Implementation of a Quality Improvement Initiative to Optimize Testing and Improve Antibiotic Utilization for Group A Streptococcal Pharyngitis in a Community Pediatric Practice

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Date Defended: 10 April 2017

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Date Approved: 05 May 2017

## Abstract

**Background and Objective:** Acute pharyngitis is a common diagnosis in ambulatory pediatrics. The Infectious Diseases Society of America (IDSA) clinical practice guideline for group A streptococcal (GAS) pharyngitis recommends strict criteria for GAS testing to avoid misdiagnosis and unnecessary treatment of colonized children. We sought to improve adherence to the IDSA guideline for testing and treatment of GAS pharyngitis in a large community pediatrics practice. **Methods:** The Model for Improvement was used and iterative Plan-Do-Study-Act (PDSA) cycles were completed in a Maintenance of Certification quality improvement project. Interventions included: provider education, modification of an existing office procedure, communication strategies, and patient/family education. Outcomes were assessed utilizing statistical process control charts. **Results:** Unnecessary GAS testing decreased by 17% (from 64% to 47%) during the project. Presence of viral symptoms was the primary reason for unnecessary testing. Appropriate antibiotic utilization did not significantly change during the project. At the end of the intervention period the majority of providers perceived an improvement had occurred in their ability to communicate with families about the need for GAS pharyngitis testing and about antibiotic use. **Conclusions:** The majority of GAS pharyngitis testing in this practice was inconsistent with guideline recommendations for testing prior to intervention. A Maintenance of Certification quality improvement initiative led to improvement in guideline-based testing for GAS pharyngitis.

**Acknowledgements**

I would like to express my sincere gratitude to those who provided their support and guidance throughout this project. Dr. Won Choi provided guidance throughout my course work and agreed to chair my committee. Dr. Angela Myers provided mentorship throughout this project. She was instrumental in the design and implementation of the project. She consistently provided feedback regarding all aspects of the project and she epitomized what it means to be a mentor. Dr. Brian Lee provided statistical support and guidance throughout the project. His insight was essential to the project. Dr. Jason Newland provided feedback regarding project design and analysis. Drs. Lory Harte and Keith Mann provided quality improvement expertise and feedback throughout the project. Megan Bledsoe, a research coordinator at Children's Mercy, assisted with data entry for this project. The project would not have been possible without the efforts of the providers and staff at the practice. Their engagement in practice improvement is commendable.

Finally, I am grateful for support from my friends and family throughout this work. My husband, Dan, unfailingly supports my pursuit of a demanding career in academic medicine. My children, Vivienne and Peter, inspire me to dream.

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## Background

Pharyngitis is common in children, resulting in more than 11 million pediatric ambulatory care visits annually [1, 2]. While group A streptococcus (GAS) causes 15-37% of pharyngitis cases, the vast majority of acute pharyngitis cases are caused by viruses [1, 3, 4]. Correct diagnosis of the etiology of pharyngitis is necessary to provide appropriate treatment to limit sequelae in cases of GAS pharyngitis, but also to curb antibiotic overuse in non-streptococcal pharyngitis. Signs and symptoms alone are not reliable to diagnose GAS pharyngitis [5]. The Infectious Diseases Society of America (IDSA) clinical practice guideline recommends testing by rapid antigen detection test (RADT) with back-up culture for negative tests to diagnose GAS pharyngitis [6]. RADTs are highly specific for the presence of GAS [7]. However, RADT and throat culture do not distinguish between GAS infection and carrier state and up to 25% of children are asymptomatic carriers of GAS in the pharynx [4, 8]. Additionally, false positive tests can result from incorrect technique [9]. Clinical judgement must be used to determine which children should be tested for GAS pharyngitis to avoid misdiagnosis and unnecessary antibiotic exposure.

Nationally, antibiotics are prescribed during 53-60% of pediatric visits for pharyngitis, nearly double the expected prevalence of GAS pharyngitis [1, 3, 10]. Since GAS pharyngitis is the only pharyngitis in children for which antibiotics are routinely indicated, the excess prescribing suggests that clinicians often inappropriately prescribe antibiotics in patients with non-streptococcal pharyngitis. Interventions are needed to eliminate excessive prescribing for pediatric pharyngitis.

Antibiotic overuse for pharyngitis may result from non-indicated GAS pharyngitis testing [9]. Chart review of patients who had GAS pharyngitis testing performed in the Children's Mercy Kansas City Emergency Department from February to April 2012 revealed 64% of testing was not

clinically indicated. This unnecessary testing resulted in 158 unnecessary antibiotic prescriptions [11].

Second-line antibiotics and unnecessarily broad-spectrum antibiotics are frequently prescribed for pharyngitis. The IDSA guideline recommends penicillin or amoxicillin as the drug of choice for treatment of GAS pharyngitis in non-allergic patients. A first generation cephalosporin, clindamycin, clarithromycin, or azithromycin are the recommended alternatives for penicillin-allergic patients with GAS pharyngitis. Dooling et al. found that narrow-spectrum penicillins accounted for only 61% of antibiotic prescriptions for pediatric pharyngitis visits over a 14 year study period, followed by macrolides and first generation cephalosporins (21%) and second/third generation cephalosporins and amoxicillin/clavulanate (18%) [1]. Prescribing of narrow spectrum penicillins decreased during the study period. Injudicious use of macrolides for GAS pharyngitis treatment is of particular concern given reports of substantial rates of macrolide resistance in GAS isolates [12].

