Physician Bias in Skin and Soft Tissue Infections and the Importance of Antimicrobial Stewardship Programs

Abstract

Antimicrobial Stewardship Programs (ASPs) play a large role in reducing antibiotic misuse and improving patient outcomes. This project's goal is to reduce physician bias in treatment of non-purulent skin and soft tissue infections (SSTIs) in the Emergency Department (ED). Through retrospective chart reviews and patient interviews, we found significant misuse of vancomycin in SSTI treatment. After educating physicians on the IDSA guidelines for SSTI, vancomycin use decreased drastically while other antibiotics were used in its place. This study shows the efficacy of ASPs to better control antibiotic resistance and improve patient outcomes. Further research should be done regarding efficacy of other types of programs as well as their limitations.

Disclaimer

This report is based on work done at The University of Massachusetts Medical School in collaboration with the UMass Memorial Healthcare system. The results within this report are part of an ongoing study conducted by John Haran M.D. and others at UMass Medical Center. For information regarding possible outcomes and future study goals, please see discussion.

Introduction

The misuse of antibiotics is problematic for hospitals and patients. While guidelines surrounding specific conditions dictate which antibiotics to give and how much, doctors are able to tailor dosage, route, and type depending on the patient (Stevens et al., 2014). Variations in prescribing practices can lead to increased antibiotic resistance and poor outcomes for patients. Regulation of prescribing practices and closer adherence to the Infectious Disease Society of America (IDSA) guidelines could reduce antibiotic misuse, therefore preventing continued antibiotic resistance and improving patient outcomes (Haran et al., 2015).

A significant portion of antibiotic prescriptions result from emergency department (ED) visits. Among those, skin and soft tissue infections (SSTI) lead the way in emergency department visits, tripling from 1993-2005 (Pallin et al., 2008a). SSTIs present general symptoms that often point towards a bacterial agent without easily identifiable characteristics of a specific pathogen (Bailey & Kroshinsky, 2011; Stevens et al., 2014). IDSA guidelines regarding SSTIs recognize the clinical judgement involved in diagnosis and therefore suggest emphasis be given to the severity and type of infection for proper treatment and management. Following IDSA guidelines or other recognized antibacterial protocols helps improve outcomes of patients with SSTIs and reduce physician bias (Gibbons et al., 2017).

Understanding physician biases on antibiotic prescribing practices allows for better patient care and tailored protocols or guidelines to assist physicians in correct prescriptions (MacDougall & Polk, 2005). Studies on sex differences in treatment and patient outcomes show women are less likely to receive as aggressive treatment as men in areas like strokes (Reeves, 2008), myocardial infarctions (Jneid et al., 2008), and sepsis (Madsen, Napoli, & Zehtabchi, 2014). Similar comparisons can be made in regards to minority groups and geriatric patients. Failure to provide patients with effective and comprehensive care results in bad outcomes and treatment failure.

Previous studies looking at gender and age disparities in treatment and management of various disease have focused on identifying the extent to which the bias exists and how it effects the patient (Haran et al., 2015; Jneid et al., 2008; Madsen et al., 2014; Reeves, 2008). This study builds upon others to understand the disparity in a larger clinical setting, and determine if education of physicians on treatment biases helps decrease the number of treatment failures and misuse.

Background

Antibiotic Resistance in Hospitals

Without proper precautions and education, antibiotic resistance could become detrimental to healthcare. A recent report published by the Center for Disease Control and Prevention (CDC) (2013) states that at least 2 million serious bacterial infections result from bacteria resistant to one or more antibiotics each year (Centres for Disease Control and Prevention, (US), 2013). The CDC estimates these infections account for $20 billion in extra healthcare costs compared to other non-resistant bacterial infections. They attribute much of the resistance to the use of antibiotics within the healthcare system.

Antibiotic resistance occurs in many ways. Generally, the longer bacteria are in the direct vicinity of an antibacterial, the higher chance they will develop resistance. This idea is similar to the notion that "what does not kill you makes you stronger." In a hospital setting there are four main ways antibiotic resistance occurs: poor infection control, poor patient compliance, lack of lab testing, and antibiotic misuse. Hospitals strive to improve infection control protocols continually through surveillance, routine cleaning between patients, improved staff hygiene, and proper precautions for infected patients; however hospital acquired infections are still rising steady and account for many resistant strains (Madisi et al., 2015). Additionally patients who do not adhere to prescriptions subject bacteria to a less than lethal dose of antibiotics resulting in more resistance. Lack of diagnostic testing does not allow physicians to know what pathogen causes the infection in that patient. Some infections cannot be cultured and when physicians cannot culture the infection, they err on the side of caution when prescribing antibiotics, often over treating patients.

Physician prescribing practices factor heavily into the misuse of antibiotics and can range from duration of therapy, choice of antibiotic, strength of dose, and initiation of therapy. Patient's age, past medical history, and specific circumstances play important roles in determining possible pathogens. Misuse of antibiotics strongly contributes to growing antibiotic resistance and occurs in almost every aspect of hospital care, from neonatal to geriatric patients, and urinary tract infections to acute respiratory infections (Aftab & Tariq, 2016; George, Norman, Ramana, Mukherjee, & Rao, 2015; Perna, 2016; Rattinger et al., 2012). Physician biases exist in regards to age, sex, and ethnicity (Jneid et al., 2008; Madsen et al., 2014; Reeves, 2008). Additionally, there are many different classes of antibiotics used to treat different types of infections; using an inappropriate antibiotic could cause wildtype bacteria to obtain resistance against a stronger antibiotic quicker than they would under normal conditions.

