USE OF A CLINICAL DECISION SUPPORT TOOL TO IMPROVE ANTIBIOTIC PRESCRIBING FOR ACUTE RESPIRATORY INFECTIONS

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INTRODUCTION

Antibiotics are often inappropriately prescribed for acute respiratory infections (ARIs) in primary care settings.1 The majority of ARIs treated by primary care providers are caused by viral infections and do not respond to antibiotic treatment,2 yet over half of all ARI visits result in a prescription for an antibiotic with increasing use of broad spectrum antibiotics.1 This antibiotic overuse leads to the emergence of antibiotic resistant bacteria, creating a growing public health problem.3,4

Over the past few decades, strategies attempted to promote judicious antibiotic prescribing have achieved varying degrees of success. Because multiple factors contribute to a provider’s decision to prescribe antibiotics for ARIs, including awareness of prescribing guidelines,5 perceived patient expectations, uncertainty of diagnosis and concern for potential complications,6 single component interventions have been found to only marginally impact providers’ prescribing behaviors. Multi-faceted interventions, combining physician, patient and public education in a variety of formats have been found to be more effective at improving appropriate prescribing.7

Clinical decision support tools (CDS), which can target multiple factors impacting antibiotic prescribing have previously been piloted; however low use by providers limited assessment of their efficacy. The Reducing Inappropriate Prescribing of Antibiotics by Primary Care Clinicians (ABX-TRIP) demonstration project was designed to assess the impact of a CDS on antibiotic prescribing for ARI in primary care practices using a multi-method intervention to facilitate its implementation. The purpose of this paper is to describe the impact of the intervention on antibiotic prescribing for ARI diagnoses during the 15 month intervention.

METHODS

Study practices

The ABX-TRIP study was conducted within PPRNet, a practice based research network of primary care practices across the United States whose members use a common electronic health record (EHR) (McKesson Practice Partner® (PP), San Francisco, CA) and pool data for quality improvement and research purposes. Nine primary care practices located in nine states and representing 27 physicians, six nurse practitioners and six physician’s assistants volunteered to participate in this demonstration project in response to recruitment via an email sent to the PPRNet listserv. Practices ranged in size from 2 to 9 providers. Eight practices were family medicine practices; one practice was a combined internal medicine/pediatrics practice. All providers agreed to use the CDS when seeing patients presenting with ARI symptoms for the study duration. The study was approved by the Institutional Review Board at the Medical University of South Carolina.

The ABX-TRIP CDS

The ABX-TRIP CDS was designed by the research team as a sophisticated progress note template embedded within the PP® EHR and intended to be used at the point of care. PP® includes the ability to customize progress note templates; creating this tool utilized existing features of the EHR and no additional programming by the vendor was
Decision support was provided in three ways. First, the CDS provided recommendations to assist with proper diagnosis of ARIs. Specific questions in the subjective history were prompted by a patient’s predominant symptom (including cough, sore throat, sinus complaints or general URI symptoms). For example, when choosing “cough” as the patient’s main complaint, providers were reminded that the evaluation of acute cough should focus on ruling out pneumonia based on clinical exam findings. If a patient’s main presenting symptom was selected to be “sore throat,” then a reminder describing the Centor criteria for diagnosis of streptococcal pharyngitis was included in the subjective portion of the note. Additional management recommendations for further testing with a rapid strep test and/or treatment were provided based on the patient’s calculated score. For patients presenting with “sinus complaints,” because at least 7 days of symptoms is a sensitive predictor of bacterial rhinosinusitis, branching logic provided different recommendations based on symptom duration less than or more than 7 days. Another prompt reminded providers that generalized facial pain or headache do not increase the likelihood of bacterial infection. Selecting “general URI complaints” included cues to assess for a history of influenza vaccination and included a prompt about distinguishing influenza from a general URI based on specific symptoms such as fever and cough.

