list-style-type: none"> - Clinical practice guideline recommendation - Not verifying allergies or acting upon them poses a threat to public health and safety - Describes the ideal situation where non-allergy specialists and high-risk patients evaluate low-risk allergies and are referred to an allergy specialist
Blumenthal & Solensky, 2024	Choice of antibiotics in penicillin-allergic hospitalized patients	UpToDate	<ul style="list-style-type: none"> - Facts on penicillin allergy: reported in 15% of hospitalized patients, and increases the length of hospital stay, mortality, infection clearance, treatment failure, drug-resistant bacteria, adverse drug events from alternative antibiotics, and infections with drug-resistant bacteria - Addresses cross-reactivity with cephalosporins 	<ul style="list-style-type: none"> - UpToDate recommendations are well-respected and followed across all hospitals - Confirms the requirement of hospitals to have antimicrobial stewardship programs and limited access to allergy consultation in many hospitals - Penicillin allergies need to be addressed in a hospital setting

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
			<ul style="list-style-type: none"> - Recommendations for assessing penicillin allergy and tolerance with and without allergist consultation - Provides an algorithm to categorize allergy categories and treatment options for each 	<ul style="list-style-type: none"> - Provides an algorithm for the choice of de-labeling and testing based on allergy reactions - Specific questions to ask when obtaining allergy history
CDC, 2023	Antibiotic stewardship when an allergy label is present improves our antibiotic care and treatment outcomes	CDC statement	<ul style="list-style-type: none"> - Less than 1 percent of the population is truly allergic to penicillin, despite the general population report of 10% - Defines true penicillin allergy - The long-term benefits for patients after removing an allergy label include better outcomes, less resistance, and more access to first-line treatment options - Guest speaker Dr. Cosby Stone references his study of 206 oral challenges performed with only one minor skin rash - Other randomized controlled trials found similar results, with 1 in 200 having a skin rash regardless of a skin test 	<ul style="list-style-type: none"> - References a study that supports PEN-FAST as a method to successfully assess a patient's eligibility as a low-risk patient for oral amoxicillin challenge - Emphasizes the need for hospitals to assess for low-risk penicillin allergies and perform oral challenges under medical supervision - Some patients may be anxious about a challenge; in these situations, it is appropriate to offer
CDC, 2024a	Clinical features of penicillin allergy	CDC	<ul style="list-style-type: none"> - Statistics and facts on penicillin allergy in the United States - Lists questions to ask patients about the allergy - Characteristics of IgE-mediated reaction and anaphylaxis - Describes skin testing and oral challenge options depending on the patient and the specific allergy symptoms 	<ul style="list-style-type: none"> - Recommendations to conduct a thorough history and exam to validate or remove penicillin allergies - Clarifies the safety of cephalosporins despite a penicillin allergy
CDC, 2024b	Core elements of hospital antibiotic stewardship programs	CDC	<ul style="list-style-type: none"> - 30% of acute-care antibiotic prescriptions are suboptimal or unnecessary - Provides detailed guidelines for the goals of antibiotic stewardship programs - Recognizes the importance of penicillin allergy assessment 	<ul style="list-style-type: none"> - Provides structural and procedural components of successful antibiotic stewardship programs in hospitals - Emphasizes the importance of assessing penicillin allergy - Nursing role in improving allergy assessments

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
Centers for Medicare and Medicaid, 2019	Medicare and medicaid programs; regulatory provisions to promote program efficiency, transparency, and burden reduction; fire safety requirements for certain dialysis facilities; hospital and critical access hospital changes to encourage innovation, flexibility, and improvement in patient care.	Final rule statement from CMS	<ul style="list-style-type: none"> - Published document from the Department of Health and Human Services, Centers for Medicare and Medicaid - Streamline regulations for a variety of healthcare settings, including hospitals, rehabilitation centers, hospice, and transplant centers - Goals of improving patient safety and quality standards while also saving costs - Hospitals must comply with new antibiotic stewardship regulations by March 30, 2020 - Identifies specific requirements of the antimicrobial stewardship programs 	<ul style="list-style-type: none"> - In 2019, a new requirement was introduced for all affiliated hospitals to have an antimicrobial stewardship program - The goal of antibiotic stewardship programs is to reduce antimicrobial resistance and inappropriate antibiotic use - Ensures hospitals follow nationally recommended guidelines about antibiotic stewardship
Copaescu et al., 2023	Efficacy of a clinical decision rule to enable direct oral challenge in patients with low-risk penicillin allergy: The PALACE randomized clinical trial	Randomized Control Trial n=382 Level II	<ul style="list-style-type: none"> - Explains the barriers to outpatient skin testing for the general population - Emphasizes the necessity of a point-of-care screening tool to serve the general population - Challenges the current standard of care, which solely involves skin testing before oral challenge to delabel allergies - Provides statistics on PCN allergies - Most PEN-FAST scores were 0 or 1 - Non-inferior results compared to skin testing before oral challenge 	<ul style="list-style-type: none"> - This RCT found comparable results of the oral challenge to allergy skin testing - The oral challenge is a safe alternative to skint testing to accurately de-label PCN allergies in the low-risk population
Dore et al., 2025	Clearance of penicillin allergies via direct oral provocation testing (DOPT): a systematic review	Systematic Review n=1786	<ul style="list-style-type: none"> - 1786 patients completed direct challenge - 3.7% of patients reacted (rashes or other reactions); however; there were no cases of epinephrine use, anaphylaxis, or angioedema - PEN-FAST, PARSS, and modified facility-specific assessments are utilized as the risk assessment tools - Confirmed direct challenge is the gold standard for removing inaccurate penicillin allergies in low-risk patients (reiterating skin testing does not have 100% sensitivity or specificity) 	<ul style="list-style-type: none"> - Declare using a validated risk assessment tool and performing amoxicillin challenges is safe in low-risk patients - Relevant to this project because it confirmed direct challenge as the gold standard for removing low-risk inaccurate penicillin testing and confirmed the safety of a single dose challenge in a non-allergist performed population