A previous study conducted at one of the hospitals in this study showed that only 43% of patients treated for SSTIs in the ED Observation Unit were treated according to the IDSA guidelines regarding SSTIs (Haran et al., 2015). Over half the patients at one hospital in this study did not receive adequate healthcare according to the IDSA. The study also found that vancomycin was prescribed more often than advised by the guidelines meaning that a significant number of patients were over-treated for their particular infections. While over-treatment with any antibiotic can contribute to antibiotic resistance, vancomycin creates added risk. Vancomycin is commonly

prescribed as the first choice antibiotic for patients with complicated methicillin resistant *Staphylococcus aureus* (MRSA). Community associated MRSA (CA-MRSA) is a growing problem in hospitals especially in SSTIs (Moran, Amii, Abrahamian, & Talan, 2005). Strains previously confined within hospitals, have now grown and spread throughout the environment allowing them to develop further resistance and become increasingly harder to treat (Frazee et al., 2005). Furthermore, the prevalence of MRSA infections has increased over the past years corresponding with the increased prescription of antibiotics active against MRSA infections, in particular vancomycin (Pallin et al., 2008b). While MRSA concerns physicians and scientists alike, strains resistant to vancomycin have already been identified (Centres for Disease Control and Prevention, (US), 2013).

Though MRSA causes large issues in hospitals, other bacteria with multidrug resistance contribute heavily to additional hospital acquired infections, bad outcomes, and costly therapies (Caini, Hajdu, Kurcz, & Borocz, 2013). Many physicians treat these infections with broad spectrum antibiotics in an effort to offer more coverage though not all infections require such strong antibiotics. These types of antibiotics add significantly to hospital acquired antibiotic resistance as bacteria can obtain resistance to antibiotics whenever they come in contact and through different mechanisms of resistance. Because the ability of each patient's immune system differs slightly, physicians should base patient treatment on the presentation of the infection taking into account pertinent past medical history. Failure to provide patients with effective and comprehensive care results in bad outcomes and treatment failures as well as increased antibiotic resistance. Better lab testing, patient compliance, and infection protocols factor into reducing antibiotic resistance in hospitals however, understanding physician biases in antibiotic prescribing practices serves as an important first step in controlling antibiotic misuse within healthcare thus reducing resistance.

Issues with Cellulitis Infections

Many types of infections happen in hospitals everyday but the most prevalent are skin and soft tissue infections (SSTIs). SSTIs account for over 3 million ED visits annually in the US alone and include cutaneous abscess, cellulitis, diabetic foot infections, necrotizing soft tissue infections, and surgical site infections. With the rate of these infections steadily rising over the past years, accurate treatment of SSTIs is vital. Typically, physicians classify SSTIs based on purulence and severity. Cultures of SSTIs aid physicians in determining the pathogenic agent and therefore reduce antibiotic misuse, however nonpurulent SSTIs, like cellulitis, are extremely difficult to culture. Additionally, cellulitis infections appear similar regardless of which pathogen caused the infection. MRSA's prevalence among SSTIs is concerning due to the similarity in clinical presentation of SSTIs caused by different pathogens. Due to the lack of discharge and the similar clinical presentation, physicians must take an educated guess on what the pathogenic agent is in order to appropriately treat the infection. Of patients diagnosed with SSTI, most receive some type of broad spectrum antibiotic which have been proven to cause more antibiotic resistance (Gunderson, 2016).

In order to combat antibiotic resistance in SSTIs, the Infectious Disease Society of America (IDSA) published guidelines regarding the treatment of purulent and nonpurulent skin infections (Stevens et al., 2014). Appendix 1 shows the flowchart of prescribing practices for the management of SSTIs. These guidelines classify infections as mild, moderate, or severe, suggesting specific antibiotic courses for each type of infection. Additionally they cover different prescribing practices for immunocompromised, neutropenic patients, and intravenous drug users as these populations

have special medical considerations. The comprehensive approach to prescribing practices helps physicians prescribe the most appropriate antibiotics for the given situation, reducing misuse and preventing antibiotic resistance.

Antimicrobial Stewardship Programs

Countries around the world publish guidelines similar to the IDSA guidelines but tailor specific recommendations to their area and individual needs. While these guidelines benefit the medical community and patients alike, all too often physicians inappropriately prescribe antibiotics leading to increased medical costs, poor patient outcomes, and further antibiotic resistance (Ashraf & Cook, 2016; Barker, Brown, Ahsan, Sengupta, & Safdar, 2017; Om, Daily, Vlieghe, McLaughlin, & McLaws, 2017). Antibiotic stewardship programs (ASPs) designed to reduce the guess work in prescribing practices have proven effective in combating antibiotic resistance by reducing treatment duration and increasing adherence to prescribing guidelines while still providing adequate care (Gerber et al., 2013; Pollack & Srinivasan, 2014; Rattinger et al., 2012). Many hospitals and areas have had success with ASPs (Buising et al., 2008; Gerber et al., 2013; Gibbons et al., 2017). They work by helping to categorize and narrow the list of possible pathogenic agents for specific clinical presentations.

