Evidence-Based Practice: Reducing Unnecessary Antibiotic Prescriptions for Pediatric Pharyngitis

Project Presented to the Faculty of the School of Nursing
Saint Peter’s University

In partial fulfillment of the requirements
for the Degree of Doctor of Nursing Practice

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Date: 12/14/2017
DEDICATION

To Dr. Valera Hascup, a nurse scientist and exemplar nursing scholar, who set the stage for learning scholarly research beyond the walls of a classroom, and who did not and would not give up on me.

To Ellen, my daughter
ABSTRACT

The purpose of this project was to decrease of the rate of unnecessary antibiotic prescribing for pharyngitis by implementing an evidence-based training session for physicians in an outpatient pediatric setting. The PICOT question explored was, "For health providers treating children aged 4-15 presenting with sore throat, will the use of a power point training session presenting the rapid antigen detection test (RADT) with reflexive culture, combined with the ICE (ideas, concern and expectations) method, improve knowledge and reduce antibiotic prescribing compared to RADT alone in a 20 day period?"

The provider study group consisted of four pediatricians and one family practice physician ranging from 32-72 years old. Their pre-test (34.63%) and post-test (53.75%) knowledge scores were significantly different ($t = -2.3822$, $df = 6$, $p <0.05$). A total of 125 cases were sampled, 64 pre-intervention and 61 post-intervention. Pearson’s Chi Square analysis revealed homogeneity between both the groups in age ($X^2 = 0.94$, $df = 1$, $p = 0.33$), gender ($X^2 = 0.64$, $df = 1$, $p = 0.42$), and ethnicity ($X^2 = 1.29$, $df = 2$, $p = 0.53$) and a decrease in overall antibiotic prescribing rates from 40.6% ($n = 26$) to 27.9% ($n = 17$). Although this was not a significant statistical reduction ($p = .13$), further analysis using a binomial test revealed statistically different rates of success in the accuracy of diagnosis and associated antibiotic prescribing pre-intervention (79.7%) compared to 96.7% post-intervention ($p = .00$; 95% CI [88.7, 99.6]). Unnecessary antibiotic exposure was reduced by 17.2%.

The most common ICE elements were thought of possible strep infection (39), viral or other infection (26), concern for pain (24), infecting other family members (14), fever (14), expectation to get better (32), test for strep (18), and pain relief (9). Only 2 of the 5 cases in the post-intervention group ($n = 61$) who expressed desire for antibiotics received them.
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CHAPTER I: INTRODUCTION AND BACKGROUND OF THE PROBLEM

Appropriate antibiotic prescribing for pharyngitis is critical to averting antimicrobial resistance to Group A Streptococcus (GAS), a common community-acquired infection. In 1928, Alexander Fleming observed the bactericidal effects of penicillium fungus and discovered penicillin. During the inception and early use of this miracle drug, Fleming (1944) stated that it is not difficult to make microbes resistant to penicillin because the surviving bacteria become educated to resist the antibiotic. In his Nobel Prize acceptance speech, Fleming noted that the indiscriminate use of penicillin to treat pharyngitis can “change the nature of the microbe,” resulting in antibiotic treatment failure and possible death (Fleming, 1945, p. 93). Despite these warnings, health care providers have not emphasized antimicrobial resistance. The prescribing of antibiotics has escalated over the years in both industrialized and less developed countries, while corresponding antimicrobial resistance has increased (Kunnin, 1993). Since then, overprescribing antibiotics has been described as a major cause of the global antimicrobial resistance crisis (World Health Organization, 2015). The pathophysiology, socioeconomic impact, and prescription practices associated with antimicrobial resistance and the national/international efforts to curtail it are described in this chapter. The effectiveness of an evidence-based project for decreasing unnecessary antibiotic prescribing for pharyngitis in children aged 4-15 in the Northeastern part of the United States was explored.

Statement of the Problem

In the United States, acute pharyngitis cases comprised 20-30% of pediatric appointments, totaling an estimated 15 million visits per year (Ebell, 2000). The etiology of acute pharyngitis is mostly non-bacterial, with only 20-35% of cases attributed to GAS (Naik, Nadagir, & Biradar, 2016; Wannamaker, 1972). GAS, most commonly occurred in children
aged 5-15, is seldom observed in children younger than three years of age, and it is most prevalent in winter and early spring (Bisno, 1996; Shaikh, Leonard, & Martin, 2014). Unnecessary prescribing for pharyngitis in pediatric populations can predispose children to antimicrobial resistance. In the United States and other countries, poor clinician adherence to international guidelines for prescribing pharyngitis has exposed children to antibiotics unnecessarily, and this poses a major challenge to curtailing antimicrobial resistance (Chiappini et al., 2011). This study explored the effects of a provider educational intervention composed of evidence-based diagnostic modalities and the ideas, concerns, and expectations of patients/parents about antibiotic prescribing for children with pharyngitis.

The National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey 2010-2011 revealed that 154 million prescriptions had been written for antibiotics in doctor’s offices and emergency departments. At least 30% (1 in 3) of these prescriptions were unnecessary, and 44% of them were written for upper respiratory conditions, including pharyngitis (CDC, 2016). Ladd (2005) extrapolated additional data from these surveys and compared diagnostic codes with corresponding antibiotic prescription practices from 13,692 physicians and 506 nurse practitioners in all regions of the United States. In non-streptococcal pharyngitis, 54% of nurse practitioners and 65% of physicians prescribed antibiotics, far above the rate of the actual existence of the disease. Nurse practitioners were nine times more likely to prescribe antibiotics in the Northeastern region (a similar region to where this study took place) compared to other regions of the United States, and they were also more likely to prescribe them if both viral pharyngitis and bronchitis were diagnosed. However, they were less likely to prescribe antibiotics for Medicaid patients (34%, compared to 53% for physicians). The major concern with overprescribing antibiotics for pharyngitis is the threat of antibiotic resistance.
Abbas, Ismael, El-Shahat, and Indian (2012) tested various antibiotic resistant strains of GAS from both children and adults and found that these bacteria showed different responses to environmental stresses, suggesting that the bacteria had undergone a genetic change. In the United States and 19 other countries, Albrich, Monnet, and Harbarth (2004) correlated the use of antibiotics with penicillin non-susceptible and macrolide antibiotic resistant streptococcal pyogenes, showing antibiotic's failures in treating GAS.

Pathophysiology of the Antimicrobial Resistance

The CDC’s Get Smart (2013) guidelines described how antibiotics place selective pressure on bacteria, killing those bacteria that would ordinarily protect the body from infection and promoting the growth of resistant bacteria, which then spread their genes to other bacteria. The resistant strains are transmitted from person to person or via meat consumption. The specific mechanisms by which bacteria developed resistance to antibiotics involve changing their genetic make-up (mutation and replication) and the development of enzymes that neutralize the effects of the antibiotic on cell walls, protein or nucleic acid synthesis, or other metabolic pathways (Tenover, 2006). This process has been documented in the laboratory as well in large populations over various timed trajectory analyses (Lee, Molla, Cantor, & Collins, 2010). Palmer and Kishony (2013) discussed the evolution of cross-resistance and multi-drug resistance, which are evolving at a greater rate than the human capability to implement pathogen genotyping and evolutionary genetics that would guide effective antibiotic production.

Significance of the Problem

Economic Impact of the Problem

The Office of Technology Assessment (1995) has estimated the cost of antimicrobials at 7 billion dollars per year. The CDC reported that antimicrobial resistance results in $20 billion
in direct health care costs and $35 billion in loss of productivity related to hospitalizations and sick days in the United States yearly. The socioeconomic consequences of treating acute pharyngitis and subsequent antimicrobial resistance are of compounding significance. The cost of the burden of antimicrobial resistance to Amoxicillin (the most common antibiotic used to treat GAS) in excess of the benefits of its use has been estimated at $225 million a year (Elbasha, 2003).

Pfo, Wessels, Goldmann, and Lee (2008) calculated the economic cost of each episode of GAS diagnosed in school-aged children at $200 per family, totaling $539 million dollars per year in the United States. The impact was greater when all pharyngitis etiologies (i.e., bacterial and non-bacterial) were considered. Parents lost wages when they took time from work to care for their sick children who were excluded from school due to fever. In a study comparing the opinions of daycare center staff, working mothers, and pediatricians, Landis and Earp (1988) found that daycare staff and mothers frequently associated low-grade fevers and mild symptoms with a need to seek medical care and to comply with daycare student exclusion policies. This is congruent with a study by Danchin et al. (2004) showing that 46% of cases of pharyngitis lead to school absenteeism and a high rate of antibiotic use. Daycare staff members also contribute to the pressure to use antibiotics, often as a requirement for attendance, with the idea that this will decrease the spread of upper respiratory tract infections. Skull, Ford-Jones, Kulin, Einarson, and Wand (2000) found that 31% of children with pharyngitis were excluded from attending daycare, and 56% of children were advised to seek medical attention to obtain antibiotics. Pressure on health care providers for a quick solution to the child’s symptoms may have arisen from the economic pressures placed upon them by working parents. Kozyrsky, Chateau, Mazowita,
Klassen, and Law (2004) documented an increased likelihood of antibiotic prescribing for viral respiratory tract infections for every $10,000 increase in parental income.

**Consequences of the Problem**

Antimicrobial resistance has been denoted as a global crisis that is most pronounced in countries with high rates of antibiotic use (Goossens, Fereche, Stichele, & Elseviers, 2005). The unnecessary prescribing of antibiotics has been identified as a major cause of antimicrobial resistance and worldwide mortality (World Health Organization, 2015). Laxminarayan et al. (2013) reported 25,000 yearly deaths in Europe and 164,833 yearly neonatal deaths in India as a result of antimicrobial resistance. The authors, who called for international collaboration to end this crisis, identified additional routes of antimicrobial resistance—such as prophylactic antibiotics in cattle, agriculture, and water irrigation—that spread resistant genes to humans via food consumption. Their specific recommendations included the amelioration of infrastructures for developing countries that overuse poorly manufactured antibiotics, agricultural regulation, correcting gaps between antibiotic guidelines and their application, academic research, and innovations for antimicrobial surveillance and drug manufacturing. In the United States, two million people were infected each year with untreatable microbes, resulting in 23,000 deaths (CDC, 2016).

The need to prevent antimicrobial resistance against streptococcus is critical. O’Brien (2002) estimated that there are 9,600-9,700 cases of invasive GAS in the United States each year, resulting in 1,100-1,300 deaths. A risk factor for invasive GAS in adults includes exposure to children with pharyngitis in the home (Factor et al., 2003). Limiting the prescribing of antibiotics for pharyngitis is necessary to preventing Streptococcal resistance and the growth of invasive strains among people of all ages worldwide. Antimicrobial resistance to amoxicillin,
clindamycin, and erythromycin has been documented, in various studies, from throat swab isolates in children. Zavadska et al. (2010) identified up to 78% of the isolates of GAS in children who were resistant to erythromycin and clindamycin. In a two-week follow up study of children who were prescribed amoxicillin for pharyngitis, the mean minimum inhibitory concentration for ampicillin more than tripled (Chung, 2007). Resistance to multiple antibiotics was also identified in Group G and C streptococcus in healthy carriers and those with acute pharyngitis (Naik, Nadagir, & Biradar, 2016). A region-wide intervention for children with pharyngitis, combined with GAS surveillance, found that the judicious use of antibiotics reduced resistance to erythromycin (Gagliotti, Buttazzi, DiMario, Moresillo, & Moro, 2015). The goal of appropriate prescribing for GAS is to prevent widespread resistance to amoxicillin, the most common antibiotic used in pediatric practices. Curtailing resistance to antibiotics is critical to preventing the spread of resistant bacteria in the bloodstream, which causes death from antibiotic treatment failure (CDC, 2013; Laxminarayan et al., 2013).

Knowledge Gaps

Various studies have been undertaken to understand why health care providers prescribe antibiotics when these are not indicated. In a study of Polish physicians’ prescribing practices for pharyngitis, researchers found that most physicians prescribed antibiotics even when clinical scoring systems indicated a low probability of bacterial infection. Many of these prescriptions were for children returning to the doctor’s office the next day, ahead of the 4-5 days anticipated for viral resolution (Chlabicz, Pytel-Kroczuk, Marcinowicz, & Marcinowicz, 2008). Cox and Jones (2001) documented physicians’ and practice nurses’ management of pharyngitis over six months in England and found similar prescribing patterns, except that the nurse practice group had a higher patient satisfaction and a shorter duration of illness than the physician group,
suggesting that patient education rather than antibiotics could be used. Goolsby (2007) surveyed 424 nurse practitioners in the United States and found that 75% of them recognized the overuse of antibiotics as contributing to antibiotic resistance, yet many of them considered short course therapies to prevent, rather than promote, antimicrobial resistance. Sixty-three percent of nurse practitioners in Goolsby's study were visited by pharmaceutical representatives who offered antibiotic samples, suggesting that sales agents exert pressure on practitioners to prescribe antibiotics.

Lack of knowledge among health care providers of the actual expectations of patients or parents when taking antibiotics has also been associated with unnecessary antibiotic prescribing (Van Driel et al., 2006). General practitioners tend to overestimate patient expectations for antibiotics and to prescribe antibiotics for patients with more severe symptoms, even though patients ranked the desire for antibiotics 11th of 13 reasons to seek medical care. Patients seeking medical consultations for a sore throat were actually asking for information on the cause of their symptom, the course of disease, and relief from pain. Moreover, patients seek antibiotics when they feel more ill than usual or when they think that the antibiotic will have a direct effect on ameliorating severe pain (Van Driel et al., 2006). Patients’ lower socioeconomic background can also influence the practitioner’s decision to prescribe antibiotics (Kumar, Little, & Britten, 2003). Hispanic patients, who comprised more than half of the cases in this study, had higher expectations for antibiotics than the general population in the United States, but these were not as high as clinicians’ estimates (Watkins, Sanchez, Albert, Roberts, & Hicks, 2015).

