2016

Awareness of antibiotic resistance in the general population as related to education level

Rachel M. Cantlon
Bethel University

Emma Wilson
Bethel University

AWARENESS OF ANTIBIOTIC RESISTANCE IN THE GENERAL POPULATION AS RELATED TO EDUCATION LEVEL

A MASTER'S THESIS SUBMITTED TO THE GRADUATE FACULTY

GRADUATE SCHOOL BETHEL UNIVERSITY

BY

RACHEL CANTLON, PA-S

EMMA WILSON, PA-S

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTERS OF SCIENCE IN PHYSICIAN ASSISTANT

AUGUST 2016

BETHEL UNIVERSITY

AWARENESS OF ANTIBIOTIC RESISTANCE IN THE GENERAL POPULATION AS RELATED TO EDUCATION LEVEL

RACHEL CANTLON, EMMA WILSON

AUGUST 2016

GRADUATE RESEARCH APPROVAL

Chair: Christy Hanson PA-C Date

Member: Cindy Goetz PA-C Date

Member: Chad Peterson PharmD Date

ABSTRACT

An antibiotic is a drug, also known as an antimicrobial, which is used to treat infectious diseases caused by bacteria (National Institute of Allergy and Infectious Diseases (NIAID), 2012). The effect of antibiotic overuse and mistreatment with these drugs has led to infectious bacteria developing antibiotic resistance (Centers for Disease Control and Prevention (CDC), 2014). Antibiotic resistance results in at least 23,000 deaths each year in the United States alone (CDC, 2014). The purpose of this study was to evaluate the general population's awareness of antibiotic resistance in regard to education level, and proper use of antibiotics as measured by completion of antibiotic courses. This study was conducted via a survey format presented to adult customers and employees of Royal Tire Commercial Store in Minneapolis, MN. Results were analyzed into descriptive statistics using SPSS. Results indicated only 18.8% of the study sample could correctly define the term 'antibiotic resistance;' however, results suggested there is no statistically reliable correlation between education level and accurate knowledge of this term (significance value 0.117, p. value <0.05). Results also indicated 13.2% of those that had been prescribed an antibiotic stopped taking the medication sooner than recommended. The most common reason given for this was gastrointenstinal upset, but other reasons included participants stated they felt better after only a portion of the treatment plan was completed, and one survey participant reported a rash as the reason for stopping treatment early. The results from this study can be used to help clinicians educate patients about the importance of correct antibiotic prescription and use, as well as education about common side effects to expect with antibiotics and remedies needed to lessen these adverse effects.

ACKNOWLEDGEMENTS

We want to thank Christy Hanson, PA-C for serving as our Research Committee Chair. The time she dedicated to advising and facilitating the completion of our research with the Bethel University Masters of Science in Physician Assistant Program standards has been greatly appreciated. We also want to thank our two Research Committee Members, Cindy Goetz, PA-C and Chad Peterson, PharmD, for their time and efforts in advising and assisting with completion of our research project.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

Chapter 1: Introduction

Background

An antibiotic is a drug, also known as an antimicrobial, which is used to treat infectious diseases caused by bacteria (National Institute of Allergy and Infectious Diseases (NIAID), 2012). Antibiotics were introduced in the 1940s and have been a mainstream treatment ever since. For the past 70 years, the use of antibiotics has sky-rocketed into inappropriately treating unknown pathogens whether they be bacterial, viral, fungal or parasitic (Centers for Disease Control and Prevention (CDC), 2014). The effect of antibiotic overuse and mistreatment has led to infectious bacteria developing antibiotic resistance (CDC, 2014). Antibiotic resistance is when bacteria that is normally destroyed or inhibited by a drug, is able to survive due to newly developed resistance patterns (NIAID, 2012). Antibiotic resistance results in at least 23,000 deaths each year in the United States alone (CDC, 2014).

Multiple mechanisms exist where bacteria can become resistant to antibiotics. Selective pressure occurs when an antibiotic does not kill all the bacteria. One possible mechanism is when the few bacteria that survive then produce bacteria that are resistant to various antibiotics (NIAID, 2012). Mutation can occur where the genotype of bacteria changes, allowing it to no longer be targeted by antimicrobial drugs (NIAID, 2012). Lastly, gene transfer allows bacteria to transfer genes to one another. Select transferred genes allow bacteria to survive when exposed to an antibiotic that would normally kill the original bacteria (NIAID, 2012). Another factor that has exacerbated the antibiotic resistance problem is inappropriate use when the infection is not bacterial (NIAID, 2012). The inappropriate diagnosis of an infection can lead to a broad spectrum antibiotic

prescription instead of a specific antibiotic being prescribed. Antibiotic use in hospitals in the critically ill is extremely high, and this, combined with close living quarters and lowered immune systems, leads to the spread of antibiotic resistant bacteria among patients (NIAID, 2012). Agricultural use may also increase the spread of antibiotic resistance because over half of the antibiotics produced in the United States have agricultural uses (NIAID, 2012). These natural and societal factors all play a role in the increase of antibiotic resistance, but the providers prescribing the antibiotics also contribute to the problem.