In the case of SSTIs, many ASPs look at purulence as well as severity when determining effective treatment options. Swabs and cultures of cellulitis infections is difficult as cellulitis does not create drainage and the source of the infection is rarely found. While ASPs provide a rough outline for treatment, the patient's past medical history and unique infection characteristics allow for a deeper understanding of the causative agent and can give physicians a better idea which antibiotic would be most appropriate. In addition to providing patients with the best possible care, ASPs slow antibiotic resistance by limiting treatment duration, reducing the use of stronger antibiotics in less severe cases, and optimizing dosage (D'Agata, Magal, Olivier, Ruan, & Webb, 2007; Gibbons et al., 2017).

This study examines the feasibility of an ASP at a teaching hospital and community hospital in Worcester, Massachusetts. Previous studies at the same hospitals found the need for such a program but didn't explore the ease or efficacy with which one could be implemented (Haran et al., 2015). This study focuses on the efficacy of an ASP for SSTIs within the emergency department with special attention to the prescription practices of vancomycin to combat MRSA infections and the overall outcome of patients before and after physician education.

Methods

Study Design

This is a retrospective study looking at physician biases in the treatment of SSTIs, more specifically cellulitis infections without abscess. The study centered on a continuing education period for ED physicians where the newest guidelines on treatment of SSTIs were reviewed. The study elements consisted of two main parts, chart reviews and follow up interviews. Figure 1: Timeline of patients flagged for data collection. Patients must have had their ED visit within this time frame to be included in the study. depicts the timeline of the study. Charts of patients treated for cellulitis in the ED were obtained from both the University and Memorial campuses of University of Massachusetts Medical Center. For the purposes of this study, the ED Observation Unit (EDOBS), was treated as an extension of the ED rather than as an inpatient setting. The University of Massachusetts Medical School Institutional Review Board reviewed and approved the study.

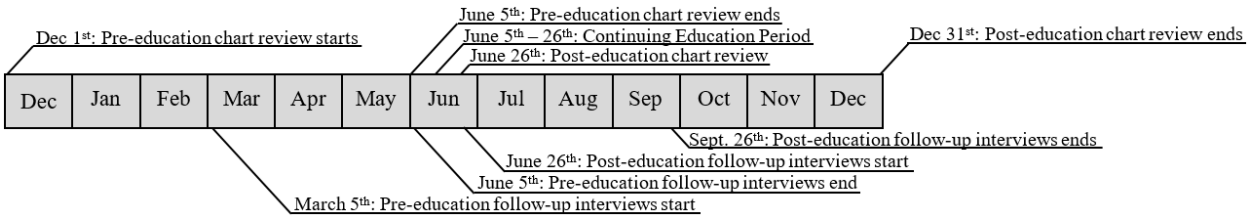

Figure 1: Timeline of patients flagged for data collection. Patients must have had their ED visit within this time frame to be included in the study.

Participants in this study must have been adults of at least 18 years of age who were seen and treated for a skin and soft tissue infection in the ED via antibiotics. Patients under 18 years of age, or who were diagnosed with other skin and soft tissue infections were excluded from the study. Patients with incomplete medical records and prisoners were also excluded.

Chart Review

Trained research assistants conducted chart reviews of ED and inpatient information and post-treatment phone call interviews. Charts were pulled of patients diagnosed with and treated for a cellulitis infection within the ED over a 12 month period, with the exception of the continuing education period in June. All patient charts fitting the inclusion criteria were pulled for six months prior to the education period, called the historic cohort, and the six months following the education, called the intervention cohort, in order to understand how biases changed in response to an intervention. Patients were unaware of the chart review and could therefore not withdraw from the study. Pertinent information regarding past medical history, current medications, ED procedures, inpatient summary, and prescriptions were recorded. The patient's current medications were used to verify their past medical history, while ED and inpatient information was used to assess treatment decisions.

Separate from the chart review mentioned above, two independent ED physicians reviewed each chart to determine appropriateness of treatment based on the 2014 IDSA Guidelines (Appendix 1) by looking at the clinical presentation and treatment received. Both clinical presentation and treatment received were characterized as mild, moderate, or severe and received a score: 1, 2, 3, respectively. After ranking, the scores were compared. In the event that the physician treated at a higher strength than the patient's clinical presentation, the patient was

considered over-treated. In the opposite case where the patient's severity outweighed the treatment plan, the patient was considered under-treated. Anything else is considered adequate treatment. Disagreements between severity were settled by a third physician.

Follow Up Interviews

Follow up phone calls served as a patient reported account of the events after treatment at either of the two sites in the study. We were particularly interested in whether they had finished all of their prescription, needed additional antibiotics, had a repeat ED visit, or sought healthcare outside of the two hospitals surveyed. These questions helped to determine if patients experienced treatment failures which might correlate to over or under treatment. Treatment failures were determined by judgement based on the survey answers and the strength of additional treatment.

