Pittsburg State University

Pittsburg State University Digital Commons

Doctor of Nursing Practice Scholarly Project | Irene Ransom Bradley School of Nursing

5-10-2019

The Usability and Acceptability of an Electronic Clinical Decision Support Tool for Antibiotic Selection for Common Pediatric Infections in Outpatient Rural Healthcare Clinics

Samantha Simpson
Pittsburg State University, sksimpson@gus.pittstate.edu

Follow this and additional works at: https://digitalcommons.pittstate.edu/dnp

Part of the Pediatric Nursing Commons

Recommended Citation

Simpson, Samantha, "The Usability and Acceptability of an Electronic Clinical Decision Support Tool for Antibiotic Selection for Common Pediatric Infections in Outpatient Rural Healthcare Clinics" (2019). *Doctor of Nursing Practice Scholarly Project*. 66.
https://digitalcommons.pittstate.edu/dnp/66

This Scholarly Project is brought to you for free and open access by the Irene Ransom Bradley School of Nursing at Pittsburg State University Digital Commons. It has been accepted for inclusion in Doctor of Nursing Practice Scholarly Project by an authorized administrator of Pittsburg State University Digital Commons. For more information, please contact digitalcommons@pittstate.edu.

USABILITY AND ACCEPTABILITY OF AN ELECTRONIC CLINICAL DECISION SUPPORT TOOL FOR ANTIBIOTIC SELECTION FOR COMMON PEDIATRIC INFECTIONS IN OUTPATIENT RURAL HEALTHCARE CLINICS

A Scholarly Project Submitted to the Graduate School
in Partial Fulfillment of the Requirements
for the Degree of
Doctor of Nursing Practice

Samantha Kay Simpson

Pittsburg State University

Pittsburg, Kansas

May, 2019

USABILITY AND ACCEPTABILITY OF AN ELECTRONIC CLINICAL DECISION SUPPORT TOOL FOR ANTIBIOTIC SELECTION FOR COMMON PEDIATRIC INFECTIONS IN OUTPATIENT RURAL HEALTHCARE CLINICS

Samantha Kay Simpson

APPROVED:

DNP Scholarly Project Advisor ______________________________
Dr. Amy Hite, School of Nursing

Committee Member______________________________
Dr. Karen Johnson, School of Nursing

Committee Member ______________________________
Dr. Kristi Frisbee, School of Nursing

Committee Member ______________________________
Dr. Anuradha Ghosh, Department of Biology

ACKNOWLEDGEMENTS

I would like to express my great appreciation to each of the committee members for their time and valuable constructive suggestions during the development of this research. I would also like to show my gratitude towards Dr. Rusty McCulloh, MD and Dr. Jessica Markham, MD for their assistance and contributions towards this research work. Finally, I would like to thank my family for their endless support.

USABILITY AND ACCEPTABILITY OF AN ELECTRONIC CLINICAL DECISION SUPPORT TOOL FOR ANTIBIOTIC SELECTION FOR COMMON PEDIATRIC INFECTIONS IN OUTPATIENT RURAL HEALTHCARE CLINICS

An Abstract of the Scholarly Project by
Samantha Kay Simpson

The purpose of this project was to determine the potential role, usability and acceptability of an electronic clinical decision support tool (ECDST) for optimizing antibiotic prescribing practices for pediatric patients in outpatient rural healthcare clinics. Providers working with pediatric patients at Community Health Center of Southeast Kansas were asked to use the ECDST to complete two case studies. Following completion of the case studies, participants completed two standardized surveys regarding usability and mental workload of the ECDST. The ECDST used in this project was found to require a low mental demand, have a high usability value, and was accepted as a potential tool for clinical practice by the majority of the providers who used it.

TABLE OF CONTENTS

CHAPTER ....PAGE

LIST OF TABLES

TABLE……………………………………………………………………………..PAGE

LIST OF FIGURES

Chapter I

Introduction

Antibiotic resistance has become a global threat, with at least 2 million people becoming infected with antibiotic resistant bacteria in the United States each year, and at least 23,000 people dying each year as a direct result of these infections (Centers for Disease Control and Prevention, 2013). Antibiotic resistance is attributed to multiple factors, such as overuse and misuse of medications, lack of new drug development, and the public's perception and use of these medications (Ventola, 2015). Approximately half of all outpatient antibiotic prescribing may be inappropriate (eg. incorrect selection of the antibiotic, dosing, duration, and necessity) and at least thirty percent of outpatient antibiotics prescribed in the United States are completely unnecessary (Sanchez et al.; 2016 Fleming-Dutra et al., 2016). The pediatric population receive a disproportionately high number of these antibiotics compared to the middle-aged population (Ready et al., 2004).

Clinical Issue

The improper use and over prescribing of antibiotics are two of the many factors surrounding antibiotic resistance that are of great importance to the healthcare community. These two areas are places that healthcare providers can work to make improvements. When prescribing antibiotics, the benefits need to be weighed against the possible risks associated with increased resistance and adverse health outcomes. Some of the areas contributing to the inappropriateness include prescribing for an unnecessarily prolonged duration, selecting an unnecessarily broad-spectrum antibiotic, or prescribing an antibiotic when it is not indicated such as for viral infections. The pediatric population is a great place to begin working on decreasing the number of inappropriate antibiotic prescriptions, especially for common infections.

Significance

In 2015 alone, 269 million prescriptions for antibiotics were dispensed from outpatient pharmacies in the United States (CDC, 2017a). That's enough antibiotics for five out of every six people to receive one prescription for an antibiotic each year. Only 70% of these antibiotics were prescribed appropriately. The Centers for Disease Control and Prevention has a National Plan to Combat Antibiotic-Resistant Bacteria (CARB). Their goal is to reduce inappropriate antibiotic prescriptions by 50% by 2020. All providers should have this goal in mind to decrease inappropriate antibiotic prescribing to help decrease the rate of antimicrobial resistance.

Healthcare providers have a moral obligation to diagnose and prescribe appropriately to the best of their knowledge and education. Antibiotic resistance is an issue that needs to be dealt with now before lifesaving antibiotics become useless in fighting common bacterial infections. It is the providers' duty to use the tools that are available to diagnose and treat appropriately based on evidence-based practice guidelines to preserve the antibiotics that are available to fight infections in their patients. All providers should be searching for innovative ways to help them diagnose and prescribe antimicrobials appropriately.

Specific Aims/Purpose

The purpose of this project was to determine the potential role of an electronic clinical decision support tool (ECDST) for optimizing antibiotic prescribing practices in rural clinical practice. The specific aim was to evaluate the usability and acceptability of an ECDST for antibiotic prescribing in pediatric patients in outpatient rural health clinics. The exploratory aim was to assess the impact of ECDST use on antibiotic prescribing practices among healthcare providers who used the tool.

Hypothesis

The primary hypothesis was that providers would find that the ECDST requires a low mental demand and has a high usability value. Based on the exploratory aim, it was hypothesized that providers would more often choose the correct diagnosis and related treatment when using the ECDST.

Theoretical Framework

The theoretical framework that provided a basis for implementation of this project is based on Lawrence Kohlberg's theory of moral development. Kohlberg's theory, developed in 1958, carried over many of the assumptions and criteria from Piaget's stage of theory of cognitive development (Snarey & Samuelson, 2008). The theory was an appropriate framework for this project because of its design in developing and improving upon one's morals or values. As providers of healthcare, it is one's duty to maintain and provide accurate care for patient's health. The theory of moral development framework helped this project by supporting and reinforcing the providers' mission to improve overall care and promoting accurate knowledge to improve outcomes by incorporating evidence into practice. Healthcare professionals have a moral responsibility to treat their individual patients effectively with a public health duty to preserve the efficacy of antibiotics to minimize the development of resistance for their future patients (Parsonage et al., 2017).

Kohlberg's theory's premise is that everyone has certain moral dilemmas that determine which stage of moral reasoning a person uses (Snarey & Samuelson, 2008). nurse practitioners, physicians, and physician assistants must make ethical and moral decisions every day when providing care for patients. Providers must first do no harm, and inappropriately prescribing antimicrobials could potentially do more harm than good and continue to contribute to the crisis of antibiotic resistance. Kohlberg's theory is appropriate and well positioned for providers to evaluate new knowledge and gain expertise to support practice change based on evidence and moral values. Once providers understand the harm that comes from inappropriate prescribing, they may transform their beliefs and change the way they practice medicine.

This scholarly project supported services that promote the development of highly competent providers, and the incorporation of evidence-based practice. The ECDST for this project uses clinical practice guidelines that include "recommendations intended to optimize patient care, and they are informed by a systematic review of evidence, and an assessment of the benefits and harms of alternative care options (AAFP, 2017, para. 1).

The project used this theoretical framework to provide the ability to consider all aspects of patients and their needs and to actively support the welfare of patients through personal and professional actions to improve antibiotic prescribing. By educating providers on the importance of antimicrobial resistance and the use of an ECDST for treating common pediatric infections, providers may change the way they use antimicrobials in their future practice to decrease inappropriate antimicrobial use. Using this tool, the providers can evaluate new knowledge and gain expertise to support practice change based on evidence and moral values.

