Creating an antimicrobial stewardship program to reduce the unnecessary use of nonpreferred antibiotics in a community hospital

By

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Abstract

Antibiotic therapy is ubiquitous with over half of patients hospitalized in the United States receiving therapy. Hospitals are required by regulation to implement antimicrobial stewardship programs, however there has been wide variation in what shape these programs take. The literature shows that even small, rural community hospitals can implement meaningful antibiotic stewardship programs. There are multiple areas where stewardship of the penicillin family of antibiotics can improve. Authors discuss how documentation of penicillin allergies is incomplete and discuss how there is room for improvement. Additionally, there is literature about pathways to determine if someone truly has an allergy to a beta lactam, which describes the cephalosporin and penicillin family of antibiotics. These methods include providing test doses to patients with non-severe reactions, seeing if patients previously tolerated beta lactams, and penicillin allergy testing. Penicillin allergy testing has the benefit of conclusively defining whether a patient has an allergy or not. Finally, it has been shown that receiving broader spectrum antibiotic in place of the widely accept beta lactam family has been associated with higher rates of hospital acquired infection, multidrug resistant organisms, and higher healthcare costs.

This paper describes an intervention that uses a multidisciplinary approach to reduce the unnecessary use of Aztreonam, an alternative therapy choice to beta lactam allergic patients. The importance of educating healthcare professionals and patients about antibiotics, the expected side effects and the difference between side effects and allergies. An additional focus will be placed on the importance of accurately documenting allergies and adverse reactions in the medical record, and to insure the completeness of these records. Additionally, the creation of a protocolized approach to using Aztreonam in our institution is described. This approach enables pharmacists to help guide ordering providers towards appropriate treatment decisions that are consistent with the
literature studied. The outcomes of this intervention are decreased days of therapy and length of therapy for Aztreonam as well as decreased incidence of serious infections. This will hopefully lead to overall decreases in healthcare costs.

Introduction

According to the Centers for Disease Control and Prevention, over half of admitted patients in hospitals in the United States receive an antibiotic for at least one day. In 2016, the CDC found that although rates of antibiotic usage have not increased from 2006 to 2012, there has been increased use of higher power antibiotics that are typically used for resistant infections. Therefore, the CDC has recommended that all acute care hospitals in the United States adopt an antibiotic stewardship program. Antibiotic stewardship is defined by The Society for Healthcare Epidemiology of America as “a set of coordinated strategies to improve the use of antimicrobial medications with the goal of enhancing patient health outcomes, reducing the resistance to antibiotics and decreasing unnecessary costs.” The CDC has education initiatives to help hospitals create and sustain antibiotic stewardship programs. The CDC cites the rise of antibiotic resistant organisms as a public health concern that leads to over two million infections and 23,000 deaths annually. The CDC describes the core elements of a hospital antibiotic stewardship program as: Leadership Commitment, Accountability, Drug Expertise, Action, Tracking, Reporting, and Education. Additionally, The Joint Commission, an accreditation agency for healthcare facilities, has added an antibiotic stewardship standard for all hospitals. Standard MM.09.01.01 establishes stewardship as an organizational priority. It includes educating both staff, providers, and patients about the appropriate use of antibiotics. Additionally, it requires hospitals to establish multidisciplinary teams to create stewardship programs that use the CDC core elements to create protocols, collect/analyze data, and to act on the areas that can be improved upon.
Sovah Health-Danville (SHD) is a community hospital located in Danville, Virginia and has 250 beds. SHD partners with the Duke Center for Antimicrobial Stewardship and Infection Prevention (DASON) for assistance with its antibiotic stewardship activities. Data from DASON shows that in 2017, Sovah Health Danville had 917.69 days of antibiotic therapy per 1,000 patient days. This is consistent with DASON’s data from other hospitals. Aztreonam is a monobactam, that has a similar mechanism of action as beta lactams, which inhibits the cell wall synthesis in bacteria, ultimately causing them to rupture. As a monobactam, it has a beta lactam ring that is not fused to another ring which makes cross allergenicity with beta lactam antibiotics unlikely. In adults, Aztreonam has indications from the FDA for urinary tract infections, moderately severe systemic infections, and severe systemic or life-threatening infections. Additionally, it has been used off label for hospital acquired or ventilator associated pneumonia and perioperative surgical prophylaxis, and osteomyelitis caused by *Pseudomonas aeruginosa*. In 2017, Aztreonam had 1,486 days of therapy, which represents 4.96% of the total days of therapy of all antibiotics at SHD. Among the 29 hospitals in the DASON network, SHD has the highest use of Aztreonam at 45.5 days of therapy per thousand patient days. This is more than double the next highest user of Aztreonam. Additionally, the 2017 antibiogram for gram negative bacteria at SHD revealed that Aztreonam was sensitive to Pseudomonas at SHD only 78% of the time. For comparison, the other antipseudomonal antibiotics are 84-99% sensitive. This paper will analyze the literature surrounding antibiotic stewardship, especially as it relates to overuse of Aztreonam and reporting penicillin allergies. Additionally, it will describe a planned intervention on reducing the misuse of Aztreonam and strategies to evaluate the intervention. Finally, the role of antibiotic stewardship as it relates to public health leadership will be discussed.