Second, once a diagnosis was selected, additional prompts provided treatment recommendations. When diagnosing “acute bronchitis,” providers were reminded that according to the CDC guidelines, antibiotic treatment is not recommended regardless of duration of cough. For “streptococcal pharyngitis,” penicillin was recommended as first line treatment. For “acute sinusitis,” providers were advised that most patients with acute bacterial rhinosinusitis improve without antibiotic treatment, but patients with moderate to severe symptoms may benefit from narrow spectrum antibiotics. When selecting “upper respiratory infection” as a diagnosis, providers were reminded that patients with green or yellow sputum do not benefit from antibiotic treatment. Consideration of other symptomatic treatment, including antihistamines and/or decongestants, was recommended.

Finally, the CDS provided specific patient education based on the selected diagnosis. Prompts were included to remind providers about the expected length of symptoms (i.e. ten days for URIs, 3 weeks for acute bronchitis). The CDS also included hyperlinks to CDC patient education handouts that could be printed and given to the patient at the point of care.

ABX-TRIP Intervention

The ABX-TRIP quality improvement intervention was conducted between January 1, 2010 and March 31, 2011 and had three components: meetings for project introduction, CDS review and “best-practice” dissemination, practice site visits for academic detailing and CDS training, and EHR based audit and feedback. Two project meetings attended by two representatives of each practice (one provider and one clinical staff member) were held. The initial project meeting was in December 2009, immediately prior to the start of the intervention. At this meeting, the goals
of the project were described, antibiotic guidelines for ARIs were reviewed, and the CDS was presented. Project representatives provided feedback and suggestions to improve the CDS. The CDS was subsequently revised to incorporate these suggestions prior to being disseminated to practices. A follow up network meeting was held midway through the intervention. At this meeting, practice representatives discussed their experiences with implementing the CDS, including the barriers and facilitators to using the CDS to improve antibiotic prescribing.

Practices also hosted two half day site visits during the intervention. The first site visits were conducted during the first two months of the intervention, while the second site visits were held during months 9 through 11 to coincide with the second ARI season (2010-2011). During these site visits, attended by the clinical staff at each practice and conducted by two members of the research team, guidelines for antibiotic prescribing for ARIs were presented, CDS training was provided, and practice performance on antibiotic prescribing measures was reviewed. At these site visits, the research team was also able to make minor modifications to the CDS to accommodate the practices’ workflow and meet the needs of the practices’ providers.

All participating practices continued the usual PPRNet procedure of quarterly data extracts. Practices received performance reports with practice level information on both use of the CDS and the use of antibiotics to treat ARIs.

Study Measures

All data was extracted from the EHRs of participating practices. An ARI encounter was defined as an ARI diagnosis within the diagnoses list. ARI encounters were extracted for all active patients (defined as having had a visit within 1 year and not designated as deceased, transferred, or inactive) over 18 years of age during the fifteen month intervention. CDS use was calculated at the practice level as the number of encounters at which an ARI diagnosis using the CDS was made divided by the number of all encounters at which an ARI diagnosis using the CDS was made.

Antibiotic use was defined as a prescription for an antibiotic written within 3 days of the ARI encounter. Antibiotics were further classified as broad or narrow spectrum; quinolones, amoxicillin/clavulanate, second and third generation cephalosporins, and azithromycin and clarithromycin were classified as broad spectrum antibiotics. All other antibiotics, including amoxicillin, penicillin, 1st generation cephalosporins, tetracyclines, erythromycin, and trimethoprim/sulfamethoxazole were classified as narrow spectrum. Intra-venous formulations, polymyxins and aminoglycosides were excluded.

Study measures included use of antibiotics to treat ARIs and use of broad spectrum antibiotics to treat ARIs. These measures were calculated for encounters for which antibiotics may be appropriate (acute otitis media, pneumonia, acute sinusitis, streptococcal pharyngitis and chronic obstructive pulmonary disease exacerbation (COPD)) or are rarely appropriate (nonspecific upper respiratory tract infection (URI), acute bronchitis and acute non-strep pharyngitis).
RESULTS

During the 15 month intervention, the CDS was used 12,664 times for adult ARI encounters in the 9 participating practices. Practice use of the CDS during adult ARI encounters ranged from 41.1% to 77.6% (median 60.8%).