Narrowing the gap between evidence-based recommendations and the prescription of antibiotics for pharyngitis is a persistent challenge. Previous attempts to curtail unnecessary antibiotic prescribing for pharyngitis have involved clinical scoring systems to diagnose GAS
(Fine, Nizet, & Mandl, 2012), guidelines stressing Rapid Antigen Detections Tests (RADT) with back-up cultures for children (Ellis & Camacho-Walsh, 2015; Shulman et al., 2012), delayed prescribing (Spurling, Del Mar, Dooley, Foxlee, & Farley, 2013), and the implementation of patients' ideas, concerns, and expectations (ICE) (Mathys et al., 2009). International guidelines for diagnosing and prescribing pharyngitis have conflicting recommendations (Chiappini et al., 2011), and greater flexibility in their application to pediatric cases is needed (Urkin et al., 2013). Poor adherence to existing guidelines has been attributed to a lack of provider knowledge of both guideline recommendations and methods to effectively manage patient expectations (Rowbotham et al., 2012). For example, the 2012 Update of the Infectious Diseases Society of America (IDSA) guideline for the diagnosis and management of pharyngitis was not followed consistently in the setting in which this study took place, as back-up/reflexive cultures were not done routinely for negative RADT in children, contrary to the guideline’s recommendations. Controversies about the diagnosis of GAS have compounded the problem because clinical scoring systems typically aim for a triad of symptoms (fever, quinsy, and adenopathy), and these have not been found to be sufficiently reliable in the pediatric population (Hall, Kieke, Gonzales, & Belongia, 2004). Queries have continued regarding the utility and costs of using reflexive culture in lieu of the prevalence of GAS in pediatric populations (Needham, McPherson, & Webb, 1998; Shaikh et al., 2014), as well regarding exclusive reliance on RADTs to detect GAS (Hall et al., 2004) and which clinical rules or symptoms could be used to select children for testing (Cohen et al., 2014). Thus, greater clarification and summary of the evidence was needed for health care providers to prescribe appropriately for their pediatric patients with pharyngitis. The provider training intervention in this study presented a practical clinical evidence summary to narrow the knowledge gaps in these areas.
Knowledge gaps have also existed regarding the means to handle perceived or actual parental expectations for antibiotics during the medical visit and other psychosocial factors that resulted in unnecessary antibiotic prescriptions. Limited but promising studies have shown a decrease in antibiotic prescribing when taking into account the provider-patient relationship and the handling of patient ideas, concerns, and expectations (ICE) in both the general medical consult and among a subgroup of respiratory illnesses (Matthys et al., 2009). Legare et al. (2012) showed that training providers on using evidence-based practices and communication skills can reduce antibiotic prescribing. Nevertheless, further interventional studies were needed to reproduce these results, along with new methods to provide physicians or nurse practitioners with the tools necessary to address parental expectations in combination with the use of diagnostic testing for GAS. The implementation of evidence-based clinical diagnostic testing for GAS pharyngitis, in combination with the ICE method of eliciting a history and managing patient/parent expectations guided by a systems framework (to be discussed in the next chapter), was implemented in an attempt to further reduce unnecessary prescribing.

**Proposed Solution**

Although antibiotic guideline adherence has been a challenge for health care providers, recent studies have shown that training providers on the diagnostic likelihood of bacterial infection, along with engaging patients in the decision to use antibiotics, can reduce unnecessary antibiotic prescribing (Legare et al., 2012). In line with these educational initiatives, this study’s intervention entailed training health care providers on the diagnosis of GAS based on current clinical evidence and diagnostic tools and the ICE method of communication. By narrowing knowledge gaps in these areas, providers could fortify their patients’ interactive communication skills and engage patients in joint decisions to avoid unnecessary antibiotic prescribing.
This study conformed with the efforts of multiple organizations that have made a call to action against antimicrobial resistance. The Association for Professionals in Infection Control and Epidemiology (APIC, 2012) released a global response statement by 25 national and international organizations citing antimicrobial resistance as “one of the world’s most pressing public health threats” (p. 94). At the White House Forum, The Infectious Diseases Society of America (IDSA, 2015) asserted its commitment to this effort in a statement to encourage widespread antibiotic stewardship. In 2012, the IDSA, Society for Health Care Epidemiology (SHEA), and the Pediatric Infectious Diseases Society (PIDS) explained how death from antimicrobial resistance could occur even in the young and healthy and issued a joint statement calling for the mandatory implementation of antimicrobial stewardship throughout the health care system. The 2015 White House Action Plan to Combat Antibiotic Resistant Bacteria (CARB) set a goal of reducing unnecessary antibiotics by half by 2020. In line with these national mandates, the purpose of this project was to explore the effects of a provider education program on the rates of antibiotic prescribing for pharyngitis in children and to compare the resulting prescribing rate with the actual prevalence of GAS in this population. The findings of this study add to the body of knowledge regarding the diagnosis and management of pediatric pharyngitis and may make a significant contribution to safeguarding against the development of resistance to antibiotics as children age and are faced with evolving resistant bacteria and insufficient antibiotics to fight them.

**Purpose of the Study**

The purpose of this study was to decrease unnecessary antibiotic prescribing for pediatric pharyngitis in a private pediatric practice. The goal was to reduce antibiotic prescribing for pharyngitis in children 4-15 years old to a rate similar to that of the actual existence of GAS in
this population, which is 20-37%, with the upper limit representing the most recent and highest reported prevalence of acute pharyngitis in children (Shaikh, Leonard, & Martin, 2014). In comparing the evidence-based intervention to existing practice, the ideal reduction rate would meet the national 2020 goal standard to reduce unnecessary antibiotics to approximately 1/2 of the national rate described by Ladd (2005), which, in that study, averaged 60% unnecessary prescriptions, 54% of which were by nurse practitioners and 65% of which were by physicians.

**PICOT Question**

Melnyk’s model of evidence based-practice was used to guide the implementation of research findings to solve a clinical problem. Stillwell, Fineout-Everholt, Melnyk, and Williamson (2010) described a step-by-step approach to integrate evidence from research findings, clinician expertise, and patient preferences/values to formulate a health plan of care to improve patient outcomes. The formulation of the research question under this model is based on the five integral components represented in the acronym PICOT: the population of study (P), the planned intervention (I), the comparison group (C), the outcome (O) to be measured or attained, and the timing/duration of the study implementation (T). This project used this model to implement research findings, formulate a research question, design a plan to investigate a solution to the problem of unnecessary antibiotics, and consider the preferences of patients in the outcomes regarding the prescribing of these antibiotics. This evidence-based project research question follows.

For health care providers treating children aged 4-15 presenting with sore throat, will the use of a training session presenting the rapid antigen detection test (RADT) with reflexive culture, combined with the ICE (ideas, concern and expectations) method, improve health care
provider knowledge and reduce antibiotic prescribing compared to RADT alone in a 20 day period?

P (population) = Health care providers (pediatric and family practice physicians) treating children aged 4-15 with pharyngitis.

I (intervention) = Teaching session containing RADT with reflexive culture + ICE.

C (comparison) = RADT alone, prior to training.

O (outcome) = Rate of antibiotic prescribing by providers and knowledge test scores.

T (time) = 20 days pre- and post-intervention, within the same season, to homogenize the pre- and post-intervention groups for similar prevalences of GAS.

Definitions

**Pharyngitis.** Pharyngitis was defined as pain and inflammation in the throat, posterior pharynx, or tonsils

**Rapid Antigen Detection Tests.** Rapid Antigen Detection Tests (RADT) uses throat swabs that detect the presence of the Group A Streptococcus cell-wall antigen. This point of care test was run by swabbing the posterior pharynx and tonsils and dislodging the cells from the swab in a solution. A test strip was then placed in a reagent, and the control and test line results are visualized at 5-10 minute intervals.

**Reflexive Cultures.** Reflexive throat cultures are backup throat cultures sent to an outside laboratory when the results of the RADTs are negative. The swab is then platted on a culture and placed in an incubator for the observation of bacterial growth. The turnaround time for the resulting report was 48 hours.

**Ideas, Concerns, and Expectations.** Ideas, concerns, and expectations referred to the patients' responses to questions elicited by health care providers. These questions were asked of
the parent (or older child) during the intake history or physical examination. Matthys et al. (2009) defined each ICE item as follows:

1. Idea: patient’s opinion about a possible diagnosis, treatment, or prognosis;
2. Concern: patient’s fear/worry about a diagnosis or treatment; and
3. Expectation: patient’s expectation about a treatment, diagnosis, or a doctor’s note for school or work.

**Intervention.** The intervention in this study entailed a fifteen minute PowerPoint presentation designed to educate health care providers on (a) the evidence-based diagnosis of pharyngitis in children based on the prevalence of the disease, clinical symptoms, and indications for RADT and reflexive cultures, (b) spectrum bias in interpreting RADT results, (c) the futility of clinical scoring systems, and (d) how to elicit and address the ICE of patients using the Neuman Systems Model.

**Health Care Provider.** Health care providers (pediatricians and family medical doctors) were the target group for the PowerPoint education.
CHAPTER II

REVIEW AND CRITIQUE OF THE LITERATURE

Search Strategy

A review of the literature was conducted with a focus on clinical and psychosocial strategies to reduce unnecessary antibiotic prescribing for pharyngitis in children. A comprehensive search of the literature using the CINAHL MEDLINE, and EBSCO databases with the MeSH terms *sore throat, pharyngitis guideline, rapid antigen test, group A streptococcal, throat culture, and ideas, concerns, and expectations of patients* was used. Since a plethora of individual studies resulted, an emphasis was placed on meta-analysis, international guideline and guideline appraisals, and Cochrane reviews. With additional random controls, cohort and qualitative studies were sought to answer queries not covered under systemic reviews. Language limitations from using international guidelines were overcome with Google Translate. Studies not meeting the criteria date, the variables of the study, or the pediatric population were excluded. After careful scrutiny of the variables in this study and the inclusion criteria, 35 articles were selected for review. After critiquing the validity and reliability of each study and critically appraising each guideline, 22 articles were retained for their evidence-based practices. Due to controversies regarding diagnostic criteria and the use of RADT and culture swabs among various guidelines, the inclusion criteria for this aspect of the study aimed at level I evidence pertaining to the pediatric population, or the pediatric and adult population combined, within the last five years. A broader time frame (15 years) was used to address inconsistencies in the literature regarding the correlation of clinical symptoms with RADT and the value of reflexive culture. Two random control studies, three well designed control studies without randomization, and two cohort studies were included for this purpose. Since few of the resulting studies
addressed the ICEs of patients associated with antibiotic prescribing, an extended timeframe (15 years) was also applied to the random control, cohort, and qualitative studies that resulted. The reasons for the exclusion of seven additional studies after a critical appraisal are listed below.

**Excluded Studies**

Dingle’s (2014) retrospective analysis of reflexive culture was excluded due its focus on age 13 to adult-aged patients, which did not account for the majority of school-aged children.

Needham et al.’s (1998) cohort study on the impact of RADT on antibiotic prescription was excluded due to that study’s age. Plainvert and Diagn’s (2015) in vitro comparison of RADT tests, meanwhile, was excluded for its lack of clinical application. McIsaac, Kellner, Aufricht, Vanjaka, and Low’s (2005) study was excluded due to its application of outdated guidelines from the Infectious Diseases Society of America. The new version of the IDSA is from 2012. Llor, Madurell, Balague-Corbella, Gomez, and Cots’ (2011) randomized control trial on the impact on antibiotic prescription of rapid antigen detection testing for acute pharyngitis among adults was excluded due to the age of the sample.

Worrall, Kettle, Graham, and Hutchinson’s (2010) Cochrane review of post-dating versus delayed antibiotic prescriptions in primary care was excluded for lack of direct relevance to the variables in this study. Finally, BAPCOC’s (2012) Belgium guide for the treatment of infectious diseases in ambulatory practice was excluded due to its lack of emphasis on the pediatric population. However, recent systemic reviews that included multiple guideline appraisals (Chiappini et al., 2011; Hoare, Ward, & Arroll, 2016) and the 2012 update of the IDSA guidelines appraised by this author in a published journal in 2015 were kept.
Procedures Used to Critique the Literature

Studies that met the inclusion criteria (RADT, reflexive culture, and ICE in the pediatric population aged 4-15) were critically appraised. The validity of these studies was examined for the inclusion of randomly assigned subjects, age cut-offs, and the numerical distribution of cohort groups. In addition, the P values of pertinent studies were reported. The reliability of the previous studies was examined to determine if the 95% CI was sufficiently narrow for similar results to be expected. The applicability of the studies was also used to include studies of similar age groups and to exclude others carried out in rural instead of urban settings. The level of evidence in each study was determined based on Melnyk’s levels of evidence (Melnyk & Fineout-Overholt, 2014). Guidelines for the diagnosis and treatment of pharyngitis were appraised using the AGREE (Appraisal Guideline for Research and Evaluation) elements: scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability, and editorial independence. A summary of study results from the literature review and corresponding critique is depicted in the Evidence Table located in the appendix.

Critique of the Literature

The appraisal of the keeper studies is reported in Evidence Table 1 (Appendix A). A narrative description of various study’s findings is given below.

International Guidelines

Chiappini et al. (2011) described differences in guidelines pertaining to GAS among 12 Western countries from 1999 to 2009 and found that controversies remained in the diagnosis and treatment of this common pathogen. The 2012 update of the Infectious Diseases Society of America discouraged the use of scoring systems for the diagnosis of GAS and recommended the selective use of RADT in children 3-15 years old with a distinctive set of clinical signs of GAS,
as well as a back-up culture on negative RADTs. In a systematic review and appraisal of 19 international guidelines, Hoare et al. (2016) continued to find significant differences in the use of testing and clinical scoring systems to guide antibiotic therapy for pharyngitis.