**Literature Review**
Rural and community hospitals have limited resources as compared to academic and tertiary care centers. Malani, et al. describe an antibiotic stewardship program conducted at a 535-bed community teaching hospital. Their stewardship program included two infectious disease physicians who contributed 0.3 full time equivalent and three critical care clinical pharmacists who had no dedicated stewardship time. Their pharmacists used the electronic medical record to audit the initial order of eight higher risk broad spectrum antimicrobials, including Aztreonam. The pharmacist would audit the patients chart to determine whether there was an indication to specifically use the antimicrobial the ordering provider chose. The pharmacist had four choices, to approve the order, to stop the order, to deescalate to a narrower spectrum antibiotic, or to obtain an infectious disease (ID) consult. The pharmacist could directly consult an ID specialist to provide the clinical support and decision making on what antimicrobial to use. The primary outcomes were death within 30 days of hospitalization and development of Clostridium difficile infection (CDI). The study included 510 orders, of which 323 were approved, 94 were deescalated, 61 were denied, and 27 led to an ID consult. They found that this program reduced the odds of developing CDI by 46% but there was no significant decrease in mortality or readmission. In addition, the intervention decreased the hospitals antimicrobial costs and the daily use of the targeted agents.

Yam et al., describe their success with a telemedicine infectious disease physician on their antibiotic stewardship team. Their study takes place in a rural community hospital with 141 beds that also has a pharmacy practice residency. Since their community did not have a local ID physician, they contracted with one to provide a 30-minute review of patient cases weekly in addition to providing immediate and routine consultations for patients in their hospital. The primary outcomes studied included the number of interventions after review of antibiotic therapy by the pharmacist, the rate of empiric streamlining based on culture results and redundant therapy,
the percentage of agreement between the pharmacist and ID physician, cost savings, and CDI infection rates. This study also examined concordance between the pharmacist’s recommendations and the ID physician’s recommendations. Except for one month during the entire study period, the concordance rate was 100%. For the one outlying month, the concordance rate dropped to 86%. Additionally, the cost of antimicrobials per 1,000 patient days dropped from $13,521 before the study began to $9,756.56 one year later, and $6,583.52 in the following year. CDI dropped from 8.2 cases per 10,000 patient-days to 3.1 at the end of the study period. Some of the successes the authors describe includes creating an ID education program for pharmacists and providers and improving the clinical surveillance of antimicrobial usage. Their successes led to a more prominent role of pharmacists on deciding which antibiotics to use and when to streamline the antibiotic regimen. Additionally, it was noted that providers began to request the stewardship team to review patient cases and make antimicrobial therapy recommendations. One significant limitation the authors recognize is that this intervention took place prior to the implementation of computerized provider order entry (CPOE) systems, so there is difficulty in quantifying and evaluating some of the metrics.7

Now that the effectiveness of antibiotic stewardship at smaller community hospitals has been examined, we will look at how allergies to the penicillin family of antibiotics are documented. Torda and Chan examine how antibiotic allergies are documented at their hospital in Australia. Their cross-sectional study looked at adult inpatients over six months. Out of 3,855 patients total, 553 had an antibiotic allergy, and 352 were interviewed by the research team. After a detailed interview 20% were able to be delabeled and educated that their reactions were non-allergic and non-severe. An additional 38% of patients had either a vague history or had definite mild cutaneous reactions that were suitable for a direct provocation test. If those patients did not have an allergic
reaction, then they could have their allergy delabeled as well. If the results from this cross-sectional study are generalizable, then the amount of inaccurately labeled allergies to penicillin could be higher than 50%.  