The use of antibiotics for ARI diagnoses when the CDS was used during the 15 month intervention is displayed in Table 1. Median practice antibiotic prescribing for encounters for which antibiotics are rarely appropriate was 29.6% (range 24.1%-72.1%). At these encounters, antibiotics were prescribed most frequently for multiple diagnoses (more than one diagnosis for which antibiotics are rarely appropriate, median 69.4%, range 38.5%-88.2%) and least frequently for URIs (median 14.3%, range 7.2%-63.7%). Median practice antibiotic prescribing for encounters for which antibiotics may be appropriate was 88.9% (range 84.7% to 96.4%). At these encounters, antibiotics were prescribed most often for multiple diagnoses (more than one diagnosis for which antibiotics may be appropriate) (median 100%, range 99.1% to 100%) and least often for COPD exacerbation (median 72.7%, range 0% to 100%).

Table 2 presents practice use of broad spectrum antibiotics when antibiotics were prescribed for ARI encounters when the CDS was used. For encounters for which antibiotics may be appropriate, broad spectrum use was highest for pneumonia (median 84.6%, range 41.7% to 100%) and lowest for COPD exacerbation (median 16.7%, range 0% to 62.5%). For encounters for which antibiotics are rarely indicated, broad spectrum use was highest for acute bronchitis (median 68.7%, range 24.0% to 100%) and lowest for acute pharyngitis (median 28.9%, range 11.1% to 66.7%).
Table 1. Use of Antibiotics for ARIs when CDS Used

<table>
<thead>
<tr>
<th>Practice</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>Total # of encounters</th>
<th>Practice median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>N= # of encounters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>27</td>
<td>7</td>
<td>12</td>
<td>5</td>
<td>21</td>
<td>8</td>
<td>8</td>
<td>89</td>
<td>175</td>
<td>96.2%</td>
</tr>
<tr>
<td><strong>Encounters for which antibiotics may be appropriate</strong></td>
<td>153</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>363</td>
<td>93.3%</td>
</tr>
<tr>
<td><strong>Encounters for which antibiotics are rarely appropriate</strong></td>
<td>28</td>
<td>438</td>
<td>250</td>
<td>36</td>
<td>466</td>
<td>107</td>
<td>130</td>
<td>1159</td>
<td>646</td>
<td>3260</td>
<td>14.3%</td>
</tr>
<tr>
<td><strong>PNA=pneumonia, COPD=chronic obstructive pulmonary disease, URI=upper respiratory tract infection</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

N= # of encounters, (% of encounters with prescription for antibiotic)
### Table 2. Use of Broad Spectrum Antibiotics when CDS Used