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
Hoffman et al., 2025	Implementation and performance of a nurse-administered modified PEN-FAST clinical decision rule in the electronic health record	Prospective observational study n=388	<ul style="list-style-type: none"> - Performed by non-allergist providers - This study compared the results of PEN-FAST screening taken by pharmacists versus nurses - Overall, nursing assessment accuracy was 84.3% - NPV 89.5% - Nurses were more likely to select unknown rather than “no” regarding “was the reaction within the last 5 years” compared to pharmacists. - Demonstrated nurses are well-equipped to utilize a modified PEN-FAST tool to assess for hospitalized patients' low-risk penicillin allergies 	<ul style="list-style-type: none"> - Relevant to this project because it demonstrates the safe and effective use of bedside nurses performing PEN-FAST questionnaire - Included nursing education that was built into the EHR for nurses to access - Similar design of EHR pop-up for nurses to complete PEN-FAST questions with the patient - Emphasizes the under-use of PEN-FAST in institutions and recommends it be utilized to de-label erroneous penicillin labels - Still recommends clinician re-assessment after nurse assessment, but this significantly increases the amount of low-risk patients identified as potentially eligible for amoxicillin challenges
Kan et al., 2023	Comparative effectiveness, safety, and real-world outcomes of a nurse-led, protocol-driven penicillin allergy evaluation from the Hong Kong drug allergy delabelling initiative (HK-DADI)	Controlled trial without randomization n= 312 Level III	<ul style="list-style-type: none"> - Confirmed benefits of de-labeling without the need for skin testing - This protocol found higher rates of appropriate PCN use after the allergy was removed - Reduced unnecessary skin test procedures - No serious reactions occurred - Unique trial because it was the first to study among the Chinese population and included long-term follow-up to assess the use of PCN antibiotics after de-labeling 	<ul style="list-style-type: none"> - Nurse-led protocol-driven initiatives are safe and necessary to increase access to penicillin delabeling initiatives - Risk-stratifying multidisciplinary approach
Khan et al., 2022	Drug allergy: A 2022 practice parameter update	Systematic Review Level I	<ul style="list-style-type: none"> - Clinical practice updates on various drug class allergies - Recommend direct challenge over skin testing for low-risk patients - Benign cutaneous reactions should undergo an amoxicillin challenge 	<ul style="list-style-type: none"> - Journal of Allergy and Clinical Immunology clinical practice guideline updated to include the recommendation of oral challenges to safely de-label low-risk allergies

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
			<ul style="list-style-type: none"> - Provides a list of consensus-based statements for beta-lactam allergy with associated strengths of recommendation and evidence 	<ul style="list-style-type: none"> - Recommend proactive penicillin delabeling and education to clinicians and patients about the necessity
Patterson & Stankewicz, 2023	Penicillin allergy	StatPearls n/a	<ul style="list-style-type: none"> - 90% of patients with a history of PCN allergy can safely tolerate this group of drugs - In-depth physiology of beta-lactam antibiotics - Anaphylaxis occurs in 0.02 to 0.04% - Type 1 IgE hypersensitivity reactions are acute anaphylaxis - Symptoms and types of type 2, 3, and 4 hypersensitivity reactions - Despite low cross-reactivity with cephalosporins, there is still hesitancy to prescribe 	<ul style="list-style-type: none"> - Pathophysiology of PCN drug and IgE allergic reaction - Interprofessional team strategies for antimicrobial stewardship and PCN allergy delabeling - Importance of proper history taking regarding allergy history
Piotin et al., 2022	Predictive factors of amoxicillin immediate hypersensitivity and validation of the PEN-FAST clinical decision rule	Cohort analysis n=142 Level IV	<ul style="list-style-type: none"> - Importance of a thorough allergy history - More than 90% of penicillin allergy labels can tolerate penicillins - Scores of 0, 1, and 2 have a high NPV for low-risk allergies - Validates PENFAST in other populations compared to previous studies - The specific aim of this study was to validate PEN-FAST in the setting of patients with a high risk of immediate amoxicillin allergy - Confirmed PEN-FAST has strong discrimination of immediate hypersensitivity reactions from low-risk reactions 	<ul style="list-style-type: none"> - Validates the PEN-FAST tool in the European population - First internationally validated application of PEN-FAST - Confirmed PEN-FAST successfully identifies the risk of immediate hypersensitivity/ anaphylaxis - 93% NPV - A score of 0, 1, or 2 is a low-risk allergy, and a score of > three is an immediate or high-risk allergy and not eligible for direct challenges
Powell et al., 2020	Impact of penicillin allergy records on antibiotic costs and length of hospital stay: a single-centre observational retrospective cohort.	Retrospective cohort study n= 5549 Level IV	<ul style="list-style-type: none"> - The study aimed to determine the impact of penicillin allergies on patient length of stay and cost to the healthcare organization - 14.3% of hospitalized patients had PCN allergy - 28% increase in the cost of antibiotics - 5.5% longer length of stay - Estimates the cost reduction if penicillin allergies were appropriately de-labelled 	<ul style="list-style-type: none"> - De-labeling penicillin allergies reduces antibiotic cost and length of stay (reduces excess bed days) - Benefits of de-labeling for the healthcare organization

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
Powell et al., 2022	Effectiveness of interventions that support penicillin allergy assessment and de-labeling of patients by non-allergy specialists: A systematic review	Systematic Review Level I	<ul style="list-style-type: none"> - Greater than 90% of patients with PCN allergy are not allergic - False allergy labels are associated with broader antibiotic use that increases the risk of resistant infections - The current limited number of allergy specialists and centers emphasizes the need for less resource-intensive methods to de-label PCN allergy in appropriate patients - Implementing direct challenge improves access to care for a larger population - The goal is to determine the safety of testing and de-labeling PCN allergies by non-allergy specialists - This is the preface to Powell et al.'s (2023) meta-analysis. It discusses the systematic review protocol and PRISMA, PROSPERO methods 	<ul style="list-style-type: none"> - Provides detailed background information on the topic - Applicable to non-allergy specialists (physicians, pharmacists, nurses) conducting these challenges and de-labeling
Powell et al., 2023	The effectiveness of interventions that support penicillin allergy assessment and delabeling of adult and pediatric patients by nonallergy specialists: a systematic review and meta-analysis	Systematic Review and Meta-analysis n=5019 Level I	<ul style="list-style-type: none"> - Primary outcome: to determine the proportion of patients successfully de-labeled compared to those experiencing harm - Other outcomes: determine which healthcare workers were involved, the type of intervention, antimicrobial stewardship, and the healthcare system impact - For the direct oral challenge, 1 percent of patients were harmed. - 1336 patients; 1288 successfully de-labeled (98%; 95% CI 97-99%) 	<ul style="list-style-type: none"> - Confirms the safety and efficacy of direct oral challenges conducted by non-allergist providers - Encourages the use of direct challenges - Skin testing is not necessary for low-risk allergy patients before direct challenge
Providencia et al., 2024	Penicillin allergy testing and delabeling for patients who are prescribed penicillin: A systematic review for a World Health Organization guideline	Systematic Review n=516 studies Level I	<ul style="list-style-type: none"> - Focus on the importance of secondary prevention of Acute Rheumatic Fever - International population focus and inclusive - Determined to have a low rate of adverse reactions 	<ul style="list-style-type: none"> - Low rate of adverse reactions with direct oral challenges - Safe option - Severe reactions are infrequent, and healthcare workers are trained to respond to these