A separate study by Inglis, et al. examined 96,708 electronic medical records in Australia. Out of the medical records reviewed, 5,023 patients had adverse drug reactions to penicillin listed in their record. Ninety-five percent of these patients had it entered as an allergy rather than an intolerance, and 20.9% had no description of what their adverse reaction was. The researchers found that trainee medical officers (the equivalent of medical residents) were significantly more likely to omit the reaction description than consultant physicians. Additionally, nurses were significantly less likely to omit the reaction description. Out of 5,023 adverse drug reactions, 4,979 were deemed appropriate for further evaluation. Only 36 reactions were documented with enough detail to describe a high-risk reaction that did not require further evaluation, and those reactions were IgE mediated hypersensitivity mediated reactions, such as anaphylaxis, angioedema, bronchoconstriction, and urticaria. Due to the variability of documentation on allergies and intolerances, the authors suggest that these labels should be reserved until after the patient has been formally evaluated through a validated diagnostic pathway. The authors recommend further education for healthcare professionals about the meaning of allergy vs intolerance and the importance of thoroughly documenting the details of the adverse drug reaction.  

In a study conducted by the University of Chicago and Northshore University Health System, researchers were interested in further evaluating the inter-physician variation of beta-lactam allergy documentation. This study included 232,616 patients seen by 199 primary care providers over a five-year period were identified. Researchers wanted to see if three features of allergy documentation were present. The features were identifying a specific agent as opposed to
a class of drug (Amoxicillin versus “penicillins”), the characteristics of the reaction were documented, and if the characteristics of a high-risk reaction were noted. High-risk reactions included anaphylaxis, angioedema, or urticaria, symptoms of IgE reaction (facial swelling, mouth swelling, shortness of breath, dyspnea), Stevens Johnson’s syndrome, exfoliative dermatitis, acute interstitial nephritis, hemolytic anemia, agranulocytosis, serum sickness, and hepatitis. Out of the 231,616 patients seen, 36,193 had a documented beta lactam allergy. There was variability in the allergy documentation by the primary care providers. There was high variability in documentation for the 131 providers with greater than 100 beta-lactam allergic patients. This included the specific allergen identified (24.0-58.2%), the characteristic of the reaction (5.4-51.9%), and high-risk characteristics (0-31.6%). Additionally, out of the 36,193 patients with allergies, only 6,218 had the allergy documented by the PCP. The rest of the allergies were either documented by a specialist or in the inpatient setting, as the health system used a comprehensive electronic health record (EHR) system. Additionally, researchers evaluated what antibiotics these patients were given. The patients were less likely to receive penicillin and cephalosporins if an allergy was documented. However, those with documented reactions that were non-severe were more likely to receive a beta lactam. There was a significant difference in the rate of beta-lactam rechallenge for those who had a specific drug listed as the allergen and when the characteristics of the reaction were documented. Fluoroquinolones and clindamycin were used more frequently in the allergic population with incomplete documentation, signifying that those who have incomplete documentation are likely to be given an entirely different class of antibiotics. The higher incidence of alternative drug classes being prescribed to beta lactam allergic patients, means that they are not getting the first line antimicrobial agents that have been proven to be safe and effective.
Now that the variability of penicillin allergy documentation has been established, we will discuss specific efforts studied that aimed to reduce the usage of Aztreonam. Estep, et al. at University of Florida Health Jacksonville retrospectively examined 186 patients who had a self-reported beta lactam allergy and were prescribed Aztreonam while admitted to the hospital. The primary outcome studied was the time in hours to discontinuation of Aztreonam after the implementation of an antimicrobial stewardship quality initiative. The intervention used at this facility involved identifying Aztreonam orders in real time using the EHR. The records were then evaluated to see the accuracy of the documented allergy and if the patient previously tolerated beta lactams. If there were no previously tolerated beta lactams in the chart, then the pharmacist would interview the patient or their family member to assess the accuracy of the allergy. If this was not sufficient, the pharmacist would contact the local pharmacy to see if the patient had tolerated a beta lactam previously. After this was complete the pharmacist would provide therapy recommendations and update the allergies listed in the EHR as appropriate. Patients were excluded from the study if they had a witnessed anaphylactic reaction, were pregnant, nursing, incarcerated, or enrolled in another clinical trial. The median time to discontinuation of aztreonam in the non-anaphylactic patients was shorter in the post intervention group, 12.7 hours, compared to the pre-intervention group, 30.7 hours. Among beta lactam anaphylactic patients, the discontinuation time was 138.1 hours pre-intervention and 43.1 hours post-intervention. Both times to discontinuation were statistically significant. Additionally, the intervention saw the percentage of patients who continued Aztreonam reduced from 7.6% to 3.7% with a rise in beta lactam antibiotic use from 22.8% to 34.6%. The researchers also noted that there were more people in the anaphylactic group of patients who were deemed to be eligible for beta lactams. The institutional Aztreonam orders
per 1,000 patient-days decreased from 1.5 to 1.0 after the intervention. The Aztreonam days of therapy per 1,000 patient-days reduced from 3.6 to 1.8.  