<table>
<thead>
<tr>
<th>Practice</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>Total # of prescriptions</th>
<th>Practice median</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Encounters for which antibiotics may be appropriate</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OM</td>
<td>0 (0%)</td>
<td>22 (31.8%)</td>
<td>7 (42.9%)</td>
<td>5 (40.0%)</td>
<td>17 (41.2%)</td>
<td>6 (37.9%)</td>
<td>8 (62.5%)</td>
<td>22 (50.0%)</td>
<td>51 (33.3%)</td>
<td>165</td>
<td>37.9%</td>
</tr>
<tr>
<td>PNA</td>
<td>1 (100%)</td>
<td>13 (84.6%)</td>
<td>12 (41.7%)</td>
<td>2 (100%)</td>
<td>18 (77.8%)</td>
<td>6 (83.3%)</td>
<td>8 (62.5%)</td>
<td>83 (95.2%)</td>
<td>187 (85.0%)</td>
<td>330</td>
<td>84.6%</td>
</tr>
<tr>
<td>Acute Sinusitis</td>
<td>34 (82.4%)</td>
<td>207 (51.2%)</td>
<td>216 (25.0%)</td>
<td>8 (50.0%)</td>
<td>140 (40.0%)</td>
<td>215 (54.0%)</td>
<td>146 (10.3%)</td>
<td>1065 (79.5%)</td>
<td>755 (37.9%)</td>
<td>2786</td>
<td>50.0%</td>
</tr>
<tr>
<td>Strep Pharyngitis</td>
<td>3 (0%)</td>
<td>42 (21.4%)</td>
<td>34 (23.5%)</td>
<td>11 (36.4%)</td>
<td>17 (27.3%)</td>
<td>37 (13.5%)</td>
<td>15 (13.3%)</td>
<td>284 (16.9%)</td>
<td>57 (31.6%)</td>
<td>494</td>
<td>21.4%</td>
</tr>
<tr>
<td>COPD exacerbation</td>
<td>0 (0%)</td>
<td>8 (62.5%)</td>
<td>1 (0%)</td>
<td>0 (0%)</td>
<td>111 (47.7%)</td>
<td>5 (0%)</td>
<td>17 (23.5%)</td>
<td>6 (16.7%)</td>
<td>75 (56.0%)</td>
<td>223</td>
<td>16.7%</td>
</tr>
<tr>
<td>Multiple (more than 1)</td>
<td>7 (71.4%)</td>
<td>107 (50.5%)</td>
<td>45 (28.9%)</td>
<td>4 (25.0%)</td>
<td>58 (34.5%)</td>
<td>110 (36.4%)</td>
<td>54 (14.8%)</td>
<td>573 (62.8%)</td>
<td>348 (42.2%)</td>
<td>1306</td>
<td>36.4%</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>45 (75.6%)</td>
<td>399 (48.1%)</td>
<td>315 (26.3%)</td>
<td>30 (43.3%)</td>
<td>355 (43.1%)</td>
<td>402 (44.0%)</td>
<td>252 (14.7%)</td>
<td>2033 (66.2%)</td>
<td>1473 (45.4%)</td>
<td>5304</td>
<td>44.0%</td>
</tr>
<tr>
<td><strong>Encounters for which antibiotics are rarely appropriate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>URI</td>
<td>4 (75.0%)</td>
<td>68 (48.5%)</td>
<td>18 (11.1%)</td>
<td>5 (60.0%)</td>
<td>46 (21.7%)</td>
<td>15 (13.3%)</td>
<td>32 (6.3%)</td>
<td>738 (43.9%)</td>
<td>114 (51.8%)</td>
<td>1040</td>
<td>43.9%</td>
</tr>
<tr>
<td>Acute Bronchitis</td>
<td>3 (100%)</td>
<td>67 (68.7%)</td>
<td>49 (51.0%)</td>
<td>15 (100%)</td>
<td>110 (43.6%)</td>
<td>77 (54.5%)</td>
<td>25 (24.0%)</td>
<td>380 (79.5%)</td>
<td>209 (74.2%)</td>
<td>935</td>
<td>68.7%</td>
</tr>
<tr>
<td>Acute Pharyngitis</td>
<td>3 (66.7%)</td>
<td>25 (44.0%)</td>
<td>38 (28.9%)</td>
<td>7 (28.6%)</td>
<td>9 (11.1%)</td>
<td>6 (50.0%)</td>
<td>3 (33.3%)</td>
<td>119 (26.1%)</td>
<td>87 (18.4%)</td>
<td>297</td>
<td>28.9%</td>
</tr>
<tr>
<td>Multiple (more than 1)</td>
<td>5 (60.0%)</td>
<td>62 (51.6%)</td>
<td>34 (58.8%)</td>
<td>7 (71.4%)</td>
<td>31 (35.5%)</td>
<td>38 (36.8%)</td>
<td>29 (20.7%)</td>
<td>582 (54.9%)</td>
<td>329 (57.1%)</td>
<td>1118</td>
<td>54.9%</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>15 (73.3%)</td>
<td>222 (55.0%)</td>
<td>139 (41.7%)</td>
<td>34 (73.5%)</td>
<td>196 (35.7%)</td>
<td>136 (44.9%)</td>
<td>89 (16.9%)</td>
<td>1820 (53.7%)</td>
<td>739 (56.6%)</td>
<td>3390</td>
<td>53.7%</td>
</tr>
<tr>
<td><strong>Total abx</strong></td>
<td>60 (75.0%)</td>
<td>621 (50.6%)</td>
<td>454 (31.1%)</td>
<td>64 (59.4%)</td>
<td>551 (40.5%)</td>
<td>538 (44.2%)</td>
<td>341 (15.2%)</td>
<td>3853 (60.3%)</td>
<td>2212 (49.1%)</td>
<td>8694</td>
<td>49.1%</td>
</tr>
</tbody>
</table>