An important job every provider must do when prescribing an antibiotic is educate their patients on what antibiotics are. A study by Chan, Y., et al. (2012) looked at five urban areas in Hong Kong that had a high prevalence of antibiotic resistance. Researchers wanted to determine if there was a correlation between lack of knowledge of antibiotics and the high prevalence of resistance (Chan, et al., 2012). In this study, 465 individuals took a questionnaire that contained questions regarding knowledge of antibiotics and adherence to recommended treatment plans (Chan, et al., 2012). The researchers found that 96.3% had heard the term “antibiotics,” 80.6% remembered being prescribed an antibiotic in the past, and 32.9% displayed non-adherence to antibiotic use (Chan, et al., 2012). The results also found that individuals who had a decrease in antibiotic knowledge had an increase in non-adherence of antibiotic use (Chan, et al., 2012). The study concluded that a lack of knowledge on antibiotics is strongly correlated to non-adherence, which is independent of community education on antibiotics (Chan, et al., 2012). This study displays the importance of educating patients on antibiotics. Specifically, patients should be educated on proper adherence behaviors, including taking the full prescribed

dose for the entire prescribed duration. Doing so may contribute to patients adhering to the full antibiotic regimen.

Another aspect contributing to antibiotic resistance prevalence is the over-prescribing of antibiotics for nonbacterial diseases or self-limiting diseases. Research by Lee, G. et al. (2014) looked at the prevalence of antibiotic prescriptions given from 2000 to 2010 and compared to earlier decades. During the 1990's, an initiative was made to decrease antibiotic prescriptions because of the increase in antibiotic resistance (Lee, et al., 2014). This research focused on whether that initiative was continuing into the 2000s. The study analyzed data on prescription use from the Medical Expenditure Panel Surveys from 2000 to 2010 (Lee, et al., 2014). Prescriptions for overall antibiotics, antibiotics for acute respiratory tract infections, and broad-spectrum antibiotics were looked at for three age groups. Results found that:

- Rate of broad-spectrum antibiotic prescriptions doubled from 2000 to 2010 (Lee, et al., 2014).
- Overall antibiotic use decreased in children and adolescents, but it increased in older adults (Lee, et al., 2014).
- Acute respiratory tract infection prescriptions decreased in children and adults, but remained the same for older adults (Lee, et al., 2014).

It was concluded that programs need to continue to initiate safe and effective antibiotic prescriptions for children and adults, and more programs need to be developed for older adults as the prevalence of antibiotic prescriptions has significantly increased (Lee, et al., 2014). This research reiterates the importance of only prescribing an antibiotic when it is necessary.

Problem Statement

Medical professionals are well aware that antibiotic resistance is a major problem in our healthcare system. However, patient awareness of antibiotic resistance and adherence to prescribed dose and duration of antibiotic medications is unknown.

Purpose of the Study

The purpose of this study is to evaluate the general population's awareness of antibiotic resistance and proper use of antibiotics in regard to education level. This study will be conducted via a survey on adults working in or visiting Royal Tire Commercial Store in Minneapolis, MN.

Significance of the problem

Antibiotic resistance poses a problem to effectively treating and preventing infections caused by commonly encountered bacteria such as pneumonias, sexually transmitted infections and skin or soft tissue infections (CDC, 2014). For example, Pneumonia caused by *Streptococcus pneumonia* is now resistant in certain areas of the country to the first line treatment of Azithromycin. Strains of *Staphylococcus aureus,* a common skin inhabitant, are now methicillin-resistant (MRSA) requiring an entirely new and more broad-spectrum class of drugs to treat. If first-line treatments for these common bacteria are no longer effective, providers are required to treat using second and third-line options. The treatment plans which are next in line may be less effective against the offending agent, more expensive, have greater side effects, and no longer on reserve to treat more severe diseases (CDC 2014). Furthermore, while MRSA strains were originally found only in hospital settings where broad antibiotics were necessary to use, there are now community-acquired MRSA strains (Mayo Clinic, 2012). The spread of

this ‘super-bug’ into the immune systems of the general population is a prime example of how difficult it is to maintain control over bacteria resistant to current treatment plans. If this cycle continues, which will likely happen without an intervention, it poses the threat of exhausting all treatment options currently available. New antibiotic creation and production cannot keep up with the rate at which bacteria have and are becoming resistant to the current available treatment (CDC, 2014). An intervention is needed to educate both patients and providers on the importance of proper use and prescription practices of antibiotics. One study done by Sharpe and Mikeal (1974) found significant improvement in compliance when patients were given a handout prior to receiving the medication stressing the importance of taking the entire dose prior. The handout provided a brief explanation in lay terms educating patients on why it was important to finish the entire prescribed dose. Bacteria are not the only infectious agents that are creating a resistance to treatments; many fungal, viral and parasitic organisms have developed antimicrobial resistance as well (CDC 2014). The reason behind the resistance is the same—inappropriate use of pharmacological antimicrobial agents causes the microbes to mutate to a more resistant strain, requiring a newer, more expensive and broader spectrum drug to treat what once was cured by a first-line therapy (CDC 2014).