We partnered with a large community pediatric practice in a collaborative, interprofessional, quality improvement (QI) initiative to evaluate and improve testing for and treatment of GAS pharyngitis. The goals of the project were to decrease unnecessary testing for GAS pharyngitis by 25% and improve antibiotic utilization for GAS pharyngitis by 25%.

## Methods

### Context

The project was conducted at an ambulatory pediatric practice in Kansas City, MO. The practice includes 12 board-certified pediatricians, 4 certified nurse practitioners, and 19 nurses. The practice cares for more than 40,000 children each year at two practice locations and received Patient-Centered Medical Home (PCMH) Level 3 designation from the National Committee for

Quality Assurance (NCQA). The practice is involved in training pediatric residents and medical students. Children's Mercy Kansas City, a 354 bed free-standing children's hospital, was the sponsoring institution for this QI project. Children's Mercy Kansas City is an American Board of Pediatrics approved Maintenance of Certification (MOC) Portfolio Sponsor. This project was approved for MOC Part 4 credit.

**QI Team**

The team was led by a pediatric infectious diseases fellow (LEN) and a pediatric infectious diseases attending (ALM) at Children's Mercy Kansas City. The team leaders have formal training in QI methodology and provided content expertise. Children's Mercy QI leaders provided feedback throughout the project.

**Measures**

Two outcomes were measured for this project. The first outcome measure was unnecessary GAS pharyngitis testing. Unnecessary GAS pharyngitis testing was defined as a patient meeting at least 1 of the following criteria: 1) age < 3 years without documentation of a household contact with GAS pharyngitis, 2) presence of 2 or more viral symptoms, 3) absence of sore throat, or 4) absence of expected GAS pharyngitis exam findings. Viral symptoms included: conjunctivitis, coryza, cough, diarrhea, hoarse voice, and viral exanthema. These criteria, including the specific viral symptoms, were chosen based on recommendations from the IDSA clinical practice guideline for the diagnosis and management of GAS pharyngitis. The decision to use 2 or more viral symptoms was made because providers involved in the project expressed a concern that documentation may not clearly reflect the timing or severity of symptoms (e.g. lingering cough after resolved viral respiratory tract infection) and they suspected viral symptoms would be over-represented in retrospective chart review.

The second outcome measure was appropriate antibiotic utilization. Appropriate antibiotic utilization was defined as: use of an antibiotic that was clinically indicated (necessary GAS pharyngitis testing performed and the test was positive) with selection of a first-line antibiotic, based on the patient's documented penicillin allergy status, for the suitable duration (single dose for intramuscular penicillin, 5 days for azithromycin, 10 days for any other antibiotic used).

**Data Collection**

The project period was October 1, 2014-October 31, 2016. A standardized abstraction form was used to collect information regarding demographics, symptoms and exposure history, exam findings, penicillin allergy status, antibiotic selection and antibiotic duration from a clinic encounter note. A convenience sample of 20 patients per month was selected from patients with a current procedural terminology (CPT®) code, 87880, for streptococcal RADT. The sample size was chosen based on minimum subgroup sizes needed to have upper and lower control limits on the control chart and ensure improvement is detectable using estimated baseline levels for our outcome measures [13]. Patient charts were excluded if RADT results were not documented. A current state analysis was conducted at the start of the project using retrospective chart review of a convenience sample of 20 charts per month for a 12 month period (October 2013-September 2014) to determine baseline levels for each outcome measure. Due to lack of provider participation at the start of the project, the pre-intervention period was extended to June 2015 (Intervention 1).

**Planning the Interventions**

A fishbone diagram (Figure 1) was constructed to determine factors leading to unnecessary testing for GAS pharyngitis. Meetings were held with stakeholders (providers and staff) at the practice site to identify key drivers and establish project aims (Figure 2). A Pareto chart was used to determine which reasons for unnecessary testing should be targeted for improvement. National

benchmark data were not available for these outcome measures. The aims of this project were: 1) Decrease unnecessary testing for GAS pharyngitis in this ambulatory pediatric practice from 64% to 39% by October 31, 2016 and 2) Improve guideline-based antibiotic utilization for GAS pharyngitis in this ambulatory pediatric practice from 45% to 70% by October 31, 2016.