Of the historic cohort, patients seeking treatment between March and May were pulled for follow up interviews. A comparable group who sought treatment between July and September was identified from the intervention cohort. Patients were called a maximum of ten times or until they answered, no more than three calls per week, and a voicemail left once. Verbal consent was obtained over the phone before the survey began and patients were informed they could stop participating at any time (Appendix 2). Patients with preferred language other than English were excluded. Questions patients forgot the answers to or were unable to answer were left blank and memory issues were recorded. Patients' answers were recorded as given on a form (Appendix 3) and cross referenced with their charts and medical histories after being entered into the electronic data capture system, RedCap.

Physician Continuing Education

During a three week period in the middle of the study all enrollment stopped in order to provide time to educate physicians on the most recent guidelines for SSTIs from the IDSA. Guidelines and recommendations change rapidly in healthcare therefore keeping physicians and other healthcare providers up to date on the newest information allows for improved patient care. During this three week period at mandatory meetings, the Antimicrobial Stewardship Taskforce updated attending physicians and residents on the recent guidelines. Presentations consisted of evidence surrounding the need for change, the current state of antibiotic use for both hospitals participating in the study as well as end goal reduction of antibiotic use at each hospital, and correct prescribing practices for given circumstances. Although the guidelines outline three classes of infection – mild, moderate, and severe – emphasis was placed on using clinical judgement to determine the needs of the patient. Additionally, presentations containing updated statistics and information regarding the physicians' current prescribing practices were presented throughout the post-education period to show the continuing improvement of physicians.

Results to Date

Over the two 6 month study periods, December 2016 to May 2017 and July 2017 to December 2017, of the 565 patients with cellulitis who sought treatment at the University Campus of UMass Memorial Healthcare, 267 were eligible for the historic group and 278 were eligible for the intervention group. The remainder met at least one of the exclusion criteria and so were not included in the study. Of those in the historic group, 119 were discharged home, 51 were placed in the EDOBS Unit, and 97 were admitted to the hospital. Within the intervention group, 171 were discharged home, 46 were placed in the EDOBS Unit, and 61 were admitted to the hospital.

Over the same two 6 month study periods, of the 562 patients with cellulitis who sought treatment at the Memorial Campus, 280 and 222 were eligible for the historic and intervention groups, respectively with the remainder meeting at least one exclusion criteria (Table 1). Of those in the historic group, 201 were discharged home and 79 were admitted to the hospital. Within the intervention group, 171 were discharged home and 51 were admitted to the hospital (Table 1). Overall both study groups had a similar distribution of patients with respect to age, sex, and ethnicity at both hospitals (Table 2).

Cohort	Disposition	Memorial	University
Historic	Discharged	201	119
	EDOBS	--	51
	Inpatient	79	97
	Total	**280**	**267**
Intervention	Discharged	171	171
	EDOBS	--	46
	Inpatient	51	61
	Total	**222**	**278**

Table 1: Total breakdown of cohort patients included in the trial for each hospital and their disposition from the Emergency Department.

Characteristics		Historic	Intervention
Age ± SD		51.8 ± 18.7	48.4 ± 16.3
Sex	Male	56.2%	55.4%
	Female	43.8%	44.6%
Race	White	77.8%	76.5%
	Black	4.7%	4.1%
	Hispanic	6.3%	9.5%
	Asian	2.1%	0.9%
	Other	8.3%	15.4%

Table 2: Breakdown of demographic information for historic and intervention cohorts. Each cohort includes patients at both hospitals during those periods.

In order to determine if the intervention effectively reduced the misuse of antibiotics, the vancomycin usage before and after the intervention was measured. Per IDSA guidelines as described earlier, physicians should prescribe vancomycin only when the clinical situation is severe enough to warrant such strong antibiotics. Although the results to date are preliminary, our data showed a significant decrease in vancomycin usage in all areas of hospital care following the educational intervention (Figure 2 Figure 3). Within the University Campus (Figure 2), vancomycin usage decreased by a little over 15% ($p<0.001$) in discharged patients and by as much as 32.8% ($p<0.001$) among admitted patients. Among patients in the EDOBS unit, vancomycin use decrease by over 24% ($p<0.006$). Similarly on the Memorial Campus, discharged patients received vancomycin 1.7% of the time post intervention, with a decrease of over 17% ($p<0.001$). Vancomycin usage for admitted patients decreased 22.4% ($p=0.013$). Additionally there was a 10% difference between those admitted at the University Campus compared to those admitted at the Memorial Campus in the historic cohort, while the vancomycin use in the intervention cohort for the same groups are more similar (31% at University compared to 33% at Memorial).