The question of who to blame for antibiotic resistance does not have a simple answer, or in other words, will not have a simple solution. The patients prescribed these medications can be at fault for not finishing the entire prescribed dose or for demanding an antibiotic for a disease caused by a non-bacterial source such as the common cold. Providers can be blamed for prescribing an antibiotic for an inappropriate cause for the sole purpose of patient satisfaction, for not educating the patient on why the entire dose

must be consumed, or forgetting to discuss non-pharmacological ways to treat illnesses such as saline nasal sprays or NSAIDS (Mayo Clinic 2012). A combination of all the listed factors, in addition to the lack of time on behalf of the provider to explain the difference between viruses and bacteria, and a lack of caring on behalf of the sick patient are all likely causes of antibiotic misuse. Without a doubt, something must be done to stop the misuse of antibiotics and prevent further advances of drug-resistant bacteria.

Chapter 2: Literature Review

Introduction

Past research on antibiotics and antibiotic resistance has mainly focused on the public's knowledge of antibiotics, effectiveness of antibiotics, and the cause of increasing antibiotic resistance. This research project is focusing on the public knowledge and awareness of antibiotic resistance. Since providers act as the main source of information for patients it is important to gather information related to healthcare providers' influence on the increase in antibiotic resistance.

Knowledge of antibiotics

Research on public knowledge about antibiotics has been a continuing effort as evident by the volume of research available. Educating patients on what antibiotics are and what they are used to treat can promote adherence to the prescription according to a study done in 2014 by Northey, McGuren, & Stupans. This study looked at the effectiveness of involving pharmacy staff in educating patients on antibiotic resistance for those who came in with a prescription for an antibiotic (Northey et al., 2014). Of the selected sample population, half were verbally educated by a pharmacist on antibiotic resistance before receiving their prescription, and half were given the prescription with no additional education provided (Northey et al., 2014). Results indicated the educated group had a significant increase in antibiotic knowledge one month after picking up their prescription compared to the non-educated control group (Northey et al., 2014). The importance of verbal education by pharmacy staff is advantageous for patient knowledge on antibiotic resistance, and it should be emphasized more often (Northey et al., 2014). This study contributes to the current research because it assesses the impact patient

education has on the knowledge of antibiotic use. Weaknesses of the Northey et al. (2014) study are the small population size of 34 individuals and strictly looking at the verbal education impact given by pharmacists. Additional research questions may include looking to determine if the increase in antibiotic knowledge correlates to adhering to antibiotic prescriptions, and if there is an impact on antibiotic knowledge when education is given by the healthcare provider prescribing the antibiotic.

A similar study done by Chan, et al. (2012) examined the correlation between knowledge of antibiotics and the prevalence of resistance in a group of individuals. Research occurred in Hong Kong, where 465 participants took a questionnaire regarding personal knowledge of antibiotics and adherence (Chan et al., 2014). Results found that 96.3% had heard the term "antibiotics," 80.6% remembered being prescribed an antibiotic in the past, and 32.9% displayed non-adherence to antibiotic use (Chan et al., 2014). Individuals who had a decrease in antibiotic knowledge, had an increase in non-adherence of antibiotic use (Chan et al., 2014). The study concluded that a lack of knowledge of antibiotics is strongly correlated to non-adherence, which is independent of community education on antibiotics (Chan et al., 2014). A weakness of the Chan et al. (2014) study is the location of Hong Kong. The information would be more relevant to our population if the questionnaire was conducted in the United States to see if similar patterns exist.

Research by Hoffmann, Ristl, Heschl, Stelzer, & Maier (2014) looked at a correlation in demographics of Austrian patients and their knowledge of antibiotics. A cross-sectional study and a 12-question survey was conducted that asked about an individual's knowledge of antibiotics, their demographic information, and their source of

how they became educated on antibiotics (Hoffman et al., 2014). The results found that a low knowledge level was correlated to low educational level, age, having a native language other than German, and being male (Hoffmann et al., 2014). Around 55% of the patients reported their knowledge of antibiotics was learned from a general practitioner (Hoffmann et al., 2014). Conclusions made from this study were that an interventional approach needs to focus on informing low-educated individuals about antibiotics (Hoffman et al., 2014). Understanding that demographics may correlate with knowledge of antibiotics can lead to more research on whether that knowledge relates to adhering to a prescribed antibiotic.

