

Grant Final Report

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Improving Otitis Media Care with EHR-based Clinical Decision Support

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Abstract

Purpose: To develop and test the effects of an EHR-based clinical decision support (CDS) intervention coupled with provider performance feedback on the quality of otitis media care and to understand patterns and reasons for physician adoption of this type of informatics application.

Scope: 24 primary care practices, 290 physicians, and 184,195 children.

Methods: An informatics application was developed to apply real-time clinical decision support for otitis media. It included: a visual display of prior episodes and treatments; a structured data collection form; guideline-based recommendations; facilitated order entry; and, individualized patient instructions. We did a cluster randomized controlled trial (12 months pre and 21 months post) to evaluate the effects of the CDS.

Results: Practices randomized to clinical decision support were significantly more likely to adhere to guidelines for management of otitis media than control practices. There was marked variation in physician adoption of clinical decision support, although feedback of prior CDS use increases its usage. **Conclusions:** Prospectively assigning encounters to a treatment episode allows for CDS at the point-of-care to account for past treatment decisions. Providing decision support at the point-of-care is an effective strategy for improving quality; however, simply making decision support available to clinicians does not assure its usage.

Key Words: Otitis media, EHR, clinical decision support, cluster randomized controlled trial

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Final Report

Purpose

This goal of this study was to determine if point-of-care decision support could improve adherence to practice guidelines, thereby reducing inappropriate antibiotic use and increasing the quality of otitis media care.

Our specific aims were:

Aim 1.

- A) Conduct a pre-study prior to CDS development to characterize patterns of electronic medical record (EMR) use at pediatric primary care acute visits. [Manuscript attached as separate file]
- B) To develop a novel CDS application that comprised a pediatric episode grouper informatics tool that links healthcare across all locations into a time-dependent service cluster, evidence-based clinical decision support for medications and referrals, and physician feedback of quality performance data.

Aim 2. To test the hypothesis that the CDS with and without retrospective physician feedback could improve the quality of otitis media care.

Aim 3. To assess the effects of the intervention on the secondary outcomes of clinician adoption of the health IT.

Scope

Background

Otitis media (OM) is a hallmark pediatric disorder, with over 80% of cases occurring in childhood¹. It is the third most common reason for pediatric office visits² the most frequent condition pediatricians refer to specialists³ and the top reason why clinicians prescribe antibiotics.⁴ Annually, there are 7 million OM episodes in the US, which account for about \$5 billion of direct costs. Despite national guidelines^{5,6} that recommend judicious use of antimicrobial therapy, variability across clinicians in the medication management of OM is substantial^{7,8} as is the use of surgery.⁹ These variations are associated with excess use of antibiotics¹⁰ and surgery, both of which increase costs of care.

Context

Evidence-based clinical practice guidelines are an attempt to reduce practice variations that are associated with uneven quality and system inefficiencies. Simply promulgating guidelines is insufficient to modify physician behavior.¹¹⁻¹⁴ Clinical decision support is a promising approach for improving quality by embedding evidence-based knowledge into workflow, thereby delivering appropriate and actionable information to the point of care. When clinical decision support is integrated into the EHR, it can reduce clinical uncertainty and improve medical decision-making,¹⁵ which we hypothesize for OM will increase adherence to evidence-based guidelines and reduce the use of medications and other interventions.

Setting

The Pediatric Research Consortium (PeRC), a Practice Based Research Network (PBRN) launched with AHRQ funding, was the study setting for the project. PeRC has been in existence for eight years, and its projects rely heavily on clinical data obtained from the EHR.

Participants

24 primary care practices from the Children's Hospital of Philadelphia (CHOP) Pediatric Research Consortium; 2 practices declined to participate.