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
			<ul style="list-style-type: none"> - There were no deaths, serious adverse events, or anaphylaxis with any of the direct oral challenges 	
Shankaran et al., 2025	An inpatient antimicrobial stewardship team-driven penicillin allergy delabeling protocol for minimal and low-risk penicillin allergic patients	Controlled Trial without randomization n=42 Level III	<ul style="list-style-type: none"> - A multidisciplinary team conducted a pilot quality improvement project to identify low-risk PCN allergy patients and offered an amoxicillin challenge - The team includes Infectious Disease doctors, pharmacists, and nurses - Developed a unique PCN allergy questionnaire - Successfully delabeled 71.4 percent of patients 	<ul style="list-style-type: none"> - The multidisciplinary/team-driven approach is comparable to this project - Quality improvement project similar to this project - Demonstrates the adaptability of these programs to the inpatient population - Provides detailed order set examples and nursing discipline orders
Shenoy et al., 2019	Evaluation and Management of Penicillin Allergy: A Review	Literature Review	<ul style="list-style-type: none"> - Conducted a literature review on PubMed - 3 societies participated in this review: American Academy of Allergy, Asthma, and Immunology, the Infectious Diseases Society of America, and the Society for Healthcare Epidemiology of America - Describes the epidemiology of penicillin allergies and the consequences of false labels - Lists common pathogens/ syndromes for that penicillins are the treatment of choice - Antimicrobial prophylaxis for dental and surgical procedures is a beta-lactam antibiotic - Provides photos of serious cutaneous reactions and how to identify high-risk patients - Recommends methods for evaluating penicillin allergies; proper allergy history, - Risk stratification evaluation categorizes patients into low, medium, and high risk, with recommended action steps for each 	<ul style="list-style-type: none"> - Recommends methods for evaluating penicillin allergies, including proper allergy history, identifying severe reactions, and actions for each risk group - Low risk group includes isolated, unlikely allergic symptoms, unknown reactions without signs of an IgE-mediated response, greater than 10 years, and a family history of penicillin allergy - These low-risk patients should be prescribed a direct amoxicillin challenge under medical supervision, and if tolerated, should be prescribed penicillin antibiotics when indicated
Solensky et al., 2010	Drug Allergy: An Updated Practice Parameter	Practice update	<ul style="list-style-type: none"> - 90-page update on drug hypersensitivity and recommendations by the Joint Task Force on Practice Parameters, which includes the AAAAI, ACAAI, and JCAAI - Diagnosis, classification, and management of drug allergies 	<ul style="list-style-type: none"> - Significant milestone in this field - Published in 2010, signifies the start of recognizing the importance of allergy delabeling and antibiotic stewardship. - Importance and effectiveness of skin testing are explained

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
			<ul style="list-style-type: none"> - Reaction types: Type A (predictable; dose dependent based on pharmacologic profile) versus Type B (unpredictable; drug intolerance, allergies, etc) - Recommend penicillin skin testing to evaluate for IgE-mediated allergy - guidelines/ instructions for skin-testing - Information on desensitization, high-risk allergy syndromes, genetic factors, and special populations 	<ul style="list-style-type: none"> - Recommendations from well-respected institutions
Stone et al., 2020	The challenge of de-labeling penicillin allergy	Evidence-based literature review	<ul style="list-style-type: none"> - Most PCN allergies are recorded from childhood and are not validated - Many true penicillin allergies dissipate over time - The goal of de-labeling penicillin allergies is to promote antimicrobial stewardship, reduce poor outcomes, and healthcare costs - Provides a timeline of significant milestone discoveries on the topic - Figure of unnecessary labels versus necessary true hypersensitivities - Table of strengths and limitations of various de-labeling approaches (history alone, skin testing, direct challenge, desensitization, etc.) - Allergy labels should be routinely evaluated and removed when able 	<ul style="list-style-type: none"> - Provides a detailed timeline of penicillin history, trials, and guidelines - Useful for the background section explaining the progression of penicillin allergies and efforts to improve antimicrobial stewardship - 2010 marked the start of recognizing the burden of over-labeling the penicillin allergy on healthcare - 2016; guidelines supporting penicillin delabeling - Implications and recommendations for future practices
Su et al., 2023	Evaluating the PEN-FAST clinical decision-making tool to enhance penicillin allergy de-labeling	Cohort Study n=120 Level IV	<ul style="list-style-type: none"> - Prior validation trials of PEN-FAST demonstrate an NPV of 93-100% - This study found a 100% NPV of the tool - Encourages further use of PEN-FAST - Describes the benefits of this tool: simplicity of minimal questions and feasibility in various clinical settings 	<ul style="list-style-type: none"> - Further supports PEN-FAST tool usability in multiple populations - 100% NPV - Provides significant validity to the tool and highlights its simplicity which allows for greater use among all clinicians
Trubiano et al., 2020	Development and validation of a	Prospective cohort study	<ul style="list-style-type: none"> - Derivation and validation of the PEN-FAST clinical decision tool 	<ul style="list-style-type: none"> - Implementation of PEN-FAST with 96.3% NPV across cohorts