Definition of Key Terms

Throughout this paper, the reader will come across specific terms that will need to be clearly defined to enable understanding. These terms include the following:

Antibiotic: a substance produced by living organisms and especially by bacteria and fungi that is used to kill or prevent the growth of harmful germs (Merriam-Webster, 2017).

Antimicrobial: a substance that has the capability of destroying or inhibiting the growth of microorganisms and especially pathogenic microorganisms (Merriam-Webster, 2017).

Antibiotic / Antimicrobial Resistance (AMR): “the ability of microbes to resist the effects of drugs – that is, the germs are not killed, and their growth is not stopped.” (CDC, 2017b, para. 1)

Clinical Practice Guidelines (CPG): "statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options” (IOM, 2011, p. 4).

Primary Care Provider: A Primary Care Provider (PCP) is a healthcare practitioner who sees common medical problems. These individuals can be a physician, nurse practitioner, or physician assistant.

Upper respiratory tract infection (URI): a nonspecific term used to describe some acute infections involving upper respiratory tract (the nose, paranasal sinuses, pharynx, larynx, trachea, and bronchi).

Logic Model

Situation: Providers are prescribing antibiotics inappropriately

Inputs	Outputs		Outcomes -- Impact		
	Activities	Participation	Short	Medium	Long
Research on antibiotic resistance -Cost -morbidity/mortality -inappropriate prescribing -solutions Evidence-Based Clinical Practice Guidelines -Sinusitis -Otitis Media -UTI -CAP -skin/soft tissue Development of ECDST	Case Scenarios Pre-survey Post-survey System Usability Scale	Family Nurse Practitioners Family Physicians Pediatricians	-Awareness of antibiotic resistance -Usability of ECDST -Motivate providers to use ECDST -Change attitudes	Behavior change Use ECDST in Decision-making process for antibiotic selection	Practice change on antibiotic prescribing Policy change on using antibiotics Incorporate ECDST into clinical practice

Assumptions	External Factors
Providers will find that the ECDST has a high usability value.	Providers willingness to participate and change their practice.

The logic model begins with inputs including: literature review, evidence-based practice guidelines and development of an ECDST. Outputs include activities and participation from the providers. The short-term goals depicted in the logic model are that providers would become aware of the issue of antibiotic resistance, they would find the ECDST usable with a low mental demand and would change attitudes and motivate providers to use the ECDST to change prescribing antibiotics inappropriately. Other outcomes included behavior changes and eventually policy and practice changes in the clinical setting.

Summary

Antibiotic resistance has become a major problem is the U.S. and around the world. Providers must become aware of the consequences of inappropriate prescribing and of their role in curbing antibiotic resistance. The purpose of this scholarly project was to determine the potential role of an ECDST for optimizing antibiotic prescribing practices in rural clinical practice. The aim was to evaluate the usability and acceptability of an ECDST for antibiotic prescribing in pediatric patients in outpatient rural health clinics.

Chapter II

Review of the Literature

A systematic search of the literature was performed using the electronic databases CINAHL Plus with Full Text and PubMed, with up-to-date information and research also obtained from the Centers for Disease Control website. In addition, the reference lists from each of the articles that were identified as relevant to this literature review were examined to identify additional references to review. The major concepts reviewed throughout this synthesis are: the problem, cost, morbidity/mortality of antibiotic resistance and the problem of overprescribing antibiotics. Possible solutions such as provider education and the use of electronic clinical decision support tools are also reviewed throughout this literature review.

The Problem

In the United States (U.S.) alone, over two million people acquire antibiotic resistant infections with a mortality rate of 23,000 individuals per year (CDC, 2013). The single most crucial factor leading to antibiotic resistance is the inappropriate prescribing of antibiotics. Antimicrobial Resistance (AMR) continues to be problematic not only in the U.S., but globally as well. There is a consensus around the world that this is a growing health concern and one that needs immediate action. The World Health Organization (WHO) states "AMR is an increasingly serious threat to global public health that requires action across all government sectors and societies" (World Health Organization, 2018, para. 1). Resistant organisms are worldwide, with the threat of more resistant organisms ever increasing.

The prevalence of extended spectrum beta-lactamases (ESBL) producing bacteria increased from 0.28 percent in 1999 to 0.92 in 2011 (Logan, Braykov, Weinstein, & Laxminarayan, 2014). It was found that slightly more than half of the isolates of ESBL-producing bacteria were found in those 1-5 years old, and 74% of these bacteria were resistant to multiple classes of antibiotics. The pediatric population play a large role in hosting antibiotic resistant bacteria. Rising rates of resistant infections are causing longer hospitalizations for children in the U.S. and cause a higher risk of death for these children (Meropol, Haupt & Debanne, 2017). The study also states that three out of five children admitted to hospitals already have an antibiotic-resistant infection, which suggests that these infections are spreading within communities.

Antibiotic-resistant *Acinetobacter baumannii* infections is one of the most common hospital-acquired infections in children across the United States (Logan et al., 2018). The rate of these infections is on the rise. A recent study by Logan et al., 2018 show that the number of cephalosporin resistant *A baumannii* increased from 13.2 percent of infections in 1999 to 23.4 percent in 2012, whereas the number of carbapenem resistant *A. baumannii* increased from 0.6 percent in 1999 to 6.1 percent in 2012. Acinetobacter are a type of bacteria that are known to cause serious infections and are difficult to treat because of growing antibiotic resistance. Children with compromised immune systems and chronic conditions are especially susceptible to these types of infections.

Cost

AMR not only has an impact on health, morbidity, and mortality; it also overburdens the U.S. health care system. Studies have estimated that in the U.S alone, AMR "adds $20 billion in excess direct healthcare costs, with additional costs to the society for lost productivity as high as $35 billion a year" (CDC, 2013, para. 4). In 2009, approximately $10.7 billion was spent on antibiotic therapy in the United States alone, including $6.5 billion in the outpatient setting, $3.6 billion in inpatient acute care, and $526.7 million in the long-term care settings (Suda et al., 2013). Infectious Disease Society states that "Treating resistant infections costs the U.S. health care system an estimated $21 billion to $34 billion annually" (IDSA, 2018 para. 2).

The economic burden these infections have on society is high and increasing every day. Antibiotic resistance adds nearly $1,400 to the medical bill when treating bacterial infections (Thorpe, Joski & Johnston, 2018). Bacterial infections that are antibiotic resistant has more than doubled over 13 years, rising from 5.2% in 2002 to 11% in 2014. The overall cost of these infections was 165% higher for patients with resistant bacteria than those with non-resistant infections. These costs are projected to increase significantly worldwide.

Olusoji et al. (2017) examined the economic and development consequences of AMR using the World Bank Group economic simulation tools to see how AMR will impact the economy in the future. The researchers were able to estimate what the global economic impact of AMR would be from 2017 to 2050. With an optimistically low rate of growth of AMR, the "simulated losses of world output exceed $1 trillion annually after 2030 and reach $2 trillion annually by 2050" (Olusoji et al., 2017, p. 18). On the other hand, if the rate of growth of AMR was high, “the absolute levels are three times as high, reaching $3.4 trillion annually by 2030 and rising further annually to $6.1 trillion annually by 2050” (Olusoji et al., 2017, p. 19). These costs are extremely high and indicate that putting resources into reducing AMR now is the best investment a country can make in helping to decrease costs.

Morbidity/Mortality

Not only are the financial costs enormous, but so is the impact of antimicrobial resistance on morbidity and mortality from these infections. It is estimated that by 2050 there will be 317,000 deaths yearly in the U.S. related to AMR (King, 2014). Deaths are even higher in other continents such as Africa and Asia where they are estimated to be over 4 million in each continent. Currently, there are an estimated 23,000 individual deaths per year related to antimicrobial resistance (CDC, 2013).

Children receive a lot of primary care health services and because of this they receive a disproportionately high number of antibiotics compared to the middle-aged population (Ready et al., 2004). Antibiotics alone are the most common cause of adverse drug events implicated in emergency department visits among children aged 5 years or younger, with 32% of adverse drug events in children and adolescents aged 6 to 19 being caused by antibiotics (Shehab et al., 2016).

From 2011 to 2015, there were an estimated 69,464 emergency department (ED) annual visits for adverse drug events caused by antibiotics by children younger than 19 years old and younger (Lovegrove, et al., 2018). The majority of these visits (86%) involved an allergic reaction, mainly mild rashes or itchy skin, but also included life threatening reactions such as anaphylaxis or angioedema. More than 95% of these visits to the ED involved the patients being on a single oral antibiotic. The researchers found that the risk for adverse drug event was higher for younger children. The researchers in these studies suggest that a way to prevent these reactions is to avoid prescribing antibiotics unnecessarily.

