

MEDICAL EDUCATION/MEDICAL STUDENT

Improving antibiotic adherence in treatment of acute upper respiratory infections: a quality improvement process

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Introduction: Approximately 25 million people in the United States visit their primary care physician each year for acute respiratory infections (ARI). They are a common cause of unnecessary prescription of antibiotics; despite well-validated national treatment guidelines, around 73% of adults with ARI are prescribed antibiotics in the United States. Inappropriate use of antibiotics has profound implications.

Methods: Our aim was to increase adherence to antibiotic guidelines for treatment of ARI in an internal medicine outpatient practice. We used a package of active and passive interventions to improve physician awareness of treatment guidelines; these included short sessions of didactic teaching, antibiotic guidelines posters in patient examination rooms and staff areas, clinical decision support (CDS) tools integrated into the electronic medical record system, guideline adherence report cards for providers, and reiteration of CDS tool use and guideline adherence at monthly group meetings. Process measures were the rate of use of CDS tools for the management of ARI and patient callbacks within 72 h for the same issue. Outcome measures were compliance with antibiotic prescribing guidelines.

Results: Our low-cost interventions led to a significant improvement in ARI treatment guideline adherence. There was improvement in compliance with treatment guidelines for sinusitis (90.90% vs. 57.58%, $p < 0.001$), pharyngitis (64.28% vs. 25.00%, $p = 0.003$), upper respiratory infection (96.18% vs. 73.68%, $p = 0.008$), and the aggregated measure of ARI (91.25% vs. 78.6%, $p < 0.001$). Rate of CDS tool usage was 40.5% with a 72-h callback rate of 0.05%.

Conclusion: Simple, low-cost interventions can improve appropriate antibiotic use for ARI and change the prescribing habits of providers in an outpatient setting. Provider and patient education is a vital component of antibiotic stewardship. Simple interventions for common outpatient conditions can have a positive impact on patient outcomes and reduce unnecessary healthcare costs.

Keywords: *antibiotics; guidelines; upper respiratory tract infection; sinusitis; pharyngitis; acute respiratory tract infections*

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Inappropriate usage of antibiotics is the key driver of antibiotic resistance worldwide (1, 2). Over a 3-year period, antibiotics were prescribed in more than 101 million ambulatory visits across the United States, representing fully 10% of all outpatient visits (3). Of these, 41% of antibiotic prescriptions were written for a respiratory tract infection, in which the clinical benefit is known to be, at best, limited, and at worst, detrimental to the patient's health through their exposure to side effects, medication interactions, and complications, including *Clostridium difficile* colitis (3–5). Another contributor to antibiotic resistance is patient non-adherence to antibiotics, with up to 40% of patients failing to appropriately complete their antibiotic regimen (6, 7). To address these

concerns national educational campaigns were launched in the 1990s, including the United States Centers for Disease Control and Prevention (CDC) 'Get Smart: Know When Antibiotics Work' campaign launched in 1995 (8). These awareness efforts, as well as the use of routine childhood immunizations with pneumococcal conjugate vaccine, are believed to have decreased antibiotic prescription rates in child and adolescent populations. However, in the adult population there was no change in overall antibiotic prescribing patterns from the year 2000 to 2010. In addition, there was an overall increase in broad spectrum antibiotic prescribing during this time (9).

Given the existing unacceptably high antibiotic prescription rates in our patient population, this quality

improvement initiative aimed to build on previously published work to reduce rates of inappropriate antibiotic usage for the diagnoses of upper respiratory infection (URI), sinusitis, and pharyngitis, collectively called acute respiratory infections (ARI) (10, 11). A needs assessment was performed after the first Plan-Do-Study-Act (PDSA) cycle. A PDSA cycle is a commonly used tool in continuous quality improvement; where a problem and the required change are identified, changes are then implemented with the subsequent results being measured and analyzed to determine next steps (12). In this way, small tests of change are performed successively in a real work setting to ensure changes result in improvement (13). The results of our initial PDSA cycle indicated that the largest areas of perceived need were a point of care clinical decision support (CDS) tool and recurring, active educational interventions with real-time feedback. To address these issues, CDS tools were created to calculate a Modified Centor Score and to determine whether a sinus infection met the criteria for a bacterial sinusitis and antibiotic therapy. Active educational interventions were instituted including provider report cards, academic detailing, and inclusion into the residency quality improvement curriculum (10, 11). The purpose of this study was to examine the effects of the CDS tool and educational support on appropriate antibiotic guideline adherence for ARIs.