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
	penicillin allergy clinical decision rule	n=945 Level IV	<ul style="list-style-type: none"> - Determined 96.3% NPV of allergy history questions (PEN-FAST tool) to successfully identify low-risk PCN allergies - PEN-FAST Tool is a mnemonic outlining the four features of a positive PCN allergy test, including five or fewer years ago, anaphylaxis/ angioedema, or severe cutaneous adverse reaction (SCAR), and the treatment needed. Each feature is 2 points, except the treatment required is 1 point. - The score of the PEN-FAST tool is grouped into risk categories, including very low risk (points), low risk (1-2 points), moderate risk (3 points), and high risk (>4 points) - Scores of 0, 1, and 2 can exclude severe PCN allergy - Similar NPV and usability to traditional PCN skin testing 	<ul style="list-style-type: none"> - Describes the methodology behind creating this tool and testing it - Provides detailed information on how to calculate the score and its corresponding clinical risk category - Provides risk categories and the percentage of possible reactions for each - Proves that PEN-FAST is a reliable rule-out test that has comparable efficacy to formal allergy skin testing in excluding severe allergy - Serves as a foundation to safely perform oral challenges on low-risk allergies
Trubiano et al., 2023	The who, what, when, and where of inpatient direct oral penicillin challenge- implications for health services implementation	Cohort study n= 1104 Level IV	<ul style="list-style-type: none"> - Acknowledges the guidelines recommending oral challenges for low-risk PCN allergies, but seeks to determine the ideal patient population and timeframe of challenge during hospitalization - Patients admitted with an acute infection diagnosis that passed the oral challenge were more likely to be prescribed a PCN in the next year 	<ul style="list-style-type: none"> - Specific to the inpatient population - provides detailed information for the ideal patient population, diagnosis, and timeline of hospitalization for the challenge
Turner et al., 2019	Time to revisit the definition and clinical criteria for anaphylaxis	WAO Anaphylaxis Committee statement	<ul style="list-style-type: none"> - Recognizes significant inconsistencies across the literature and medical practice of anaphylaxis definition/ diagnosis - Provides a detailed explanation by body system - Provides revised definition statement: “anaphylaxis is a serious systemic hypersensitivity reaction that is usually rapid in onset and may cause death. Severe anaphylaxis is characterized by potentially life-threatening 	<ul style="list-style-type: none"> - Provides definition, syndromes, and treatment of anaphylaxis - Compares and contrasts different definitions by organization and evidence - Utilized this information in nursing education intervention material

Citation Information	Title of Publication/ Document	Type of Evidence	Main Outcomes of Findings	Relevance to Project
			compromise in breathing and /or circulation, and may occur without typical features or circulatory shock being present” (pg. 3)	
World Health Organization, 2021	Antimicrobial stewardship interventions: a practical guide	Clinical guidelines	<ul style="list-style-type: none"> - Strategies to promote antimicrobial stewardship and reduce antimicrobial resistance - Many patients outgrow PCN allergy after 10 years - Inaccurate allergy labels limit medication options and often force a second-line option to be given - Detailed rationale for implementing antimicrobial stewardship programs, like de-labeling 	<ul style="list-style-type: none"> - International recommendations from the World Health Organization - Provides a list of necessary prerequisites for organizations planning to implement delabeling programs - Academic environments are ideal for implementation

Appendix B

University of Arizona Institutional Review Board Authorization Letter



University of Arizona IRB
 845 N Park Ave., Suite 537A
 Tucson, AZ 85719
 Fax: 520-621-9810
VPR-IRB@arizona.edu

NOT HUMAN RESEARCH

September 5, 2025

Riley Oberholtzer

Dear Riley Oberholtzer:

On 9/4/2025, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title:	ENHANCING KNOWLEDGE AND ATTITUDES TOWARDS PENICILLIN ALLERGY LABELS AND AMOXICILLIN CHALLENGES
Investigator:	Riley Oberholtzer
IRB Submission ID:	STUDY00006942
Sponsor:	None
Prime Sponsor:	None
IND, IDE, or HDE:	None
Documents Reviewed:	<ul style="list-style-type: none"> • Advisor Attestation.pdf, Category: Other; • consent.docx, Category: Consent Form; • DNP Project Survey questions (1).docx, Category: Participant Material; • EducationSlides.pdf, Category: Participant Material; • MayoIRBe.pdf, Category: External Site Authorization; • OberholtzerIRB-Protocol-for-Determination-of-Human-Research-v2025-07.docx, Category: IRB Protocol; • Recruitment Email.docx, Category: Recruitment Materials; • Site approval , Category: Institutional Approval;

The IRB determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations.





University of Arizona IRB
845 N Park Ave., Suite 537A
Tucson, AZ 85719
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IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are research involving humans in which the organization is engaged, please submit a new request to the IRB for a determination.

All Covered Individuals must disclose all sponsored and non-sponsored Research Projects to the Office for Responsible Outside Interests (OROI) prior to Conducting Research if the individual is an Investigator. Please visit the [OROI](#) website for more information.

We value your feedback and would appreciate you taking the time to complete our survey about your experience with the IRB staff:


https://uarizona.co1.qualtrics.com/jfe/form/SV_ehQ04WxNA06b42j.

If questions arise at any time during your study, please email the general IRB inbox at VPR-IRB@arizona.edu.



Appendix C

Mayo Clinic Institutional Review Board Authorization Letter

 Outlook

25-009136 - An application has been deemed Not Research by IRB

From IRBe <irbe@mayo.edu>
Date Tue 8/26/2025 12:18 PM
To Oberholtzer, Riley K., R.N. <Oberholtzer.Riley@mayo.edu>

Principal Investigator Notification:

From: Mayo Clinic IRB
To: Riley Oberholtzer
CC: Riley Oberholtzer

Re: IRB Application #: [25-009136](#)

Title: ENHANCING KNOWLEDGE AND ATTITUDES TOWARDS PENICILLIN ALLERGY LABELS AND AMOXICILLIN CHALLENGES

IRB Approval Date: 8/26/2025
IRB Expiration Date:

The IRB reviewed the above referenced application. The Reviewer noted that the application involves quality improvement/assurance and determined that it does not constitute research as defined under 45 CFR 46.102. Continued IRB review of this application is not required.