N=# of prescriptions (% broad spectrum antibiotics)

PNA=pneumonia, COPD=chronic obstructive pulmonary disease, URI=upper respiratory tract infection
DISCUSSION

In this study we were able to successfully develop and implement a CDS for ARIs that was widely used across the nine participating practices. Median use of the CDS among practices was 60.8%, an order of magnitude greater than in previous reports. The broad use of our CDS provides confidence that its impact on providing can be reliably assessed. Practices using this CDS prescribed antibiotics more appropriately for many ARI diagnoses compared to national prescribing data. In a recent analysis of data from the National Ambulatory Medical Care Survey (NAMCS) and the National Ambulatory Medical Care Survey (NHAMCS) in 2005-2006, among persons 5 years or older, the proportion of ARI visits for conditions for which antibiotics are rarely indicated resulting in an antibiotic was 48%. Antibiotic prescribing for these conditions was lower in seven of nine practices in this study.

Notable among our findings is the great variability in antibiotic prescribing for ARIs by ARI diagnosis. An analysis of 1997-1999 NAMCS survey data is the most comparable study reporting national rates of antibiotic use and broad spectrum use by diagnosis. In our study, median practice antibiotic prescribing for URI was 14.3%, compared to 46% this NAMCS analysis. Antibiotic prescribing for acute sinusitis, a condition for which antibiotics may be indicated in moderate to severe cases, was actually higher than in this NAMCS study (practice median 92.0% compared to 69% in NAMCS). However, median use of broad spectrum antibiotics when antibiotics were prescribed was lower for URI, otitis media, acute pharyngitis and acute sinusitis than reported percentages of broad spectrum use for these diagnoses in this NAMCS analysis.

Antibiotic use also widely varied by practice. For example, antibiotic prescribing for URIs by practice ranged from 7.2% to 63.7% of diagnoses made using the CDS. The percentage of broad spectrum antibiotics prescribed for diagnoses of acute sinusitis by practice ranged from 10.3% to 82.4%. These findings highlight the multiple factors that likely affect provider prescribing of antibiotics for ARIs. Despite using the CDS with embedded guidelines, providers reported patient expectations for antibiotics, concern about missing a more serious diagnosis and some disagreement about antibiotic prescribing guidelines as reasons for prescribing antibiotics when not indicated.

There are several important limitations to this study. It was conducted within a group of volunteer practices, and lacked a concurrent control group. Because the data used for analysis was obtained from diagnoses made using the CDS, comparable pre-intervention data is not available to assess whether prescribing actually changed in response to use of the CDS. Moreover, a 15 month intervention period is a relatively brief timeframe for changing physician behavior. Finally, although the CDS was an essential component of the intervention, academic detailing and performance review were also utilized to promote judicious antibiotic use. Although these additional components likely aided CDS adoption, they limit the ability to assess the independent effect of the CDS.

Despite the study limitations, we believe that the intervention appears to have had an impact both on antibiotic prescribing for inappropriate indications and use of broad spectrum antibiotics compared to national prescribing data. Although a randomized trial will ultimately be need to confirm the success of this intervention, we believe that a CDS, when implemented within the context of academic detailing, user training and performance review, shows promise for promoting judicious antibiotic use for ARIs.
REFERENCES


ACKNOWLEDGMENTS

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Dr. Litvin is an Assistant Professor in the Division of General Internal Medicine and Geriatrics at the Medical University of South Carolina and a PPRNet investigator. She currently has a career development award from the Agency for Healthcare Research and Quality to study how clinical decision support tools can be used to improve primary care chronic disease management.

Dr. Ornstein is a Professor in the Department of Family Medicine at the Medical University of South Carolina and the founder of PPRNet.