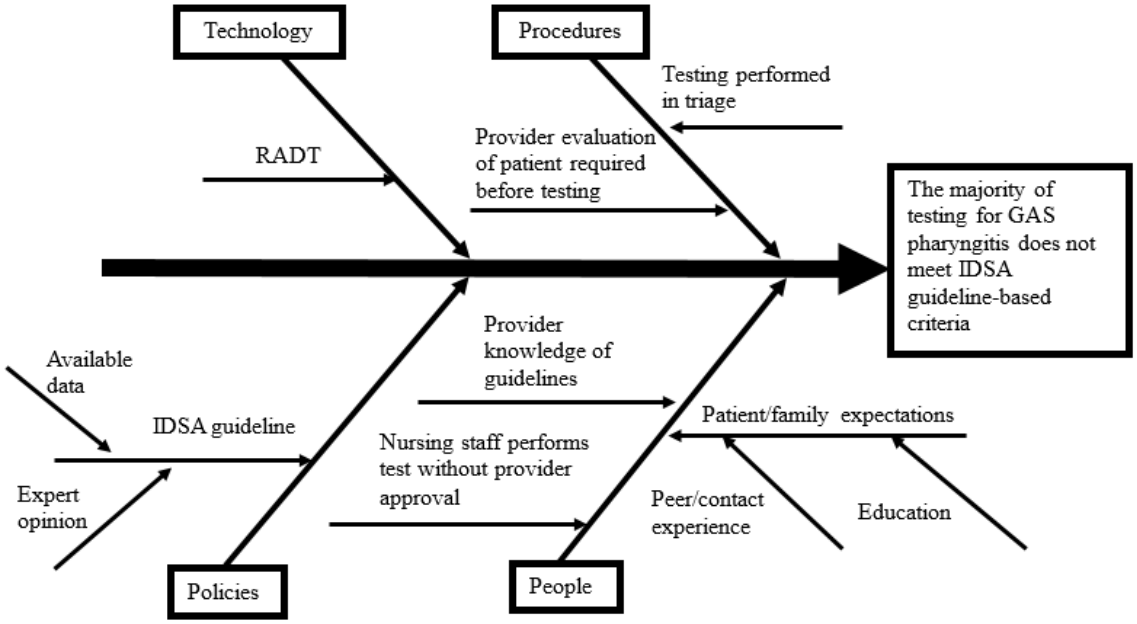


**Figure 1.** Fishbone diagram identifying factors leading to unnecessary GAS pharyngitis testing.

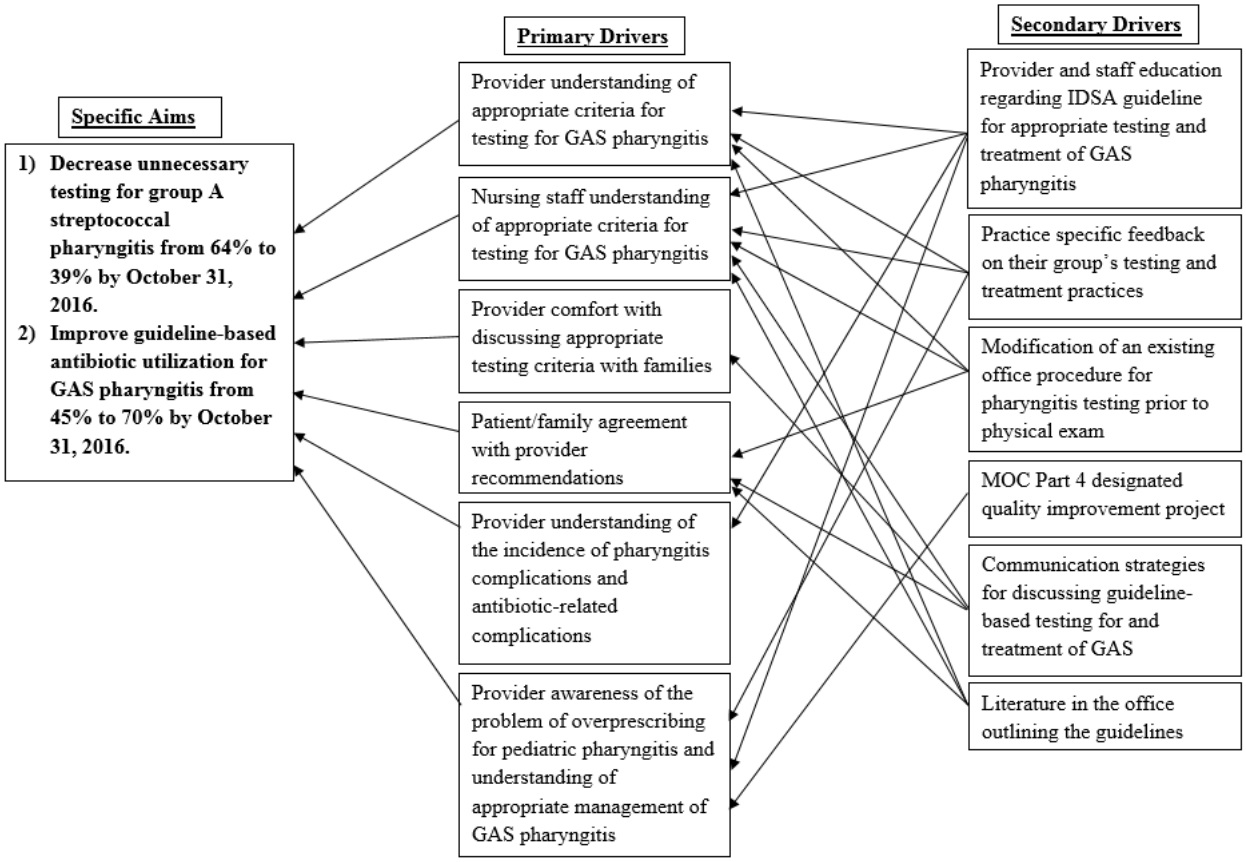


**Figure 2.** Key driver diagram for improving testing for and management of GAS pharyngitis.

**Interventions**

**Education.** A webinar was presented to educate providers and staff regarding incidence of GAS pharyngitis, incidence of GAS colonization, complications of streptococcal pharyngitis, antibiotic complications, and a review of the IDSA guideline for diagnosis and management of GAS pharyngitis. This webinar was offered at the start of the project period and repeated 2 months into the project. Only two of sixteen providers participated in these webinars. Due to the lack of provider participation in the webinars the same information was presented along with data from the current state analysis at an onsite, face-to-face meeting with providers (Intervention 1). This meeting included an orientation to QI methodology. Subsequently, an email update with a control chart depicting trends in the practice's unnecessary GAS testing was sent to providers along with