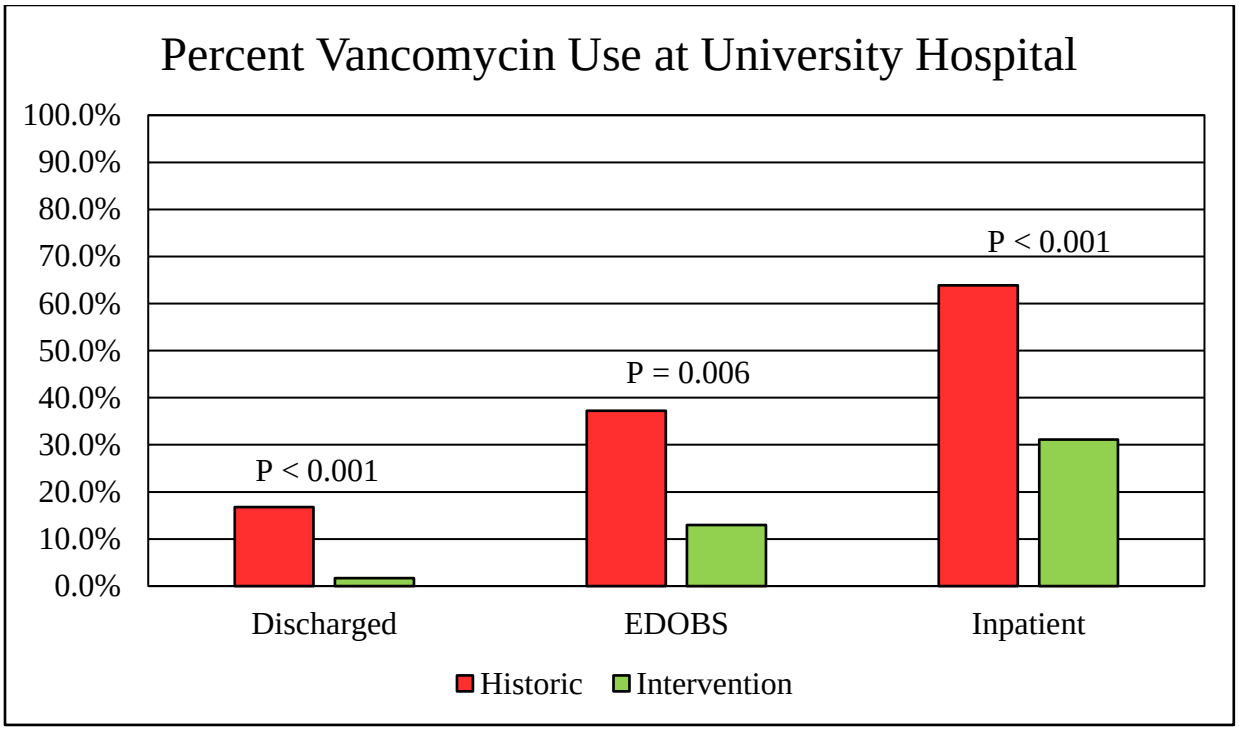

Figure 2: Percentage of patients at University Campus treated with vancomycin in the ED who were then either discharged home, admitted as inpatients, or placed in ED Observation (EDOBS) in both the historic and intervention cohorts. P values were determined using a Chi Squared Test for Significance.