A Cochrane review was then selected to evaluate the evidence for the effectiveness of antibiotic therapy for pharyngitis. Spinks, Glasziou, and Del Mar (2013), in a review of 27 RTCs incorporating 12,835 cases of sore throats among children and adults, found that symptom duration was not significantly affected by antibiotics and that the practice of initiating antibiotics pending culture results was discouraged. The risk of suppurative (e.g., quisy), non-suppurative (e.g., rheumatic fever), and sore throat symptoms were evaluated. On day three, the assumed risk of sore throat was 0.66 for patients prescribed antibiotics compared to 0.77 for a placebo group (95% CI [.68, 76]), and on day 7 the RR for the antibiotic group was 0.18 compared to 0.65 for the placebo group (95% CI [.55, .76]). In this review, the trend of children benefitting from antibiotics at day three was not significantly different: RR 1.27, 95% CI [.76, 2.13] for antibiotic and RR .29, (95% CI [.06, 1.51] for the placebo. The benefits and risks of antibiotics for pharyngitis were found to be relative to the actual benefits conferred by the antibiotics, with the antibiotics diminishing the duration of the GAS symptoms by only 16 hours. The greatest benefit of antibiotic treatment was at day three of an illness (NNT <6), but the effect was not as strong as at week one (NNT =21). The authors concluded that antibiotics conferred relatively modest benefits and that the amount needed for treatment for one person to benefit was significant. In a separate Cochrane review, Spurling et al. (2013) showed that the delayed prescribing of antibiotics for respiratory infection can significantly reduce antibiotic consumption from RR 0.77, 95% CI [.73, .81] to RR 0.25, 95% CI [.19, .34].
Rapid Antigen Detection Tests

Additional studies were reviewed regarding the utility and clinical correlation of Rapid Antigen Detection Tests (RADT) in the diagnosis of pharyngitis in children. Three level I studies were found on the effectiveness of RADT in detecting and differentiating the presence of GAS (sensitivity). In a Cochrane review, Cohen, Bertille, Cohen, and Chalumeau (2016) evaluated 98 studies from 1980-2015 that encompassed 101,121 children. The summary sensitivity was 85.6%, 95% CI [83.3, 87.6] and the specificity was 95.4%, 95% CI [94.5, 96.2]. Although the review accounted for differences in the reference standard used (i.e., how the culture was prepared), the researchers still concluded that, in a population of 1000 children with a GAS prevalence of 30%, 43 patients with GAS will be missed. The researchers also determined that whether RADT can be used without a reflexive culture depends on the epidemiologic context (practice location, season, and incidence/prevalence of GAS). Thus, in 100 children with GAS, 86 would be identified by RADT while 14 would be missed and not receive antibiotics.

In another level I systemic review, Lean Arnup, Danchin, and Steer (2014) identified 159 studies from 1996-2013 using a blood agar throat culture as a reference standard. RADTs had a sensitivity of 0.86, 95% CI [0.83, 0.88] and a specificity of 0.96, 95% CI [0.94, 0.97]. Lean et al. (2014) concluded that RADTs might not require a backup throat culture in low-incidence rheumatic fever settings. In a review by Van Brusselen (2014), however, antibiotic treatment was advised for children in lieu of re-emerging complications, and RADT with or without culture was deemed necessary, especially for school-aged children.

Information was also sought regarding the symptoms for which the RADT is ordered and their effect on the prescribing of antibiotics. In a level II study, Maltezou (2008) randomly
assigned children into three different groups: diagnosis by clinical picture only (private practice pediatricians), diagnosis by RDTA and culture (private practice), and diagnosis by culture (hospital providers). Maltezou found that pediatricians without access to RADT were more likely to prescribe antibiotics than those with access to the test (72.2 vs. 28.2%, p < .001) and that private pediatricians prescribed at a higher rate than hospital pediatricians (55.7 vs. 19.9%, p < .001). These findings suggested that a screening of children with pharyngitis for Centor criteria with the selective use of RADT guide the selected therapy. The study's population included pediatricians and nurse practitioners in a private setting similar to that of the present study.

Evidence from other studies explained false negative RADT test results by identifying a spectrum of clinical symptoms (i.e., spectrum bias) correlating with RADT results. In a blind chart review of 1,184 consecutive children visits to a single clinic, Edmonson et al. (2005) correlated increases in clinical symptom with a greater probability of positive RADT results. The resulting sensitivity to RADT was low (0.73, 95% CI [0.62, 0.86]) in patients with a slight likelihood of GAS and high (0.94, 95% CI [0.89, 0.99]) in children with tonsillar exudates and no cough (high probability of GAS). The heterogeneity of RADT results in the pediatric population was explained by degree of symptom severity, where the sensitivity of RADT increased with more severe symptoms (Cohen & Chalumeau, 2013). In a systematic review and prospective cohort study of clinical prediction rules for GAS from 1975 to 2010 involving 678 children classified as low, medium, or high risk according to clinical scoring rules, Cohen et al. (2014) found that selecting when to administer RADT based on these rules produced a wide range of sensitivities and specificities that did not meet the minimum goal of 85%. Cohen et al. (2017) used these data to devise a computerized model to guide the selection of children who
should undergo RADT and administered it to 676 children with pharyngitis who underwent both RADT and culture swabs. The researchers found that a reliance on signs and symptoms to perform the RADT was not sufficiently accurate, and they recommended universal RADT for all children with pharyngitis. Spectrum bias in RADT results was also associated with the Centor scores, where the likelihood of positive RADT results was greater for Centor scores of 3 or more (which is considered clinically severe). In another study, Hall et al. (2004) found the sensitivity of RADT too low to support its exclusive use without a culture confirmation of negative results. Finally, in a Cochrane review, Cohen, Cohen, and Chalumeau (2013) synthesized data on the value of RADT. In this level I review, spectrum bias, younger aged children (school aged), and disease prevalence were factors supporting the use of RADT for all children with pharyngitis.

**Reflexive Throat Culture**

In a level IV cohort study examining the effects of variations in clinical presentation (clinical spectrum), size of inoculum (GAS culture growth), and physician characteristics on the sensitivity of RADT, Cohen, Chalumeau, Levy, Bidet, and Benai (2012) found that RADT sensitivity was higher for symptomatic children (89% vs. 41% asymptomatic), children younger than 9 years old (88% vs. 79% older than 9), and those with heavy inoculum (94% vs. 53% light inoculum) and also higher for physicians with hospital-based clinical activity in addition to an office-based practices (OR 3.4, 95% CI [1.9,6.3], p < .001). The researchers recommended diagnostic accuracy monitoring when RADT is used without a culture. It can be inferred that cultures have value even for children who are low risk and who have negative RADTs at their initial consultation.

A level II random control study (Fine, Nizet, & Mandl, 2011) added an element of bio-surveillance to the value of throat cultures. In their statistical analysis of 132,821 randomly
selected patient records (including patients younger than 15) from across six states, researchers correlated the incidence of GAS with a numerical value for the Real Time Pre-test Probability (RLPP) of GAS based on local epidemiological data. The researchers found that adding a point in Centor scoring when the RLPP was high and subtracting a point when the RLPP was low correlated to a statistically significant value ($p < .001$). They concluded that adding a consideration for the epidemiology of GAS can influence testing decisions and refine the diagnosis of GAS. Thus, more careful consideration of reflexive throat cultures is indicated in a high season of GAS prevalence. Due to the highly dense urban population and large households of the members in this sample study, the need for backup cultures was significant, especially in the winter and early spring, when the prevalence of GAS is higher.

Three level III studies on the value of RADT and reflexive cultures were found to be pertinent to this research. Woodburn (2007) analyzed data from 57,331 patients 18 months to 79 years old with rigid guideline adherence directives who were seen by both physicians and nurse practitioners over a one-year period. Reflexive throat cultures were done on 99.1% of the patients with negative RADTs and 96% of those with positive RADTs were treated with an antibiotic. Another level III cohort study (Needham et al., 1998) conducted on 465 adult and pediatric patients with symptoms of acute pharyngitis revealed that RADT aided a positive physician outcome (decreased unnecessary exposure to antibiotics and 87% increased accuracy of detection of GAS). Throat cultures did not alter the outcome, according to the results, but this conclusion was not stratified by age.

The cost effectiveness of using reflexive throat cultures compared to RADT alone in a pediatric population aged 5-17 years has also been analyzed in a study accounting for the specificity and sensitivity of the tests and the benefits of treating GAS to avoid complications
(Ehrlich, Demopoulos, Daniel, Ricarte, & Glied, 2002). Based on five million children per year, it costs $100.8 million to treat using RADT, $252 million using culture, and $269.7 million using RADT with culture. The specificity for this analysis was 0.99 for both treatments combined and 0.80 for RADT compared to 0.90 for culture; the rate of rheumatic fever was 0.004, suppurative complications 0.005, and serious rheumatic sequelae 0.038. The researchers synthesized these values and supported RADT stand-alone testing. Their recommendation did not take into account spectrum bias or prevalence variation in winter months, however.

**Patient Ideas, Concerns, and Expectations**

Seven studies on the ideas, concerns, and expectations of patients and corresponding clinician prescribing practices were appraised for validity, reliability, and applicability to this research. A systematic review of RTCs pertaining to the interaction between patients and practitioners showed that providing a note from patients about their concerns before this interaction improved communication with regard to the patients’ most pressing symptoms and feelings about their illness (Griffin et al., 2004). The researchers recommended using explicit theoretical frameworks to elicit key communication and interaction techniques that improve outcomes. The information made available to providers, ideally, before the encounter can aid them in understanding the feelings of parents in busy medical practices.

In a level III cross sectional study of 613 physician consultations conducted by Matthys, et al. (2009), the expression of at least two or three of the ideas, concerns, and expectations of patients elicited by the providers reduced medication prescribing, including a subgroup of antibiotic prescribing for respiratory infections. A regression analysis of 350 new contacts showed that expressed concerns ($p = 0.037$, OR 1.73, 95% CI [1.03, 2.9]) and expectations ($p = .009$, OR 2, 95% CI [1.2, 3.4]) were associated with not prescribing new medications. In 17% of
all patient visits and in 22% of new visits, no ICEs were elicited, and the physician proceeded with their consultations without this patient information. In a subgroup of 90 patients with respiratory tract infections, Matthys et al. (2013) reported that fewer patients received antibiotics when 2-3 ICE components were present compared to 0-1 ICE components (6/36 vs. 20/54, \( p = .056, 95\% \text{ CI [0.10, 1.04]} \)). The researchers called for a theoretical framework that physicians can use to guide the eliciting of information and to address the ICEs of patients.

Four additional qualitative studies pertaining to ICE and antibiotics were also reviewed. Hart and Morgan (2013) performed 655 household telephone surveys in Wyoming regarding their concerns and expectations for antibiotics. In this study, the most important patient items were providers listening to their symptoms, concerns, and worries and receiving an explanation of the etiology and course of infection, symptom management, and treatment options. Concerns and worries ranked higher than expectations. In a qualitative study of 60 recorded videos specific to parents of children with respiratory infections (including pharyngitis), Cabral et al. (2016) found that parental expectations for antibiotics were associated with increased perceptions of disease severity, child susceptibility, and parental ability across all cultures. This finding was reinforced inadvertently by physicians minimizing the language for viral illnesses and associating antibiotic prescriptions with illness severity. Parents believed that antibiotics were indicated for more severe illness presentations and were already aware that antibiotics do not treat viral infections. A qualitative analysis of health care providers’ reasons for prescribing antibiotics for pharyngitis indicated that providers prescribed for sicker patients and socioeconomically deprived patients because they were concerned about complications (Kumar et al., 2003).
Additional studies were found pertaining to the effects of patient expectations on antibiotic prescribing. Attempts to manage patient expectations were reported in a qualitative semi-structured interview of 20 family physicians in England (Mustafa, Wood, Butler, & Elwyn, 2014). The interviewed physicians stated that they assumed most patients wanted antibiotics, as well as wanting to be checked and to obtain reassurance that nothing severe was evolving. Physicians in that study preferred to elicit expectations for antibiotics in an indirect manner in the form of a “running commentary” during or immediately after the patient exam in order to influence patient/parent expectations and avoid generating resistance or negative feelings when antibiotics were not prescribed. In a qualitative study involving video recordings of 60 primary care children’s consultations, Cabral et al. (2016) found that antibiotic prescriptions confirmed parent beliefs regarding illness severity and that problems with minimizing language on the part of physicians reaffirmed parent perceptions of viral illnesses as less severe. The authors concluded that interventions to reduce antibiotics in pediatric populations must take into account the communication that occurs during the consultation.

In a randomized control study (Legare et al., 2012), the implementation of a provider training program containing communication skills for providers to elicit patient concerns, promote patient participation in decisions, and account for patient preferences reduced antibiotic consumption compared to a control (52.2% vs. 27.2%, respectively). A systemic review (Griffin et al., 2004) also showed that interventions to alter the interactions between patients and practitioners produced positive health outcomes (achieving significance in 44% of trials), especially with interventions that had a note from patients included about their concerns before the consultation.
Two control studies (one level II randomized and one level III non-randomized) regarding expectations for antibiotics in the Hispanic population were also included in this review to anticipate cultural differences within the study's population. A national survey revealed that Hispanic consumers (Watkins et al., 2015) have higher expectations of receiving antibiotics than European American consumers. This finding was supported in a study documenting higher parent expectations for antibiotics in Los Angeles, California (Watkins, Sanchez, Albert, Albert, Roberts, & Hicks, 2015). The latter study’s findings may not adequately depict this study's sample, however, as the Hispanic population in California is comprised largely of immigrants from Mexico while Hispanics on the East Coast, where the present study took place, are primarily from South America and the Caribbean. The California study took place in 43 different community HMO settings, whereas this study took place in a private pediatrician’s office. Both of the studies reviewed recommended culturally sensitive interventions to curtail prescribing unnecessary antibiotics to the Hispanic population.

**Synthesis of the Review of the Literature**

Although controversies have existed over the best method to diagnose and treat children with pharyngitis, this review of the literature indicated that consideration of the spectrum bias of RADT, lack of predictive value of symptoms, age of the child, and the prevalence of GAS all supported the use of RADT and reflexive culture in the intervention group for this study. Consideration of the epidemiologic context (the anticipated higher prevalence of RADT in winter months in a densely populated urban location) also supported this conclusion.

Clinical knowledge alone has not resolved the problem of unnecessary prescribing for pharyngitis. Thus, this study incorporated findings from the literature demonstrating that training health care providers to communicate with patients/parents about their ideas, concerns,
and expectations resulted in fewer antibiotics prescribed. A combination of knowledge gathered from studies with a medical focus and those with a psychosocial focus was expected to bridge the gap between medical guidelines and practical applications that took into account the feelings of patients and parents. Melnyk and Rhinehart-Overhault (2014) highlighted the importance of incorporating patient preferences into the application of evidence-based projects. A synthesis of the key findings from the review of the literature is provided below, along with comments regarding their application to this project.