Inappropriate Antimicrobial Use

In an adult based study conducted by Fleming-Dutra et al. (2016) it was shown that in the U.S. between 2010 and 2011, there was an annual antibiotic prescription rate of 506 per 1000 patient visits, but only an estimated 353 of these antibiotics were likely appropriate. Sinusitis was the diagnosis associated with the most antibiotic prescriptions, followed by otitis media and pharyngitis (Fleming-Dutra et al., 2016). Only 50% of the antibiotic prescriptions for these conditions were appropriately prescribed. Fleming-Dutra et al. (2018) again looked at antibiotic prescribing rates in the pediatric population specifically, finding that in 2013, 66.8 million antibiotics were prescribed to the U.S. children ≤ 19 years of age; amoxicillin and azithromycin being the two most commonly prescribed antibiotics. Pediatricians prescribed the most antibiotics, followed then by family practitioners who were more likely to prescribe azithromycin in all age groups (Fleming-Dutra et al., 2018). These findings correlate with a study published by Hicks et al. (2015) who reported that penicillins were the most commonly prescribed antibiotic class, and azithromycin was the most commonly prescribed antibiotic. Fleming-Dutra et al. (2018) suggested that public health interventions should focus on improving antibiotic selection in the pediatric population.

Children with upper respiratory tract infections are often prescribed broad-spectrum antibiotics, which leads to the emergence of resistant bacteria (Alzahrani, Maneno, Daftary, Wingate, & Ettienne, 2018). Alzahrani et al. (2018) found that 39% of the children were prescribed a broad-spectrum antibiotic. These prescriptions accounted for an estimated 6.8 million visits annually. The two diagnoses attributing to the greater odds of a broad-spectrum antibiotic prescription were acute sinusitis and acute otitis media.

The problem of over-prescribing antibiotics is multi-factorial; one of the most important contributors is the providers' concerns to meet a perceived patient expectation. Fletcher-Lartey et al. (2016) reported that 57% of general providers would often prescribe an antibiotic for an upper respiratory tract infection (known to be of viral origin by the provider) only to meet patient expectations. Other possible contributors to overprescribing may be the fear about whether the infection may be bacterial and missed (Teepe et al., 2016), the ease of antibiotic prescribing and the time-consuming process of discussion regarding a viral process and not needing an antibiotic prescription.

Possible Solutions

Provider Based Education

One approach to solving the issue of the over prescribing of antibiotics is provider-based education. A study conducted by Al-Twafiq and Alawami (2017) examined a multifaceted approach to decrease inappropriate antibiotic use in upper respiratory tract infections in outpatient pediatric clinics. Interventions included educational grand rounds, academic training in small rounds and with individuals, audits, feedback, and peer comparisons (Al-Tawfiq & Alawami, 2017). The authors were able to show an improvement in antibiotic use with a decrease in inappropriate antibiotic prescriptions from 12 % to 4% using the above educational approaches (Al-Tawfiq & Alawami, 2017, para. 3).

Link et al. (2016) conducted a quality improvement project in a central North Carolina urgent care, to determine whether education would improve providers' inappropriate antibiotic prescriptions for healthy adults with uncomplicated acute bronchitis. Twenty providers attended at least one of the four training sessions offered, which included face-to-face interactive training that focused on factors associated with inappropriate prescribing, the current clinical guidelines, and patient communication (Link et al., 2016). A retrospective chart review of the 217 pre-testing encounters and 335 post-training encounters by 19 providers demonstrated a 62% reduction in inappropriate antibiotic prescribing (Link et al., 2016).

Electronic Clinical Decision Support Tools (ECDST)

Decision support tools can have a significant impact on provider prescribing as seen in a study by McCullough et al. (2014) who evaluated the antibiotic prescribing rates for acute bronchitis and upper respiratory infections in the National Ambulatory Medical Care Survey data from 2006 to 2010. The use of decision support rose from 16% in 2006 to 50% in 2010, with the use of a decision support tool being associated with a 19% lower likelihood of providing an antibiotic prescription.

Panesar et al. (2016) assessed the attitudes and behaviors of prescribers after replacing a paper based antimicrobial prescribing guide with a smartphone app, a form of ECDST, using two structured cross-sectional questionnaires. The researchers found that the smartphone app was used more frequently, was found useful, and allowed users to challenge their peers' inappropriate antimicrobial prescribing (Panesar, et al., 2016).

ECDST can be an effective format to deliver guidance on antimicrobial prescribing and support antimicrobial stewardship efforts.

Charani et al. (2017) evaluated a similar ECDST for antibiotic prescribing by adding a mobile health app to an established antimicrobial stewardship program (ASP). The researchers used a segmented regression analysis to assess the impact of the apps prescribing indicators. They found that there was an increase in compliance with policy (such as empirical therapy and expert advice) in both medical and surgical units when the app was used (Charani, et al., 2017, p. 1825).

Similarly, Fralick et al. (2017) evaluated whether a smartphone app with local bacterial resistance patterns (antibiogram) and treatment guidelines could improve medical trainees' knowledge for prescribing antimicrobials. They found a significant change in knowledge for participants who used the app compared to the control group. Most students found the app easy to navigate, and useful, and about 25% continued to use it daily. Findings from these studies reinforce the idea that ECDST can be a useful innovative way to deliver antimicrobial education to providers.

Summary

Antibiotic use around the world has increased, and so has the increase in antimicrobial resistance. The pediatric population is a key group that should be focused on to help reduce this issue. Antibiotics are continuously prescribed inappropriately, often without indication. The medications can be harmful in the short-term but can also cause antibiotic resistance in the long-term. Resistant bacteria are continuously becoming more prevalent in our communities, with children being hosts to the bacteria. The focus should be on treating infections appropriately with evidence based clinical guidelines. ECDST has been shown as a useful way to deliver education and increase awareness of treatment guidelines.

Chapter III

Methods

Antibiotic resistance is a threat to every individual person, with the problem increasing every day. The problem increases when providers prescribe antimicrobials when there is no clinical indication for their use. Antimicrobial resistant infections are life threatening with a significant amount of deaths occurring worldwide every year because of them. With the ECDST, it was the researcher's goal to provide an easily usable tool to help providers in choosing the appropriate treatment for common infections seen in the pediatric population to decrease the use of inappropriate antibiotic prescriptions.

Project Design

This scholarly project was a descriptive vignette-based study to evaluate the effect of ECDST on antibiotic prescribing practices for providers seeing pediatric patients presenting with common infectious etiologies in outpatient rural health clinics. Participants completed two different case scenarios using the ECDST as well as completing usability assessments and assessments of cognitive effort when choosing antibiotics for patients in the clinical scenarios.

Participants completed a pre-survey asking about their prior exposure and familiarity with ECDST. Demographic information was collected including: the participants' gender, age range, provider type, and percentage of pediatric patients seen weekly. During each case scenario participants used a computerized PowerPoint equipped with easy to navigate interactive information from the American Association of Pediatrics (AAP) or the Infectious Disease Society of America (IDSA) guidelines for treating infectious diagnoses commonly encountered in the outpatient settings.

After completion of the case studies, participants completed two standardized surveys: one to assess the usability of the application (the System Usability Scale), and the other to assess subjective mental workload using the NASA Task Load Index (Hart & Staveland, 1988). A comment section was also be provided for participants to provide feedback on the ECDST, and a question about the likelihood of using this ECDST in their practice. The SUS and NASA Task Load Index creators did not require permission for their forms to be duplicated.

Target Population

Attempts were made to enroll a minimum of 10 practitioners who worked at Community Health Center of Southeast Kansas (CHC SEK). The CHC SEK includes providers with varied training backgrounds including Family Physicians, Pediatricians, Physician Assistants and Family Nurse Practitioners. Inclusion criteria included all providers working with pediatric patients, employed at CHC SEK at any of their practice locations. Exclusion criteria included any providers who do not work with pediatric patients and providers who are not Family Physicians, Pediatricians, Physician Assistants, and Family Nurse Practitioners who work at one of the CHC SEK clinics. The researcher recruited participants based on information provided by clinical administration at CHC SEK. The researcher approached the clinic administration for permission to contact eligible providers.

The researcher approached the participants at the CHC of SEK during regular business hours. Additional attempts were be made by email with providers and requested their voluntary participation. The researcher met with each participant individually when they were available throughout the day and strove to accommodate each participant's schedule. The researcher did not keep any identifying information including emails or phone numbers, which were deleted after each contact.

Protection of Human Subjects

Prior to enrolling participants in this study, an Application for Approval of Investigations was submitted to Pittsburg State University's (PSU) Institutional Review Board (IRB). An Exemption for Research Involving Human Subjects Criteria Form was obtained allowing for the project to be exempt from review by the entire Committee for the Protection of Human Research Subjects (CPHRS). The research project was submitted under exemption status because the research was on individual perceptions using a survey without the information being obtained and recorded in such a manner that human subjects could be identified, directly or through identifiers linked to the subjects, or any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation. The benefits of the present study were that the providers will be educated on an ECDST to help choose a treatment for common infections seen in the pediatric population. After IRB approval from PSU was obtained, a

Statement of Mutual Agreement with CHC SEK was also obtained before enrolling participants.