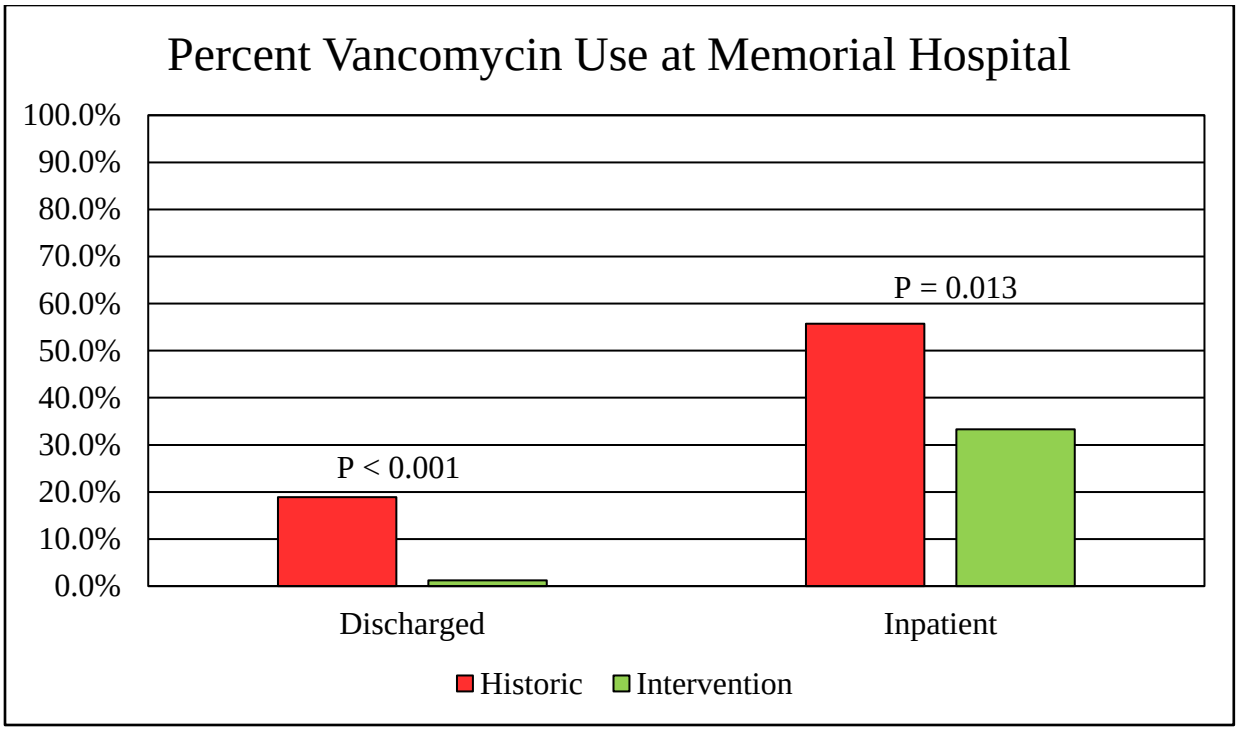

Figure 3: Percentage of patients at Memorial Campus treated with vancomycin in the ED who were then either discharged home or admitted before and after the continuing education period. P values were determined using a Chi Squared Test for Significance. Memorial Hospital does not have an EDOBS Unit.

Discussion

Antibiotic misuse due to physician bias in treatment of bacterial infections aids in growing antibiotic resistance. This study addressed the efficacy of an ASP at both a large teaching and small community hospital. Through two 6 month study periods where researchers conducted retrospective chart review and analysis, we found the implementation of an ASP focusing on non-purulent SSTIs, namely cellulitis, decreased the use of vancomycin. The reduction of vancomycin usage regardless of the patients' disposition from the ED at either hospital shows stricter adherence to the guidelines of the ASP though final results will be known after the full trial concludes and all analysis is complete.

While the preliminary results show promise for the future work of the study, some aspects of prescribing behaviors could still benefit from improvement. Even after the educational intervention, physicians prescribed vancomycin to patients who were then discharged, albeit at a significantly lower rate. Per the IDSA guidelines the intervention was based on, patients for whom vancomycin use is indicated should receive multiple days of IV antibiotics and therefore be admitted to the hospital or placed in the EDOBS Unit. The failure to do so by ED physicians could indicate antibiotic misuse. However, patient wishes and compliance issues could also factor into these decisions. It is not completely out of question to send a reliable patient home after receiving vancomycin if that patient agrees to return to the ED the following few days for continuing IV antibiotic treatment.

While vancomycin prescriptions were not expected to cease altogether, assuming similar patient populations and infection presentations within both the historic and intervention cohorts, the reduction seen through this study indicates a large misuse in prescribing practices prior to the intervention. The large difference in vancomycin use between the historic inpatient cohorts of Memorial and University campuses, shows a possible treatment disparity between large teaching hospitals and small community hospitals. It is not likely that medical residents accounted for the difference as the new residents begin on July 1st and would not have been included in the historic data set. Additionally, if they did account for a variance in prescribing practices this means there would be a difference in all the University Campus data, especially in the intervention cohort. Infection severity and presentation could also account for this difference however, the data for the intervention cohort at both sites showed similar decreases in vancomycin use (31.1% at University Hospital and 33.3% at Memorial Hospital) making that explanation less likely. Therefore, neither age, training, nor experience predisposes any physicians to prescribe inappropriate antibiotics after proper education.

The high prescribing percentages for both hospitals in the historic group closely resemble prescribing practices reported for other hospitals in regards to vancomycin use (Moran et al., 2012). The similarity shows hospitals across the country can benefit from implementation of comparable interventions; therefore the efficacy of the creation of a national antimicrobial stewardship program seems altogether feasible. Hospitals looking to implement comparable guidelines should choose empirically proven ASPs as some ASPs have resulted in higher usage of vancomycin when not clinically appropriate (Punnoose, 2011). A hospital in Denver, Colorado implemented its own guidelines through physician education focusing on elevation and anti-inflammatory use as well as reduction of broad spectrum antibiotic use. The study took place throughout the entire hospital rather than just the emergency department and showed a marked increase in vancomycin usage throughout the 1 year intervention period accompanied by a decrease in most other antibiotics ((Punnoose, 2011). ASPs, such as this, counteract those looking to reduces strong antibiotic use when not appropriate though the use of anti-inflammatory drugs and lower extremity elevation are common among other ASPs.

Limitation and Future Goals

This study is not without its limitations, most of which surround the lack of complete information. As this is still an ongoing study as of May 2018, not all the information has been collected yet. Further results regarding treatment outcomes from patient interviews described in Methods will allow us to determine if the intervention improved patient outcomes in the long run or whether they experienced a treatment failure and needed to seek further treatment. This information is important in determining if the treatment will help combat antibiotic resistance while still providing the best care to patients as patient care is most important. Although reduction of antibiotics remains a goal of many health professionals, providing the best care for patients supersedes this ASP. If we find the ASP implemented here does not provide beneficial outcomes to patients, future research should focus on the minimum does of antibiotics that would sufficiently treat cellulitis and other infections.

Additionally the portion of results depicted in this paper fails to take into consideration the over or under-treatment of patients based on their clinical presentation. Although vancomycin use

decreased in the intervention group, it is possible patients are being undertreated as a result and therefore not receiving the best care. Since physicians originally over prescribed vancomycin at one of the sites in this study, it is likely they have continued to overprescribe but much less than previously (Haran et al., 2015). This would result in the decreased vancomycin use while still providing patients with the best care. At the conclusion of this trial, patient outcomes as well as over and under treatment of patients will be readily available.