A study performed by Salazar, Englih and Eiland (2012) examined how caregivers' level of understanding regarding antibiotics determined their expectation of antibiotic prescription and use for the children and/or patients under their care. Caregivers of lower socioeconomic status were more likely to expect antibiotics in inappropriate situations and less likely to have accurate knowledge regarding correct antibiotic use (Salazar et al., 2012). The study's conclusion found when an explanation and indication of antibiotic use was provided to the caregiver, the level of misuse and inappropriate expectations decreased (Salazar et al., 2012). The results from this study indicate a higher level of caregiver knowledge regarding proper antibiotic indications leads to a higher level of appropriate antibiotic use and lower levels of patient disappointment (Salazar et al., 2012). Patients who understand the limitations of antibiotic therapy are less likely to request a prescription for an inappropriate condition. Improved patient knowledge can lead to increased patient satisfaction and providers will receive less pressure to inappropriately prescribe these medications, knowing the drug

has zero efficacy. Patient education needs to become a main priority of providers as a method of reducing improper antibiotic use, requests, and prescriptions. Through this increase of understanding proper antibiotic use in the general population, a halt in antibiotic resistance caused by inappropriate use could be a beneficial outcome. Since patient education has been identified as a component of the antibiotic resistance crisis, the focus shifts on ways to improve patient education.

Effectiveness of antibiotics

The 1940s was an innovative time in medicine due to the discovery of antibiotics for treatment of bacterial infections (Centers for Disease Control and Prevention (CDC), 2014). Today, antibiotics are still prescribed for countless bacterial diseases, but are also inaccurately prescribed for viral, fungal, and parasitic diseases (CDC, 2014). Because of this, there has been a spike in research on the effectiveness and indications of antibiotics.

Recent research conducted by Sanchez, Roberts, Albert, Johnson, & Hicks (2014) looked at how primary care providers' (PCP) knowledge, attitudes, and practices of recommended antibiotics for common infections affects their antibiotic selection. Methods for this involved in depth interviews with 36 PCPs in the US (Sanchez et al., 2014). Results found that the PCPs understood the clinical guidelines for first line antibiotic therapy in common infections, but they do not always follow those guidelines (Sanchez et al., 2014). Reasons for noncompliance to these guidelines included belief that other antibiotics were more effective as treatment, concern for satisfaction of the patient or parent, and fear of medical complications from the recommended antibiotic (Sanchez et al., 2014). The growing issue of antibiotic resistance was known to the PCPs, but this consideration was typically not taken into account when prescribing an antibiotic

(Sanchez et al., 2014). Conclusions from this study are to focus more research on ways to improve antibiotic selection and to increase antibiotic effectiveness by promoting appropriate first line antibiotic therapy in primary care settings (Sanchez et al., 2014). Further research that would enhance this study would be to assess the success rate in patient outcomes for those that were prescribed a non-guideline antibiotic versus patients that were prescribed the recommended guideline antibiotic for the same infection.

A study by Rattanaumpawan, Sutha, & Thamlikitkul (2010) analyzed the effectiveness of an 'Antibiotic Selection Initiative' program in Thailand that promotes optimizing correct antibiotic selection, dose, duration and route and minimizing unnecessary antibiotic use to improve clinical outcomes. This program is based on authorizing the use of antibiotics through drug use evaluation (DUE) (Rattanaumpawan et al., 2010). The three antibiotic prescriptions studied at Siriraj Hospital were piperacillin/tozobactam (Zosyn), imipenem, and meropenem (Rattanaumpawan et al., 2010). Over the course of three months, 953 patients received a prescription of these antibiotics. Of those prescriptions, 462 patients received authorization and 486 did not receive authorization based on the DUE (Rattanaumpawan et al., 2010). Results found that patients who received authorization had better clinical outcomes, shorter duration of antibiotic use, and lower mortality rates than those who did not receive authorization (Rattanaumpawan et al., 2010). In addition, the total cost of antibiotics in the authorization patients was less than the non-authorization patients (Rattanaumpawan et al., 2010). This Antibiotic Selection Initiative program is an effective way to reduce inappropriate antibiotic prescription while selecting appropriate antibiotics that will not compromise clinical outcomes (Rattanaumpawan et al., 2010). A weakness of this

research is the antibiotics used in this study may vary in efficacy when prescribed for a patient in a US hospital. Implementing an antibiotic selection initiative, such as this, in the US may be beneficial in reducing inappropriate antibiotic prescriptions while improving patient outcomes. This study did not mention if antibiotic adherence was a factor in patient outcomes, which could be addressed in future studies. An important reason for these initiatives is to promote a decrease in antibiotic resistance and antibiotic misuse.

Cause of increasing antibiotic resistance

A number of components contribute to the compounding antibiotic resistance crisis. Bacteria are living organisms with the ability to mutate spontaneously. Some of these mutations are quite beneficial to the immortality of the strain when faced against first-line antibiotic treatments (CDC, 2014). This is when second and third-line therapies are of great need. Other factors contributing to the increased resistance put either the patient or the provider at fault. Providers may prescribe antibiotics at inappropriate times, whether due to the pressure of patient satisfaction, or from honest misperception of viral versus bacterial illness, as in upper respiratory infections (Mayo Clinic, 2012). Providers may not stress the importance of taking the full course as instructed on the bottle, and patients may feel it is not important to do so if symptoms have cleared (Mayo Clinic, 2012). Patients may also feel inclined to save some medication for the next time an illness hits, which ensures two treatment plans are now sub-optimal and more likely to lead to resistant bacterial growth (Mayo Clinic, 2012). A multi-factored problem requires a multitude of solutions. If the few main components responsible for the majority of

resistant bacterium formation can be realized, then solutions to the world-wide problem can begin to focus mainly on those components as a serious initiative to halt the problem.