The 2012 update of the Infectious Diseases Society of America discouraged scoring systems for the diagnosis of GAS and recommended selective use of RADT for children 3-15 years old with a distinctive set of clinical signs of GAS as well as a back-up culture taken on negative RADTs. However, this recommendation was not entirely supported by a meta-analysis indicating that reliance on signs and symptoms to select children for RADT was not sufficiently accurate and recommending RADT for all children with pharyngitis (Cohen, Chalumeau, Levy, Bidet, & Benai, 2012). Although RADT use was found to decrease antibiotic prescriptions (Woodburn, 2007), a meta-analysis of group data that supported RADT use without a culture for low rheumatic fever settings (Lean et al., 2014) did not separate the pediatric population. In children, RADT’s sensitivity and specificity were found to be variable and too low to use without a culture (Hall et al., 2004). The need for the use of RADTs without a reflexive culture also depended on the epidemiologic context (Cohen et al., 2016), disease prevalence (Cohen et al., 2013), and bio-surveillance (Fine et al., 2011). This study took place when the incidence of GAS was higher than it was in the season preceding its inception; thus, the use of RADT with a backup culture (for negative RADTs) reflected the presence of GAS more accurately. The control group did not use a routine reflective culture in the practice location for that study, and
standard periodic diagnostic accuracy monitoring was not done. In this study, both the control and intervention health care provider groups continued the use of initial RADT as part of their usual practice. Health care providers in the intervention group were taught indications for RADT and back up cultures according to evidence gathered from the literature review in a concise, user-friendly fashion. Reflexive culture offered an opportunity for delayed prescribing in cases when the culture results of RADT were initially negative.

An understanding of RADT results was also derived from the literature and was useful in diminishing potential bias in interpreting test results. RADT results were more likely to be read as positive for children with more severe clinical symptoms (Cohen, Bertille, Cohen, & Chalumeau, 2013; Edmonson et al., 2005), those younger than 9 years old, those with heavy inoculum, and those seen by a physician in a private practice (Cohen et al., 2016). In the study setting, incidental negative culture results followed a positive RADT, demonstrating the possibility of leaning toward a positive interpretation of RADT test results by physicians in private practice.

The psychosocial components of the management of pharyngitis discussed in the literature were implemented in this study. This entailed a worksheet for providers to document patient/parent concerns before, during, or after the course of the consultation in order to improve communication, per the study’s findings (Griffin et al., 2004), and to facilitate the eliciting of at least 2 of the 3 ICE components that have been associated with decreased antibiotic prescribing (Mathys et al., 2009). The expression of parental concerns about their children and their actual expectations of antibiotics compared with those of health care providers were also incorporated into the training session for providers (Hart & Morgan, 2013). Additional challenges were anticipated in Hispanic patients seen by the providers in this study based on a higher expectation
of receiving antibiotics that has been documented for this population (Mangione-Smith et al., 2004; Watkins et al., 2015). Across all sociocultural groups, however, parental expectations for antibiotics were associated with increased perceptions of disease severity (Cabral et al., 2016), and a “running commentary” during or immediately after the patient exam influenced patient/parent expectations (Mustafa et al., 2014). Understanding parents’ decision to bring children to the health care provider opened the door to treatment alternatives to antibiotics, as parents’ perceptions of the threat of the illness’ severity and susceptibility of their child, and their perceived efficacy to cope with the problem, are the main motivators for seeking care (Ingram et al., 2013). Provider training sessions containing both medical knowledge and provider-patient communication skills have demonstrated efficacy in decreasing antibiotic prescribing (Legare et al., 2012), and similar methods were applied to the provider intervention group in this project. Prescribing rates for pharyngitis for the control group of providers in the 20 days after the completion of the training session were compared with the prescribing rates from 20 days before the intervention in immediate time succession to limit seasonal variances in GAS prevalence.
CHAPTER III

METHODOLOGY AND IMPLEMENTATION

Theoretical Framework

The Neuman Systems Model (NSM) is a systems model that takes into account patients' psychological, sociocultural, spiritual, and physiological aspects, their responses to stressors in their internal and external environments, and interventions by health care providers to assist them to the reconstitution phase of health and system stabilization. Given its dynamic nature and utility across cultures, the NSM was the guiding framework for this study.

The NSM provides an interactive systems approach to patient and parental resources, provides information on perceptions of threat to the inner system core of the patients and the communities in which they live, and provides the physician or nurse practitioner with tools to address their concerns. The client exists in an open interactive system that responds to internal or external stressors. These stressors, in pharyngitis, are the symptoms it inflicts, its effects on school, family, and economic systems, and the threat of antimicrobial resistance. The NSM presents a mechanism whereby the patients’ or parents’ concern for the threat of current infection, pain, fever, or dehydration in pharyngitis can be offset by the threat of altering the child’s immune system to protect himself/herself from future infections.

The Neuman Systems Model has been utilized in a variety of clinical settings worldwide (Neuman, 2017). It was developed by Betty Neuman in 1970 to explain the patient health continuum and interactive systems to nurse providers. The dynamic nature of the model was represented in a diagram containing the patient’s flexible lines of defense against threats exterior to the patient’s core and the patient’s lines of resistance against perceived or actual threats (Neuman & Fawcett, 2011). Figure 1 (Appendix B) contains a figure that represents a sample
adaptation of the NSM (1990) diagram to the subject matter of this project. The internal and external environments of the NSM are represented by the child’s ability to combat the pharyngitis infection and the threat of resistant strains arising from the community. In applying the NSM, primary prevention entailed preventing illness, such as measures against GAS contagion; secondary prevention entailed diagnosis and treatment of acute pharyngitis; and tertiary prevention entailed monitoring for recurrence to avoid unnecessary antibiotics in carrier states and the infection of other family members or school peers.

Matthys et al. (2009) found that eliciting the ICE of patients reduced prescriptions for antibiotics, and they called for a model to help providers address disclosed ICEs to avoid prescribing unnecessary medications. The NSM provided a framework for the provider to address parents’ ICES by placing their perceived threat within the context of lines of defense not only from the current infection but also from future threats should their children develop resistance to antibiotics and, subsequently, become unable to fight simple infections in their older years. This framework provided a means for the health care provider to communicate with patients and to assist parents in preserving their children’s ability to fight off infections in their older years. As a systems model, the NSM incorporated multiple aspects of child and family life (school, work, family dynamics, and economics) along with an understanding of parental concerns for the etiology of their child’s symptoms and the effects of antibiotics as described by Jonson and Haraldson (2002). Each major element of the NSM (for example, a reaction and convalescent phase represented by the acute infection and resolution of symptoms, respectively) was applied to the child with acute pharyngitis. The NSM provided guidance for health care providers not just to elicit parent concerns but also to provide them opportunities to use treatment alternatives to antibiotics.
Feasibility Assessment

Several facilitators and barriers to this scholarly project were anticipated and others were not. The principal researcher in this study is familiar with the private practice site and has elicited staff support for other meaningful projects. Rapport was positive with the practice’s health care providers, and management supported the project. Barriers involved challenges to health care provider’s already-acquired knowledge base, disruption of their busy practice flows, provider scheduling to attend the Power Point presentation, and the perceived novelty of complying with evidence-based practice guidelines that recommend backup cultures on negative RADT. Lack of electronic charting prolonged data collection efforts, but the office manager offset this barrier by enabling the use of the office’s electronic practice management system to pull cases from the diagnostic billing codes. The duration of the study was a small challenge to the practice, compared to a longitudinal study. A significant barrier was that the study took place just before the take-over transition phase of another company, which introduced two new part-time staff to the practice to compensate for the full-time nurse practitioner who left the practice. One new pediatrician actively resisted changes in practice and declined to fill the post-test portion of the study, but soon began valuing the project and collaborating.

There were two full-time and three part-time physicians in this study's setting. The providers routinely performed RADT without back-up/reflexive culture, did not perform diagnostic monitoring or negative RADTs, and, at times, prescribed empirically without testing. Nevertheless, they expressed a need to manage patients’ expectations for antibiotics, and they supported the reduction of unnecessary antibiotics. The prescribing rates for pharyngitis cases for these providers were obtained from chart reviews. This convenience sample of cases was facilitated by the practice’s billing program, containing diagnostic ICD10 codes for pharyngitis
key terms (sore throat, pharyngitis, and strep throat), CPT procedure codes for RADT, and throat culture logs. A worksheet containing the ICE patient responses based on the content from the review of the literature was devised in a way that facilitated history intake for the provider in anticipation of the overwhelming feeling of having “one more form to fill out.” Provider resistance to change, in practice, was aided by their frequent availability to answer questions and concerns. A minor barrier for the prospective provider group involved ensuring that supplies were available to facilitate compliance with the established guidelines for testing for GAS. Culture and RADT swabs had to be clipped together to enhance adherence to reflexive culture and reminder logarithm signs for reflexive culture indications created. One out of 61 cases in the post-intervention involved a cash-paying patient who needed a throat culture after a negative RADT test. This patient was given a 75% discount coupon, provided by Labcorp, limiting the cost of this medically necessary test (per IDSA guideline adherence) to less than $10. This limitation was minor, since over 98% of pediatric patients had either Medicaid or private insurance.

The paired physician staffing of the practice necessitated that the Power Point training session be repeated instead of offering the class only once in order to maximize physician attendance. In addition, limited time constraints from pressure to return to patient consults led to post-test knowledge assessments having to be collected days after the presentation, when the provider had time to complete the tests. This prolonged the implementation phase of the intervention in order to capture data from the entire physician study group, but it offered an opportunity to rehash the key elements of the presentation, such as the data from the literature, answer questions, listening to provider thoughts and opinions, and offering a continuing presence that fostered a culture of evidence-based practice.
Data Collection and Analysis

Project Design

This evidence-based project was developed as pre- and post-intervention study of the effects of a provider training session on knowledge and compliance with guidelines for RADT testing using reflexive cultures in children aged 4-15 with pharyngitis and the ICEs of patients. This pre-and-post design was used to measure adherence to the established guidelines, which recommend antibiotic prescribing based on the positive results of RADT or a reflexive culture and the resulting prescribing rates for antibiotics preceding and following the training intervention.

The intervention consisted of training providers on the evidence-based use of RADT, reflexive throat cultures (for negative RADT), and the ICE method. A fifteen-minute Power-Point presentation training session contained specific and concise information on the prevalence of GAS in children, evidence from studies regarding the sensitivity and spectrum bias of RADTs, the futility of clinical scoring systems in the pediatric population, indications for RADT and reflexive culture, and using the NSM to elicit the ICE and respond accordingly. The educational intervention was reinforced by office posters containing key elements of the Power Point presentation, and a copy of the presentation was provided to the physicians enrolled in the study. This created a culture of change toward evidence-based practice for providers and their medical assistants in the office.

Setting

This study took place in a private pediatric practice in a multicultural, densely populated, urban setting in New Jersey. The practice patients comprised approximately 70% Medicaid, 20% private pay, and a maximum of 10% cash paying patients. The daily patient flow averaged
50 patients per day. Most of the patients lived within a short commune from the office, often in extended family or shared communal living, had multiple young siblings, and attended private or public schools or daycare centers. This multicultural setting included a vast majority of Hispanic children, followed by those of Arabic descent and a few Caucasians. Daily consults were managed by two physician providers with the aid of several medical assistants and receptionists. The exam rooms were equipped with worksheets for use on all patients meeting the study criteria (children aged 4-15 presenting with sore throat). This facilitated case identification and data collection, as the office’s practice management system did not have an EMR with meaningful use, so notes and prescriptions had to be retrieved from chart reviews.

**Population and Sampling and Recruitment Strategies**

Medical records of pediatric patients aged 4-15 were pooled in accordance with the peak prevalence of GAS among children in this age group (Bisno, 1996; Cohen et al., 2012). Convenience sampling from the charts was done with the aid of the practice management system containing diagnostic ICD10 key words (*sore throat, pharyngitis, and strep throat*) and CPT procedure codes for RADT. The following related diagnostic differentials were excluded: allergic rhinitis, seasonal allergies, sinusitis, otitis media without pharyngitis, and lower respiratory tract infections. No cases were identified from the billing software with the diagnosis of scarlatina rash. Due to the possibility of alternate microbial etiologies, otitis media was included only when it occurred concurrent with, and as a suppurated complication of, pharyngitis. Upper respiratory tract infection (URI) diagnostic codes were evaluated for the inclusion of pharyngitis symptoms, as the literature readily includes viral pharyngitis in this category. To complete the data collection, all charts listing a chief complaint of sore throat one month preceding and following the intervention were reviewed.
A power analysis was conducted using a power of 80, an effect size of 0.30, and an alpha of 0.05 to determine the number of charts needed to measure rates of antibiotic prescribing, resulting in a total of 83 charts needed for review. Forty-one charts needed to be reviewed preceding the intervention and 42 charts after the intervention. In the winter months, approximately 15-20 daily RADT tests occur in this setting, of which an estimated 5 were positive for GAS. An opportunity for oversampling occurred, resulting in a total of 64 charts pre-intervention and 61 charts post-intervention, for a total sample of 125 cases. The total sampling took place in consecutive months in the Fall of 2017, from the beginning of September to mid-October (prior to intervention) and mid-October to mid-November, before peak winter incidence of GAS was anticipated to occur.

**Measurement Tools and Sources of Data**

Prospective data were collected from charts and the worksheets given to providers for their consultations. Data from previous pharyngitis cases were extracted from the physical charts and decoded for the use of the diagnostic tool and antibiotic prescriptions. Worksheet papers containing the three core ICE values were placed on the chart so that the provider could mark the parent/patient expectations before, during, or after the examination, along with RADT results, culture order, or RADT negative results. In order to facilitate data collection and de-code personal patient data, the worksheets were separated from the patient charts upon the conclusion of each visit. The anonymity of providers and patients was maintained. Identification numbers were assigned to each patient record to protect patient confidentiality. The role of the principal investigator was to provide the educational intervention, administer the pretest and posttest, collect the data worksheets, and conduct pretest and posttest chart reviews for analysis. Appendix C contains the knowledge assessment tests administered before and after the fifteen-
minute PowerPoint training. A sealed box was devised to provide additional confidentiality protection for provider pre-test and post-test data collection.

Data collected were analyzed for their rates of GAS and antibiotic prescribing for the intervention group post-training session compared to control (with the same providers before the intervention). Descriptive and inferential statistics were used to analyze these data. Independent samples and tests were done to determine mean differences between groups. Chi square tests were used to determine the demographic (age, gender, ethnicity, diagnosis) homogeneity of the sample of cases seen by providers pre/post-intervention. Tabulated provider demographic data included age, gender, specialty, medical school location (foreign or domestic), and year of graduation. Paired t-tests were also done on provider pre-/post test scores. Finally, a binomial test was performed to evaluate the success of the intervention.

**Stages for Implementation with Timeline**

- September 2017: IRB approval.
- September - November 2017: Deployment of study.
- 22 office days (Monday-Saturday, from Sept 5- October 4) followed by intervention and pre-test/post-test data collection period, and 26 office days (from October 26- Nov 20) for prospective data collection.