Prevalence

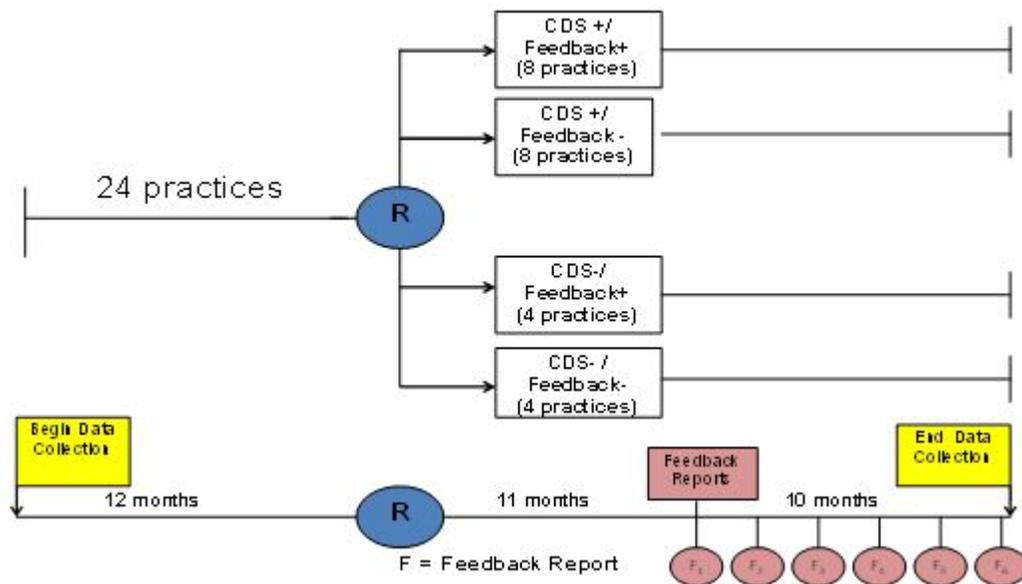
Among primary care visits, 12% of visits (145,390/1,223,784) were for otitis media; 30% of primary care patients 0-12 years of age had otitis media during the study period of 33 months (56,650/184,195).

Methods

Study Design

Cluster randomized controlled trial with the practice as the unit of randomization. Practices were randomized in December, 2008.

Figure 1. Study design



Data Sources/Collection

All data were obtained from the CHOP EHR system. We extracted both structured data fields (e.g., medication codes) and unstructured text (e.g., narrative from the physical exam and history) as inputs for the CDS system and our statistical analyses.

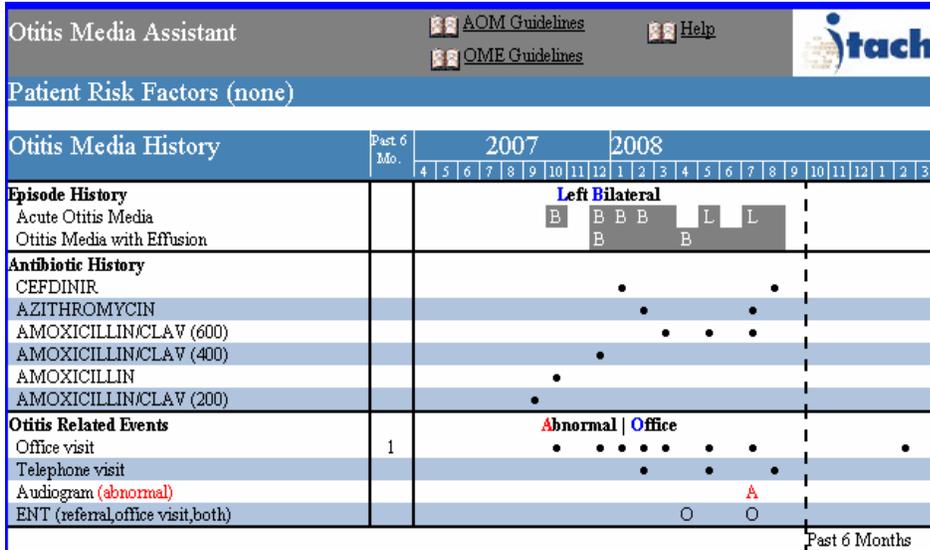
Interventions

Clinicians in practices randomized to CDS intervention (n=16 practices) underwent a one hour training session on the otitis media guidelines, the purpose of the study, the CDS tool, and the optional nature of the CDS tool.