Mayo Clinic Institutional Reviewer

Appendix D
Recruitment Email

Email for Recruitment:

Dear 3 West CVPCU nurses,






You are invited to participate in a Doctor of Nursing Practice (DNP) Quality Improvement project. This project aims to enhance nurses' understanding of penicillin allergy de-labeling, allergic reactions, and amoxicillin challenges. This project also aims to utilize feedback on knowledge and attitudes to further guide hospital-wide education on these topics.


This project, conducted by me, Riley Oberholtzer, consists of three steps that should take approximately 30 minutes to complete. Please complete the pre-educational survey, watch the recorded presentation, and then complete the post-educational survey. I am attaching the disclosure form, presentation, and links to the pre- and post-surveys.


Any participation would be greatly appreciated; however, participation is completely voluntary. Please don't hesitate to reach out if you have any questions.

Thank you for your time,
Riley Oberholtzer, BSN, RN

Penicillin Allergy De-Labeling DNP Project

 Oberholtzer, Riley K., R.N.
 To: DL ARZ 3W
 Cc:  Fix, Lindsay D., M.S.N., R.N., PCCN;  Dickinson, Drew T., Pharm.D., R.Ph., BCIDP;  Gangness, Jeanine E., Ph.D., R.N., NP-D-BC;  Chase, Julia R., APRN, DNP, R.N.

Tue 9/9/2025 7:30 AM  3


 Disclosure Form.pdf
74 KB

Dear 3 West CVPCU nurses,

You are invited to participate in a Doctor of Nursing Practice (DNP) Quality Improvement project. This project aims to enhance nurses' understanding of penicillin allergy de-labeling, allergic reactions, and amoxicillin challenges. This project also aims to utilize feedback on knowledge and attitudes to guide hospital-wide education on these topics.

This project, conducted by me, Riley Oberholtzer, consists of three steps that should take approximately 20-30 minutes to complete. If you choose to participate, please complete the pre-educational survey, watch the recorded presentation, and then complete the post-educational survey. I am attaching the disclosure form, presentation, and links to the pre- and post-surveys.

Any participation would be greatly appreciated; however, participation is entirely voluntary. Please don't hesitate to reach out if you have any questions.

Pre Survey: https://u.arizona.co1.qualtrics.com/jfe/form/SV_7UjGloY4VhKHxw
 Presentation:  [Microsoft Teams meeting-20250907_161915-Meeting Recording.m4](#)
 Post Survey: https://u.arizona.co1.qualtrics.com/jfe/form/SV_eEcFWcu1AC2c5F4

Thank you for your time,
 Riley Oberholtzer, BSN, RN
 480-662-1712

My University of Arizona Project Advisor, Dr. Heather Carlisle, PhD, DNP, PMHNP, AGACNP, may be reached at hlc@arizona.edu

Appendix E
Disclosure Form

Disclosure/ Consent

ENHANCING KNOWLEDGE AND ATTITUDES TOWARDS PENICILLIN ALLERGY
LABELS AND AMOXICILLIN CHALLENGES

Principal Investigator: Riley Oberholtzer

Registered Nurses affiliated with the Mayo Clinic Cardiovascular Progressive Care Unit (3 West) are invited to participate in a Doctor of Nursing Practice (DNP) Quality Improvement project. This project is designed to enhance nurses' understanding of penicillin allergy de-labeling, allergic reactions, and amoxicillin challenges. This project also aims to utilize feedback on knowledge and attitudes to further guide hospital wide education on these topics.

If you choose to participate in this project, you will be asked to:

1. Complete a pre-educational survey to assess baseline knowledge of allergy assessment and amoxicillin challenges.
2. Watch the educational presentation on allergies, penicillin de-labeling, and amoxicillin challenges.
3. Complete a post-education survey to assess the education efficiency and provide feedback for future education.

Participating in the educational presentation and completing the surveys will take approximately 30 minutes. There are no foreseeable risks associated with participating in this project. You will receive no immediate benefit from your participation. Your responses are anonymous. Your name will not be collected or linked to your answers.

Participation in this project is entirely voluntary. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may withdraw from the project at any time. By participating, you do not give up any personal legal rights you may have as a participant in this project. By participating, you agree to have your responses used and analyzed for this DNP project. Participation in the presentation and surveys signifies consent.


If you have any questions, concerns, or complaints, please contact:

Riley Oberholtzer, BSN, RN
DNP-AGACNP Candidate
Email: roberholtzer@arizona.edu
Phone: X

Thank you for your consideration to participate.

Appendix F

Education Materials (PowerPoint Presentation)


**PENICILLIN ALLERGY NURSE
PROTOCOL AND ORAL
AMOXICILLIN CHALLENGE
EDUCATION**
 RILEY OBERHOLTZER, BSN, RN, DNP-AGACNP CANDIDATE
 SEPTEMBER 2025

1

LEARNING OBJECTIVES

1. Understand the negative consequences that inaccurate penicillin allergy labels have on health outcomes and healthcare utilization
2. Differentiate adverse drug reactions from allergy reactions
3. Understand the importance of penicillin allergy screening and accurate allergy labels
4. Gain confidence performing oral Amoxicillin challenges


2

1 **BACKGROUND**

3

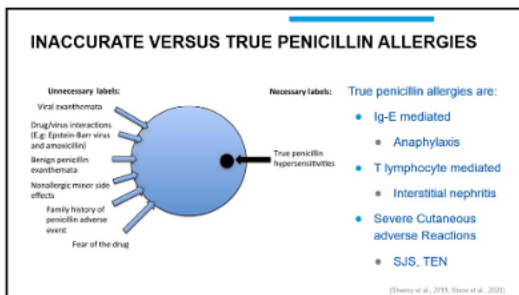
BACKGROUND OF PENICILLIN ALLERGIES

- 10-15% of hospitalized patients report a penicillin allergy
- General population incidence of penicillin allergy <1%
- 90% of penicillin allergy labels are inaccurate
- Consequences of inaccurate penicillin allergy labels



(Barnes et al., 2017; Shallice et al., 2015)