Swearingen, et al., describe an intervention targeting Aztreonam use at a 550-bed academic teaching hospital. The hospital’s antimicrobial stewardship first limited use of Aztreonam to patients who have an anaphylactic reaction to penicillin. They then conducted a daily inquiry of their EHR to search for Aztreonam orders. For patients who had a documented anaphylactic reaction to penicillin, such as bronchospasm, angioedema, or throat swelling, the team recommended continuation of Aztreonam. For mild reactions, the patients underwent the study intervention which included multidisciplinary communication with the medicine team managing the patient, assessing the patient for the development of allergic reactions, and asking the patients to participate in the Naranjo adverse drug reaction assessment. There were ninety patients in the retrospectively analyzed group and 63 in the prospective study group that met inclusion criteria. Out of the prospective group, 83% of patients underwent order modification either discontinuing Aztreonam without additional antibiotic therapy or to a different antibiotic therapy. Out of the group that changed to a different antibiotic, 86% of patients switched to a beta lactam, with no allergic reactions resulting from the switch. As the institution studied did not have penicillin skin testing, they used the Naranjo score. A Naranjo score was conducted on sixteen patients, with a median score of 5, or probable adverse drug reaction. Of the sixteen patients, 11 had a probable score, 4 had a possible score, and 1 had a doubtful score. No patient scored a definite adverse drug reaction. The authors found a statistically significant decrease in the median days of therapy for Aztreonam from 4.0 to 2.0 with a reduction in median days of therapy per 1,000 patient days dropping from 14.5 to 9.3. There was statistical significance in the length of hospital stay and in hospital mortality. Additionally, the authors note that there was a high percentage of patients with
incomplete allergic reaction documentation, and a clear majority of these profiles were completed and updated by the study investigators during the trial.\textsuperscript{12}

Krey, et al. conducted a pharmacy-led intervention at a 167-bed tertiary care community hospital. Unlike many institutions instead of having nursing collect the allergy history on a patient, this hospital has a dedicated pharmacy technician on first and second shift. These pharmacy technicians were given a standardized tool with scripted questions to collect beta lactam allergy information. Once the assessment was complete, the information was presented to pharmacists who completed any necessary documentation in the EHR. Pharmacists changed their order verification routine in two ways. The first was to flag patients who had incomplete documentation on a beta lactam allergy for follow up by a pharmacy history technician. The second intervention was to perform a historic antibiotic profile review in the EHR to see if a patient had been exposed to more than one dose of a beta lactam. If the patient had received more than one dose without incident, then they were tolerant, and this was appropriately documented in the allergy section of the EHR. The investigators created an algorithmic approach to beta lactam use that included a chart for alternative beta lactam therapy for patients with non-severe allergic reactions. The investigators found a significant difference in the postintervention group among patients initially receiving a non-beta lactam. This population was transitioned to a beta lactam significantly more often than in the preintervention group. Additionally, significantly more patients in the postintervention group received an antibiotic prescription at discharge than the preintervention group. This group also received significantly more beta lactams. This multidisciplinary approach to confronting non-beta lactam use did not result in a significant decrease in overall non-beta lactam use, but did find significance in transitioning patients to beta lactam therapy.\textsuperscript{13}
Alternatively, another way to approach accurate allergy labeling is through allergy testing. Trubiano et al, describe a standardized antibiotic allergy testing program that was started at two hospitals in Australia. Patients in this study were grouped into non-immune mediated, pharmacologically mediated reactions versus immune mediated reactions. The intervention undertaken was to follow previously published and validated allergy testing pathways with trained ID physicians or allergy nurses. Following testing, an observed single dose of the antibiotic was given while being directly observed for two hours by medical personnel. For patients with a non-severe delayed or unknown hypersensitivity history, a prolonged oral provocation of five days was performed. Following testing, patients and providers were given written recommendations on what antibiotics could be safely administered, and this recommendation was updated in the medical record. The investigators then followed up with the patients and clinicians three months after the allergy testing to assess post discharge adverse reactions and antibiotic usage. Out of the 118 patients who underwent allergy testing, 111 had their allergy list revised. This did lead to a statistically significant decrease in the number of penicillin allergies listed. Additionally, using the post-testing survey results, the authors found a significant increase in the prescribing of guideline preferred antibiotics. There was a significant decrease in the prescribing of broad spectrum antibiotics. A multidisciplinary antibiotic allergy testing program can be incorporated into antibiotic stewardship programs and help delabel patients who do not have actual antibiotic adverse drug reactions.¹⁴