Clinicians in practices randomized to feedback (n=12 practices equally balanced in the CDS groups) received a series of 6 reports during the last 10 months of the project on their usage of the CDS tool and performance on various quality of care metrics.

CDS Intervention. The CDS system was presented to clinicians as a series of “panels” that were created specifically for this project.

Figure 2. (Panel #1) Episode grouper: This was automatically “launched” given a variety of conditions, such as a reason for encounter



“The Blue Panel”: The first section viewed by clinicians is informational. It includes important patient risk factors and provides an “otitis timeline” with up to 2 years of information compiled from the patient chart. Episode history displays past AOM and OME encounters grouped into episodes. Antibiotic history displays a history of antibiotic orders for any condition. Otitis related events displays a history of office visits, phone encounters, audiograms, referrals, and surgery. Items displayed in the timeline are “clickable” and link to standard screens within the EMR.

Figure 3. (Panel #2) Structured history and physical exam forms: Clinicians interested in using the OM CDS had to “launch” this panel by clicking on a button

The screenshot shows two side-by-side form panels. The left panel, 'History of Present Illness', includes fields for fever (102.5°F), Tmax (103), and Duration (3 days). It has checkboxes for 'Normal', 'Otalgia', and 'Otorrhea'. The right panel, 'Physical Exam', includes a 'General appearance' section (Well/Ill) and a table for ear exam findings. The table has columns for 'Right', 'Left', and 'Not assessed'. Findings include 'Normal', 'Unable to visualize', 'TM Injected', 'Bulging', 'Otorrhea', 'Effusion/Air fluid level', 'Decreased mobility', 'Tubes in place', and 'Perforation'. A 'Show suggested diagnosis/plan' button is at the bottom.

“The White Panel”: This section allows the clinician to record patient information regarding history or present illness and physical exam. The blue “i” icons display images of physical exam findings that may be of interest to the clinician and patient/parent. Once the information is entered, the clinician can click the “Show suggested diagnosis/plan” button to receive an evidence-based assessment and plan.

Figure 4. (Panel #3) Guideline-based treatment recommendations

Assessment and Plan			
Type	AAP Guideline	Action	Reason Declined
Diagnosis	Acute Otitis Media	<input checked="" type="radio"/> Accept/Sign <input type="radio"/> Decline	
Analgesic	IBUPROFEN 100 mg/5 mL susp, give 150 mg (=1.5 tsp) po q6h prn	<input checked="" type="radio"/> Accept/Sign <input type="radio"/> Decline	
Antibiotic	AMOXICILLIN-CLAVULANATE 600 mg/5 mL susp, give 720 mg (=6 mL) po bid for 10 days	<input checked="" type="radio"/> Accept/Sign <input type="radio"/> Decline	
Antibiotic	OFLOXACIN 5 gtt bid to affected ear 10 days	<input checked="" type="radio"/> Accept/Sign <input type="radio"/> Decline	
Documentation	Otitis Media Progress Note	<input checked="" type="radio"/> Accept/Sign <input type="radio"/> Decline	

“The Red Panel”: This section displays the guideline-based recommendations for treatment of the patient. The possible types of recommendations are Diagnosis, Antibiotic, Referral, Analgesic, and Documentation. Each recommendation can be accepted or declined. Clinicians who choose to process orders would receive facilitated order entry with weigh-based dosing calculated and parts of the progress note written.

Figure 5. (Panel #4) Personalized patient instructions

General Information
Your child has acute otitis media, commonly known as an ear infection. Virus or bacterial germs can get behind the eardrum and cause ear infections. Fluid and pressure may build up and cause ear pain. Some, but not all children with ear infections have a fever. Young children may be fussy or sleep poorly at night when they have an ear infection. Pulling at the ears may or may not be a sign that a young child has an ear infection.