4



5

ASK MAYO EXPERT

Remove unnecessary PCN allergies whenever possible as this decreases

- Inappropriate antimicrobial use
- Length of stay
- Medical costs
- Adverse effects from antibiotic use
- Surgical site infections
- Use of broad-spectrum antibiotics

Direct Amoxicillin Challenge

- Direct oral challenge is considered low risk in patients with allergy limited to
 - Benign somatic symptoms
 - GI symptoms like GI upset, C Diff infection
 - Benign morbilliform rash

AskMayoExpert

6

ASK MAYO EXPERT

Remove unnecessary PCN allergies whenever possible as this decreases

- Inappropriate antimicrobial use
- Length of stay
- Medical costs
- Adverse effects from antibiotic use
- Surgical site infections
- Use of broad-spectrum antibiotics

Direct Amoxicillin Challenge

- Direct oral challenge is considered low risk in patients with allergy limited to
 - Benign somatic symptoms
 - GI symptoms like GI upset, C Diff infection
 - Benign morbilliform rash

AskMayoExpert

7

2 ADVERSE DRUG REACTIONS

8

HOME | PROCEDURES & POLICIES

Procedures & Policies

ALLERGY DOCUMENTATION AND REVIEW PROCEDURE- ARIZONA

Allergy Documentation and Review Procedure- Arizona
Upon patient admission, RN should "review patient allergy history and allergy information previously documented, and update any information in the EHR"


9

ADVERSE DRUG REACTION CLASSIFICATION

Type A	Type B
<ul style="list-style-type: none"> • Common and predictable • Related to the action of the drug • Side effects • Indirect effects • Drug interactions • Overdose 	<ul style="list-style-type: none"> • Rare and unpredictable • Immunologic reactions • Idiosyncratic reactions • Examples: Anaphylaxis, SJS, TEN, HIT

10

DRUG HYPERSENSITIVITY REACTIONS



- <10% of all adverse drug reactions
- Immunologic or inflammatory mediated mechanisms
- **Type I:** Immediate reactions
 - IgE mediated
 - Anaphylaxis
- **Type II, III, IV:** Delayed reactions
 - II and III: IgG mediated
 - IV: T cell-mediated; SJS, TEN, DRESS

11

PENICILLIN ADVERSE DRUG REACTIONS

Adverse effects	Serious immunologic reactions
Not consistent with allergy (Type A) <ul style="list-style-type: none"> • GI Upset • Headache • <i>C. difficile</i> infection • Fatigue • Benign rash (typically single tone on trunk, NOT mucosal areas or genitals) 	True allergies (Type B) <ul style="list-style-type: none"> • Anaphylaxis • Angioedema of lips, tongue, and face • Severe cutaneous adverse reactions • Organ-specific <ul style="list-style-type: none"> - Cytopenias, liver injury, interstitial nephritis, vasculitis

12

ANAPHYLAXIS

Definition and symptoms

- Immediate, potentially life-threatening systemic allergic reaction
- Possible symptoms include sudden onset of hypotension, angioedema, wheezing, dyspnea, chest tightness, respiratory compromise, itchy sensation, generalized hives, severe sudden N/V/ crampy abdominal pain, sense of impending doom, or incontinence

Treatment

- Refer to Anaphylaxis Management RN Protocol
 - Call provider and Rapid response
 - Oxygen
 - Intramuscular epinephrine
 - Albuterol nebulizer

(Touss, et al., 2019)


13

3 PENICILLIN ALLERGY ASSESSMENT & DE-LABELING

14

COMPONENTS OF AN ALLERGY HISTORY

- Do you remember the details of the reaction?
- How many years ago did the reaction occur?
- What was the management of the reaction?
- Why were you prescribed the drug?
- Have you tolerated similar drugs since the reaction?



15

WHAT IS PENICILLIN DE-LABELING

- Process of removing the penicillin allergy from patients EHR after evaluation of the reported reaction
- Done by
 - Allergy history alone
 - Direct oral amoxicillin challenge
 - Graded challenge
 - Skin testing

(Samarakoon et al., 2023)

16

PEN-FAST

- Validated tool to stratify risk of true PNC allergy
- Very low risk patients = the population for this initiative

PEN	Penicillin allergy reported by patient	
1	How often or how severe reaction?	2 points
0	Anaphylaxis or angioedema	2 points
0	Severe cutaneous reaction	2 points
1	Treatment required for reaction	1 point
	Total points	

0-2 points	Very low risk of positive penicillin allergy test
1 to 2 points	Low risk of positive penicillin allergy test
3 points	Moderate risk of positive penicillin allergy test
4 to 5 points	High risk of positive penicillin allergy test

(Su et al., 2021; Trubiano et al., 2010)


17

UPCOMING NURSE PROTOCOL

- Our Practice Advisory for eligible patients

18

QUESTIONS FOR RN TO ASK PATIENTS



- Was the reaction within the last 5 years?
- Did you experience anaphylaxis (a life-threatening reaction that consists of low blood pressure, shortness of breath, etc), or angioedema (swelling of tongue/ lips/ face) ?
- Did you experience severe blisters and were diagnosed with a severe cutaneous adverse reaction (SJS, TEN, DRESS) ?
- Did you require medical treatment (ex. Epinephrine injection, albuterol, ER visit, or hospitalization)

If No to all --> will prompt RN to place a general pharmacy consult for Pharmacist to evaluate for amoxicillin challenge eligibility

19


4

AMOXICILLIN CHALLENGE

20

WHAT IS AN ORAL AMOXICILLIN CHALLENGE?


- Administration of PO Amoxicillin to low-risk patients to document medication tolerance and safely remove the penicillin allergy label
- Can be performed on alert and oriented patients at Mayo Clinic Arizona on any patient unit



(1 Mayo et al., 2022)

21

NURSE RESPONSIBILITIES



Bedside safety check

- Anaphylaxis Reaction Kit (IM Epi)
- Ambu bag
- Suction canister with tubing
- Oxygen supplies
- Continuous pulse ox
- Patient alert and oriented, able to demonstrate call light use

Per provider orders:

- Baseline vital signs
- Administer 250mg PO Amoxicillin once
- Vital signs q 30 minutes x2 (more frequent if indicated)
- Report tolerance to provider after 1 hour

22

Monitoring patient response

23

Result of passing challenge

Patient informational letter

24

* Of note, slides 9, 18, 23, and 24 have images taken out for purposes of Mayo Clinic privacy as they are images of policies or EHR procedures that are specific to Mayo Clinic.