Methods and analysis

This was the second PDSA cycle in a quality improvement process carried out at an internal medicine outpatient practice at a university affiliated community hospital internal medicine residency program (10, 11). The initial PDSA cycle involved a package of passive education-based small-scale interventions that demonstrated a small improvement in adherence to appropriate antibiotic prescribing guidelines (10). Following these initial efforts, further analysis was done to identify an additional seven

interventions for the second PDSA cycle (Table 1). The first intervention occurred in October 2013 and was an educational session regarding appropriate usage of antibiotics in ARI conducted for internal medicine residents and faculty. In November 2013, summaries of CDC antimicrobial guidelines for treatment of URIs, sinusitis, and pharyngitis were placed in patient examination rooms, staff conference areas, and patient and employee restrooms (14–16). A CDS for appropriate antimicrobial usage integrated into the Epic electronic health record (Epic Systems Corporation, Verona, Wisconsin) was initiated in December 2013. Regular monthly reminders to adhere to antibiotic adherence guidelines and use CDS were sent via email to all practice providers (22 residents, 1 nurse practitioner, and 5 attending physicians). Further reinforcement regarding antibiotic guideline adherence and use of the CDS were included via academic detailing by team members in monthly practice meetings. In addition, visual prompts to use the CDS for appropriate diagnoses were placed at each computer workstation in the office. In March 2014, the final intervention, provider report cards, were sent to the clinicians outlining their adherence to guidelines from October 2013 to February 2014 (Table 1).

A physician author (RH) performed a chart review to determine rates of appropriate antibiotic guideline adherence, CDS tool usage rate, and patient callback within 72 h based on predefined criteria for inclusion and exclusion (10, 11). A second physician author (RA) independently reviewed the first 10% of encounters and then subsequently every 10th encounter to assess inter-rater variability. There was 100% consensus between the two independent reviewers.

Data were pooled by year, individual diagnosis (URI, sinusitis, pharyngitis), aggregate diagnosis ARI, and rate of guideline adherence. Analysis was performed by chi-square test of association using the statistical software SPSS version 20.0.0 (International Business Machines,

Table 1. Timeline for interventions in PDSA cycles 1 and 2

Three simultaneous interventions in October 2012		
First PDSA cycle	Date	Intervention
Second PDSA cycle	October 2013	Education session for attendings and residents
	November 2013	CDC antibiotic guideline summaries in patient examination rooms, conference room, staff and patient restrooms
		Monthly email reminders regarding antibiotic guideline adherence and CDS tool usage
		Reinforcement in monthly practice meetings
	December 2013	CDS tool available in EPIC
	February 2014	Visual reminders for CDS tool on every computer in the practice
	March 2014	Individual provider report cards regarding guideline adherence

Armonk, NY) with significance of results determined by $p < 0.05$.

Results

Patient characteristics

From 24 October 2013 to 15 July 2014, a total of 273 patients were identified using the Epic electronic health record by reviewing acute patient visits for diagnoses of URI, sinusitis, or pharyngitis. Of these encounters, 240 patients met the inclusion criteria of acute visits that were identified in the EPIC (EPIC Systems Corporation, Verona, WI) medical health records system using visit diagnosis of URI, pharyngitis, and sinusitis. The remainder met the exclusion criteria of active malignancy, immunocompromised state, including HIV infection, more than one visit for the same presentation during the study period, and concurrent use of antibiotics for another etiology, for example, urinary tract infection (Fig. 1).

Outcomes measures

Since 2012, adherence to antibiotic guidelines continued to improve with the implementation of the iterative interventions described (10, 11). A total of 240 patients were eligible to be included in this series of interventions. Of these patients, 55 (22.92%) were treated for sinusitis, 28 (11.66%) for pharyngitis, and 157 (65.42%) for URI. The adherence rate for each of these subsets improved to 90.90% for sinusitis ($p < 0.001$), 64.28% for pharyngitis ($p = 0.003$), and 96.18% for URI ($p = 0.008$). The adherence rate for the aggregated measure of ARI was 91.25% ($p < 0.001$), an increase from the ARI adherence rate of 78.68% from the previous PDSA cycle in 2012–2013 (Table 2).

Process measures

Process measures included rate of usage of the CDS tool. The CDS tool was made available for use in December 2013. In the 179 encounters that occurred after the CDS tool rollout, the tool was used in 71 encounters (39.7%).

Balancing measure

Balancing measures were callback rates within 72 h of office visit. There were 11 callbacks within 72 h for the same clinical issue during the entirety of the study period, for a rate of 0.05%, which was unchanged from prior interventions.

Discussion

This quality improvement initiative shows an improvement in overall antibiotic guideline adherence for all process and outcome measures demonstrating that simple, low-cost, iterative interventions can change the prescribing habits of providers. Interventions were chosen on the basis of a needs assessment following the findings of previous PDSA cycles. Previous work indicated that limited-scale passive interventions could generate moderate change but had not yielded the desired levels of antibiotic guideline adherence. By basing our most recent interventions on the needs assessment, we were able to more specifically target areas that would produce the most substantial changes.