a published commentary on the changing value of testing for and treating GAS pharyngitis (Intervention 2) [14].

**Modification of an existing office procedure.** This practice allowed a standing order for nursing staff to perform RADT on any patient presenting with sore throat prior to provider evaluation of the patient and regardless of associated signs or symptoms. During the initial face-to-face meeting with providers the practice agreed to eliminate this standing order and require provider evaluation of patients prior to GAS pharyngitis testing. Intervention 1 included both the first face-to-face meeting as well as the date of the change in office procedure.

**Communication strategies.** Discussions were held with providers regarding how to communicate with families about recommendations for testing and management of pharyngitis (Intervention 3). Providers reported concerns about parental expectations for testing even when it was not indicated and parental request for second-line antibiotics based on a perception that amoxicillin was ineffective. Strategies were provided to respond to these parental concerns. These strategies were also discussed with staff at the practice during an onsite, face-to-face meeting with providers and staff where updates on outcome measures were presented (Intervention 4). A one-page handout outlining key points from these discussions was developed and distributed to families at the providers' discretion (Intervention 5).

**Study of Interventions**

The Model for Improvement was used as a framework to guide this project [15]. Iterative Plan-Do-Study-Act cycles were completed. Outcome measures were assessed on statistical process control charts using Excel QI Macros. The effectiveness of the interventions was determined by presence of a shift (≥ 8 points above or below the centerline) indicating special cause variation, or a nonrandom pattern in the data as a result of a sustained change [16]. Ongoing

audit of outcome measures was performed throughout the intervention period with feedback provided to the practice at each face-to-face meeting. A sub-analysis was performed to look for a trend in necessary antibiotic prescribing for pharyngitis over time. This sub-analysis was conducted with interrupted time series by using a segmented logistic regression model to determine whether a difference in the slope of the line occurred after Intervention 1. Necessary antibiotic prescribing was defined as a prescription provided to a patient whose GAS pharyngitis testing was clinically indicated and had a positive RADT result. Antibiotics prescribed for diagnoses other than pharyngitis were excluded. Providers were surveyed at the end of the project to assess their perception of the impact of the project on their individual practice.

Post-hoc exploratory analysis was performed to examine individual provider-level unnecessary testing. This analysis included retrospective chart review of additional charts not included in the primary analyses to ensure inclusion of at least 1 chart per provider per quarter beginning with data for July 2016. Provider level data were not shared with the providers until the end of the intervention period.

**Ethical Considerations**

The project was considered a local quality improvement project and not human subjects research by the Children's Mercy Kansas City Office of Research Integrity. A data use agreement was executed between Children's Mercy Kansas City and the practice involved in this project.

## Results

A total of 709 patient charts were reviewed (392 from the pre-intervention period and 317 from the intervention period). The average level for unnecessary GAS pharyngitis testing per month was 63.6% prior to Intervention 1. This average decreased to 46.5% during the intervention period (Figure 3). Following Intervention 2 there was evidence of special cause

variation with eleven points below the baseline average. The presence of viral symptoms was the most frequently observed criteria for unnecessary testing followed by absence of documented sore throat. Testing of patients with viral symptoms and patients less than 3 years old decreased during the project period (Figure 4).