Macy and Shu describe a multicenter study in Southern California that analyzed 421 patients who had received penicillin allergy testing over the course of two years. Using the EHR, the researchers were able to select control subjects that were not allergy tested but did have an active penicillin allergy listed in their record. Subjects were matched based on sex, visit type
(outpatient clinic, emergency department, or inpatient), Charlson comorbidity index group, and age. The researchers then looked at the courses of antibiotics prescribed to the subjects over the lead in period and the course of the study. During the follow up period, penicillin allergy tested patients averaged a statistically significant decrease in number of outpatient clinic visits and inpatient hospital days. There was a decline in the number of emergency department visits, but it did not reach statistical significance. Additionally, those who underwent allergy testing were more likely to receive penicillins and other beta lactam antibiotics, while the control cases were more likely to receive clindamycin and macrolides. Twenty-nine percent of the people analyzed in this study were under the age of 14, so it helps confirm the safety and efficacy of penicillin allergy testing in pediatrics. The authors also anecdotally noted that there was a sizable number of penicillin allergies listed in the EHR for people who received courses of beta lactam antibiotics over the study period. They note that 2.5% of penicillin allergic patients received a course of antibiotics and while none had a documented intolerance, none of them had their allergy profiles relabeled. The authors also discuss the cost benefit ratio of allergy testing. Their data shows a reduction of 0.089 outpatient clinic visit ($145/visit), 0.132 emergency department visit ($1233/visit), and 0.553 hospital days ($3146/day) per year. This is a reduction of $1945.40 per year in healthcare costs for patients who receive allergy testing, compared to the $145 one-time cost of allergy testing supplies and nursing time.\textsuperscript{15}

Now that various methods to be an effective steward of penicillin allergies have been explored, it is important to realize why this matters in the broader picture of healthcare outcomes. Macy and Contreras conducted a separate study using the same population in Southern California to analyze the prevalence of serious infections in the penicillin allergic patient. The authors used their EHR to find patients who had an admission to a hospital within a two-year history with an
active penicillin allergy listed in their record at admission. Cases were controlled using ICD-9 discharge diagnosis codes, sex, age, and month of admission. The authors tracked three serious infections in this population, CDI, Methicillin resistant *Staphylococcus aureus* (MRSA), and Vancomycin resistant *Enterococcus* (VRE). Using their search criteria, the authors identified 51,807 cases. The investigators found that penicillin allergic patients averaged more hospital days over the study period and follow up time and that the severity of this finding was different based on sex. Females averaged 0.68 more hospital days, while males only averaged an additional 0.35. This gender imbalance was even more marked when analyzing patients over the age of 50, with females averaging 0.80 days while males only had 0.26 days. Odds ratios for CDI prevalence in penicillin allergic patients were 1.234, MRSA was 1.141, and VRE was 1.301. Most of these infections were determined to be hospital acquired. The authors show that having a penicillin allergy documented resulted in higher usage of broader spectrum antibiotics instead of the safe and well-studied beta lactam family of antibiotics. Five of the top ten antibiotics used in the penicillin allergic group were associated with the highest rate of CDI. This results in longer hospital stays and higher rates of severe infections. Additionally, using cost benefit analysis, the cost of the additional hospital days for the population studied was 9.5 times greater than the cost of penicillin allergy testing. Cost savings could be even greater if targeted to women over the age of 50 due to their markedly higher rate of longer hospital stays.\(^\text{16}\)