ECDST Development

The ECDST for this study was an interactive PowerPoint created using Microsoft PowerPoint® by the author using the AAP and IDSA evidence based clinical guidelines for diagnosis and management of common pediatric infections. Guidelines for otitis media, sinusitis, pharyngitis, uncomplicated community acquired pneumonia (CAP), urinary tract infections (UTI) and skin and soft tissue infections were included within the slides. Questions regarding each disease process were incorporated into each slide, with the corresponding answer linking the participant to the next slide based on the answer they chose. Based on the answers to each question, participants were guided to the different treatment options for each diagnosis. A "home" button and "back" button were also incorporated to allow for users to navigate to the beginning slide or the previous slide.

Instruments

The study used two different case scenarios involving fictional pediatric patients with common infections seen in outpatient clinics. Each case scenario asked questions that the participants answered using the ECDST. Each participant answered each question on a printed case study. The researcher graded each case against the answer key for each scenario.

At the completion of the cases, participants were asked to perform a survey regarding usability and mental workload of the ECDST. The usability of the ECDST was assessed using the System Usability Scale (SUS) (Brooke, 1986). The SUS is a ten-question Likert scale that quantifies the subjective assessment of usability. Each item on the SUS has a value from one to five based on their level of agreement with the question. When finding the SUS score, each odd number question is subtracted by one and on the even number questions the number five is subtracted from each questions value. The new values were added together for the total and then multiplied by 2.5. Each score is out of a total of 100 points. If the total score is 80.3 or higher, it is considered a good score with a total score of less than 51.0 considered a poor score.

The mental workload of the ECDST was evaluated using the NASA Task Load Index (NASA TLX) (Hart & Staveland, 1988). The NASA TLX is a tool used for measuring and conducting subjective mental workload. The tool determines the mental work load for each participant based on six dimensions. The six dimensions include: mental demand, physical demand, temporal demand, effort, performance, and frustration level. Each participant was asked to rate their score on an interval rating from low (1) to high (21).

Procedure

An Application for Approval of Investigations was submitted in October 2018 to PSU's IRB along with an Exemption for Research Involving Human Subjects Criteria Form allowing for the project to be exempt from review by the CPHRS. After IRB approval was obtained, a Statement of Mutual Agreement with CHC SEK was al obtained. Recruitment of participants and collection of data occurred in December 2018. The evaluation of the results from the data collected occurred in February, with the edits and discussion occurring in March and April of 2019. The project was completed in May of 2019.

The resources needed to complete this project included computer access, no personnel except the researcher, and no financing. Marketing analysis, strategic analysis and products/services were not needed to complete the project. Subjects were identified from a list provided by administration at CHC SEK. Providers including Family Physicians, Pediatricians, Physician Assistants and Family Nurse Practitioners who see pediatric patients were approached by the researcher either in person, by email, or phone.

Once participants were identified, each participant was assigned an individual research identifier that did not contain any personal identifying information. Informed consent for each participant was obtained. Prior to beginning each simulation, each participant completed a pre-survey. The participants then completed two tests with simulated case scenarios each using the ECDST. A computer with the ECDST was provided for the participant. After completing the two clinical scenarios, each participant was asked to complete the SUS, NASA TLX assessments, and a post-test survey. All data, results, and information collected from the study were uploaded to a password protected computer maintained securely for two years by the lead researcher.

Treatment of Data and Evaluation Plan

The potential role of the ECDST for optimizing antibiotic prescribing practices in rural clinical practice along with the usability and acceptability was evaluated using feedback from each participant after completing the clinical scenarios, post survey, SUS, and NASA-TLX. The primary hypothesis that providers would find that the ECDST requires a low mental demand and has a high usability value along with the aim that providers would more often choose the correct diagnosis and related treatment when using the ECDST was evaluated using the data collected from each individual participant.

After the collection of data, the process of data analysis began. The two case scenario scores were calculated based on the answers that the participants provided for the each scenario. There were three questions for each scenario for a total of six questions. The scores were calculated for each case study as a percentage out of a high score of one hundred percent. It was elected to include median and interquartile range in the data analysis because of the small sample size. The pre and post-survey answers were analyzed with the total of each answer calculated and represented graphically. The SUS scores were analyzed with each odd number question subtracted by one and with the even number questions the number five is subtracted from each questions value. The new values were added together for the total and then multiplied by 2.5. Each score is out of a total of 100 points. The overall rating combined from each participant score from the six categories and the total weighted score will be graphically represented.

There is currently no plan for sustainability.

Summary

Throughout this section, there was a discussion of the population to be studied, procedure for data collection, development of the ECDST and its implications for data analysis. By obtaining the SUS and NASA TLX scores, the mental demand and usability of the ECDST were evaluated. The case study scores data were used to analyze whether or not the ECDST will allow for providers to choose the right diagnosis and treatment options for common pediatric infectious diseases in rural outpatient health clinics.

Chapter IV

Evaluation Results

Introduction

The purpose of this project was to determine the potential role of an ECDST for optimizing antibiotic prescribing practices in rural clinical practice. The specific aim was to evaluate the usability and acceptability of an ECDST for antibiotic prescribing in pediatric patients in outpatient rural health clinics. The exploratory aim was to assess the impact of ECDST use on antibiotic prescribing practices among healthcare providers who use the tool. The primary hypothesis was that providers would find that the ECDST requires a low mental demand and has a high usability value. Based on the exploratory aim, it was hypothesized that providers would more often choose the correct diagnosis and related treatment when using the ECDST.

Description of Population

The data for this study was collected throughout the month of December 2018. Ten providers participated in the data collection process. All providers were CHC SEK employees. Of the ten participants 70% identified themselves as female (n=7) and 30% identified themselves as male. Fifty percent of the participants were between the ages of 30-39, 40% were between the ages of 40-49 and 10% were between the ages of 50-59, (Table 1).

Although the study set out to include a range of providers including Family Nurse Practitioners, Family Physicians, Physician Assistants and Pediatricians; the providers who participated included Family Nurse Practitioners (n=7), Physician Assistants (n=2) and one Pediatrician (n=1), (Table 1).

Table 1

Demographics

Items	Frequency (%)
Gender	
Female	7 (70)
Male	3 (30)
Age	
30-39	5 (50)
40-49	4 (40)
50-59	1 (10)
Provider Type	
Family Nurse Practitioner	7 (70)
Pediatrician	1 (10)
Physician Assistant	2 (20)

The percent of pediatric patients seen by each provider weekly varied. The majority (50%) of the participants see an average of 50% pediatric cases weekly, while four providers see 25% pediatric patients weekly and one provider only sees pediatric patients in their practice (Figure 1).

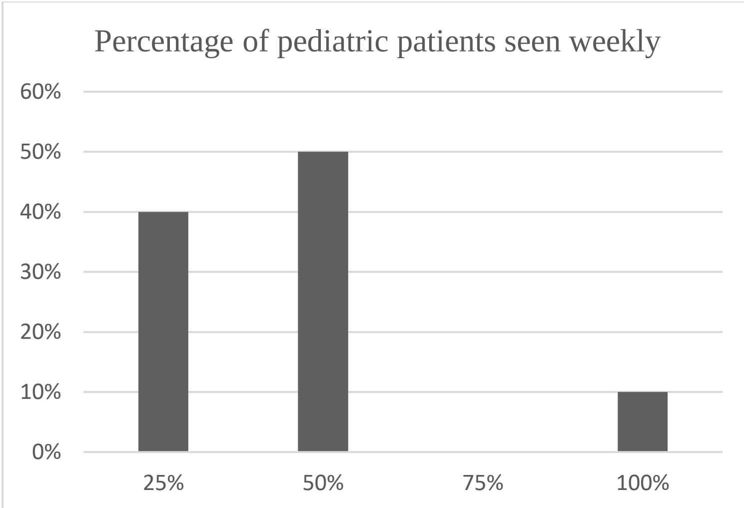

Figure 1. Pre-Survey: Percentage of Pediatric Patients Seen Weekly

Statistical Analyses

To gather additional data on electronic clinical decision support tools in general and assess the participants prior knowledge about these tools, the participants completed a pre-survey (Appendix A) before conducting the case studies using the researcher's developed ECDST. The first question addressed the participants comfort level with using electronic clinical decision support tools using a scale from one to five, five being very comfortable and one being uncomfortable. The participants chose the number four 50% of the time, five 40% (n=4) and three 10% (n=1) of the time (Figure 2).

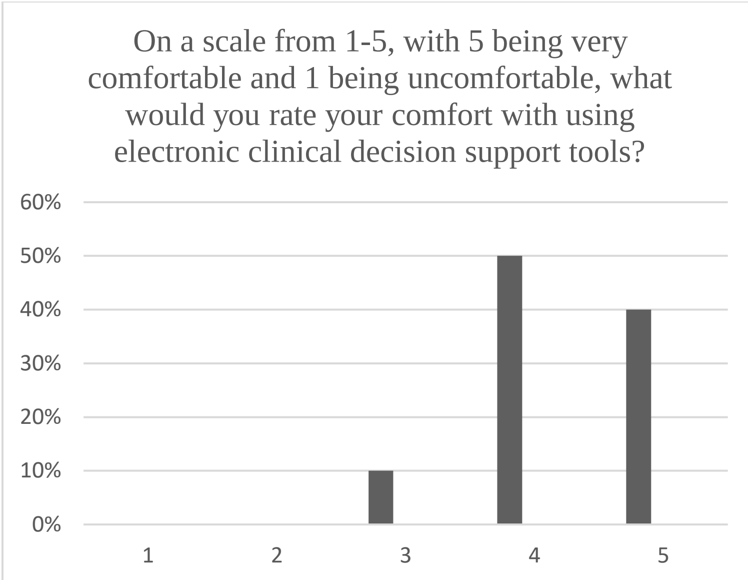

Figure 2. Pre-Survey: Question 1

Participants were asked how often they use their computer, phone, or tablet in practice to help with clinical decision, to look up information, to look up dosing of medication, etc. (other than use of calculator or to chart). All (n=10) of the participants said that they used their electronic devices "multiple times a day" to help with clinical decisions. To look for diagnosis and treatment options, 100% (n=10) of the participants use UpToDate, 30% (n=3) use text books, 30% (n=3) wrote that they use Epocrates and one participant uses YouTube as a source of information. (Appendix A) (Figure 3).