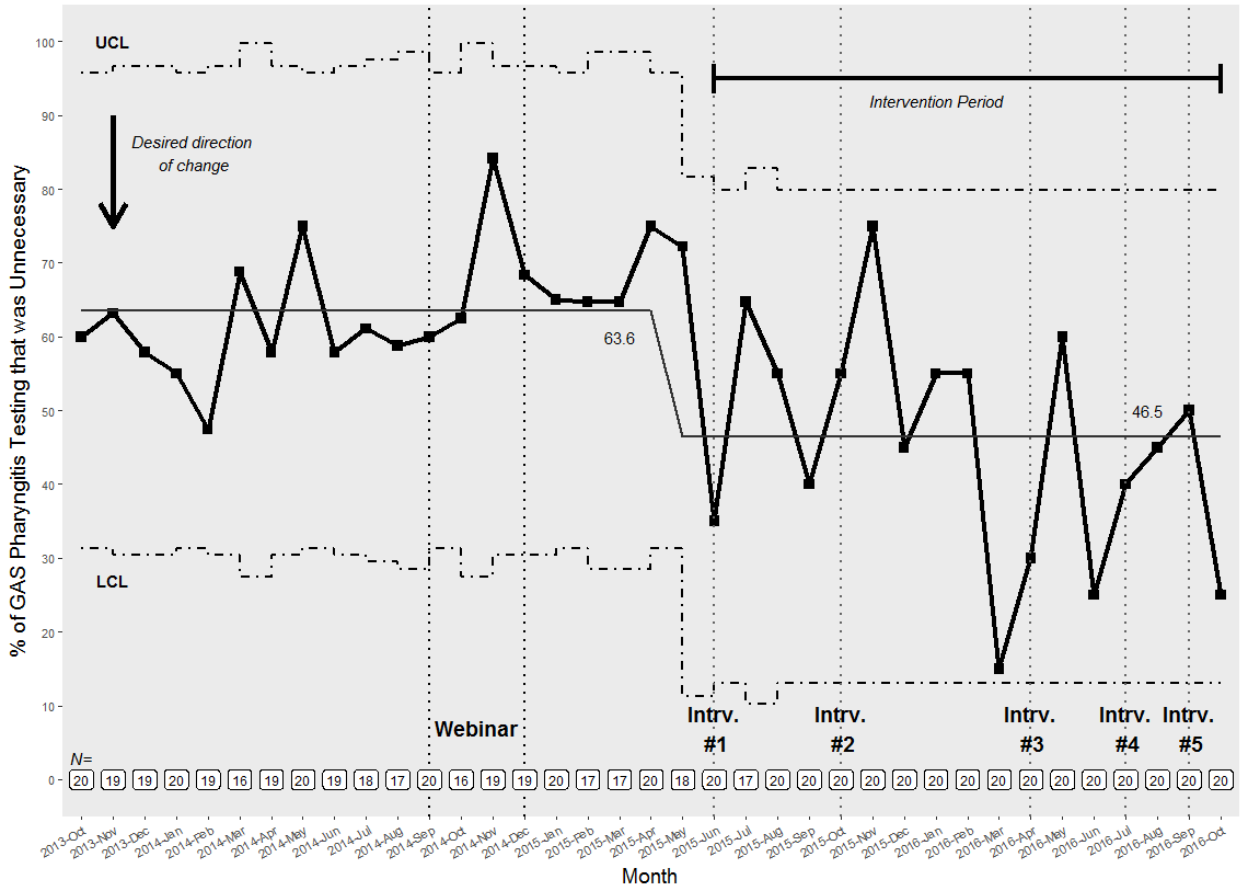


**Figure 3.** P-chart for proportion of patients with unnecessary GAS pharyngitis testing over time. LCL, lower control limit; UCL, upper control limit. Intrv #1. Face-to-face meeting, modification of office procedure (06/26/15) Intrv #2. Email update (10/29/15) Intrv #3. Face-to-face meeting, communication strategies with providers (04/22/16) Intrv #4. Face-to-face meeting, communication strategies with staff (07/29/16) Intrv #5. Handout for families (09/01/16).