Determining the factors that correlate to an increase in antibiotic resistance has been a highly researched topic. Research by Lee et al. (2014) analyzed the number of antibiotic prescriptions given from 2000-2010 in the US. The focus of the research was to see if an initiative started in the 1990's which aimed to decrease antibiotic prescription use, was continuing into the 2000s (Lee et al., 2014). The analysis was done by using data from the Medical Expenditure Panel Surveys from 2000 to 2010 (Lee et al., 2014). Prescriptions for overall antibiotics, antibiotics for acute respiratory tract infections (ARTI) and broad-spectrum antibiotics were looked at for three age groups (Lee et al., 2014). Results found that the rate of broad-spectrum antibiotic prescriptions doubled from 2000 to 2010, with overall antibiotic use decreasing in children and adolescents, but increasing in older adults (Lee et al., 2014). It was concluded that programs need to continue to initiate safe antibiotic prescriptions for children and adults, and more programs need to be developed for older adults as the prevalence of antibiotic prescriptions has significantly increased (Lee et al., 2014). This study is important because it supports that there is an increase in antibiotic prescriptions in the US despite a previous initiative. A next step in this research would be to determine the reasoning as to the increase in prescription use in providers.

A study done by Sharpe and Mikeal (1974) investigated a possible method to increase antibiotic regimen compliance in the general population. Eighty patients who had been prescribed a 10 day course of antibiotics were randomly divided into two groups (Sharpe & Mikeal, 1974). One group received the medication with only the

typical prescription label, instructing patients to take X pill X times daily for X days. The alternative group received a paper handout at the pharmacy which contained information in lay terms providing more details about the prescription (Sharpe & Mikeal, 1974). In the handout, patients were briefly educated on what types of illness their antibiotic was able to treat, specifically instructed to take the entire dose of medication in the vile, and why it was important to do so to prevent the formation of drug-resistant bacteria (Sharpe & Mikeal, 1974). The study found that at the end of the treatment course, patients who received the extra information handout had significantly higher compliance to the antibiotic regimen (85% compliant) versus the patients who had received only the typical prescription label (63% compliant) (Sharpe & Mikeal, 1974). The results from this study greatly support providing patients with a small amount of education in order to stress the importance of following specific prescription instructions. The next question to consider would be which medical professional should provide this information, and what format would be most beneficial to the majority of patients.

Hospitals are well known reservoirs of bacteria, and research has been done to see if antibiotic resistance in hospitals is on the rise. A study by Edelsberg et al. (2014) looked at the prevalence of antibiotic resistance in 19 urban US hospitals from 2007-2010. The most common pathogen/antibiotic pairs that showed the highest percentage of resistance were *Enterococcus faecium*/vancomycin (87.1%), *Staphylococcus aureus*/oxacillin-methicillin (56.8%), *S. aureus*/clindamycin (39.7%), *Pseudomonas aeruginosa*/fluoroquinolones (32.6%), and *Escherichia coli*/fluoroquinolones (31.3%) (Edelsberg et al., 2014). When comparing these resistant percentages to a previous study conducted in 2006, the data stayed constant (Edelsberg et al., 2014). In concluding that

antibiotic resistance in these hospitals has neither increased nor decreased, the next step could include implementing protocols to reduce antibiotic resistance.

Summary of Literature Review

With a rise in appropriate antibiotic prescription and patient compliance to the regimen, there would be an expected decrease in the creation of stronger, antibiotic-resistant strains of common bacterium. A decrease in new and resistant strains would equate to the current antibacterial treatment options continuing to be viable choices for patients. The completion of this study will give an estimate of general population's knowledge of antibiotics and personal use compliance in suburban Minnesota communities. With this information, local efforts can be made in the future to fill the knowledge gaps in the community, and motivate medical professionals to address antibiotic use to their patients.

Chapter 3: Methodology

Introduction

The purpose of this study was to evaluate the general population's awareness of antibiotic resistance as well as proper use of antibiotics as related to education level. This study attempted to evaluate the following:

- The percentage of the general population that is aware of antibiotic resistance
- The percentage of the general population that has stopped taking an antibiotic short of the recommended time frame and the reason why.

The following sections will outline the protocol of how, where, and on whom the study was conducted. The study design, population description, study validity and reliability, data collection and analysis, as well as study limitations will be described below.

Study Design

This was a pre-experimental research study utilizing a survey (Appendix 1) offered to adult employees and customers of Royal Tire Commercial Store in Minneapolis, MN. The demographic that was requested from study participants is the highest level of education achieved. The survey asked five structured questions intended to evaluate participant's knowledge of antibiotics, antibiotic resistance and personal antibiotic use. The participants selected 'True/False" or 'Yes' or 'No' as an answer for the majority of questions with two opportunities to provide a short written response. The participants also provided researchers with highest level of education, categorized as high school diploma, two-year college degree, or four-year college degree. This was obtained verbally from each participant and documented on the survey. The nominal answers from the surveys were evaluated for descriptive analysis using SPSS.