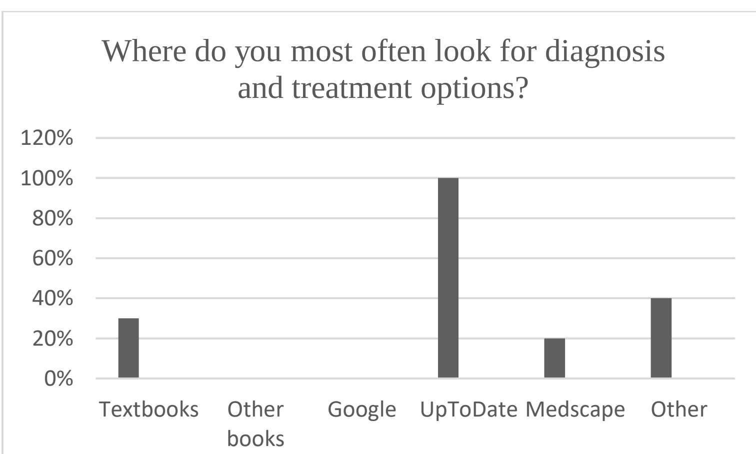

Figure 3. Pre-Survey: Question 4

To assess the participant's willingness to adopt an ECDST in their practice, the researcher asked what the reasons were that the participants would use an electronic clinical decision support system (Appendix A). The majority (90%) of participants chose that they would use an electronic support tool because it's easy to find information and it uses clinical practice guidelines (Figure 3). Other reasons included presentation, decreasing chance of medical error, improves quality of patient care, and one participant wrote in "timely" as a reason they would use an electronic support tool in their job (Figure 4).

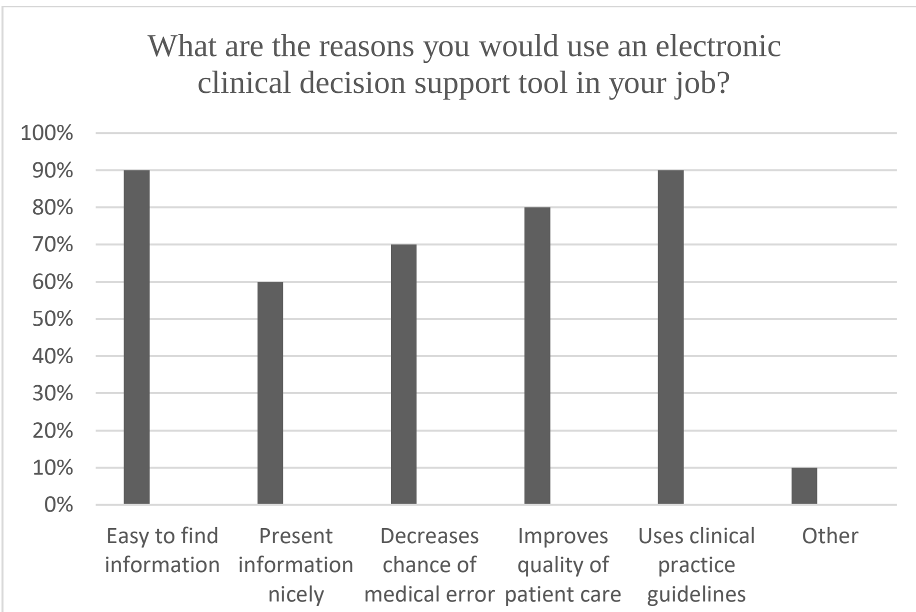

Figure 4. Pre-Survey: Question 5

To assess for possible obstacles in implementing an ECDST in rural outpatient health care clinics, the researcher asked what the reasons are the participants would not use an ECDST in their job (Appendix A). Over half (60%) of the participants chose lack of time/time constraint as a reason they would not use an ECDST in their job. Other reasons included competing clinical demands (20%), interference in work flow (10%), poor system design (20%), lack of computer/phone skills (10%) and do not want to use in front of patients (10%) (Figure 5).

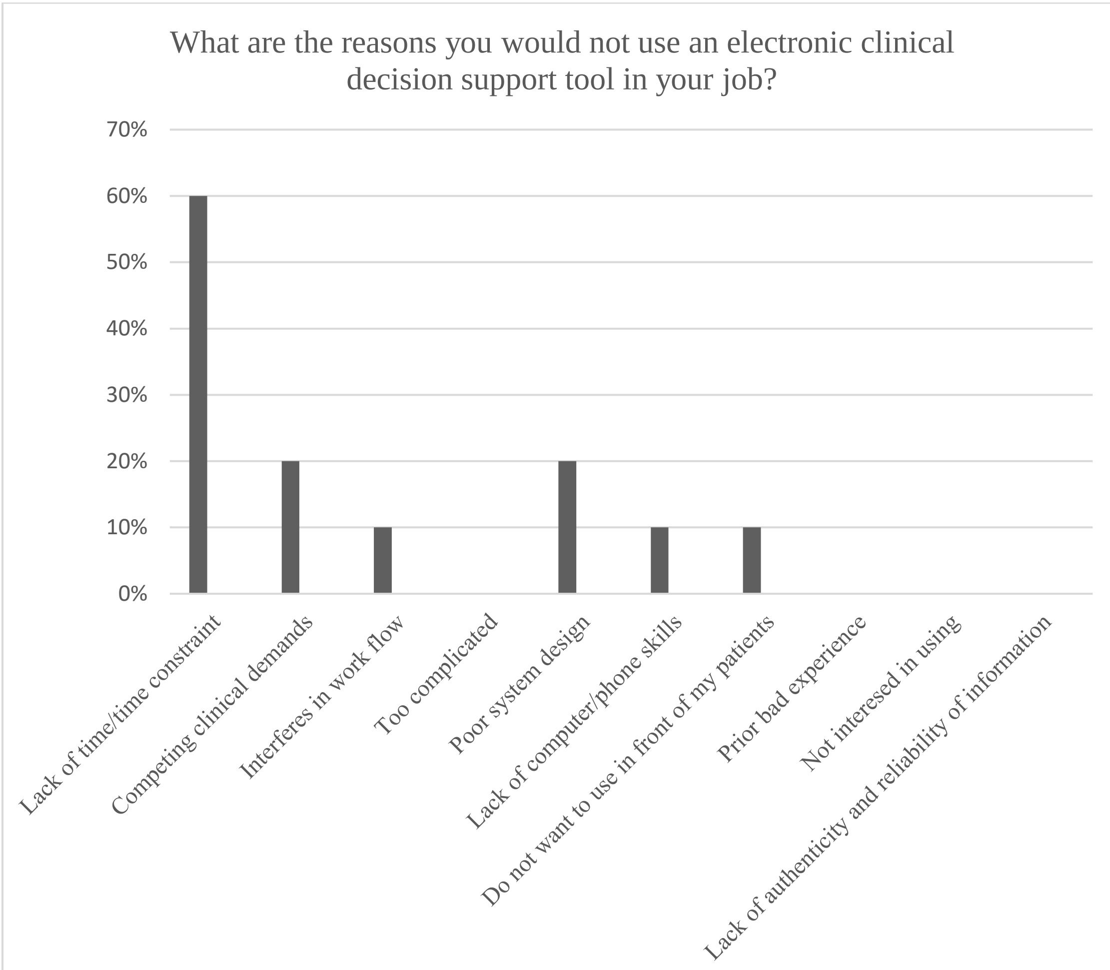

Figure 5. Pre-Survey: Question 6

Analysis of Hypotheses

The primary purpose of this study was to determine the potential role of an ECDST for optimizing antibiotic prescribing practices in rural clinical practice. The researcher asked each participant to complete two case studies while using the developed ECDST. The first case study (Appendix B) asked three questions about the diagnosis and treatment for a pediatric patient with acute otitis media. The median total score for case study number one was 83% with an Interquartile range (IQR) of 59% (Table 2). The second case study (Appendix D) asked three questions about the diagnosis and management for a pediatric patient with acute bacterial rhinosinusitis. The median total score for this case study was 100% with an IQR of 34%. The hypothesis that the participants would choose the correct diagnosis and treatment options the majority of the time while using the ECDST was met.