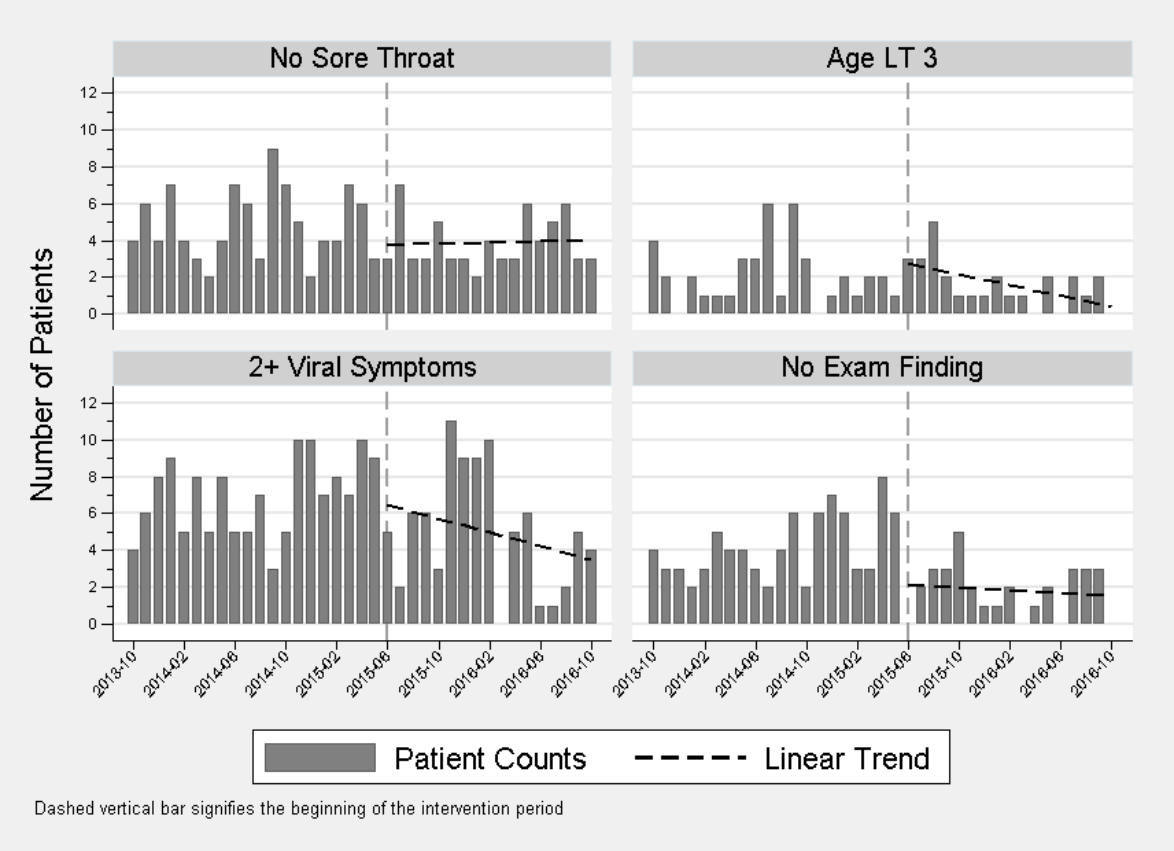


**Figure 4.** Bar and line graphs of reasons for unnecessary GAS pharyngitis testing over time. LT, less than.

Post-hoc analysis revealed large differences in unnecessary testing between providers within the practice (Figure 5). Differences were observed in the slope of the linear trend between providers. An increasing linear trend in unnecessary testing over time was observed for one provider in the practice.

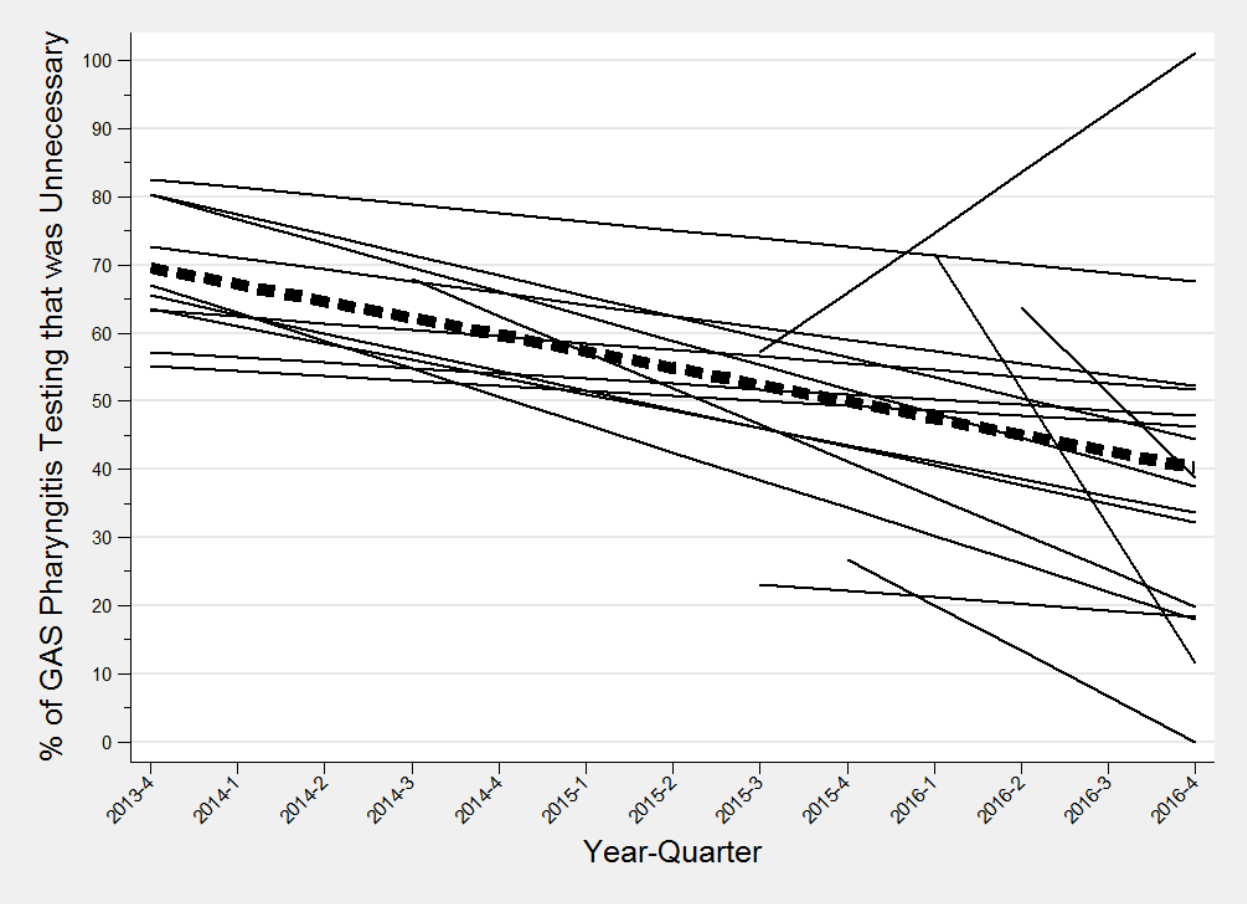


**Figure 5.** Spaghetti plot of linear trend for quarterly proportions of unnecessary GAS pharyngitis testing for individual providers over time. Solid lines represent linear trend for indiviual providers. Dashed line represents linear trend for all providers.