Study Site and Subjects

In order to survey as large of group as possible, the survey was offered to all adult employees and customers of Royal Tire Commercial Store in Minneapolis, MN. Verbal permission was obtained from the store manager for the authors of the study to proctor the survey one morning during the weekday. The survey was given in the waiting area of the Minneapolis Royal Tire Commercial Store. The authors of the study asked for voluntary participation of all eligible adults entering the store during the workday. All survey participants were required to read an informed consent prior to taking the survey. No demographic or personal information was obtained from participants other than the highest level of education completed. This population was selected based on convenience, as well as variability in age and education levels. The expected number of participants, based on the number of adults visiting or working in the store was approximately 75 persons, which was met.

Validity and Reliability

The reliability of the study was determined by making the survey questions precise and consistent throughout by having "yes/no" and "true/false" responses. Having no biases in our sample population as to who completes the survey also made the study reliable. This allowed the data to be consistent, providing us with accurate results. Consistently using the same survey for all participants kept the study reliable over time. The validity was determined by the usefulness of the data. Once again, the survey questions are all precise and consistent, which made the data we received valid. Validity was based on the relevancy of the questions to antibiotics as determined by the review board during the approval meeting of this study.

Data Collection

With IRB approval, during early summer 2015, the employees and customers of Royal Tire Commercial Store in Minneapolis, MN were asked to complete the survey. The survey was anonymous, but verbal permission was obtained and the participant received an informed consent statement to read (see Appendix II) prior to completion of the survey. The survey was completed at that time, and was collected immediately after completion to be analyzed at a later date. The survey was given only once to each participant. The number of participants during one work day of survey completion was sufficient for our data collection, n=80 persons.

Data Analysis

The data received from our survey was compiled, and the qualitative "yes/no", "true/false" and written responses were converted quantitatively into nominal data. The nominal data was then be analyzed and complied into descriptive statistics using SPSS. This measured our dispersion of the data, including standard deviation and variance. The analysis was compiled into tables and charts (Tables 1,2 and 3, and Figures 1 and 2) . The survey data has been collected on a drive and stored with the Bethel University Research Coordinator for security purposes. These statistics will determine the survey participant's knowledge of antibiotic resistance and antibiotic use.

Limitations/Delimitations

Possible limitations to the methods of this study was having the population sample all work in the same industry. This could have potentially caused bias to the results because there was not enough variance in the population sample. As long as the survey questions provided a direct measurement of useful and appropriate results, then

the validity of the study should be ensured. Another limitation was who choose to participate in the survey. When the survey distribution occurred, any study participant that had increased or decreased knowledge in the medical field could have skewed results.

Chapter 4: Results

This study was conducted in an attempt to evaluate the general population's awareness of antibiotic resistance, to gather information about the proper use of antibiotics in this population, and to evaluate if the responses given by survey participants had any correlation in regard to education level. After surveying 80 participants, the study data was analyzed using SPSS to find all percentages, significance value, and Pearson correlation values as they related to the study objectives.

Data Analysis

The first survey question asked participants if s/he was familiar with the term 'antibiotic resistance', and if so, to define it in his/her own terms. Those definitions were then evaluated by study writers for accuracy. As seen in Table 1, the percentage of survey participants with accurate knowledge of the term 'antibiotic resistance' was 18.8%. Conversely, the percentage of study participants that did not have correct knowledge, or any knowledge at all, of the term 'antibiotic resistance', was 81.3%. This information was used along with the survey participant's education level to see if knowledge base about the term 'antibiotic resistance' had any correlation with education level (Table 2). The participant's highest education level was categorized as high school diploma, two-year college degree, or four-year college degree, with 23 out of 80 participants (28.75%) of study participants reporting high school diploma, 39 out of 80 (48.75%) participants reporting two-year college degree, and 18 out of 80 (22.5%) reporting four-year college degrees as highest level of education. The Pearson correlation between knowledge of antibiotic resistance and participant education level was found to be -0.177. Pearson correlation compares the significance value to 1 or -1, with a value closer to 1 being

considered more direct correlation, and a value closer to -1 considered a more indirect correlation between variables. Since this value of -0.177 is not close to 1.0, it can be concluded that there is not a strong relationship between the two variable of knowledge regarding the term 'antibiotic resistance', and education level. Additionally, the 2-tailed significance value found from this correlation evaluation was also 0.177, which is greater than the p value of 0.05, indicating that there is no statistically significant correlation between the two variables. From both of the evaluated significance and correlation values, it can be concluded that if education level were to rise in a person, knowledge of the term antibiotic resistance would not necessarily be any more accurate, or vice-versa.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	15	18.8	18.8	18.8
	No	65	81.3	81.3	100.0
	Total	80	100.0	100.0	

Table 1: Percentage of survey participants with accurate knowledge of the term antibiotic resistance.

		TERM	EDUCATION
TERM	Pearson Correlation	1	-.177
	Sig. (2-tailed)		.117
	N	80	80
EDUCATION	Pearson Correlation	-.177	1
	Sig. (2-tailed)	.117	
	N	80	80

Table 2: Correlation between accurate knowledge of the term antibiotic resistance and education level.