Lastly, as these results show preliminary data, they include cases in which an abscess was drained and the physician prescribed antibiotics to treat the surrounding cellulitis. When physicians drain abscesses and collect the discharge, they often send it to the lab for further testing and determination of the pathogenic agent. Tests such as these help physicians to prescribe appropriate antibiotics to treat the infection. Though this benefits overall patient care, it can skew the results of the study as physicians could know what pathogen is causing the infection. As more information is collected and chart reviews are finalized, abscesses and other disparities will be identified and accounted for in the final results.

Future Recommendations

While this study shows promise for an ASP aimed at the physicians in the ED, future research regarding inpatient physician prescribing practices could help combat antimicrobial resistant further and provide consistent patient care. In addition, determining the adherence of Infectious Disease consults to IDSA or similar guidelines and their effectiveness in inpatient prescribing practices could help streamline patient care and provide cohesive care among departments. Furthermore, a broader implementation of ASPs in other hospitals or patient care settings could help other patients provided empiric evidence supports the ASP chosen. In some cases hospitals have worked to implement their own ASPs which contradict IDSA and other guidelines on appropriate treatment (Punnoose, 2011). Special care should be taken to assure all ASPs follow similar treatment procedures for a given clinical presentation.

Additionally, since cellulitis does not produce pus, cultures are rarely obtained. In order to reduce the guesswork in prescribing practices and ensure physicians prescribe proper antibiotics, faster diagnostics and lab tests to determine a pathogen should be developed and used in hospital settings. Currently physicians can only discover the pathogenic agent through secondary sources of infection, well document prior occurrences, or through blood cultures if the infection worsens. These tools do not deliver adequate diagnostic tools for physicians to provide proper healthcare.

Conclusion

Treatment of SSTIs with appropriate antibiotics per national guidelines has shown to reduce antibiotic resistance while ensuring positive outcomes. This study adds to the growing literature showing ASPs can help lower vancomycin use and reduce the misuse of antibiotics in the ED. Further research regarding inpatient ASPs, broad implementation of similar programs across hospitals, and faster diagnostic tools could aid the effort to provide patients with best possible care while reducing the chance for antimicrobial resistance. Further results from this study will be focused on patient outcomes, treatment durations, overall antibiotic choices, and percentage of antibiotic misuse after the intervention.

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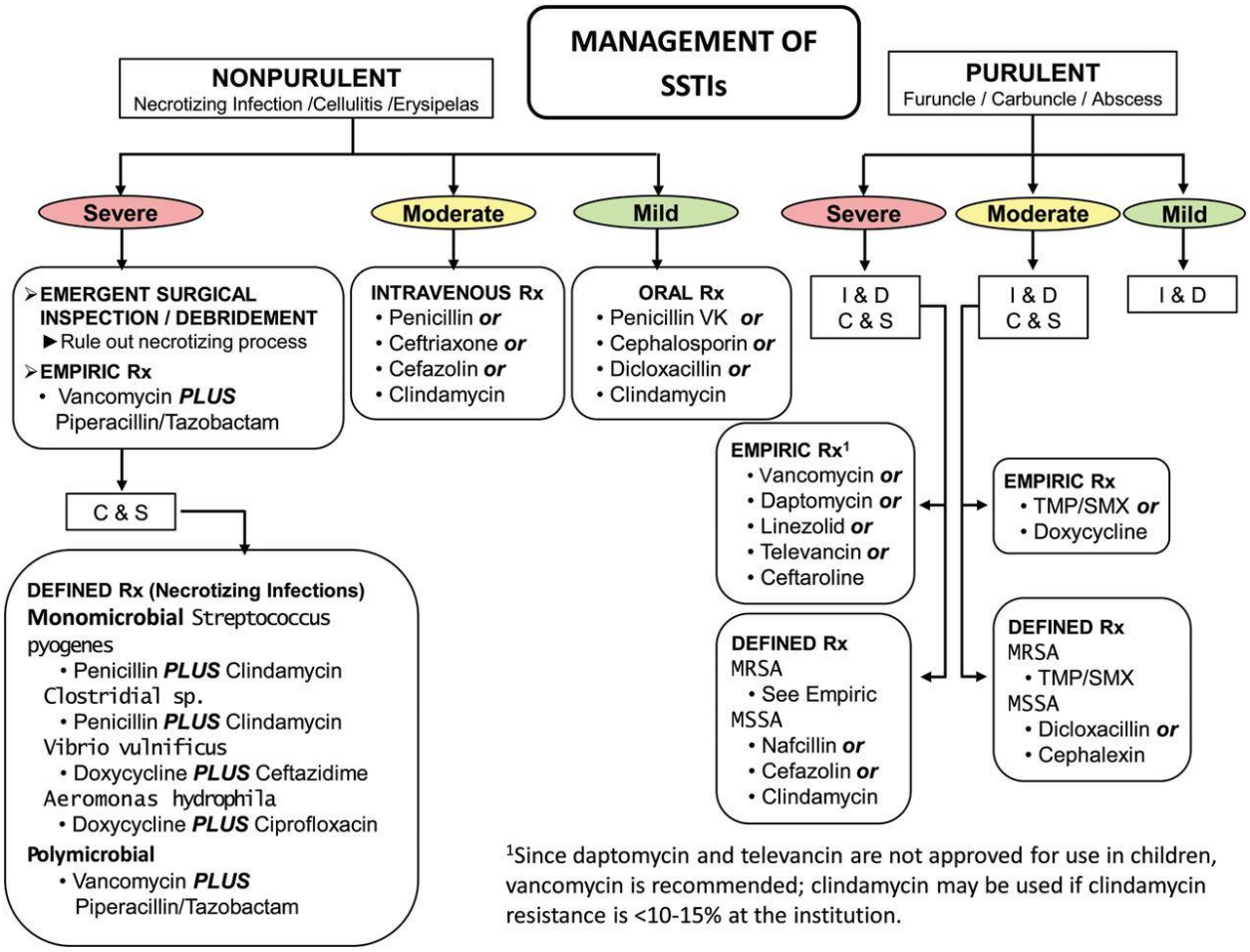
Appendix