The centerline for appropriate antibiotic utilization per month was 49% throughout the entire project with a random pattern of data indicating common cause variation (Figure 6). Unnecessary GAS pharyngitis testing was the most frequently observed criteria for inappropriate antibiotic utilization throughout the pre-intervention and intervention periods (Table 1). Over the course of the project, including the baseline period, 119 unnecessary antibiotic courses were prescribed for pharyngitis. There was no change in the slope of the linear trend of necessary prescribing after Intervention 1. Throughout the baseline period and the entirety of the project the median proportion of appropriately selected (first-line) antibiotics was 87.5% [75%, 100%].

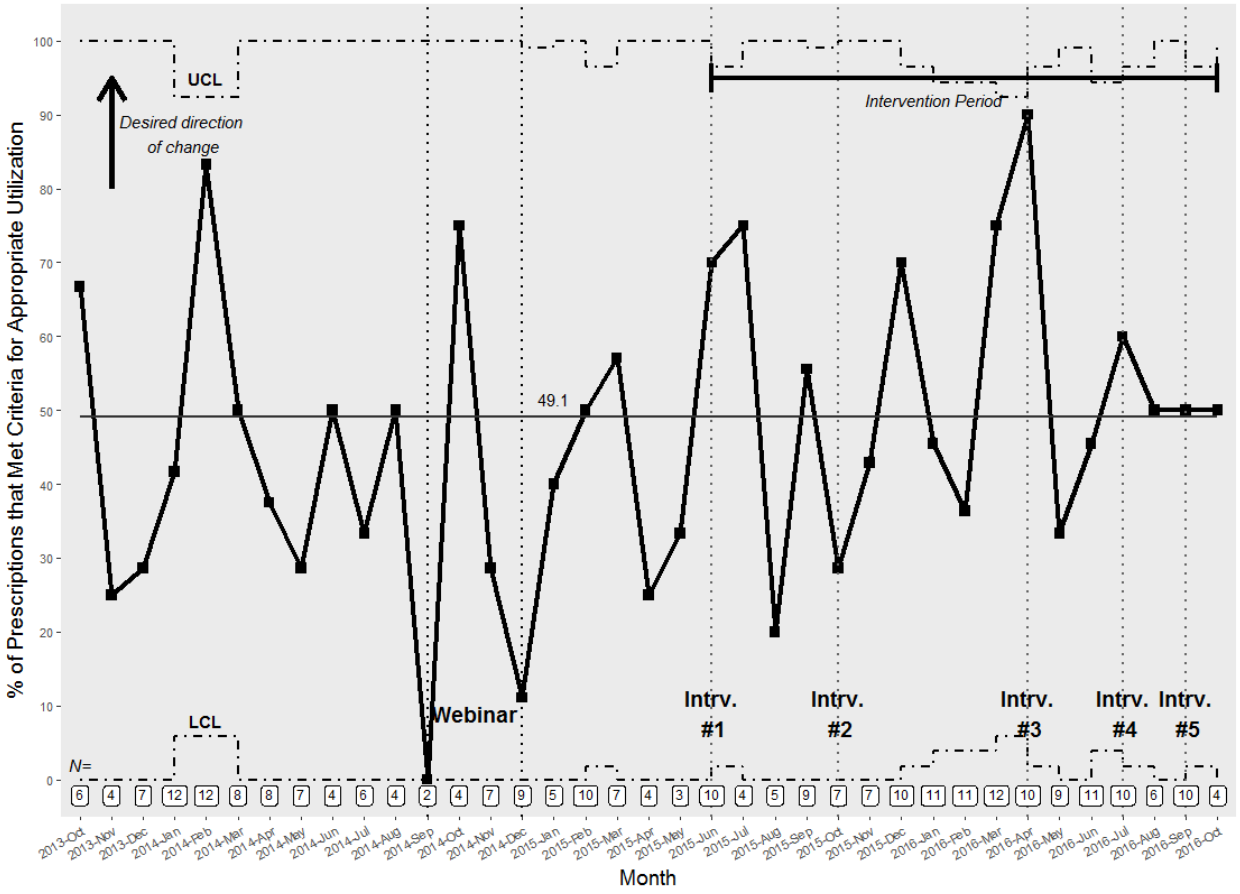


**Figure 6.** P chart for proportion of antibiotic prescriptions that met criteria for appropriate utilization (clinically indicated, appropriate selection, appropriate duration) over time. LCL, lower control limit; UCL, upper control limit

| **Table 1.** Reasons for Inappropriate Antibiotic Utilization | |
|---|---|
| **Reason** | **Number of Patients** |
| Unnecessary GAS Pharyngitis Testing | 116 |
| Negative GAS RADT Result | 6 |
| Inappropriate Antibiotic Selection | 36 |
| Inappropriate Antibiotic Duration | 3 |

The provider survey response rate was 100% (16/16). All providers responded affirmatively when asked if this project was meaningful and if they would participate in a similar project again. Additionally, most providers (88%) believed their ability to communicate with families about the need for testing and about antibiotic use improved during the project. The majority of providers (94%) believed that the project did not negatively impact clinic efficiency. Spontaneous responses to inquiry about what had the greatest impact on reducing unnecessary GAS pharyngitis testing in their practice included: "limiting nurses from testing kids with URI symptoms," "specific criteria for testing," and "education on best practice."