The last objective of this study was to evaluate proper use of antibiotics, and was evaluated by asking participants if s/he had ever stopped an antibiotic course short of the recommended duration, and if so, what the reason was. While 85% of participants had been prescribed an antibiotic at some point in time, 13.3% of participants reported having stopped taking the prescription before the recommended stop-date (Table 3). Reasons given for stopping the medication early included gastrointestinal upset as the most common reason, with this being the response given from 56% of the participants who stopped taking an antibiotic earlier than recommended, participants stating s/he felt better after only a portion of the medication was given as the reason in 33% of surveyed participants,, and one participant reported a rash from the medication prescribed.

Although no significant correlations were found from study results, the information obtained through this survey can be used as guidance in the future to help clinicians educate patients on the above topics as seen necessary.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Stopped early	9	11.3	13.2	13.2
	Full dose	59	73.8	86.8	100.0
	Total	68	85.0	100.0	
Missing	System	12	15.0		
Total		80	100.0		

Table 3: Percentage of survey participants that stopped an antibiotic course short of recommended duration.

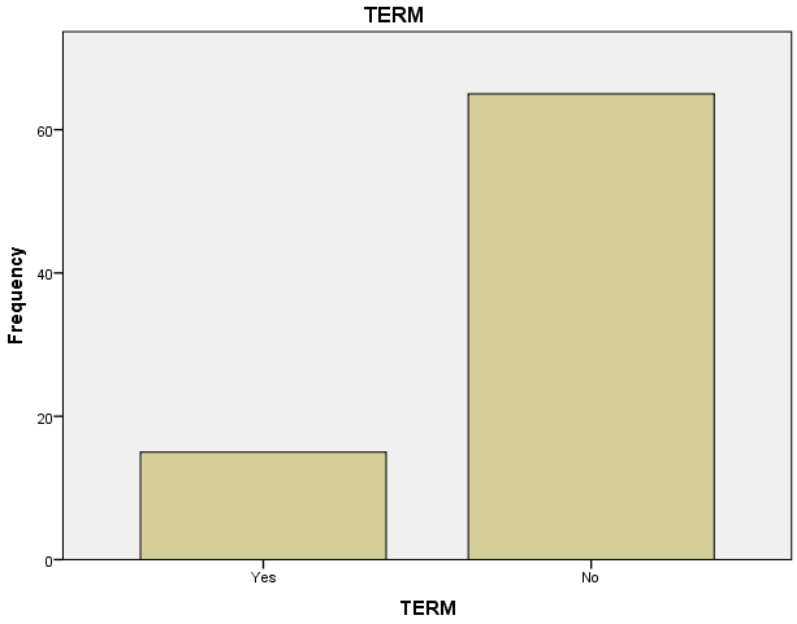

Figure 1: Number of survey participants with accurate knowledge of the term antibiotic resistance.

Chapter 5: Discussion and Conclusions

Summary

The first objective of the study was to determine a possible relationship between knowledge of the term 'antibiotic resistance' and the participant's education level. Of the study participants, 18.8% were accurately aware of the term antibiotic resistance. When comparing the knowledge of the term to the participant's education level, there was no significant correlation between the two. The majority of study participants reported a two-year college degree as highest level of education. It was hypothesized that an individual with a higher level of education would be more likely to accurately define the term antibiotic resistance. While the study did not support this hypothesis, there is previous research that suggests patient education regarding the term antibiotic resistance does effect patient compliance. Per the literature review, there is a higher adherence rate of antibiotic prescriptions when a patient is educated about the implications of potential antibiotic resistance when discontinuing the prescription early. Because there was no significant correlation found between knowledge of antibiotic resistance and an individual's education level, the importance of educating patient's about antibiotic resistance should be increasingly emphasized to all patients, regardless of educational background.

The second study objective was to investigate the percentage of study participants who stopped taking an antibiotic prescription short of the recommended time frame, and determining the why. Of the study participants who had taken an antibiotic, 13.2% were not adherent to the full dose or duration of treatment. Reasons for discontinuing the antibiotic included gastrointestinal upset, rash, and symptoms resolving before antibiotics

were completed. This information is of value because it is important as a clinician to educate a patient of the common side effect of antibiotics, and ways to lessen these side effects if needed while completing the antibiotic course. In order to increase patient adherence to antibiotic prescriptions, education from the medical provider needs to be emphasized, as research shows the clinical outcome is improved when patients are educated about antibiotic resistance.

Limitations

There were two major limitations in our study. The first was the study location. Due to restrictions at the original planned study site, Anderson Center in Arden Hills, MN, a new location was found to complete the survey. This limited the study to a location that was willing to have both employees and customers participate in the survey to include a diverse population sample and limit any potential bias to the study. Royal Tire Commercial Store in Minneapolis, MN, gave permission to do such. It was difficult to obtain a large variety of education levels with one location as many of the employees had a similar education status, as expected when surveying persons in a similar work field. This could be a factor as to why there was no correlation between knowledge of antibiotic resistance and an individual's education level as indicated by study results. Conducting the study at one location also decreased the amount of study participants, which is the second limitation. The original goal was to obtain at least 100 completed surveys. This goal had to be re-evaluated as there was not a large enough sample size to reach this goal. In order to assess results from the general population, a study with a larger sample size at a more diverse location would need to be conducted.