**Evaluation Plan**

The effectiveness of this evidence-based project was evaluated through a statistical analysis of the data collected and a determination of the statistical success of the intervention compared to control. The outcome measure for the intervention (using ICE and RADT with reflexive culture as the independent variables) and the control group (RADT alone as an
independent variable) were the rate of prescribing an antibiotic for pharyngitis (the dependent variable). This was also measured against the existence of GAS. The number of prescriptions as a percentage of total pharyngitis visits was then measured and compared to goal reductions. Additional analysis was conducted to measure changes (if any) in antibiotic prescribing rates, which was aimed at a range of 20-37% of all cases of pharyngitis.

Additional measurements, such as rates of RADT and reflexive cultures on negative RADTs, were compared for both groups using logs of culture send-outs for both intervention and control groups. A reduction in antibiotics in the reflexive culture group would be a positive effect of this study. Consideration of the effects of a higher sensitivity of the culture (which would identify greater cases of GAS) compared to RADT alone may potentially call for additional antibiotics, while a delay period pending results was expected to diminish the immediate decision to use antibiotics for RADT-negative results. Although the addition of the reflexive culture may have imposed variations, the evidence-based training session in this study complied with established guidelines and scientific evidence that strongly recommended its use. The ICE data sheets were also used to identify the most common ICE elements for the patient population in this study's setting. The study was evaluated for its significance in answering the question, "Does RADT with reflexive culture with the ICE method reduce antibiotic prescribing compared to RADT alone?" The measure of the effect was evaluated in terms of a significant reduction in antibiotic rates of prescribing that matched <37%, the upper limit of GAS prevalence in children. Anticipated variances were encountered, such as additional antibiotic prescribing from greater GAS identification and the continued use of RADT without a back-up culture. This was possibly offset by consideration of the delayed prescribing of antibiotics awaiting culture results. A comparative analysis included the ICE, as one of the main
differences in the intervention group was the ICE method for ascertaining and managing expectations of antibiotics. Objectives were met if it was demonstrated that combining RADT, reflexive cultures, and the ICE method resulted in a lower rate of prescribing compared to the usual (RADT alone or no testing) method of practice before the implementation of this evidence-based project.

**Ethics and Protection of Human Subjects**

The principal investigator completed the National Institutes of Health (NIH) Office of Extramural Research certification course, “Protecting Human Research Participants,” in February of 2017. Providers were offered informed consent, as they were the main subjects of the study. The consent form included the following information: (a) a basic background on antimicrobial resistance and the need for evidence-based diagnoses of pharyngitis; (b) the purpose of the project; (c) a description of the risks and benefits of participation, including no association with employment status or loss of job as a result of participating in or declining to participate in the study and no results obtained from the study impacting their performance evaluation or job sustainment; (d) assurance of volunteer, non-compensated, non-coerced participation; (e) assurance that anonymity and confidentiality are protected, especially regarding the disclosure of individual practitioner’s prescribing patterns; (f) allowance for refusal to participate in and/or stop participation at any time without penalty; (g) name and telephone number of the principal investigator; (h) a signature line for participants and witnesses; and (i) resources should they become distressed by the study, although the study was classified as not providing any stress that would be otherwise normally encountered in every-day life.
**Budget**

The project did not incur significant expense to the practice, as RADT was already in place and is largely covered by health insurance. RADT and culture swabs were provided by Labcorp at no cost to the office. The principal investigator provided the data collection, incurring no costs. No financial incentives were provided to staff. Labcorp provided their usual 75% discount coupons for occasional cash-paying patients, minimizing the effects of a financial expense.

**Support, Sustainability**

The continued use of RADT and a culture was considered sustainable based on lack of problems with insurance coverage for these tests and their low price for cash paying patients. The practice replenished its RADT and culture supplies daily as usual office supplies. Gathering the ICEs of patients, along with diagnostic testing, was proposed for incorporation into standard operating procedures for pharyngitis, especially during periods preceding increased seasonal prevalence. One of the providers commented on a need to modify the worksheet based on the most common elements found in the practice's patients/parents.

**Plans for Dissemination of Outcomes**

The results of these findings were disclosed in a poster presentation format at the National Hispanic Association New Jersey Chapter conference at Rutgers University, College of Nursing on December 9th, 2017. Key findings will be incorporated into charts for display at the practice settings of participating providers, managers, and support staff. Future publication is planned in a peer reviewed medical/nursing journal and may involve the implementation of the Betty Neuman Systems Model in the management of ideas, concerns, and expectations of the parents of children with pharyngitis.
CHAPTER IV

RESULTS

Data Analysis

Quantitative data from the instruments and demographic questionnaire were analyzed using SPSS for descriptive and inferential statistical analysis.

Demographics of Provider Study Sample

The providers who participated in the project were titled “study team.” A distribution of their demographic and educational background is shown in Table 2 (Appendix E). The study team consisted of a total of five providers (three full-time and two part-time). The full-time providers consisted of a 72 year-old Arabic male pediatrician graduate from a foreign medical school in 1972, a 43-year-old African female pediatrician graduate from a United States medical school in 2001, and a 32-year-old Arabic male pediatrician graduate from a foreign medical school in 2012. Unlike the other providers, who had completed their residencies more than ten years prior to the study, the latter provider had completed his pediatric residency within the last year. The part-time providers consisted of a 70-year-old Hispanic female pediatrician, graduate of a foreign medical school in 1972, and a 36-year-old male family physician graduate from a U.S. medical school in 2008. The older pediatricians in the group had been in private practice for over 40 years. A demographic description of the provider sample by age, gender, and ethnicity is presented in Table 3 (Appendix F). The mean age for the providers was 50.6 (SD = 17.036). Most (60%) of the providers were male, and 40% were female; most (60%) were Arabic, 20% were Hispanic, and 20% were African.
Demographics of Total Sample

A total of 125 cases were collected. Overall, patients ranged in age from 4 years to 15 years, with a mean age of 9.48 (SD = 3.21). The mean age for the pre-intervention sample was 9.73 years (SD = 3.16) and the mean age for the post-intervention group was 9.21 years (SD = 3.27), as shown on Table 4 (appendix G). A t-test was conducted to determine if the difference in the mean ages differed significantly from zero, and it did not (t = .906, df = 122.21, p = .37).

The majority of children (n = 74, 59.2%) were Hispanic, followed by Arabic (n = 39, 31.2%), and Caucasian (n = 12, 9.6%). More than half of the sample (51.2%) were males (n = 64), with females comprising 48.8% of the total sample (n = 61). The sample was also examined for age 9 and older in order to evaluate the variations by risk for GAS identified in the literature (Cohen et al., 2012). This sample breakdown consisted of 67 children aged 10 or older (53.6%) and 58 (46.4%) 9 or under. Only 32 children of the total sample (25.6%) were positive for GAS.

Demographics of Sampled Cases by Intervention Group

Chi-square testing was done to determine whether the pre-intervention sample was significantly different than the post-intervention sample. Chi-square tests are recommended when comparing two categorical variables. The sampled cases were divided into pre-intervention and post-intervention sampling groups and analyzed for age, ethnicity, and gender in order to assess the homogeneity of the samples and, subsequently, to draw comparisons. On all demographic variables, there were no differences between the pre- and post-intervention groups.

Pre-intervention (control group) data consisted of 64 cases. The majority (n = 37, 57.81%) were age 4-9, and 27 (42.19%) were 10-15 years old. Ethnic variations included a majority of Hispanic (n = 37, 57.81%), Arabic, (n = 19, 29.69%), and Caucasian (n = 8, 12.5%). The pre-intervention sample consisted of 35 males (54.69%) and 29 (45.31%) females.
The post-intervention group consisted of a total of 61 cases with a similar breakdown in age, ethnicity, and gender compared to the control. Thirty cases were between the ages of 4-9 (49.18%), and 31 (50.82%) were between the ages of 10-15. A Pearson’s chi-square was computed to determine whether the ages of the patients in the groups were significantly different, and they were not \( (X^2 = .94, df = 1, p = .33) \). During the intervention, 37 (60.66%) patients were Hispanic, 20 (32.79%) were Arabic, and only 4 (6.56%) were Caucasian. A Pearson’s chi-square was computed to determine whether the ethnicities of the patients in the groups were significantly different, and they were not \( (X^2 = 1.29, df = 2, p = .53) \). In terms of gender, in the intervention group, 32 (52.46%) were female and 29 (47.54%) were male. As for the other demographic variables, a Pearson’s chi-square was computed to determine whether the ethnicities of the patients in the groups were significantly different, and they were not \( (X^2 = .64, df = 1, p = .42) \). Finally, 15 of the pre-intervention groups were positive for GAS (23.43 %) compared to 17 (27.87%) in the post-intervention group. A Pearson’s chi-square was performed and there was no difference in the presentation of a positive strep test between the samples \( (X^2 = .32, df = 1, p = .57) \). Thus, both the control and intervention groups were homogenous for all of the measured demographic variables. Percentages for the subgroups described above and percentages of the total sample for each demographic variable pre- and post-intervention are shown in Table 5, Appendix H.

**Pre-test and Post-test Results**

Four clinicians participated in the pretest, the educational intervention, and the post-test. A paired sample \( t \)-test was performed on the staff’s educational pre- and post-tests to determine if there was a mean different in scores. At pretest, the average score was 34.63% \( (n = 4, SD = 9.88) \); at post-test, the average score was 53.75% \( (n = 4, SD = 12.66) \). The differences in these
mean scores was 19.12%. The pre- and post-test group scores (using the critical value 1.943) were statistically significant ($t = -2.3822$, $df = 6$, $p < .05$), as shown in Table 6, Appendix I. Based on these statistical results, clinicians showed improvement in their understanding of the significance of RADT testing with reflexive culture, incidence of GAS, and the ideas, concerns and expectations of patients.

In order to determine the specific areas of knowledge regarding test content, scores for the pre-test ($n = 5$) and post-test ($n = 4$) results were also described for each study question. The greatest positive differences were found in the degree of RADT sensitivity in sole testing in children, ICE effects on the consultation, and magnitude of antimicrobial resistance and percentage of unnecessary antibiotics (Table 7, Appendix J). Most test questions were the recanting of facts from the educational intervention based on research findings.

The recently-graduated provider demonstrated initiative to explore the new sources of information, while the older graduates from medical school demonstrated disagreement (not necessarily lack of knowledge) with the facts provided on the test questions, derived from the review of literature. Going over the test questions provided an opportunity for the providers to verbalize the practice change and ongoing education during the intervention period of data collection. For example, provider practices involving the empirical prescribing of antibiotics without reflection on negative RADTs were discussed by comparing results to the greater sensitivity of RADT in the adult population.

The most persistent and prevailing provider error on the assessments was disbelief that parents did not want antibiotics as the primary reason for the visit. This was re-encountered in the implementation portion of the project when worksheets revealed the ICEs of patients. Providers often felt prepared to counteract parental requests for antibiotics by imposing parent
education on the futility and dangers of antibiotics. By observing and following up on both RADT results and the reflexive cultures (the practice's policy is to contact the parents on results), the providers began to observe the unexpected identification of GAS, improving their diagnostic accuracy. All providers stated the importance of protecting patients, for future immunity, from unnecessary antibiotic exposure. Chart reviews consistently reflected provider documentation of supportive measures (saline nose drops, cough medications, and fluids) instead of antibiotics, consistent with the application of Neuman Systems Model’s interventions toward the resumption of normal lines of defense. The test question dealing with this model, however, did not capture physician's understanding enough to be considered a fair question for this short presentation given to physicians newly familiar with the topic. Only one of the physicians seemed to have understood the nature of the question, and more time was needed to teach all segments of the system this model of care.

**Antibiotic Prescribing Pre- and Post- Intervention**

A chi-square test was done to test for any association between completing the intervention and prescribing antibiotics. Prior to the intervention, 60.5% \((n = 26)\) of patients were prescribed antibiotics, and 39.5% \((n = 17)\) were prescribed antibiotics after the intervention. Although this was not a significant statistical reduction \((X^2 = 2.25, df = 1, p = .13)\), it did meet the goal of reducing the rate of antibiotic prescribing to approximate the highest rate of pediatric prevalence of GAS (37%), reported by Shaikh, Leonard, and Martin (2010).

Further evaluation of diagnostic accuracy and appropriate antibiotic prescribing behavior was also done. A binomial test was performed to test the hypothesis that participation in the intervention would significantly change the rates of prescribing antibiotics for patients in the sample. Binomial testing is appropriate for testing hypotheses when the variables being
considered are counts and the following conditions apply: the observations are independent of one another, there are two possible outcomes (i.e., success or failure), and the probability of success is known and constant. In the current study, each patient was completely independent of the other. That is, strep diagnosis and treatment in one patient did not impact the others. In this study, success was defined as a patient being prescribed antibiotics only when he/she had GAS and not being prescribed antibiotics when both GAS tests (RADT and culture) were negative. All other situations were considered failures. Finally, the known probability of success was defined as the proportion of success prior to intervention, as is consistent with accepted statistical practices (Zeitlin & Auerbach, in press).

Prior to intervention, 15 out of 64 patients (23.4%) tested positive for GAS and 26 patients (40.6% of this sample) were prescribed antibiotics (Figure 2, Appendix K). In the intervention phase, 17 out of 61 patients (27.9% of the sample) tested positive for GAS and 17 were prescribed antibiotics (27.9% of the sample) (Figure 3, Appendix L). Thirteen patients who did not have GAS were prescribed antibiotics \((n = 9)\); (10.4% of total sample). Of those 13 patients, 12 were prescribed antibiotics prior to the intervention (18.8% of the pre-intervention sample), while only 1 was prescribed antibiotics after the intervention (1.6% of the post-test sample). In the pre-intervention phase, 12 patients who either were not tested for GAS or whose test results were negative were prescribed antibiotics (18.8% of the pre-intervention sample), and there was 1 such patient in the post-intervention group (1.6% of the post-test sample). During the pre-test phase, the success rate was 79.7%, while in the intervention phase it was 96.7%. The binomial test was then used to determine whether these rates of success were significantly different, and they were \((p = .00)\). The 95% confidence interval for the population’s rate of post-intervention success ranged from 88.7% to 99.6%.
As diagnostic accuracy was increased, appropriate antibiotic prescribing occurred, resulting in a 17.2% decrease in unnecessary antibiotic exposure. The overall rate of antibiotic prescribing was reduced from 40.6% pre-intervention to 29.9% post-intervention, meeting the goal of reducing antibiotic prescribing rates to the prevalence rate (20-37%) reported in the literature (Figure 4, Appendix M). This reduction (compared to the national average of 65%) was also congruent with the national CARB goals of reducing unnecessary antibiotics by 2020.