## Discussion

Injudicious use of GAS pharyngitis testing may lead to avoidable healthcare costs, unnecessary antibiotic exposure, and unintended harms [14]. Our results suggest that an interprofessional collaboration using QI methods can successfully improve adherence to guideline-based GAS pharyngitis testing in ambulatory pediatric practice. Additionally, these QI methods were associated with provider perception of improved ability to communicate with families about the need for GAS pharyngitis testing and about antibiotic use. Despite a reduction in unnecessary testing, a significant improvement in antibiotic utilization was not observed during the project underscoring the need for further efforts.

The majority of GAS pharyngitis testing in this practice was inconsistent with guideline recommendations for testing prior to intervention. The use of ≥ 2 viral symptoms as a criteria to determine unnecessary testing may even underestimate unnecessary testing. The decision to use this criteria is supported by a recent publication by Shapiro et al. in which they found an inverse relationship between number of viral features and the prevalence of GAS pharyngitis demonstrating that patients with ≥ 2 viral features were > 40% less likely to have GAS

pharyngitis compared to patients with no viral features [17]. Additionally, when we examined a subset of baseline data for our project (196 charts of patients > 3 years of age) the odds of a positive RADT for patients with 1 viral symptom was non-significant (OR: .665; CI: .332, 1.33; p-value: 0.2494) when compared to patients with no viral symptoms; statistical significance was observed for patients with ≥ 2 viral symptoms (odds ratio: 0.372; CI: 0.171, 0.809; p: 0.0127) when compared to patients with no viral symptoms. The use of a conservative estimate of unnecessary testing would not be expected to affect the proportion of reduction that was observed which was the focus of this project.

A number of local factors were key to reducing unnecessary testing. The practice involved in this project prioritizes delivery of high-quality healthcare as evidenced by their PCMH Level 3 designation from NCQA. The practice was receptive to process change including modification of an existing office procedure which likely contributed to the observed improvement in guideline-based testing. Additionally, physicians received MOC Part 4 credit for their work on this project which incentivized their engagement. Faculty engagement in an MOC project, along with other interventions, was previously used to successfully improve adolescent pregnancy screening rates [18].

Despite these local contextual factors, we still observed variability in unnecessary GAS pharyngitis testing between providers within this practice. We suspect that these differences were the reason we did not observe the magnitude of reduction in unnecessary GAS pharyngitis testing for which we aimed. Cognitive bias likely played a role in the observed baseline rate of unnecessary GAS pharyngitis testing and may have played a role in the ongoing variation between providers. Providers reported a fear of missed diagnosis and the complications that could result as a driver of their decision to perform GAS pharyngitis testing. We recognized that

base rate neglect played a role in their assessment of the need for testing as they over-estimated the risk for complications associated with GAS pharyngitis and under-estimated risks associated with antibiotic use [19].

Our project design relied primarily on educational interventions. Prior studies demonstrate that passive educational interventions result in limited sustainable improvement [20]. Face-to-face educational outreach, involvement of local opinion leaders, and a combination of interventions deployed simultaneously have been used to successfully create quality improvement [21]. We combined educational interventions with some of these methods to increase stakeholder buy-in and audit with feedback on performance in outcome measures to achieve greater improvement. Despite these efforts not all providers achieved reductions in unnecessary GAS pharyngitis testing. Our results underscore the challenges associated with quality improvement initiatives aimed at modifying provider behavior and highlight the importance of provider buy-in to achieve improvement. The post-hoc provider-level exploratory analysis allows identification of specific providers who can be targeted for individualized future interventions. Additionally, future projects evaluating the use of higher reliability interventions, such as decision support tools embedded in electronic health records, are needed.

We aimed for improvement in antibiotic utilization following our interventions. Our definition encompassed clinical indication, antibiotic selection, and antibiotic duration. Adherence to guideline-based first-line antibiotic selection was higher in this practice than published national data leaving little room for improvement in antibiotic selection [1]. Adherence to guideline-based antibiotic duration was also high. Prescribing of antibiotics to patients with unnecessary GAS pharyngitis testing remained the primary reason for inappropriate antibiotic utilization before and after intervention. These data suggest that a larger reduction

than we observed in unnecessary GAS pharyngitis testing is needed to significantly improve antibiotic utilization for GAS pharyngitis. Further efforts are needed to tackle the important national problem of antibiotic overuse for pediatric pharyngitis.

Our project has limitations. Multiple PDSA cycles were introduced in a 6 month period making it difficult to know which intervention had the greatest impact. The QI infrastructure available for our project may not be available in smaller practices which may limit generalizability of our results to smaller practices. The sample was selected from patients based on GAS pharyngitis testing and not based on antibiotic prescribing or clinical presentation. This sampling method resulted in small sample sizes of antibiotic prescriptions each month.

## Conclusions

Our collaborative, interprofessional QI initiative was successful in reducing unnecessary GAS pharyngitis testing in a large community pediatric practice. Interventions utilized to achieve improvement included provider and patient/family education, modification of office procedure, and communication strategies with periodic feedback provided on performance in outcome measures. Important contextual factors included QI infrastructure, provider buy-in, and MOC status of the project. Additional work is needed to identify higher reliability interventions which reduce variability in testing practices between providers and result in improved antibiotic utilization for GAS pharyngitis.

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