Further Research

There are further investigations that can be conducted to advance the results indicated from this research study. This includes surveying more participants from a variety of locations to increase the sample size. Increasing the sample size and survey area has the possibility to coincide with an increased variance in education levels. This has potential to show significant correlation between knowledge of antibiotic resistance and education level. A further advancement would be to evaluate correlation between other study variables, such as whether education level correlates with adhering to the full dose and duration of an antibiotic prescription. This study focused only on investigating correlation between antibiotic resistance knowledge and education level, but did not investigate any other correlating variables. In general, additional research would be needed to determine how patients can best be educated on antibiotic resistance.

Conclusion

In conclusion, the study results indicated there is not a significant correlation between a participant's knowledge of the term 'antibiotic resistance' and the participant's education level. However, there is a need for a larger sample size to determine if this is an accurate statistic when considering the entire general population. Reasons for why an individual discontinued an antibiotic prescription short of the recommended time frame included gastrointestinal upset, rash, and symptoms resolving before antibiotics were completed. Previous research supports that when a patient has been appropriate educated on antibiotic resistance and antibiotic side effects, adherence of an antibiotic prescription increases. Continuing to emphasize the importance of educating patients about antibiotic resistance needs to be stressed by medical professionals, and further research on effective ways to educate patients about antibiotic resistance is of utmost importance.

References

Centers for Disease Control and Prevention. (2014 Aug. 6). Antibiotic/Antimicrobial resistance. Retrieved from http://www.cdc.gov/drugresistance/

Chan, Y., Fan, M. M., Fok, C., Lok, Z. L., Ni, M., Sin, C., et al. (2012). Antibiotics nonadherence and knowledge in a community with the world's leading prevalence of antibiotics resistance: Implications for public health intervention. *American Journal of Infection Control, 40*(2), 113-117.

Lee, G. C., Reveles, K. R., Attridge, R. T., Lawson, K. A., Mansi, I. A., Lewis II, J. S., et al. (2014). Outpatient antibiotic prescribing in the United States: 2000 to 2010. *BMC Medicine, 12*(1)

Mayo Clinic. (2012 Feb 4). Consumer health. Retrieved from http://www.mayoclinic.org/healthy-living/consumer-health/in-depth/

National Institute of Allergy and Infectious Diseases. (2012 Jan 3). Antimicrobial (drug) resistance. Retrieved from http://www.niaid.nig.gov/topics/antimicrobialResistance/Understanding

Sharpe, T & Mikeal, R. (1974-05). Patient compliance with antibiotic regimens. American journal of hospital pharmacy, 31(5), 479-484.

Suda, K. (2012-01). Improving safe and appropriate use of antibiotics. Journal of the American Pharmacists Association, 52(1), 6-10.doi:10.1331/JAPhA.2012.12500

APPENDIX A

Survey

Please answer the following questions.

1. Are you aware of the term ‘antibiotic resistance’? YES NO

In your own words, please define the term:
_____

2. Antibiotics are used to treat only bacterial infections: TRUE FALSE

3. Have you ever taken an antibiotic? YES NO

IF YOU ANSWERED NO TO QUESTION #4, PLEASE STOP THE SURVEY HERE

4. Were you instructed to take the full dose of antibiotics? YES NO

5. Have you ever stopped taking an antibiotic short of the recommended time frame?

YES:
Please provide the reason why (side effects, illness resolved, forgot to take, etc.)
_____

NO

***Education level was verbally obtained after participant read informed consent. It was then documented on each survey.**

APPENDIX B

Informed Consent Statement

The purpose of the research project is to determine the general population's awareness of antibiotic resistance and proper use of antibiotics. This research project is being conducted by Rachel Cantlon and Emma Wilson for their research capstone project in the Physician Assistant Program at Bethel University. We ask you to participate in this research project because your response would be greatly beneficial to determining the significance of our study's purpose.

Participation in this study is voluntary, and you may chose not to participate. If you chose to participate, you may withdrawal at any time and will not be penalized.

The survey involves giving "yes/no" and multiple choice responses to five questions. Your responses are confidential and your name will remain anonymous. The survey questions are about your knowledge of antibiotic resistance and your previous use of antibiotics.

Your information will be kept confidential, and all data will be stored in a security locked facility with the Bethel University Research Coordinator. The surveys will not contain information that personally identifies you. The results from this survey will strictly be used for scholarly purposes and will not be shared with any representatives outside Bethel University.

If you have any questions about the research study, please contact Rachel Cantlon or Emma Wilson at rac57679@bethel.edu and emw58527@bethel.edu. This research has been reviewed by the Bethel University IRB Committee for research involving human subjects.