**Ideas, Concerns, and Expectations**

None of the pre-intervention samples had any patient/parent ideas, concerns, or expectations documented, either on the yellow intake form or in the chart review. In the post-intervention group, there were several items marked for each of the ICE components corresponding to the ideas, concerns, and expectations documented for cases of sore throat. The most common ICE elements are depicted in Table 8 (Appendix N). Out of 61 post-intervention cases documented on the intake sheets, 39 showed “it could be a Strep;” 15 showed “it is an infection;” 11 showed “it could be viral;” and 6 were marked “patient caught it from a family member.” The most common parental concerns documented were pain (24), concern for a family member getting infected (15), fever not going away (14), and poor appetite (7). Additional items of concern were lack of sleep the previous night (3) and child not acting like his/her normal self (2). The most common items documented for expectations were wanting the child to get better (32), test for strep (18), need to know if it is strep or not (15), medication for pain (9), and note for school (8). Only 5 out of 61 cases had documented an expectation for antibiotics. Out of the five cases that had requested antibiotics, four of them had ideas that antibiotics would cure the infection, but only two received antibiotics based on positive RADT results, and one of these was a positive HIV child with recurrent pharyngitis. This supports
Matthy’s (2013) report that expectations for reassurance and explanation of symptoms, rather than obtaining antibiotics, compromise expectations of the physician encounter, and that disclosing the child's ICE actually leads to fewer antibiotics prescribed (Matthys, 2013).
CHAPTER V
DISCUSSION OF FINDINGS/OUTCOMES

Limitations

The results of this evidence-based project were congruent with Legare et al.'s (2012) study showing that combining provider training with communication skills can reduce antibiotic prescribing. The reductions of unnecessary prescribing also added to the few studies regarding the use of ICE to reduce unnecessary antibiotics for respiratory tract infections in outpatient settings (Matthys, 2013). The findings were also consistent with the study by Cabral et al. (2016) that showed that disclosing parental expectations reduces the use of antibiotics. The findings about the diagnostic accuracy involved in identifying and treating GAS and not prescribing antibiotics in the absence of GAS were also in line with previous studies (e.g., Woodburn, 2007) that encompassed nearly 60,000 patients in a year. The comparatively limited sample size of this project limited its extrapolation to comparatively large populations, but the findings contributed to a larger body of knowledge.

Although each set independent variables (the ICE method and RADT with reflexive culture) showed results that were consistent with the literature, this project was the first to combine both methods. It is possible that doing so may have provided a synergistic effect, as tools for diagnostic accuracy (RADT and culture swabs clipped together at the bedside) and less pressure to prescribe may have ensued with the use of the intake sheets (on which alternate expectations instead of antibiotics could be marked) during the consultation. A qualitative study would possibly reveal provider feelings of relief in this case. The limiting factors in this study were primarily its short duration just prior to the winter, when the prevalence of GAS is typically higher. A year-round study comparison of several practices with similar populations would encompass more cases for a regression analysis to take place.
Additionally, diagnostic accuracy was reflected in the degree of missed GAS cases based on RADT. Without a reflexive culture, an expected 14/100 cases would be missed (Cohen, 2016). In this evidence-based project, only one patient in the intervention group was not treated for GAS upon initial evaluation. The limiting factor in drawing comparisons was that the actual presence of GAS in the pre-intervention group was not known due to lack of back-up cultures.

This study is also limited to a pediatric population aged 4-15. Younger children may have other pathogens and conditions, such as otitis media, not caused by GAS, and IDSA guidelines do not require reflexive cultures to be administered on adults. There were a few cases of teenagers older than 15 who were excluded from the total sample.

Other drawback of the study's design were the short duration of the training interventions, which took place during work days in a busy practice, and difficulties scheduling providers to attend the training. The pre/post-test was based on recanting the facts from the presentation and understanding the meaning of the questions. The test, however, became a teaching tool in itself, as providers learned the rationale behind the correct answers.

Finally, the pre-intervention sample may reflect a high rate of antibiotics due to the established practices of foreign trained senior physicians in private. Even though the literature described older and foreign trained physicians as having more tendencies to prescribe antibiotics (Cohen et al, 2012), this small mixed population of physician providers demonstrated that a change in antibiotic prescribing practice is possible. Extensions of this project could incorporate nurse practitioners, medical residents, and physician assistant providers for an analysis of the magnitude of its effect. It is also possible that prescribers may over-read RADT results, which may result in a rate of prescribing at the higher range of the anticipated prevalence of 20-37%.
Nevertheless, the time of the study reflect a transition into the winter months, when cases of GAS are more numerous.

**Implications for Practice and Future Research**

The successful outcomes of this evidence-based project (increased diagnostic accuracy and reduction in unnecessary antibiotics for pediatric pharyngitis), warrant consideration of the application of the dual method of RADT with a reflexive culture and the ICE for pediatric pharyngitis.

Future test tools, with inter-rater reliability using experts in the field, can be developed with fewer questions presented to providers and interactive digital devices used as the actual teaching tool. This would get to the point of diagnostic criteria and prevalence, and it would introduce the ICE and use the remaining time to demonstrate communication skills to ascertain the ICE and use the NSM to address the responses. Two of the providers related stories about their Pediatric Board simulations that limited their patient intake histories to 5-10 minutes. It would be useful for a future study to measure the duration of each visit involving the ICE to determine if it entailed significant additional time, something the providers were concerned about during the initial implementation phase. More education and research is recommended overall for training providers on dealing with the ICEs of patients. This can be accomplished through audio-visual communication training with the Neuman System’s Model as a guiding framework of assessment and intervention. Nurse practitioner providers who receive theoretical models of care as part of their training can also assist physician providers to understand and implement the NSM or other systems into the practice by disclosing its content in the practice setting or via publication in interdisciplinary journals. Although the intervention group received fewer antibiotics, including unnecessary second-line antibiotics, some children did receive
second-line antibiotics without justification. Future training interventions must include preserving alternate or second-line antibiotics in order to minimize the risk of developing antimicrobial resistance to broad-spectrum antibiotics.

Future research should also encompass the number of children in each category that are positive for GAS in this urban, multicultural population. During the course of data collection, several physician providers in the study related a perception that there was more GAS in the study population than the national average due to the multi-family living arrangements of both Hispanic and Arabic immigrant families representing the patients in this setting. A longer study containing information regarding the actual living arrangements of the patients would have to be conducted to draw conclusions about practices with similar populations.

Sustainability of the effective results found in this project, especially for new health care providers coming into the practice setting, can be established with the use of an evidence-based guideline for pharyngitis. An algorithm previously published by this author (Ellis & Camacho, 2013), can be used to guide the distinctive use of RADT and cultures in the pediatric population, and to differentiate it from its use in the adult population (Figure 5, Appendix O). Finally, policies should be put into place that increase adherence to this guideline and incorporate working sheets into the templates or notes for providers to use on all patients.

Conclusion

Antimicrobial resistance can be prevented by reducing patient exposure to unnecessary antibiotics. The aim of this evidence-based project was to decrease the rate of unnecessary antibiotics for pharyngitis by implementing a training session on the prevalence, spectrum bias, and diagnostic modalities enabling the implementation of the 2012 IDSA Guidelines for the Diagnosis and Treatment of Pharyngitis. The use of bedside testing using RADT and reflexive
culture along with the ICE of patients provided a successful method to narrow the gap between evidence-based guideline recommendations, the prescribing of antibiotics for pediatric pharyngitis, and reduced rates of antibiotic prescribing not only to match the prevalence rate of GAS but also to improve diagnostic accuracy and the appropriate prescribing of antibiotics. Recommendations for future work include the use of digital media interactive test questions, exploration of all the components of the NSM for addressing the ICEs of patients, and short video simulations to optimize the time required for provider training.
References


Doi:10.1371/journal.phone.0172871


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**APPENDIX A**  
**EVIDENCE TABLE**

**Table 1**  
Evaluation Table of Studies

<table>
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<tr>
<th>Author, Year and Title</th>
<th>Theory Base</th>
<th>Design &amp; Method</th>
<th>Number, Attrition</th>
<th>Independent &amp; Dependent Variables</th>
<th>Measurement Scales</th>
<th>Data Analysis</th>
<th>Findings Limitations</th>
<th>Levels of Evidence Hierarchy and Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohen, J. F., Bertille, N., Cohen, R., &amp; Chalumeau, M. (2016). Rapid antigen test for Group A 67 physican67s67s in children with pharyngitis. <em>Cochrane Database of Systemic Reviews, 4</em>, CD010502.</td>
<td>Medical focus</td>
<td>Literature search Meta-analysis Estimated summary</td>
<td>98 studies from 1980 to 2015 116 test evaluations 101,121 participants Children to age 21</td>
<td>Sensitivity and specificity, and Heterogeneity across studies</td>
<td>Data extraction using QUADAS-2 tool</td>
<td>Bivariate analysis Multiple table comparisons</td>
<td>RDT summary Sensitivity 85.6% CI [83.3-87.6] Specificity 95.4% CI [94.5-96.2] Heterogeneity not explained by culture medium, symptom severity or GAS prevalence EIA and OIA types of RADT had comparable sensitivity (85 &amp; 86.2 %) In studies with all cultured, GAS prevalence was 29.5%. Limited by Different methods across studies In 100 children with GAS, 14</td>
<td></td>
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</table>

| Medical focus | Prospective, multicenter, in France, from 2009-2011 Hospital throat culture is reference test | 807 children, excluded those with lost or unreadable swab results, residual 785 sample | GAS inoculum GAS specific immune-chromatographic strip assay and agar plating RADT result | Culture medium Mc Isaac scores RADT results | Chi square Binomial model for combining spectrum effect and inoculum size, Wald test between inoculum size ad McIsaac score | 10% children will have GAS undiagnosed by RADT sensitivity affected by light inoculum size. A policy of RADT only without culture is applicable to populations low incidence of complications from GAS |

III

<table>
<thead>
<tr>
<th>Medical focus</th>
<th>Case cohort</th>
<th>Sensitivity</th>
<th>RADT Culture</th>
<th>Univariate analysis</th>
<th>RADT sensitivity higher for symptomatic children (89% vs 41%), children &lt;9 than 9 or older (88% vs 79%), and those with heavy inoculum (94% vs 53%). RADT results influenced by physician (higher sensitivity if hospital &amp; private practice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruited October 2010 to May 2011 714 symptomatic kids 250 asymptomatic</td>
<td>RADT for symptomatic &amp; Asymptomatic Age child Physician</td>
<td>Multivariate multilevel model</td>
<td>Univariate analysis with chi-square, Multilevel logistic model, Multivariate multilevel model</td>
<td>IV</td>
<td></td>
</tr>
<tr>
<td>Medical focus</td>
<td>Systematic review and prospective multicenter external validation, MEDLINE &amp; Embase (1975-2014) Validated against prospective cohort (2010-2011) Divided children into low (no test no antibiotic) Intermediate RADT, antibiotic if positive) and high risk for GAS (empiric antibiotic)</td>
<td>1272 articles Full text 38 reports assessed 8 final articles included With median 313 sample per study</td>
<td>Rules based strategy for selective RADT RADT</td>
<td>6 clinical prediction rules followed by RADT</td>
<td>QUADAS clinical prediction modules. Clinical prediction rules</td>
</tr>
</tbody>
</table>
prediction rules to select children for RADT testing. Only 8/1413 studies accepted for review, pertaining to pediatric population, representing 8 clinical prediction rules. Centor score not listed.
<table>
<thead>
<tr>
<th>Medical focus</th>
<th>Multi-centers</th>
<th>Prospective Cross-sectional</th>
<th>Designed predictive model based on symptoms</th>
<th>678 children, 1 un-interpretable results 1 lost sample Mean age 6.1</th>
<th>Efficiency of clinical symptoms for selective testing for RADT</th>
<th>Clinical prediction model (computerized) RADT Culture</th>
<th>Model calibration optimism corrected index 0.73 Logistic regression</th>
<th>Culture GAS+41.4% RADT could be avoided in 6.6% of participants (95% CI [4.7,8.5]) Support RADT test for all children with sore throat</th>
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</thead>
</table>

**Medical focus**

- Systematic review and meta-analysis

**Multi-centers**

- Prospective Cross-sectional

**Designed predictive model based on symptoms**

- 678 children, 1 un-interpretable results 1 lost sample Mean age 6.1

**Efficiency of clinical symptoms for selective testing for RADT**

- Clinical prediction model (computerized) RADT Culture

**Model calibration optimism corrected index 0.73 Logistic regression**

- Culture GAS+41.4% RADT could be avoided in 6.6% of participants (95% CI [4.7,8.5]) Support RADT test for all children with sore throat

<table>
<thead>
<tr>
<th>Medical focus</th>
<th>Systematic review and meta-analysis</th>
<th>59 studies 55,766 patients 43 studies and 18,464 met inclusion criteria 10,325 children</th>
<th>RADT Sensitivity and specificity</th>
<th>RADT Culture as reference standard</th>
<th>Heterogeneity</th>
<th>RADT had higher heterogeneity /inconsistent sensitivity (88%) and specificity (86%) in children RADT not sensitive or specific enough for children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edmonson, M. B. &amp; Farwell, K.R (2005). Relationship between the clinical likelihood of Group A streptococcal pharyngitis and the sensitivity of a rapid antigen-detection test in pediatric practice. <em>Pediatrics, 115</em>(2), 280-285.</td>
<td>Medical focus</td>
<td>Blinded chart review</td>
<td>Lab logbooks</td>
<td>RADT Clinical likelihood of GAS</td>
<td>Pre-test likelihood of GAS using McIsaac scores</td>
<td>Pre-test likelihood of GAS using McIsaac scores</td>
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<tr>
<td>Fine, A. M., Nizet, V., &amp; Mandl, K. D. (2011). Improved diagnostic accuracy of Group A streptococcal pharyngitis with Epidemiologic focus</td>
<td>RTC Adjusted Center scores according to bio surveillance report over 132,821 patient encounter across 6 states, in Minute clinics Included</td>
<td>RADT testing selection based on surveillance</td>
<td>Live bio surveillance RADT &amp; Culture</td>
<td>Pearson correlation Recent Local Proportion Positive (last 14 days positive for</td>
<td>NNT to detect each additional GAS is 7.2 Minute clinic less acutely ill Biosurveillance improves accuracy in</td>
<td>II</td>
</tr>
</tbody>
</table>
use of real-time biosurveillance. Annals of Internal Medicine, 155(6), 345-352.