Appendix G
Participant Pre-Survey

Enhancing Knowledge and Attitudes Towards Penicillin Allergy Labels and Amoxicillin
Challenges
Riley Oberholtzer
DNP Project

Pre survey link https://uarizona.co1.qualtrics.com/jfe/form/SV_7UiGLoY4VhKHtXw
Post https://uarizona.co1.qualtrics.com/jfe/form/SV_eEcFWcu1AC2c5F4

Pre-Education Survey

Do you agree to participate in this Quality Improvement Project? (This serves as consent for participation in this voluntary pre and post survey)

- Yes
- No

Please create and remember a 4 digit code that will be used for the pre and post-survey data analysis and is anonymous

- Free text

How many years of nursing experience do you have?

- Less than 1 year
- 1 to 4 years
- 5-10 years
- 11-15 years
- 16 + years

How many amoxicillin challenges have you performed as an RN at Mayo Clinic

- None
- 1-2
- 3-5
- More than 5

How familiar are you with the topic of penicillin allergy delabeling?

- Extremely unfamiliar
- Unfamiliar
- Neutral
- Familiar
- Extremely familiar

How comfortable are you with performing oral amoxicillin challenges?

- Extremely uncomfortable
- Uncomfortable
- Neutral
- Comfortable
- Extremely comfortable

How important are allergy assessments to your job as an RN?

- Extremely unimportant
- Unimportant
- Neither important nor unimportant
- Important
- Extremely important

Knowledge questions

1. Which of the following is true regarding penicillin allergies:
 - Patients with a family history of penicillin allergies should list penicillin as an allergy
 - The only way to remove a penicillin allergy is with skin testing
 - The majority of penicillin allergies are inaccurate
 - 15% of the population is truly allergic to penicillin
2. Symptoms such as nausea, GI upset, and rash without systemic symptoms after penicillin administration are examples of
 - Adverse reactions/ side effects
 - Immunologic drug reaction/ allergy
3. Hypotension, blisters, and sudden GI distress after penicillin administration are examples of
 - Adverse reactions/ side effects
 - Immunologic drug reaction/ allergy
4. All of the following statements regarding anaphylaxis are true except:
 - Treatment includes an albuterol inhaler
 - Symptoms include dyspnea, chest tightness, and wheezing
 - Treatment includes intravenous epinephrine
 - There is a nursing protocol available for anaphylaxis management
5. Oral Amoxicillin challenges are
 - Given under direct observation by the provider or pharmacist
 - Only done outpatient in the allergy clinic
 - Given to low-risk patients with frequent vital signs and monitoring
 - Given in ICU only due to the high risk of reaction

Appendix H

Knowledge Questions and Correct Answers

- 1. Which of the following is true regarding penicillin allergies:**
 - 1.1. The majority of penicillin allergies are inaccurate
 - 1.2. (Patterson & Stankewicz, 2023)
- 2. Symptoms such as nausea, GI upset, and rash without systemic symptoms after penicillin administration are examples of**
 - 2.1. Adverse reactions/ side effects
 - 2.2. (Pichler et al., 2023).Pichler et al., 2023; Stone et al., 2020)
- 3. Hypotension, blisters, and sudden GI distress after penicillin administration are examples of**
 - 3.1. Immunologic drug reaction/ allergy
 - 3.2. (Turner, 2024; Yan et al., 2025)
- 4. All of the following statements regarding anaphylaxis are true except:**
 - 4.1. Treatment includes intravenous epinephrine
 - 4.2. (CDC, 2024a; Turner et al., 2019))
- 5. Oral Amoxicillin challenges are**
 - 5.1. Given to low-risk patients with frequent vital signs and monitoring
 - 5.2. (Blumenthal et al., 2019; Liviya et al., 2022; Shenoy et al., 2019)

Appendix I
Participant Post-Survey

Post-Education Survey

Please enter the same 4-digit code below from the pre-survey to keep answers anonymous and comparable

- Free text

1. Which of the following is true regarding penicillin allergies:
 - Patients with a family history of penicillin allergies should list penicillin as an allergy
 - The only way to remove a penicillin allergy is with skin testing
 - The majority of penicillin allergies are inaccurate
 - 15% of the population is truly allergic to penicillin

 2. Symptoms such as nausea, GI upset, and rash without systemic symptoms after penicillin administration are examples of
 - Adverse reactions/ side effects
 - Immunologic drug reaction/ allergy

 3. Hypotension, blisters, and sudden GI distress after penicillin administration are examples of
 - Adverse reactions/ side effects
 - Immunologic drug reaction/ allergy

 - 4.. All of the following statements regarding anaphylaxis are true except:
 - Treatment includes an albuterol inhaler
 - Symptoms include dyspnea, chest tightness, and wheezing
 - Treatment includes intravenous epinephrine
 - There is a nursing protocol available for anaphylaxis management

 - 5.. Oral Amoxicillin challenges are
 - Given under direct observation by the provider or pharmacist
 - Only done outpatient in the allergy clinic
 - Given to low-risk patients with frequent vital signs and monitoring
 - Given in ICU only due to the high risk of reaction
- I believe the information presented in this session will be helpful in my future nursing practice
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree

I will be able to use what I learned immediately

- Strongly disagree
- Disagree
- Neither agree or disagree
- Agree
- Strongly agree

The knowledge presented is relevant to my job

- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree

I would recommend this education to my coworkers

- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree

Prior to this education, my confidence level regarding amoxicillin challenges was _____

- Extremely not confident
- Not confident
- Neutral
- Confident
- Extremely confident

After this educational experience, my confidence level regarding amoxicillin challenges is

- Extremely not confident
- Not confident
- Neutral
- Confident
- Extremely confident

After receiving this education, what barriers do you anticipate from a nursing perspective regarding the penicillin screening tool protocol?