The overall antibiotic guideline adherence rate was 91.25%, despite the CDS tool being used in approximately 40% of visits suggesting the other interventions had a positive impact independent of CDS tool usage. The balancing measures suggest high adherence to clinical guidelines with only 0.05% of encounters resulting in a 72-h callback, of which the majority of patients reported symptoms of

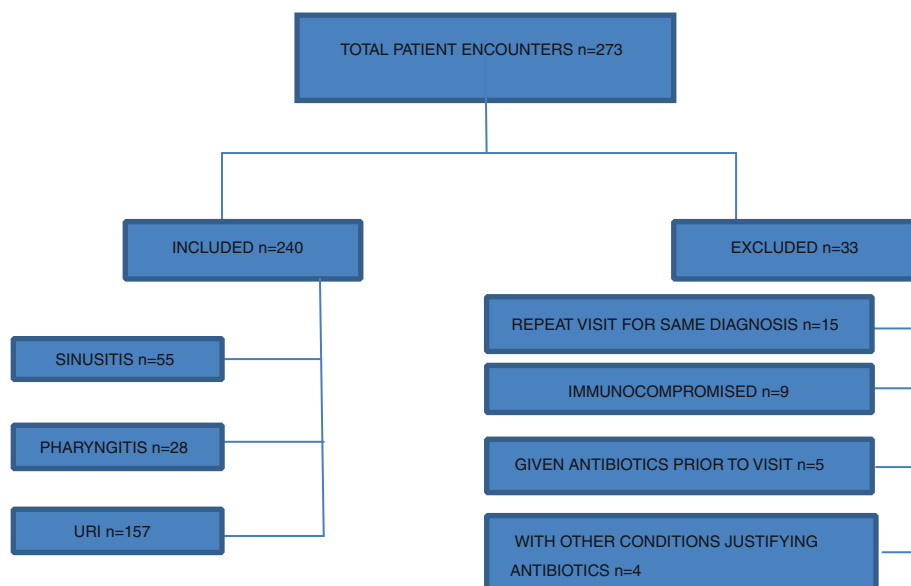


Fig. 1. Patient population and subgroups in PDSA cycle 2.

Table 2. Guideline adherence rates comparing data prior to intervention, PDSA cycle 1, PDSA cycle 2

Guidelines adherence		2008–2012 Prior to intervention	2012–2013 PDSA cycle-1	2013–2014 PDSA cycle-2	<i>p</i>
Sinusitis	Yes	93	19	50	<0.001
	No	130	14	5	
	Total	223	33	55	
	Adherence (%)	41.70	57.58	90.90	
Pharyngitis	Yes	33	7	18	0.0031
	No	104	21	10	
	Total	147	28	28	
	Adherence (%)	24.09	25.00	64.28	
URI	Yes	287	194	151	0.0083
	No	75	25	6	
	Total	362	219	157	
	Adherence (%)	79.28	88.58	96.18	
ARI	Yes	413	220	219	<0.001
	No	309	60	21	
	Total	722	280	240	
	Adherence (%)	57.20	78.68	91.25	

double worsening which includes worsening cough, nasal discharge and fevers after initial improvement. This rate was unchanged from historical controls, indicating that previously identified fears that antibiotic stewardship would increase condition workload post-visit were unfounded.

This multiyear process was conducted in a combined resident–faculty practice, which is a potential limitation as not all providers were exposed to all interventions. However, even with this variation there was still a statistically significant improvement in guideline adherence.

Future reassessment of guideline adherence will demonstrate whether our iterative approach to creating an antibiotic stewardship focused cultural change has persisted within this practice in the absence of continued active interventions. The CDS tool remains in EPIC for provider use in the future.

A potential confounder for this study is the change in the pattern of outpatient encounters for these illnesses. Barnett et al. demonstrated that between 1997 and 2010, visits for pharyngitis in a primary care setting decreased from 7.5 to 4.3% of all visits; however, visits for pharyngitis to emergency departments remained unchanged at around 2.3% (17). In addition to seeking healthcare at the emergency department, there has been an increase in the availability of stand-alone urgent care centers that cater to this patient population (i.e., ‘minute clinics’). Decreased frequency of outpatient encounters for ARI may also be related to improved public awareness of disease processes; availability of advice from other sources, such as the Internet; and medical insurance policy changes where antibiotics may no longer be covered for a certain subset of diagnoses, based on ICD-9 codes used in billing encounters as noted in the operations bulletin for the

Geisinger Health Plan-2014. Regardless, it is highly likely that ARI will continue to represent one of the most common diagnoses assessed in the ambulatory setting, and more appropriate antibiotic usage will remain a public health priority.

Simple, low-cost interventions can improve appropriate antibiotic use for ARIs and change the prescribing habits of providers in an outpatient setting. Provider and patient education is a vital component of antibiotic stewardship with a potential for positive impact on patient outcomes and reduction of unnecessary healthcare costs. Physician education including academic detailing and the use of CDS-based interventions are promising areas for improving adherence to antibiotic prescribing guidelines and deserve further study for optimization and avoidance of extinction.

Disclaimer

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