Las 2 weeks preceding patient visit <15 (82,062) GAS.

GAS) determining if a symptomatic patient has GAS. Used Centor score adjusted.
| Ehrlich, J. E., Demopoulos, B. P., Daniel, K. R., Rocarte, M. C., & Glied, S. (2002). Cost-effectiveness of treatment options for prevention of rheumatic fever disease in a pediatric population. *Preventive Medicine, 35*(3), 250–257. | Economic Systemic Review | 14 studies published from 1951-1999, Cost of 5 strategies to prevent RHD in children 5-17 yrs. Treat none Treat all Treat RADT + Culture all, treat + RADT & reflexive culture no details of how data was combined cost per 5 million children/year | Direct costs of throat culture estimated from New York City Hospital microbiology and cost of treatment of complications was derived from Children’s Hospital of Philadelphia Cost per 5 million children/year $39 million - none $211.8 million treat all $100.8 million RADT $252 culture $269 RADT and culture Cost per study population not clear on the magnitude of the sample Not clear how the estimated cost and benefit was calculated |
| Griffin, S., Kinmonth, A., Veltman, M. W. M., Gillard, S., Grant, J., & Stewart, M. (2004). Effect of health-related outcomes of interventions to alter the interaction between patients and practitioners: A systemic review of trials. *The Annals of Family Medicine, 2*(6), 595–608. | Psychosocial focus | Systematic review MEDLINE HealthSTAR and PsycINFO | Studies through 1999 | Health related outcomes Interaction between patients and practitioners | Review | % effect of interaction on outcome | In 73% (22/30) trials, interventions on the patient-practitioner interaction affected outcome. With a positive effect 44% of the time. Simple approaches such as providing a note from patients about their concerns beforehand showed promise as well as programs that paid attention to patients emotions |
| Medical focus | Retrospective study, from Jan 2002-March 2002 Lab records consecutive pediatric patients who underwent RADT | 589 children 28 excluded d/t test performed at follow up visit | RADT Disease severity based on Centor scores | RADT color immunochromatographic dipstick assay | Cultures obtained in sheep blood agar plates | SAS 8.2 software (SAS Institute, Cary, NC) Stratified children into 4 groups based on Centor scores, with score 3 & 4 combined | 8% of negative RADT results were positive on culture Overall prevalence 27% GAS Prevalence GAS for scores; 0 = 18% Score 1 = 16% Score 2= 32% Score 3 or 4=50% Cultures from RADT negative patients, assume RADT cultures would have been + |
| Hoare, K. J., Ward, E. & Arroll, B. (2016). International sore throat guidelines and international medical graduates: A mixed methods systematic review. *Journal of Primary Health Care, 8*(1), 20–29. | Generated theory that New Zealand international recent graduate unaware rates of New Zealand problem | Mixed methods Systemic review Medline, Google scholar, Trip, NHS for guides For NZ statistics and practicing new foreign graduates NZ Ministry Health, 3 out of 59 citations | 20 of 26 guides met AGREE criteria 3 of 59 for | Guideline recommendations New Zealand RF Knowledge international graduates | Comparison charts | AGREE appraisal RAMESES search | New Zealand has 41% foreign medical graduates who operate under international guidelines for sore throat, but NZ guides are different due to higher rate of RF RF rates not matched by guideline per country |
| Kumar, S., Little, P., & Britten, N. (2003). Why do general practitioners prescribe antibiotics for sore throat? Grounded theory interview study. *BMJ, 26*, 1–6. | Grounded theory | Qualitative interview study Identified each interview script with published concepts | 40 general practitioners, 25 maximum variety sample 15 theoretical sample | Reasons prescribe antibiotics | Face to face open ended questions audiotaped | Constant comparative analysis | Prescribers estimated they prescribe fewer than 1 in 10 to max of half of patients with sore throat, for sicker economically deprived background, pressured |

| Health Belief Model | Qualitative | 7 focus groups 30 semi-structured interviews Parents of children 5 months to 17 years, range socioeconomic backgrounds | Per HBM: Illness severity Illness susceptibility Self-Efficacy | Semi-structures interviews with set guiding questions | Descriptive tables analysis or transcribed recordings | Parent concerns involve perceived severity, susceptibility of their child to illness and parents perceived self-efficacy | VI |

- **Systemic Review Meta-analysis**
- **EMBASE MEDLINE**
- **48 of 159 studies from 1996-2013**
- **Included RADTs using throat culture on blood agar**

<table>
<thead>
<tr>
<th><strong>Sensitivity</strong></th>
<th><strong>Specificity</strong></th>
<th><strong>RADT</strong></th>
<th><strong>CI</strong></th>
<th><strong>RADTs</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.86, 95% CI [0.83-0.88]</td>
<td>0.96, 95% CI [0.94-0.97], similar for pediatric Low RF Settings. May not need Back up Culture Different methods Across studies</td>
<td>Throat culture</td>
<td>RADTs</td>
<td>0.86, 95% CI [0.83-0.88]</td>
</tr>
<tr>
<td>Legare, F., Labrecque, M., Caucho, M., Castel, J., Turcotte, S., &amp; Grimshaw, J. (2012). Training family physicians in shared decision-making to reduce the overuse of antibiotics in acute respiratory infections: A cluster randomized trial. <em>Canadian Medical Association Journal, 184</em>(13), e726–e734.</td>
<td>ICE</td>
<td>RTC Clustered at level family practice teaching unit, with 2 arms: Decision+2 and control</td>
<td>181 patients, 77 physicians</td>
<td>Antibiotic prescription Training Decision +2 or control</td>
</tr>
</tbody>
</table>

| Medical focus | RTC | 820 children in 2 year period, 270 diagnosed by clinical picture only | Prescribing with and without access to RADT (private and hospital access) | RADT culture | Chi square and ANOVA p values | Pediatrician without access to test prescribed more antibiotics than those with access (72.2% vs 28.2, \( p < .001 \). Private practice pediatricians prescribed more than hospital based (55.7% vs 19.9%, \( p < .001 \)). | II |
| Mangione-Smith, R. E., R. E., Elliott, M.N., McDonald, L., Heritage, J. & McGlynn. (2004). Racial/ethnic variation in parent expectations for antibiotics: Implications for public health campaigns. *Pediatrics, 113*(5), e385–e394. | Psycho-social | Cross-sectional study pediatric visits 2000-2001 | 38 pediatricians (64% participation rate) 543 consecutive parents (83% response rate) | Antibiotic expectation: Likelihood of bacterial diagnosis Antibiotic prescriptions in lieu of perceived expectations | Likert scales Surveys all in English | Multivariate logistic regression | Latino and Asian parents were 17% more likely than white parents to expect antibiotics. Hispanics were 43% more likely to worry about their child’s symptoms compared to white parents (17%). Up to 80% non-white Hispanic parents expected an antibiotic compared to white counterparts (51%). Hispanic parents had a higher expectation of antibiotics and providers diagnosed ... |
more infections as bacterial and prescribed more antibiotics when they perceived parental expectation for them ($p < .05$). Study compares various ethnic groups in community and HMO clinics in California.

| Patient centered | Cross sectional 39 GP trainees underwent observational training (role playing and video-training) to observe and record ICE | 36 teaching practices affiliated with University of Ghent, Belgium. All patient consulting and their doctors, new and follow up visits 350 New consultation 263 follow up consultations | ICE identification Prescriptions | Observational Reasons for visit categorized per International Classification of Primary Care (ICPC) | Inter-observer reliability score for ICE 0.87 (excellent) SPSS statistical analysis Logistic regression for presence or absence of medication Fisher’s extract for proportion comparisons | New contacts: concerns ($p = .037$), OR 1.73, 95% CI [1.03, 2.9], expectations ($p = .009$, OR 2.0, 95% CI [1.2, 3.4]) was associated with not prescribing a new medication. Subsample on antibiotics showed similar results. | III |

| Spinks, A., Glasziou, P. P., & Del Mar, C. B. (2013). Antibiotics for sore throat. *Cochrane Database of Systematic Reviews, 11*, CD000023. | Medical focus | Meta-analysis | 27 RTCs out of 61 met criteria 12,835 cases sore throat children & adults | Stratified data from confirmed GAS cultures. | Pooled data on forest plot. | OR/CJ Forest plot | Antibiotics shorten symptom by 1 day, can reduce chance RF by 2/3 in high risk communities scant parts world. Antibiotic reduced symptoms 3rd day (RR 0.58, 95% CI [0.48-0.71]), compared to negative throat swabs (RR 0.78, 95% CI [0.63-0.97]). 7th day: Positive swabs had RR 0.29, 95% CI [0.12-0.70] compared to Negative swabs (RR 0.73, 95% CI [.50, 1.07]). Many required to prevent suppurative And non- |
suppurative complications for 1 person to benefit in high income countries
Antibiotics shortened duration of sore symptoms by 16 hours. Limited by few recent trials, only 3 since 2000, NNT may be lower in low income countries
| Spurling, G. K., Del Mar, C. B., Dooley, L., Foxlee, R., & Farley, R. (2013). Delayed antibiotics for respiratory infections. *Cochrane Database Systems Review, 4*, CD004417. | Medical focus | Data synthesis from pooled high quality studies (4) Blinded data pool without knowledge of test results | 4 high quality studies | Differentiates by infection type OR and CI Variables: Fever, Malaise, Throat pain, Patient satisfaction, Delayed vs immediate Antibiotic | Differentiates various types respiratory infections | Chi2 and I2 | Throat pain reduced by 3rd day in immediate antibiotic group in one study, but not significantly different among all studies. Fever reduced on 3rd day by immediate antibiotics (pooled OR 0.53, 95% CI [0.31-.74]) but number of days with fever was not different in one study. No difference in clinical outcome Patient satisfaction greater with immediate antibiotics, delayed or no antibiotics achieved 80% |
None | National surveys from 2012-2013 | 4703 surveys distributed to US consumers in 2012 (86% response, n = 4044) and 4420 in 2013 (79%) | Total US consumers (all ethnic groups) vs Hispanic consumers Beliefs regarding the value of antibiotic to help their colds. Health care | Health Styles national-random Estilos surveys from recruited Hispanics via QueOpinas media ads DocStyles surveys recruitment with nominal fee | Comparison charts Percentage of responses | Hispanic consumers were more likely than US consumers to believe antibiotics cured colds (48% vs 25%) and were more likely to obtain them from grocery store (23% vs 5%).

Satisfaction. Delayed antibiotic reduced antibiotic use. Favors delayed antibiotic, OR 0.00, 95% CI [0.00-0.02]. Malaise less on 3rd day, not different in another. Few studies Conflicting results in some outcome measures.

| providers | response rate, \( n = 3502 \) | 2609 Hispanic consumers (38% response, \( n = 1503 \)) | 3149 health care providers (48% response, \( n = 1503 \), including 1001 adult and family physicians, 252 nurse practitioners, 250 pediatricians) | providers perception of patient expectations of antibiotics | 54% providers believed patients expected antibiotics but only 26% of all consumers reported this expectation |
APPENDIX B

Figure 1. Using the Neuman Systems Model to Evaluate and Treat Children with Pharyngitis

**Primary prevention:** Hand hygiene, not sharing glasses, toothbrushes, prevent resistance to antibiotics, protect lines of defense

**Secondary prevention:** Assess etiology & ICE, Address concerns & symptoms, Test for cause, Antibiotic if RADT +, Protect lines of resistance/immune response from unnecessary antibiotic

**Tertiary prevention:** Avoid infecting others, monitor recurrence, throat culture if RADT-, consider carriers to avoid repetitive antibiotics

**Stressor:** Fever, pain, dehydration, loss school, work, fear illness, fear side effect of medicines, infecting siblings, loss activities

**Reaction:** Acute illness, not feeling well, not eating

**Reconstitution**

Adapted from Neuman Systems Model, Betty Neuman, 1970.
APPENDIX C

PRE- AND POST-TEST ASSESSMENT

Circle only one answer:

1. The prevalence of Group A Streptococcus in children age 5-15 is
   a. 10-19%  b. 20-37%  c. 38-58%  d. 59-70% in the winter

2. RADT sensitivity in children is:
   a. 40% if minimally symptomatic  c. 85% pooled data
   b. 53% if have light inoculum  d. All of the above

3. For every 100 children diagnosed and treated based on RADT, how many children with GAS would be missed and not receive antibiotics?
   a. 4  b. 14  c. 24  d. 34

4. RADT is likely to be positive in children with:
   a. More severe symptoms  b. 3-9 years old
   b. Heavy inoculum  d. All of the above

Mark true or false:

5. GAS resistant bacteria has been documented in children __ __

6. In the USA, rate of antibiotic prescribing equals GAS prevalence __ __

7. RADT sensitivity is sufficiently high for sole testing in children __ __

8. Parents rank desire for antibiotics as #1 reason for consultation __ __

9. Parents rank desire to know the cause and prognosis of their child’s symptoms as the least reason for consultation __ __

10. Parent opinion in the decision to prescribe antibiotics must be avoided in order to objectively reduce antibiotic use __ __

11. Parental ideas, concerns and expectations leads to extensive conversation __ __

12. The Neuman Systems Model is used to prevent unrealistic parental expectations and concerns that lead to unnecessary antibiotics __ __

13. In the USA, one of 10 prescriptions for antibiotics are unnecessary __ __

14. Antimicrobial resistance is a global crisis, except for USA & England __ __
APPENDIX D

PROVIDER WORK SHEET

Case #________

Instructions: Elicit the ideas, concerns and expectations from parents and observe for verbal responses. Mark/fill parent responses as applicable to your history intake.

Ideas

☐ Illness is severe ☐ It is an infection ☐ Infection will weaken child

☐ Antibiotics will cure ☐ Antibiotics are harmful/bad side effects ☐ Deviation from health

☐ Could be a viral infection ☐ Could be Strep Throat ☐ Antibiotics kill viruses

☐ Caught infection from family member ☐ Antibiotic will fix the illness faster

☐ Doctor’s note will allow child to return to school

☐ Previous antibiotic helped/ did not help

☐ Other ____________________________________________________________

Concerns

☐ Poor appetite ☐ Child not his/her usual self ☐ Fever does not go away

☐ Pain ☐ Crying ☐ Cannot fix it at home

☐ Parent already tried everything ☐ He may not be able to attend school/activity/social event

☐ Child had bad infection in past ☐ Antibiotics might weaken his immune system

☐ Siblings/family might get infected ☐ Parent needs to go back to work/can’t take more time off

☐ Other ____________________________________________________________

Expectations

☐ Want child to get better ☐ Resume normal activity/make it to special event/sport game

☐ Medication for pain ☐ Medication for fever ☐ Improve appetite ☐ Test for Strep
☐ Note for school/work ☐ Find out what is going on ☐ How long will child be sick?