Table 2

Case Study Results

	Mean	SD	Median	Q1	Q2	IQR
Case Study 1	73%	31%	83%	41%	100%	59%
Case Study 2	77%	35%	100%	66%	100%	34%

The primary hypothesis was that providers would find that the ECDST requires a low mental demand and has a high usability value. The usability of the study was determined by analyzing the System Usability Scale (SUS) scores for each participant. See Appendix D for the System Usability Scale used in the data collection process. The median SUS score for all participants was 93.75 with an IQR of 12.5 meaning that the ECDST has a high usability value based on the participants overall rating of the system. Using the NASA-TLX rating scale the participants rated their experience using the ECDST on mental demand, physical demand, temporal demand, performance, effort and frustration (Appendix E). The scale is numbered from one to 21, with 1-4 being very low and 18-21 being very high or requiring more demand. The median score for mental demand was 2 (IQR 6.75). The median scores for physical demands, temporal demand, performance, effort and frustration were all in the very low category as represented in

Table 3. This indicates that participants found the ECDT tool to be very convenient and easy to use making their task manageable with very little stress.

Table 3

NASA-TLX Results

	Mean	SD	Median	Q1	Q2	IQR
Mental Demand	4.5	4.28	2	1	7.75	6.75
Physical Demand	1.3	0.67	1	1	1	0
Temporal Demand	1.9	1.45	1	1	2	1
Performance	1.3	0.48	1	1	1.75	0.75
Effort	1.5	0.97	1	1	1.75	0.75
Frustration	2.8	3.16	1	1	1.75	0.75

After each participant completed the case studies, they completed a post survey (Appendix F). When asked "Did the electronic clinical decision support tool change the way you diagnosed the patient?" 100% (n=10) of the participants did not find that the tool changed the way they diagnosed the patient; however, when asked "did the electronic clinical decision support tool change the way you treated the patient?" Sixty percent of the participants said that yes it did change the way they treated the patient. (Figure 6).

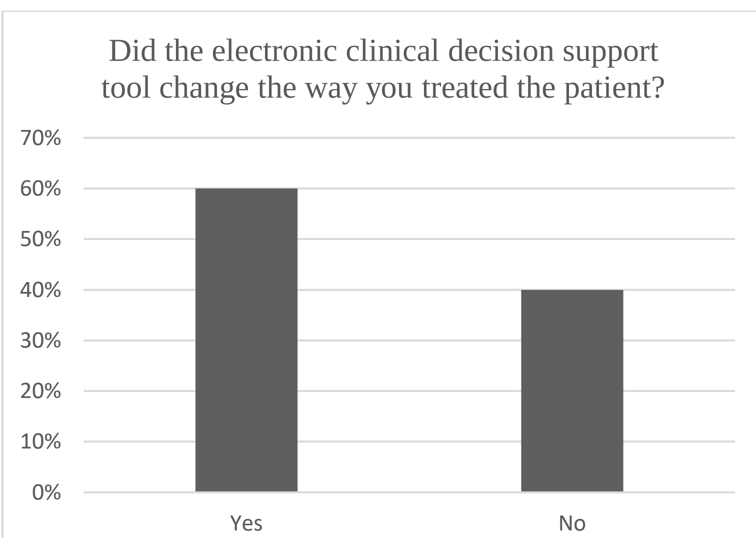

Figure 6. Post Survey Question 2

The post survey also asked, "Would you consider using this ECDST in your future practice?" This question helped to assess the acceptability of the ECDST. The vast majority (90%) of the participants said that they would consider using this tool in their future practice. One participant commented "Nice Job! Very easy and would use!"

Summary

The purpose of this project was to determine the potential role of an ECDST for optimizing antibiotic prescribing practices in rural clinical practice. The specific aim was to evaluate the usability and acceptability of an ECDST for antibiotic prescribing in pediatric patients in outpatient rural health clinics. It was found that the ECDST implemented in this study has a high usability value, requires a low mental demand and was generally accepted by the providers who used it. The providers who participated included Family Nurse Practitioners, Physician Assistants, and a Pediatrician, with the majority of the providers seeing pediatric patients as 50% of their practice. The majority of participants were female between the ages of 30-39 years old. The providers use established ECDST tools in their practice such as UpToDate and Epocrates. It was found that the participants use these tools multiple times a day because the information is easy to find, and the ECDST's use clinical practice guidelines. The major obstacle to using electronic support tools was found to be lack of time/time constraint.

Chapter V

Discussion

Relationship of Outcomes to Research

The overall purpose of this study was to determine the usability and acceptability of an ECDST designed to optimize antibiotic selection for pediatric patients in outpatient rural healthcare clinics. It was discovered through this project that the antibiotic prescribing ECDST has a high usability based on the data received from the ten participants. The usability score of the ECDST was high (93.75) based on the SUS scale used to measure it. The ECDST was accepted by the participants, with 90% of the providers saying they would consider using the tool in their practice. The simulated case studies used to assess the impact of the ECDST on the diagnosis and treatment of acute otitis media and acute bacterial rhinosinusitis showed that the ECDST helped the providers choose the correct diagnosis and treatment option over 70% of the time. Over half of the participants (60%) said that the ECDST changed the way the treated the simulated patient. This information shows that with the ECDST, antibiotic prescribing was optimized for the infectious diagnosis and the correct treatment was initiated based on evidence-based practice guidelines.

Observations

The primary hypothesis that providers would find that the ECDST was usable correlates with earlier findings from Fralick et al. (2017) who found that their smartphone app with local antibiograms and appropriate treatment option was useful and easy to navigate and Panesar et al. (2016) who found that their ECDST was also useful. The providers who used the ECDST in this project accepted this tool and said they would use it in their clinical practice. These finding correlate with previous studies who found that ECDST's could be incorporated into clinical practice (Fralick et al., 2017; Panesar et al. 2016., Charani et al., 2017; McCullough et al., 2014). It was also observed during this project that the providers chose the correct treatment option for the diagnosis over 70% of the time. These findings correlate with McCullough et al. (2014) who observed that an ECDST can have a significant impact on providers prescribing. During this project it was also found that 60% of the providers changed the way they prescribed an antibiotic because of the ECDST. McCullough et al. (2014) also saw a change in prescribing patterns with their ECDST which was associated with a 19% lower likelihood of providing an antibiotic prescription.

Throughout the data collection process it was observed that time constraint plays an important role in using ECDSTs in the clinical setting. The data for this project was collected during normal business hours while the participants were in the clinical setting. It was observed by the researcher that the participants were often busy with competing demands of their time and were often hurried to complete the tasks because of these time constraints. This observation correlates with the data that 60% of the participants say that lack of time/time constraints play a big role in not using ECDST's in their practice. It was also observed by the researcher that some of the participants chose treatment options on the case studies that were not an option on the ECDST. This observation shows that even with the available resources, inappropriate antibiotic selection and other treatment options can still be made.

Limitations

The biggest limitation for this project is the sample size. With the sample size of only ten participants, potential error or bias may exist. There were a disproportionally higher number of family nurse practitioners (70%) who completed this study, with 50% of the participants seeing pediatric patients as only half of their patient population. There were also significantly more female participants compared to males who completed the study. The study also failed to include family physicians in the data collection process. There was also a time constraint of only one month available to collect data during the data collection process that may have hindered the available sample size.

Evaluation of Theoretical Framework

The theoretical framework used in this project was Lawrence Kohlberg's theory of moral development. The theory of moral development framework was used to support and reinforce the provider's mission to improve overall care and promote accurate knowledge to improve outcomes by incorporating evidence into practice. With the use of evidence-based practice guidelines that are available in the ECDST, providers were able to choose the correct antibiotic treatment for the pediatric illness most of the time. The ECDST promotes knowledge and helps the provider choose appropriate treatment for the diagnosis, which improves the overall care they give their patient. More information regarding the use of the ECDST and the providers moral development needs to be gathered in future research.

Evaluation of Logic Model

The logic model used for this project correlates well with the research findings. The logic model began with inputs including literature review, evidence-based practice guidelines and development of an ECDST. The literature review was appropriate but could have included more information about ECDSTs and their impact on antibiotic prescribing. Outputs included activities and participation from the providers. The sample size for this project was ten providers. The participation was lacking and could have been increased by allowing more time for data collection. The short-term goals in the logic model were that providers would become aware of the issue of antibiotic resistance, find the ECDST usable and motivate providers to use the ECDST to prescribe antibiotics appropriatley. These short-term goals were not all met. The problem of antibiotic resistance was not fully discussed with the participants, and motivation to change the way the providers prescribed antibiotics was not assessed. Other outcomes include behavior changes and eventual policy and practice changes in the clinical setting. This project did not address these future outcomes.