Appendix 1



IDSA guidelines for the treatment of skin and soft tissue infections. Infections clinically characterized as mild, moderate, or severe for both purulent and nonpurulent skin infections.

Appendix 2

Phone Script Verbal Consent

Patient Medical Record # _____ Today's Date _____
Research Assistant doing Enrollment Name _____
Assigned Study Identification Number _____

Hello. My name is _____ and I am a research assistant within the department of emergency medicine at the University of Massachusetts Medical School. I work with Dr. John Haran who is an emergency medicine researcher.

We are contacting you because you were a patient in the ED at UMass back on _____ and you were given antibiotics. We are conducting a research study to determine which antibiotics cause patients to have diarrhea and other complications. We are doing this in the hope of identifying factors that lead to patients failing treatment or having problems after antibiotic therapy.

We only need less than five minutes of your time to ask you a few questions about your encounter within the ED and if you had any complications after receiving the antibiotics. Would you be willing to take part in this study? (At this point answer any further questions the subject has.)

If no, then…
Well thank you for your time and have a nice day.

If yes, then…
Well let me briefly tell you more about this study.
It is important for you to know that:

Your participation is entirely voluntary.

There are minimal risks by being involved in this research study. We will only be collecting information from you about your medical history, illness and any therapies you have received, and we will use the information until the study concludes in 4 years. As in any human research study, there is the small, but possible risk that your identity may be exposed to an individual not associated with this study. To prevent this from happening, you will be assigned a unique study number that will be used on all study related documents. Only the researchers associated with this study will have access to the documentation of the link between your number and any information that may identify you, such as your name or medical record number. All information resulting from this study will be reported anonymously.

There is no direct benefit to you from being in this study.

Your privacy is important to us. Your research records will be confidential to the extent possible, and will be disclosed only with your permission or as required by U.S. or state law. Members of the study team, UMMS IRB, and other UMMS representatives may have access.

You may contact Dr. John Haran at (508) 421-5527, the Principal Investigator at any point if you have any questions or concerns.

Do you have any questions?
I have a few questions for you.

Research Assistant Signature _____

Appendix 3

ED Follow-up Questionnaire

A. <u>Questions to screen for the complications after they were discharged from the hospital/ED/EDOU</u>

1. Did your skin infection go away after you were sent home from the hospital/ED?
   Circle: yes or no
2. How long did it take?
   Number of days _____
3. Did you finish all of your antibiotic prescription?
   Circle: yes or no
   If not, how many days did you take your antibiotics? Number of days _____
4. Did you need additional antibiotics?
   Circle: yes or no
   If yes, who prescribed them and why? _____
5. Were you admitted to the hospital (again) after treatment?
   Circle: yes or no
   If yes, explain _____
6. Did you need to o to another healthcare provider after your initial treatment? If so, then whom did you go visit (ED, primary care, clinic)?
   Circle: yes or no Type of provider _____
   Describe the encounter
   _____
   _____
7. Did you need to have a surgical procedure?
   Circle: yes or no
   If yes, describe _____
8. Did you have any other complications after your hospital/ED visit?
   Describe:

B. **<u>Questions to screen for antibiotic associated diarrhea</u>**

9. Did you at any point since your ED visit have diarrhea and is so for how many days did you have it?
   Circle: yes or no Number of days _____

<u>If the answer to question 9 was no please skip questions 11 – 15</u>

10. Was the diarrhea you experienced at least three or more loose stools per day for two or more consecutive days?
    Circle: yes or no
11. How many days after you visited the ED did the diarrhea begin?
    Number of days _____
12. How long did you have the diarrhea?
    Number of days _____
13. If you have diarrhea was it while you were taking the antibiotic?
    Circle: yes or no
14. Did the diarrhea you experienced influence you to stop taking your antibiotic?
    Circle: yes or no
15. Were you at any point in the last couple of weeks diagnosed with *Clostridium difficile* or *C. diff*?
    Circle: yes or no