☐ Need reassurance that child will be ok ☐ Want support/advise to care for ill child

☐ Explain what’s wrong with child ☐ Need to know if it is Strep or not

☐ Give him antibiotic ☐ Do not give him antibiotic ☐ Need stronger antibiotic

☐ Other ____________________________________________________________

Provider comments: ________________________________________________
**APPENDIX E**

**PROVIDER SAMPLE DISTRIBUTION**

Table 2

*Distribution of Provider Sample*

<table>
<thead>
<tr>
<th>Work</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Medical School</th>
<th>Year</th>
<th>Specialty</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>70</td>
<td>F</td>
<td>Hispanic</td>
<td>Foreign</td>
<td>1971</td>
<td>Pediatrics</td>
</tr>
<tr>
<td>PT</td>
<td>36</td>
<td>M</td>
<td>Arabic</td>
<td>US</td>
<td>2008</td>
<td>Family</td>
</tr>
<tr>
<td>FT</td>
<td>43</td>
<td>F</td>
<td>African</td>
<td>US</td>
<td>2001</td>
<td>Pediatrics</td>
</tr>
<tr>
<td>FT</td>
<td>72</td>
<td>M</td>
<td>Arabic</td>
<td>Foreign</td>
<td>1972</td>
<td>Pediatrics</td>
</tr>
<tr>
<td>FT</td>
<td>32</td>
<td>M</td>
<td>Arabic</td>
<td>Foreign</td>
<td>2012</td>
<td>Pediatrics</td>
</tr>
</tbody>
</table>
## APPENDIX F

**PROVIDER SAMPLE DEMOGRAPHICS**

Table 3

*Demographic Description of Provider Sample by Age, Gender and Ethnicity (N=5)*

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>( f )</th>
<th>%</th>
<th>Ethnicity</th>
<th>( f )</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>32-72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>50.6</td>
<td>Female</td>
<td>2</td>
<td>40%</td>
<td>Arabic</td>
<td>3</td>
</tr>
<tr>
<td>( SD )</td>
<td>17.036</td>
<td>Male</td>
<td>3</td>
<td>60%</td>
<td>Hispanic</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>African</td>
<td>1</td>
</tr>
</tbody>
</table>
APPENDIX G

DEMOGRAPHICS OF TOTAL SAMPLE

Table 4

*T-test Analysis of Demographics of Total Sample of Cases (N = 125)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>f</th>
<th>%</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (4-15)</td>
<td></td>
<td></td>
<td>9.48</td>
<td>3.21</td>
<td>.906</td>
<td>122.21</td>
<td>.37</td>
</tr>
<tr>
<td>&lt; 10</td>
<td>58</td>
<td>46.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 +</td>
<td>67</td>
<td>53.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arabic</td>
<td>39</td>
<td>31.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>12</td>
<td>9.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>74</td>
<td>59.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>61</td>
<td>48.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>64</td>
<td>51.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive GAS</td>
<td>32</td>
<td>25.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX H

### ANALYSIS OF SAMPLE GROUPS

Table 5

*Chi Square Analysis of Sample by Intervention Group (N = 125)*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
<th>$X^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 10</td>
<td>(n = 64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$%n$</td>
<td>$%N$</td>
<td>$%n$</td>
<td>$%N$</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>57.8</td>
<td>30</td>
<td>49.18</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>42.2</td>
<td>31</td>
<td>50.82</td>
</tr>
<tr>
<td>10+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>9.73 years</td>
<td>9.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>3.16</td>
<td>3.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arabic</td>
<td>(n = 64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$%n$</td>
<td>$%N$</td>
<td>$%n$</td>
<td>$%N$</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>29.7</td>
<td>20</td>
<td>32.79</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>12.5</td>
<td>4</td>
<td>6.56</td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>(n = 64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$%n$</td>
<td>$%N$</td>
<td>$%n$</td>
<td>$%N$</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>57.8</td>
<td>37</td>
<td>60.66</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>(n = 64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$%n$</td>
<td>$%N$</td>
<td>$%n$</td>
<td>$%N$</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>45.31</td>
<td>32</td>
<td>52.46</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>54.69</td>
<td>29</td>
<td>47.54</td>
</tr>
</tbody>
</table>

*Note: $n$ values rounded to one decimal place.*
APPENDIX I

PRE-TEST/POST-TEST SCORES

Table 6

*Paired T-test Analysis on Provider Study Team Pre-test and Post-test Scores*

<table>
<thead>
<tr>
<th>Provider Team #</th>
<th>Pre-test scores</th>
<th>Post-test scores</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>46</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>38</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>54</td>
<td>31</td>
</tr>
<tr>
<td>4</td>
<td>38.5</td>
<td>69</td>
<td>30.5</td>
</tr>
<tr>
<td>M</td>
<td>34.63</td>
<td>53.75</td>
<td>19.12</td>
</tr>
<tr>
<td>Variance</td>
<td>97.56</td>
<td>130.25</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>9.88</td>
<td>12.66</td>
<td></td>
</tr>
</tbody>
</table>

df = 6          \quad t = -2.3822 \quad \text{Critical value} 1.943 \quad \alpha = .05 \quad p < .05
APPENDIX J

PROVIDER KNOWLEDGE CONTENT CHANGE

Table 7
Provider Correct Answers to Specific Knowledge Test Questions Before and After Educational Intervention

<table>
<thead>
<tr>
<th>Pre-test (n = 5)</th>
<th>Post-test (n = 4)</th>
<th>Change</th>
<th>Knowledge Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>f   %</td>
<td>f    %</td>
<td>Δ</td>
<td></td>
</tr>
<tr>
<td>2   40</td>
<td>3    60</td>
<td>20</td>
<td>Prevalence of GAS</td>
</tr>
<tr>
<td>2   40</td>
<td>4    100</td>
<td>60</td>
<td>RADT sensitivity</td>
</tr>
<tr>
<td>3   60</td>
<td>2    50</td>
<td>-10</td>
<td># GAS missed without culture</td>
</tr>
<tr>
<td>4   100</td>
<td>3    75</td>
<td>-25</td>
<td>RADT spectrum bias</td>
</tr>
<tr>
<td>4   80</td>
<td>4    100</td>
<td>20</td>
<td>GAS resistance</td>
</tr>
<tr>
<td>4   80</td>
<td>4    100</td>
<td>20</td>
<td>Antibiotic vs prevalence</td>
</tr>
<tr>
<td>0   0</td>
<td>1    25</td>
<td>25</td>
<td>RADT for sole testing</td>
</tr>
<tr>
<td>0   0</td>
<td>0    0</td>
<td>0</td>
<td>Parental desire for antibiotics</td>
</tr>
<tr>
<td>1   20</td>
<td>2    50</td>
<td>30</td>
<td>Expectation for diagnosis/prognosis</td>
</tr>
<tr>
<td>1   20</td>
<td>0    0</td>
<td>-20</td>
<td>Parental opinion on antibiotics</td>
</tr>
<tr>
<td>1   20</td>
<td>3    75</td>
<td>55</td>
<td>ICE effect</td>
</tr>
<tr>
<td>2   40</td>
<td>3    75</td>
<td>35</td>
<td>Percent unnecessary antibiotics</td>
</tr>
<tr>
<td>2   40</td>
<td>3    75</td>
<td>35</td>
<td>Antimicrobial resistance</td>
</tr>
</tbody>
</table>

GAS = Group A Streptococcus; RADT = Rapid Antigen Detection Test
APPENDIX K

ANTIBIOTIC PRESCRIBING PRE-INTERVENTION

Figure 2. Antibiotic Prescribing Behavior Pre-intervention

Figure 2. No = Antibiotics not prescribed in the absence of Strep (Group A Streptococcus). Yes = Antibiotics prescribed in the presence of Strep.
APPENDIX L

ANTIBIOTIC PRESCRIBING POST-INTERVENTION

Figure 3. Antibiotic Post-intervention Prescribing Behavior

Figure 3. No = Antibiotics not prescribed in the absence of Strep (Group A Streptococcus). Yes = Antibiotics prescribed in the presence of Strep.
APPENDIX M

COMPARISON OF PREVALENCE AND ANTIBIOTIC PRESCRIBING

Figure 4. Comparison of Prevalence/Diagnostic Identification of GAS and Antibiotic Prescribing Rates

Comparison on prevalence (identification/diagnosis of Group A Streptococcus/Strep) and corresponding antibiotic prescribing rates before and after an educational intervention.
APPENDIX N

IDEAS, CONCERNS AND EXPECTATIONS

Table 8

*Frequencies of Most Common Ideas, Concerns and Expectations in Pediatric Pharyngitis*

<table>
<thead>
<tr>
<th>Idea</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>It could be Strep</td>
<td>39</td>
</tr>
<tr>
<td>It is an infection</td>
<td>15</td>
</tr>
<tr>
<td>Could be viral</td>
<td>11</td>
</tr>
<tr>
<td>Antibiotic will cure it</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concern</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>24</td>
</tr>
<tr>
<td>Sibling/family might get infected</td>
<td>15</td>
</tr>
<tr>
<td>Fever</td>
<td>14</td>
</tr>
<tr>
<td>Poor appetite</td>
<td>7</td>
</tr>
<tr>
<td>Lack of sleep</td>
<td>3</td>
</tr>
<tr>
<td>Child is not being his or her usual self</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expectation</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desire for child to get better</td>
<td>32</td>
</tr>
<tr>
<td>Test for Strep</td>
<td>18</td>
</tr>
<tr>
<td>Medication for pain</td>
<td>9</td>
</tr>
<tr>
<td>Note for school</td>
<td>8</td>
</tr>
<tr>
<td>Give antibiotic</td>
<td>5</td>
</tr>
</tbody>
</table>
APPENDIX O

GUIDELINE FOR PHARYNGITIS

**Figure 5.** Algorithm for Diagnostic Testing for Pharyngitis

Sore throat with viral-like presentation (hoarseness, dry cough, coryza)

**Adults:** **No RADT**
- No throat culture
- No antibiotics

All ages with suspected bacterial infection (exudates, fever, rash, swollen tonsils/nodes, dysphasia)

**Do RADT**

Children: **Do RADT** on 3-15 yrs old with sore throat (in lieu of spectrum bias, biosurveillance, & Group A Strep exposure)

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**Negative RADT**

Age 3-15 years: **Do back up throat culture, antibiotics if positive culture**

Adults: **No back up throat culture, No antibiotic**

Positive RADT any age: **Rx penicillin/amoxicillin or alternative if allergic**

Consider alternate microorganism (e.g., adults/teens with N. gonorrhea, Group G streptococcus, chlamydia, Mono)

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APPENDIX P

FACILITY ACCEPTANCE LETTER

We Care Pediatrics
Saeed Abbassi, MD
7505 Bergenline Avenue North Bergen, NJ 07047
Phone (201) 868-1950 / Fax (201) 868-5844

August 25, 2017

To: Saint Peter’s University IRB

From: Iyad Saadi, Office Manager

Re: Evidence-based project: Reducing Unnecessary Antibiotic Prescriptions for Pediatric Pharyngitis

We Care Pediatrics is a pediatric medical office that performs primary care and episodic illness care on an outpatient basis.

Mercedes Camacho-Walsh APN has expressed a desire to perform research involving health care providers in our North Bergen office. It is our understanding that this evidence-based project will involve a power point training session on evidence-based practice on communication methods and diagnosis of pharyngitis. The research will entail brief before and after presentation tests as well as 83 chart reviews to identify communication methods and rate of antibiotic prescriptions for pharyngitis.

We support and approve Ms. Camacho-Walsh work on this project. We hope that this project can help health care providers prevent unnecessary antibiotic prescriptions for children and contribute identifying means to reduce the global crisis of antimicrobial resistance.

Ms. Camacho-Walsh has requested access to our health facility, medical chart reviews, and electronic health record to identify cases for prescribing for pharyngitis. We will collaborate with Ms. Camacho-Walsh to maintain anonymity of the health care providers and medical record reviews involved in this project.

Sincerely,

Iyad Saadi, Office Manager

Date

8/25/2017
APPENDIX Q

IRB APPROVAL LETTER

Saint Peter’s University
Institutional Review Board

To: MERCEDES CAMACHO-WALSH
   DNP Program
   School of Nursing
   Saint Peter’s University

From: Dr. Peter P. Cvek, chair
      SPU Institutional Review Board

Date: September 19, 2017

Project Title: Evidence-Based Practice: Reducing Unnecessary Antibiotic Prescriptions for Pediatric Pharyngitis.

Protocol Approval Date: September 19, 2017 – December 30, 2017

In accordance with DHHS Regulations for Protection of Human Subjects (45 CFR 46.110), the human subjects application for this Evidence-based project underwent Expedited review and was approved as minimal risk to subjects. This project is approved for September 19, 2017 and the approval remains active until December 30, 2017.

The investigator agrees to conduct this Evidence-based project in accordance with the Belmont Report, all the SPU Institutional Review Board guidelines, as well as all applicable HIPAA rules and regulations.

Important: SPU IRB approval requires documented on-site approval by the appropriate Hospital Institutional Review Board and/or Nursing Research Committee, or, when applicable, the appropriate on-site approval. The IRB notes the approval of Iyad Saad, Office Manager, We Care Pediatrics, North Bergen, NJ, August 25, 2017.

Re-review of this project is required if:
   - You wish to continue the project beyond December 30, 2017.
   - There are any changes in the protocol.
   - There are any reports of injury or unanticipated problems involving risks to human subjects.
   - Any injuries or adverse events must be reported to the IRB within three days of the event.

The IRB wishes you the best of luck in the successful completion of your project. Should you have any further comments and/or questions, please do not hesitate to contact me at your earliest convenience.

Peter P. Cvek, Ph.D.
Chair, Institutional Review Board
Saint Peter’s University
pcvek@ saintpeters.edu
APPENDIX R

NIH CERTIFICATE

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Mercedes Camacho-Walsh successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 02/21/2017.

Certification Number: 2326976.