Adverse events could also be higher in patients who are reportedly beta lactam allergic and avoid a beta lactam antibiotic, despite it being the preferred one. MacFadden et al., conducted a prospective study at three hospitals in Canada. ID residents conducted interviews with patients who reported a beta lactam allergy and collected information about the reaction type, preferred antibiotic therapy, and selected antibiotic therapy. The outcomes studied included length of stay,
Charlson Comorbidity Index, indication for antibiotic therapy, survival to discharge, readmission for same infection, duration of antibiotic therapy, CDI, acute kidney injury, and antibiotic related adverse reactions. The study included 507 patients, and of these, 95 had a beta lactam allergy listed. For 72 of the 95 patients a beta lactam was the preferred agent. Out of the 72, 47 received a beta lactam while the other 25 received a non-beta lactam. Interestingly, out of the group that had a beta lactam allergy but did not receive the beta lactam antibiotic, 48% had a severe reaction, which was significantly higher than the group that received the preferred beta lactam antibiotic. Additionally, those with a beta lactam allergy that did not receive the beta lactam had a 3.43 odds ratio of adverse event than those who did not report beta lactam allergy. Even when performing multivariate logistic regression analysis and adjusting for confounders, there was 3.18 odds ratio. The other outcomes had no statistical significance. Some weaknesses of this study include the small number of patients analyzed and the study design. The study was designed to only list the most “important” antibiotic being used, regardless of how many different agents the patient was receiving. Additional limitations include the fact that the authors used a composite outcome and only included patients that were encountered by the ID service.17

**Literature Analysis**

A few themes have been recurrent in the literature discussed. Antibiotic stewardship programs can be developed at community and rural hospitals. There are several different methods available to help establish stewardship programs. This includes creating a network of community hospitals that pool their resources to undertake stewardship programs. This could also include using technology such as telemedicine to consult with ID specialists at larger institutions. In addition to having physician led stewardship, community hospitals can utilize educational programs with their existing base of providers and empowering pharmacists to help guide
antibiotic therapy choices. Additionally, small community hospitals can realize tangible benefits of these stewardship programs including decreased length of stay, decreased hospital acquired infections, and decreased antimicrobial cost.

As this paper seeks to create an antibiotic stewardship program for beta lactam allergies and reduce the use of the alternative Aztreonam therapy, it is important to consider how allergies are documented. A significant amount of allergy labels are inaccurate, and this has been demonstrated by multiple authors. The difference between intolerance and allergy are not well understood by many people who document adverse reactions in medical records, and therefore there is inaccurate documentation. Additionally, multiple studies point out the high prevalence of incomplete documentation, such as saying the entire class of penicillins as opposed to a specific agent like amoxicillin or by not listing what reaction the patient had when exposed to the agent. Through educating employees about importance of thorough and complete documentation and interviewing patients previously identified to carry a beta lactam agent, many can either be delabeled or referred for allergy testing to confirm whether there is a true allergen present. Additionally, the literature shows that some of the people who have a specific reaction listed have been rechallenged on a medication without having an adverse reaction, especially when the reaction listed is a minor one.

Another approach to beta lactam allergy stewardship is to provide allergy testing to adjudicate whether a patient is truly allergic. Studies have shown a statistically significant decrease in the number of people who have penicillin allergies after allergy testing. Additionally, studies have shown that penicillin allergic patients have more outpatient and emergency department visits and have longer stays as inpatients in the hospital. Therefore, the significance of allergy testing reducing the number of allergic patients can be taken one step further to say that it reduces overall
healthcare costs. Additionally, people who are allergic to beta lactams are exposed to more powerful, broader spectrum antibiotics that carry with them a higher risk of serious or multi-drug resistant illnesses. One study even showed an odds ratio of 3.18 for having a severe adverse drug reaction for patients who have an allergy to beta lactams and did not receive the beta lactam antibiotic.