Treating pain
Pain from an ear infection may last for several days. It is important to treat your child's pain with acetaminophen (Tylenol) or ibuprofen (Motrin or Advil). The correct dose for your child is:
IBUPROFEN 100 mg/5 mL susp, give 150 mg (=1.5 tsp) by mouth every 6 hours as needed

Antibiotics
Your child has an ear infection that needs treatment with antibiotics. Unless they have a serious allergy to penicillin type antibiotics, your child will get the antibiotic Amoxicillin. Studies have shown that Amoxicillin is the best antibiotic to use for ear infections. We have decided as a network of CHOIP pediatricians and sub-specialists to follow the recommendations of the American Academy of Pediatrics and use this antibiotic first for ear infections because it works well, is less likely to cause bacterial germ resistance to other antibiotics and is covered by insurance companies. Be sure to give the proper dosage every day for the full time it is prescribed. The dose for your child is:
AMOXICILLIN-CLAVULANATE 600 mg/5 mL susp, give 720 mg (=6 mL) by mouth twice daily for 10 days
OFLOXACIN 5 drops twice daily to affected ear 10 days

Perforated Tympanic Membranes
Sometimes, pressure builds up behind the eardrum and fluid may drain out of the ear through a hole in the eardrum. In most cases, the hole will heal itself and the drainage will go away in a couple of days. In addition to other treatments, your doctor will give you an antibiotic drop to put in the ear. Do not put any other medicines in the ear.

Press F3 key to expand form

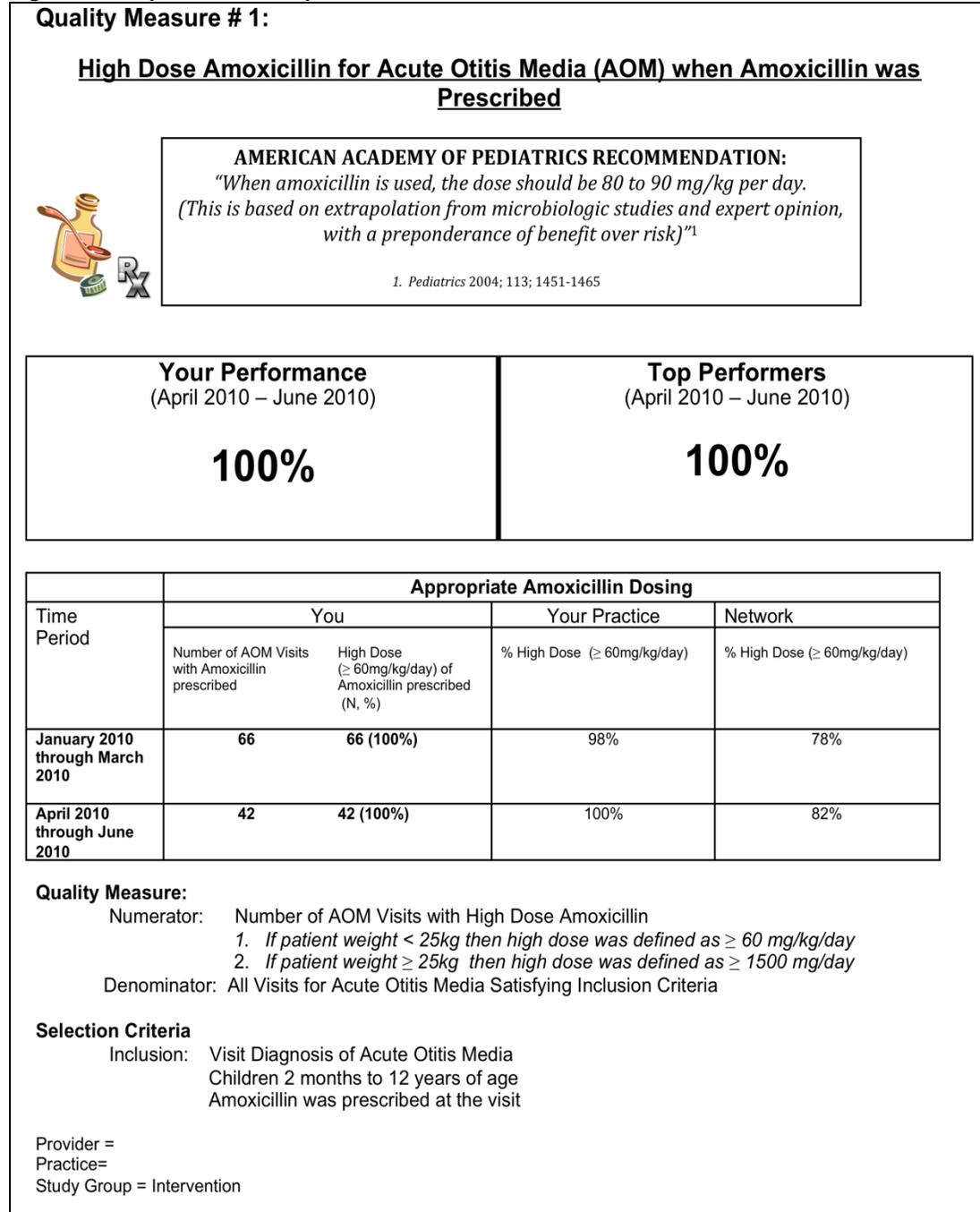
Patient Instructions: The CDSS automatically generates patient’s instruction tailored to the diagnosis and treatment plan.