Implications for Future Projects and Research

Future research could include using this ECDST in other rural healthcare settings with a larger provider population. Using the same methods used in this project with a larger sample size, the impact of the ECDST can be further evaluated. The ECDST also has guidelines for antibiotic selection for skin and soft tissue infections, pharyngitis, urinary tract infections, and uncomplicated community acquired pneumonia, which could also be used in future projects. A quality improvement project could also be developed to see if using the ECDST in the clinical setting impacts the way providers diagnose and prescribe for common pediatric infections in rural healthcare settings. The ECDST could be incorporated into an existing outpatient Antimicrobial Stewardship Program (ASP) or be a tool that is used in creating a new ASP in an outpatient rural health care clinic. The CDC's CARB goal is to reduce inappropriate antibiotic prescribing by 50% by 2020 (CDC, 2017a). Future projects using this ECDST could look at the impact the tool has on changing the percentage of inappropraite prescribing for certain disease processes that are included in the ECDST. The design of this project could be improved upon for future projects. More educational offerings on appropriate prescribing and its impact on antibiotic resistance needs to be completed with the providers to help them understand the role the ECDST can have on this issue.

Implications for Practice

The ECDST is designed to be a usable and easy tool for providers to use to diagnose and treat common pediatric infections in the outpatient setting. It was found that it has a high usability value and was accepted by the providers that used it. It can easily be integrated into the clinical practice setting to optimize antibiotic selection for pediatric infections. ECDST's were already widely used by all the participants in their everyday practice. It is suggested that providers integrate the developed ECDST into their current clinical practice to optimize antibiotic selection and reduce inappropriate prescribing. Advanced Practice Registered Nurses (APRNs) should continue to grow their knowledge about appropriate antibiotic prescribing and use current practice guidelines when treating their patients. This ECDST uses these practice guidelines and makes it easy for providers to choose appropriate treatment. APRNs should incorporate these tools into their clinical practice to easily make these treatment decisions. The ECDST could also be incorporated into an educational institutes graduate programs as an educational tool for student APRNs to learn about diagnosing and treating common pediatric infections.

Conclusion

The overall purpose of this project was to determine the usability and acceptability of an ECDST designed to optimize antibiotic selection for pediatric patients in outpatient rural healthcare clinics. It was discovered the antibiotic prescribing ECDST has a high usability value, requires low mental demand, and was generally accepted by the providers who used it. The ECDST used in this project can easily be integrated into outpatient clinical settings to optimize antibiotic prescribing practices. With the use of clinical practice guidelines used in the ECDST providers can feel confident knowing that they're treating their patient's safety and doing their part to combat antimicrobial resistance.

.

References

Al-Tawfiq, J.A., & Alawami, A.H. (2017). A multifaceted approach to decrease inappropriate antibiotic use in pediatric outpatient clinic. *Annal of Thoracic Medicine, 12*(1), 51-54. doi: 10.4103/1817-11737.197779

Alzahrani, M.S., Maneno, M. K., Daftary, M. N., Wingate, L., & Ettienne, E.B. (2018). Factors associated with prescribing broad-spectrum antibiotics for children with upper respiratory tract infections in ambulatory care settings. *Clinical Medicine Insights: Pediatrics, 12*, 1- 8. doi: 10.1177/1179556518784300

American Academy of Family Physicians (AAFP) (2017). Clinical practice guideline manual. Retrieved from: https://www.aafp.org/patient-care/clinical recommendations/cpg-manual.html

Antibiotic. (2017). Retrieved from: https://www.merriamwebster.com/dictionary/antibiotic

Brooke, J. (1986). *SUS-A quick and dirty usability scale*. United Kingdom: Redhatch Consulting Ltd.

Centers for Disease Control and Prevention. (2013, September 16). *Untreatable: Report by CDC details today's drug-resistant health threats*. Retrieved from: https://www.cdc.gov/media/releases/2013/p0916-untreatable.html

Centers for Disease Control and Prevention. (2017a, October 6). *Antibiotic Use in the United States, 2017: Progress and Opportunities*. Retrieved from Centers for Disease Control and Prevention: https://www.cdc.gov/antibiotic-use/stewardship-report/outpatient.html

Centers for Disease Control and Prevention. (2017b, June 12). *Antibiotic/Antimicrobial Resistance*. Retrieved from: https://www.cdc.gov/drugresistance/index.html

Charani, E., Gharbi, M., Moore, L., Castro-Sanchez, E., Lawson, W., Gilchrist, M., & Holmes, A. H. (2017, February 28). Effect of adding a mobile health intervention to a multimodal antimicrobial stewardship programme across three teaching hospitals: an interrupted times series study. *Journal of Antimicrobial Chemotherapy, 72*, 1825-1831. doi:10.1093/jac/dkx040

Fleming-Dutra, K.E., Demirjian, A., Bartoces, M., Roberts, R. M., Taylor Jr., T. H., & Hicks, L. A. (2018, January). Variations in antibiotic and azithromycin prescribing for children by geography and specialty-united States, 2013. *The Pediatric Infectious Disease Journal, 37*(1), 52-58. doi:10.1097/INF.0000000000001708

Fleming-Dutra, K. E., Hersh, A. L, Shapiro, D. J., Bartoces, M., Enns, E. A., File Jr, T, M.,… Hicks, Lauri A. (2016). Prevalence of inappropriate antibiotic prescriptions among US ambulatory care visits, 2010-2011. *JAMA, 315*(17), 1864-1873. doi:10.1001/jama.2016.415

Fralick, M., Haj, R., Hirpara, D., Wong, K., Muller, M., Matukas, L. M…Taggart, L. R. (2017, November 19). Can a smartphone app improve medical trainees' knowledge of antibiotics? *International Journal of Medical Education, 8*, 416-420. doi:10.5116/ijme.5a11.8422

Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. *Advances in Psychology, 52*, 139-

King, Anthony. (2014, December 16). *Antimicrobial resistance will kill 300 million by*

2050 without action. Retrieved from: https://www.chemistryworld.com/news/antimicrobial-resistance-will-kill-300-million-by-2050-without-action/8086.article

Imanpour, S., Nwaiwu, O., McMaughan, D. K., DeSalvo, B., & Bashir, A. (2017). Factors associated with antibiotic prescriptions for the viral origin diseases in office-based practices, 2006-2012. *Journal of the Royal Society of Medicine, 8*(8), 1-8. doi:10.1177/2054270417717668

Infectious Disease Society of America. (2018). *Antimicrobial Resistance*. Retrieved from Infectious Disease Society of America: https://www.idsociety.org/public-health/antimicrobial-resistance/antimicrobial-resistance/

Link, T. L., Townsend, M. L., Leung, E., Kommu, S., Vega, R.Y., & Hendrix, C. C. (2016). Reducing inappropriate antibiotic prescribing for adults with acute bronchitis in an urgent care setting: A quality improvement initiative. *Advanced Emergency Nursing Journal, 38*(4), 327-335.

Logan, L. K., Braykov, N. P., Weinstein, R. A., & Laxminarayan, R. (2014). Extended-spectrum beta-lactamase-producing and third-generation cephalosporin-resistant Enterobacteriaceae in children: trends in the United States, 1999-2011. *Journal of the Pediatric Infectious Diseases Society*, 3(4), 320-328. doi:10.1093/jpids/piu010

Logan, L. K., Gandra, S., Trett, A., Weinstein, R. A., & Laxminarayan, R. (2018). *Aceinetobacter baumannii* Resistance Trends in Children in the United States, 199-2012. *Journal of the Pediatric Infectious Disease Society, piy018*. doi: https://doi.org/10.1093/jpids/piy018

Lovegrove, M. C., Geller, A. I., Fleming-Dutra, K. E., Shehab, N., Sapiano, M. R., & Budnitz, D. S. (2018). US emergency department visits for adverse drug events from antibiotics in children, 2011-2015. *Journal of the Pediatric Infectious Diseases Society*, 1-8. doi: https://doi.org/10.1093/jpids/piy066

McCullough, J.M., Zimmerman, F. J., Rodriguez, H. P., Bell, D. S., & Torrens, P. R., (2014). Impact of clinical decision support on receipt of antibiotic prescriptions for acute bronchitis and upper respiratory tract infection. *Journal of the American Medical Informatics Association, 21*, 1091-1097. doi:10.1136/amiajnl-2014-002648

Meropol, S. B., Haupt, A. A., & Debanne, S. M. (2017). Incidence and outcomes of infections caused by multi-drug-resistant *Enterobacteriaceae* in children, 2007-2015. *Journal of the Pediatric Infectious Diseases Society*, 7(1), 36-45. doi:https://doi.org/10.1093/jpids/piw093

Olusoji, A. O., Baris, E., Jonas, O. B., Irwin, A., Franck, C. J., Le Gall, F.G…Thiebaud, A. (2017). *Drug-resistant infections: a threat to our economic future (vol. 2): Final report (English).* Washington, D.C.: World Bank Group.

Panesar, P., Jones, A., Aldous, A., Kranzer, K., Halpin, E., Fifer, H… Pollara, G. (2016). Attitudes and behaviors to antimicrobial prescribing following introduction of a smartphone app. *PLoS ONE, 11*(4). doi:10.1371/journal.pone.0154202

Parsonage, B., Hagglund, P. K., Keogh, L., Wheelhouse, N., Brown, R. E., Dancer, S. J., (2017) Control of Antimicrobial Resistance Requires an Ethical Approach. *Frontiers in Microbiology.* doi: 10.3389/fmicb.2017.02124

Ready D, Lancaster H, Qureshi F, Bedi R, Mullany P, Wilson M. (2004) Effect of amoxicillin use on oral microbiota in young children. *Antimicrobial Agents Chemotherapy*, 48:2883-7. doi:10.1128/AAC.48.8.2883-2887.2004.