- Free text

Please share any Suggestions for the penicillin allergy screening group as they are preparing to launch this tool and anticipate more amoxicillin challenges

- Free text

Any other thoughts or knowledge gaps you would like to share

- Free text

Appendix J
Site Approval Letter

MAYO CLINIC ARIZONA

5777 E Mayo Blvd.

Phoenix, AZ 85054

August 26, 2025

Human Subjects Protection Program
The University of Arizona
845 N Park Ave., Suite 537A
Tucson, AZ 85719

Please note that Riley Oberholtzer, University of Arizona Doctor of Nursing Practice student, has permission of the Mayo Clinic Arizona to conduct a quality improvement project at our facility for her project, "ENHANCING KNOWLEDGE AND ATTITUDES TOWARDS PENICILLIN ALLERGY LABELS AND AMOXICILLIN CHALLENGES."

Riley Oberholtzer will conduct nursing education regarding the adverse drug reactions, penicillin allergy assessment, and oral amoxicillin challenges. She will conduct pre and post surveys with the CVPCU nurses that participate in the education session.

If there are any questions, please contact my office at 480-342-0963.

Signed,

Carrie Brown, M.Ed.

Mayo Clinic Arizona Academic Affairs | Nursing Professional Development |
ARZStudentNurses@mayo.edu | 5777 E Mayo Blvd | Phoenix, AZ 85054 |

Appendix K
Executive Summary

October 12, 2025

Executive Summary

Dear penicillin allergy workgroup,

The focus of my Doctor of Nursing Practice (DNP) project was to enhance the knowledge and attitudes of nurses in the CVPCU (3 West) regarding penicillin allergies and the effective de-labeling of inaccurate allergies using oral amoxicillin challenges. This initiative was taken in anticipation of the upcoming nurse penicillin screening protocol implementation this group is working towards.

As we know, approximately 15 percent of hospitalized patients report a penicillin allergy, yet studies reveal that 90 percent of these reports are inaccurate. Such inaccuracies often lead to unnecessary second-line antibiotic usage, extended hospital stays, and negative patient outcomes. Therefore, it is crucial for nursing professionals to be well-versed in proper allergy assessment techniques and the safe application of oral amoxicillin challenges to address antimicrobial stewardship.

The project involved a recorded education session designed to equip nurses with essential knowledge about allergic reactions, safe practices in allergy assessment, and the protocols for amoxicillin challenges. Participants were asked to complete pre- and post-surveys that aimed to evaluate changes in nursing knowledge and attitudes. The results demonstrated a significant improvement in participants' knowledge, with a 16.8% increase in survey scores post-education, accompanied by a p-value of less than 0.05, confirming statistical significance.

The qualitative feedback gathered from the open-ended survey questions was compiled and is presented below in tables to depict the suggestions and anticipated barriers nurses reported after learning about the upcoming protocol and penicillin allergy topics. A bar graph is included to demonstrate the significant increase in nurse level of confidence before and after the education and to display the average number of amoxicillin challenges CVPCU nurses have completed at Mayo Clinic Arizona.

In conclusion, this DNP project has effectively highlighted the imperative need for thorough nursing education on penicillin allergies. The positive outcomes from the education session indicate not only the potential for improved nursing practices but also encourage ongoing education to further bolster our nursing staff's competence in allergy assessments and amoxicillin challenge procedures.

Thank you for considering the outcomes and insights from this project as we move towards enhancing patient safety and care.

Thank you,

Riley Oberholtzer

DNP-AGACNP Candidate

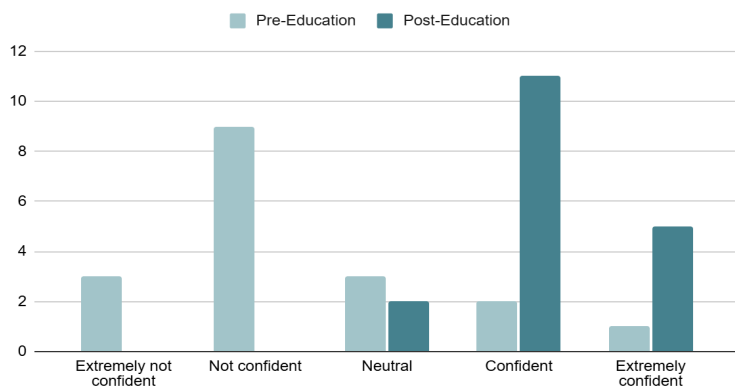
Feedback on potential barriers

Patient not willing participate
 Patient refusal
 time to complete
 It is not something that occurs often on our floor so I worry that retention will be low when staff encounter this situation on the floor.
 I anticipate that nursing will have a lack of time to complete the screening protocol or consider it less important compared to other admission tasks.
 Patient continued reluctance to participate. Unknown reactions as a child.
 if you dismiss the OPA will it come back to fill out?
 making it fluent in their workflow since it will be new
 Nurses being nervous about challenging allergies
 who can remove allergies- nurse or doctor? what is the process?

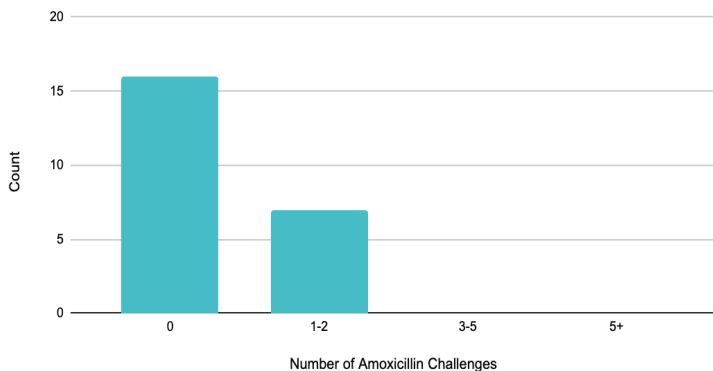
Suggestions for the workgroup

I anticipate that patients may express extreme hesitancy to complete the amoxicillin challenge and that the team and nursing staff should be prepared to deliver extensive patient education to help reassure them.
 Have everyone learn about this tool to create successful monitoring for every patient performing the challenge.
 make information available on MyNursing page
 video demo once this launches on how to use
 continue this excellent education!

Confidence level regarding amoxicillin challenges



How many Amoxicillin challenges have you performed as a RN at MCA?



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