**Recommendations**

Some of the most effective outcomes in healthcare are realized when a multidisciplinary team works together towards a shared outcome. This paper sets forth a program by which SHD providers can be better stewards of Aztreonam and have a more purposeful process to determine which patients have true beta lactam allergies, as opposed to those who do not. The first part of the stewardship program is education. Both providers and nursing must be educated about the differences between intolerances and allergies. Additionally, training should be conducted regarding the different types of reactions. This includes discussing what reactions are IgE mediated hypersensitivity reactions, and therefore not compatible with test dose of beta lactam antibiotics versus adverse reactions that can be minimized with better patient instructions. For example, when a patient reports an adverse reaction of nausea when taking a penicillin product, they should be educated on the importance of taking antibiotics with food. It is a known side effect that beta lactam antibiotics can cause nausea when taken on an empty stomach. Additionally, we need to be more deliberate about educating patients about the medications they take by providing printed discharge instructions about their antibiotics when they leave the hospital.

Allergy documentation processes must be improved. At our institution, nursing interviews what patients are allergic to as part of the admission process on the floor or in the emergency department. Due to various reasons, sometimes allergies are incompletely documented, or simply
reviewed and unchanged. After receiving education about the differences between allergies, intolerances, and the various severities of reactions to a drug, we should change the policies regarding allergy documentation. The policy should require the thorough and accurate documentation of allergen, ideally the specific drug rather than a class, and the reaction the patient has. If the patient is unable to recall the reaction, then nursing should mark that and if the patient has any comments regarding why they are allergic, they should be noted in the free text comments box. Ideally, if our software can support it, we should add additional queries to the allergy documentation process. One query could be for when a nurse tries to select a class such as penicillins, rather than a specific agent, to ask the patient what drug from a drop-down list of agents in the class the patient is allergic to, with an option at the bottom of the list to keep the choice of the entire drug class. An additional query could ask when the patient first noticed a reaction to the drug, to determine whether the allergic reaction is recent or a distant exposure that could warrant a test dose. A final query or policy could flag all previously documented beta lactam allergies so when a patient with a previously documented allergy is being admitted the nurse is reminded to verify the accuracy and completeness of the antibiotic allergy in the computer system.

An important part of our approach to Aztreonam stewardship includes empowering our clinical pharmacists and increasing their role in antibiotic regimen selection. Currently, pharmacists verify medication orders placed by providers electronically. If there is an order that is inappropriate, the pharmacist will not verify the order and will attempt to contact the provider. The pharmacy policy should be changed so Aztreonam ordering is restricted and requires an intentional review by the pharmacist to be verified. This review should include what allergies have been documented, what reactions the patient has to the allergen, and what antibiotics the patient has been exposed to previously. The EHR allows providers and pharmacists to see what antibiotics
have been previously ordered since the implementation of the system over ten years ago. Additionally, it would also allow pharmacists to search for allergic reaction resuscitation drugs, such as epinephrine and diphenhydramine. If there is no beta lactam allergy documented or the allergic reaction documented is minor, the pharmacist must be empowered to reject the Aztreonam order. If this occurs, the pharmacist should immediately call or page the ordering provider to inform them that the Aztreonam is not indicated and to consult with the provider on an alternative therapy. If the provider states there is an allergy, then they must enter the appropriate documentation in the allergy section of the EHR. Alternatively, if a provider cannot be reached in an appropriate amount of time, the pharmacist should have a protocol regarding preferred antibiotic therapy, and to switch the ordered drug to that therapy. The pharmacist should document this interaction in the medical record, so providers and nursing can easily see why the therapy was changed. Additionally, if Aztreonam is ordered and a chart review shows that the patient has previously tolerated a beta lactam antibiotic without requiring a resuscitative drug, the pharmacist should not verify the medication, and contact the ordering provider as described above. Finally, if a non IgE mediated reaction is listed, and the pharmacist is unable to verify a previous exposure to beta lactam, then the pharmacist should approve the Aztreonam, but contact the ordering provider and document the need for penicillin allergy testing in the outpatient setting after discharge from the hospital. Below is a flow chart for the proposed Aztreonam ordering algorithm
Figure 1: Proposed Aztreonam ordering process algorithm