Sanchez, G. V., Fleming-Dutra, K. E., Roberts, R. M., & Hicks, L. A. (2016). ore elements of outpatient antibiotic stewardship. MMWR Recomm Rep, 65, 1-12. Retrieved from https://www.cdc.gov/antibiotic-use/community/pdfs/16_268900-A_CoreElementsOutpatient_508.pdf

Shehadeh, M.B., Suaifan, G. A. R. Y., & Hammad, E. A. (2016, September). Active educational intervention as a tool to improve safe and appropriate use of antibiotics. *Saudi Pharmaceutical Journal, 24*(5), 611-615.

Shehab, N., Lovegrove, M., Geller, A. I., Rose, K. O., Weidle, N. J., & Budnitz, D. S. (2016). US emergency department visits for outpatient adverse drug events, 2013-2014. *Journal of the American Medical Association*, 316(20), 2115-2125. doi:10.1001/jama.2016.16201

Snarey, J. & Samuelson, P (2008). Moral Education in Cognitive Developmental Tradition: Lawrence Kohlberg's Revolutionary Ideas. In L. P. Nucci, & D. Narvaez, *Moral Education in the Cognitive Developmental Tradition* (pp. 53-79). New York: Routledge

Suda KJ, Hicks LA, Roberts RM, Hunkler RJ, Danziger LH. (2013) A national evaluation of antibiotic expenditures by healthcare setting in the United States, 2009. *Journal of Antimicrobial Chemotherapy*, 68:715–8

Thorpe, K. E., Joski, P., & Johnston, K. J. (2018). Antibiotic-resistance infection treatment costs have doubled since 2002, now exceeding $2 billion annually. *Health Affairs*, 37(4). doi:https://doi.org/10.1377/hlthaff.2017.1153

Ventola, C. L. (2015). The Antibiotic Resistance Crisis. *Pharmacy and Therapeutics, 40*(4), 277-283.

World Health Organization. (2018, January). antimicrobial resistance. Retrieved from: http://www.who.int/mediacentre/factsh

APPENDIX

Appendix A
Pre-Survey

1. On a scale from 1-5, with 5 being very comfortable and 1 being uncomfortable, what would you rate your comfort with using electronic clinical decision support tools?
    - 1
    - 2
    - 3
    - 4
    - 5

2. How often do you use your computer, phone or tablet in practice to help with clinical decisions, to look up information, to look up dosing of medication, etc (other than use of calculator or to chart)?
    - Multiple times a day
    - Daily
    - About once a week
    - Monthly
    - A few times a year
    - Never

3. Which of the following electronic clinical decision support have you used or heard of? (check all that apply)
    - Electronic order set
    - Medication dose calculator
    - Medical reference tools
    - I don't know
    - Other

4. Where do you most often look for diagnosis and treatment options?
    - Text books
    - Other books
    - Google
    - UpToDate
    - Medscape
    - Other______________________________
    - None

5. What are the reasons you would use an electronic clinical decision support tool in your job? (check all that apply)
    - It's easy to find information with the electronic decision support system
    - It presents information nicely
    - It decreases chances of medical error
    - It improves quality of patient care
    - It uses clinical practice guidelines
    - Other_______________________________

6. What are the reasons you would not use an electronic clinical decision support tool in your job? (check all that apply)
    - Lack of time/time constraint
    - Competing clinical demands
    - Interferes in work flow
    - Too complicated
    - Poor system design
    - Lack of computer/phone skills
    - Do not want to use in front of my patients
    - Prior bad experience
    - Not interested in using
    - Lack of authenticity and reliability of information
    - Other________________________________

Demographics

Gender: ___Male ____Female

Age: ___20-29 years ___30-39 years ___40-49 years ___50-59 years ___60 years or older

Provider Type:

____ Family Nurse Practitioner

____ Specialty Nurse Practitioner ____________________

____ Pediatrician

____ Family Physician

____ Other________________________

Percent of pediatric patients seen weekly: ___25% ____ 50% ____75% ____100%

Appendix B
Case Study 1

SUBJECTIVE *(given by the patient's mother)*
CC: ear pain and fever

HPI: Jane is a 22-month-old, previously healthy female presenting with 2 days of fever and pulling on her right ear. She had rhinorrhea, nasal congestion and cough for 5 days starting last week which have improved. Today, she developed fever up to 38.8°C (101.8°F). Mother reports patient is more tired than usual, taking additional naps during the afternoon. Parent denies any change in feeding or elimination patterns. No sick contacts. Attends daycare. She has not been on any antibiotics during the past 30 days.

Allergies: Penicillin (mild rash)
Immunizations: Up to date

OBJECTIVE

VS: T 38.5C (101.3F), RR 18 breaths/min, HR 84 beats/min, BP 96/52 mmHg, SpO2 99% on Room air, Weight 10.5kg, Height 77cm
General: Well nourished, no acute distress
HEENT: Eyes: sclera white, conjunctiva pink. Ears: clean canals bilaterally**. Right tympanic membrane intensely erythematous and bulging with diminished light reflex, bony landmarks not visualized. No purulent drainage observed.** No pain to palpation of mastoid bone.
Neck: Supple, no masses, 1cm palpable right cervical lymph node, mobile nontender
Lungs: Clear to auscultation in all lobes, no wheezing, rhonchi, rales

Questions:

1. What is Jane's diagnosis? ____
2. How would you manage Jane? ____
3. How would you manage Jane if had severe penicillin allergy (anaphylaxis)?

   ____

Appendix C
Case Study 2

SUBJECTIVE *(given by the patient's mother)*
CC: cough, rhinorrhea and fever

HPI: John is a previously healthy 4-year-old male presenting with persistent daily purulent nasal discharge with daytime and nighttime cough for 11 days that is not improving, associated with intermittent fever to 38.2°C (100.8°F). John has also complained facial pain and intermittent headaches. John's mother reports that he does not attend daycare or school and stays at home with her during the day. He has had no sick contacts. His mother has treated John with over the counter cough medication and acetaminophen. He has not received any type of prescription medication in the last 30 days.

Allergies: penicillin (rash)

Immunizations: Up to date

OBJECTIVE

VS: T 38°C (100.4°F), RR 18 breaths/min, HR 85 beats/min, BP 100/72 mmHg, SpO2 99% on Room air, Weight 18kg, Height 101cm
General: Well nourished, no acute distress
HEENT: Ears: external canals clear bilaterally. Left and right tympanic membranes pearly grey with positive light reflex and visible bony landmarks. Nose: nasal turbinate's erythematous and swollen with visible purulent nasal drainage. Mouth/Throat: moist mucous membranes. Oropharynx clear without exudates. Uvula with mild erythema, post-nasal drainage visualized on exam
Neck: Supple, no masses, no lymphadenopathy
Lungs: Clear to auscultation in all lobes, no wheezing, rhonchi, rales

Questions:

1. What is John's diagnosis? ______________________________________

2. How would you manage John? ______________________________________

3. How would you manage John if he did not have any allergies?

   ____

Appendix C

System Usability Scale

Instructions

Based on your experience today with the electronic clinical decision support tool (ECDST), check the box that reflects your immediate response to each statement. Make sure to respond to each question

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Appendix E
NASA TLX Survey

Instructions: circle the number on each scale that best indicates your experience with the electronic clinical decision support tool (ECDST)

Mental Demand
How mentally demanding was the case with use of the app?

1	2	3	4	5	6	7	8	9	10	**11**	12	13	14	15	16	17	18	19	20	**21**

Very Low Very High

Physical Demand
How physically demanding was the case with use of the app?

1	2	3	4	5	6	7	8	9	10	**11**	12	13	14	15	16	17	18	19	20	**21**

Very Low Very High

Temporal Demand
How hurried or rushed was the pace of the case with use of the app?

1	2	3	4	5	6	7	8	9	10	**11**	12	13	14	15	16	17	18	19	20	**21**

Very Low Very High

Performance
How successful were you in accomplishing what you were asked to do?

1	2	3	4	5	6	7	8	9	10	**11**	12	13	14	15	16	17	18	19	20	**21**

Perfect Failure

Effort
How hard did you have to work to accomplish your level of performance?

1	2	3	4	5	6	7	8	9	10	**11**	12	13	14	15	16	17	18	19	20	**21**

Very Low Very High

Frustration
How insecure, discouraged, irritated, stressed, and annoyed were you?

1	2	3	4	5	6	7	8	9	10	**11**	12	13	14	15	16	17	18	19	20	**21**

Very Low Very High

Appendix F
Post Survey

7. Did the electronic clinical decision support tool change the way you diagnosed the patient?
   - o Yes
   - o No
   - o Other________________________________

8. Did the electronic clinical decision support tool change the way you treated the patient?
   - o Yes
   - o No
   - o Other_________________________________

9. Would you consider using this ECDST in your future practice?
   - o Yes
   - o No
   - o Other_________________________________

10. Additional comments____

    ____

    ____

    ____