Retrospective Feedback. After an initial 11month period of CDS use, six rounds feedback were hand-delivered to study clinicians over 10 months. Two members of the study team visited the intervention practices to distribute the reports, answer questions, and obtain input on the report or any part of the study. We kept careful logs of the reasons why clinicians reported they did or did not use the CDS system.

Quality metrics for OM care were added to the reports in a step-wise fashion. Ultimately the reports included 4 quality metrics and a measure of tool use. All quality indicators were based on American Academy of Pediatric (AAP) Acute Otitis Media (AOM) guidelines. For AOM, they included: 1) appropriate use of amoxicillin as a first line antibiotic, 2) use of high dose amoxicillin, 3) pain assessment, and 4) use of analgesia. For each of the quality metrics as well as overall tool use, the reports included the performance of the clinician, their practice, the

network as whole, and the performance of top 10% of the providers. A sample of the feedback report can be seen below.

Figure 6. Sample feedback report



Measures

Quality Measures. 12 quality measures were assessed.

Acute Otitis Media.

1. Adequate diagnostic documentation
2. Antibiotic appropriately not prescribed
3. Penicillin allergic patient received the most appropriate first-line antibiotic
4. Non-penicillin patient prescribed amoxicillin as a first-line therapy
5. High-dose amoxicillin prescribed when amoxicillin prescribed

Otitis Media with Effusion.

1. Adequate diagnostic documentation
2. Appropriate Non-use of Antihistamines, Decongestants, and Oral Corticosteroids
3. Diagnosis confirmed with pneumatic otoscopy and tympanometry
4. Antibiotic non-prescribed

Otitis Media.

1. Pain Documented
2. Pain treated with analgesics
3. Use of 3rd generation Cephalosporins

Other Measures.

1. Clinician usage of the CDS (tool use)

Limitations

The CDS system that we developed was an extension of an existing decision support framework previously developed at CHOP. Nonetheless, there were several parts of it that were novel and highly complex to create, requiring greater than expected time and financial resources. Second, the application was developed as a research project, but it interfaced with operational systems. We had to negotiate with our enterprise IT unit when and how the system could be implemented. This was more of a challenge than a limitation. Third, as we discussed this

project with all the intervention practices and physicians, we learned that there was a general sense that they know how to care for patients with otitis media. A CDS system for a problem for which there was no perceived need—even though the literature and our preliminary data suggested high levels of quality gaps—was unlikely to be widely used. Fourth, our concern of low usage was realized, and was the primary reason for a lower than expected signal for the CDS system. Still, despite rather low usage, we were able in intention to treat analyses to detect a beneficial impact of the intervention.