It is important to have a framework to evaluate the progress of any intervention towards achieving its goal. The educational component of the intervention can be evaluated using surveys for both healthcare professionals and patients regarding their understanding of antibiotic use, side effects, and allergies. Additionally, surveys can ask whether the educational program increased their knowledge about antibiotics and make people feel more comfortable taking/prescribing/administering antibiotics. The initiative to improve the accuracy and thoroughness of allergy documentation can be evaluated by analyzing the EHR for incompletely documented antibiotic allergies for admitting patients and seeing if the trend for incomplete documentation changes over time. SHD is fortunate to already have a collaboration with an antibiotic stewardship network, DASON. By using the resources of DASON, we can evaluate
changes in duration of antibiotic therapy and length of antibiotic therapy. Additional outcomes to evaluate include increased duration/length of therapy of beta lactam antibiotics after implementing the interventions. Outcomes based on the hospital course include length of hospital stay and incidence of serious infections such as CDI, MRSA, or VRE. One critical outcome based on the algorithm described above is the incidence of allergic reactions to beta lactam antibiotics given per protocol or the recommendations of the clinical pharmacist. These patient accounts will need to be flagged so data can be mined regarding the use of allergic reaction resuscitation drugs. This is crucial because having a pharmacist led protocol to reduce the inappropriate use of Aztreonam increases the autonomy of the pharmacist in our health system, and closely monitoring patients who have their therapy changed by the protocol, will insure that there are no increases in patients who experience adverse drug reactions.

By creating an antibiotic stewardship program that focuses on Aztreonam, we will be able to ensure that our patients get the best antibiotic therapy possible for their infection. Antimicrobial stewardship is a field that comprises many of the core functions of public health because it is a process that insures patients get the most effective antibiotic regimen to treat an infection and avoid unnecessary side effects. By monitoring and restricting the use of certain antibiotics, we can decrease the number of serious infections that occur because of antibiotic usage. Infections such as CDI, MRSA, and VRE, are costly both in terms of the healthcare system but also in terms of the time lost from work, family, and friends. Being good antibiotic stewards reduces the prevalence of multidrug resistant organisms. Public health leaders can advocate for evidence based best practices in antimicrobial stewardship. Leaders can stand up and speak out when the status quo of antibiotic usage in the organization is no longer appropriate. Public health leaders can use their knowledge of health systems, epidemiology, evidence-based practice, and continuous quality
improvement to improve the policies about antibiotic stewardship. In other words, antibiotic stewardship promotes public health by appropriately treating infections before it spreads, by reducing the prevalence of multidrug resistant organisms, and by reducing the amount of serious infections.

Conclusion

This paper has described a multidisciplinary approach to being more effective stewards of Aztreonam in our community hospital. The literature review shows that stewardship programs can occur at any size hospital, even a rural community hospital with limited resources. Additionally, the literature shows a variety of approaches to stewardship of broad-spectrum, second line therapies and the benefits of having effective stewardship. The first part of this program is to increase the education efforts for healthcare professionals regarding the definition of allergy versus intolerance, the importance of thorough documentation of antibiotic allergies, and the different types of allergy severity. Additionally, the program will work on increasing its effort to educate patients about the proper use of antibiotics, how to avoid side effects, and what are expected side effects while taking antibiotics. The second major component of the intervention is to increase the accuracy and thoroughness of antibiotic allergies and tolerances documented in the EHR. This includes identifying specific antibiotic agents rather than classes of drugs and to identify the specific reaction that occurred. The final major component addresses the ordering process for Aztreonam at SHD. Aztreonam ordering will be restricted and placed in an algorithm that uses practices adopted from institutions described in the literature review. It applies a stepwise approach to the ordering process. Additionally, it analyzes whether patients have tolerated test doses of beta lactam antibiotics in the past and whether the patient would be a suitable candidate for outpatient penicillin allergy testing to possibly reclassify an allergy. Finally, a framework for evaluating the
success of the project has been laid out with both subjective surveys about the effectiveness of the education components and objective data about antibiotic use and patient outcomes.

As this intervention continues, future areas of study include health system outcomes. One health system outcome that can be studied on a longer-term basis includes cost benefit analysis of using Aztreonam versus penicillin allergy testing and delabeling penicillin allergies. Another study could look at whether the rate of readmission for recurrent infection, the rate of hospital acquired infection, and the rate of multidrug resistant organism infections change after the implementation of this intervention. Data from readmissions could then be extrapolated to see how antibiotic stewardship leads to better healthcare outcomes and reduces the overall costs of healthcare. Antibiotic stewardship is an underrecognized aspect of public health that not only improves the wellbeing of patients but the community as a whole.

References