Results

Study Sample

The description of the RCT study samples is shown in Table 1.

Table 1. Study sample

Sample Characteristics	Pre-CDS Phase (12 mos)	Post-CDS Phase (21 mos)	TOTAL
# primary practices	24	24	24
# non-resident physicians/NPs	216	247	290
# patients with ≥ 1 primary care visit	138,947	164,671	184,195
# primary care visits	437,905	785,879	1,223,784
# primary care visits with a pediatric resident (% of primary care visits)	9,117 (2.1%)	25,381 (3.2%)	34,498

Two practices left the primary care network for reasons unrelated to this study during the post-CDS phase. They are included in the intention to treat analysis. The loss of these practice's visits led to an increased proportion of pediatric resident visits because the denominator of the proportion became smaller with no change in the numerator (i.e., neither was a teaching site.)

Identification of Otitis Media Visits

Using both structured and unstructured text from the medical record, we developed algorithms to identify a visit as otitis media and then its type as acute otitis media, otitis media with effusion, and otitis media unspecified. Using these methods, the CDS system identified 54,465 visits in the Pre-CDS and 90,925 visits in the Post-CDS phases as otitis media. These visits constituted approximately 12% of all office visits to the primary care practices. The proportions of otitis media categorized as acute otitis media (62%), otitis media with effusion (20%), and otitis media unspecified (18%) did not change between the Pre-CDS and Post-CDS periods.

Quality of Care

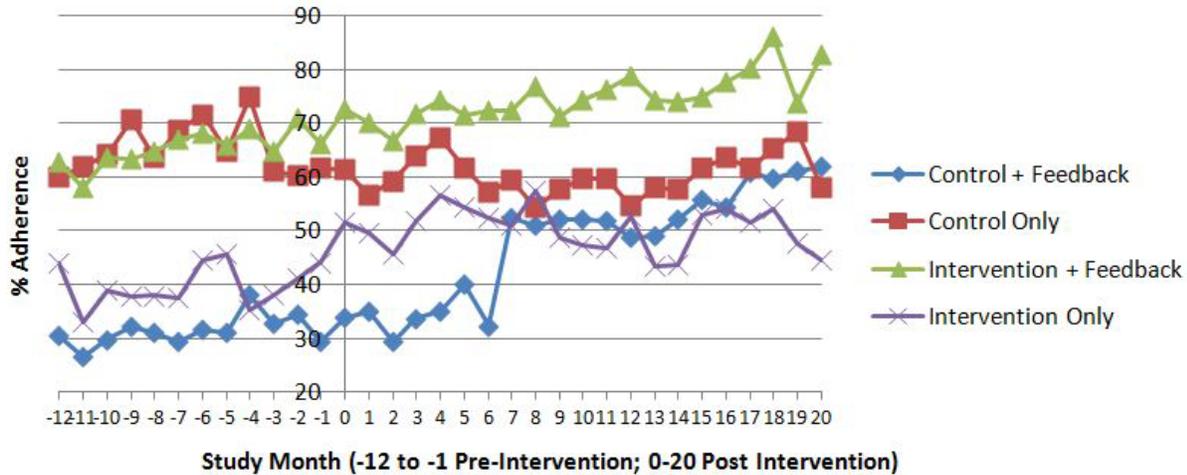
Quality outcomes were assessed in the pre and post intervention periods by study group. Unadjusted change scored (Post-phase proportion minus Pre-phase proportion) results can be shown in Table 2. Many but not all of the quality metrics appeared to increase as a result of the intervention.

Table 2. Quality indicators: unadjusted change scores by intervention group

	% Change from Post- to Pre- Intervention: Control Only	% Change from Post- to Pre- Intervention: Feedback Only	% Change from Post- to Pre- Intervention: CDS Only	% Change from Post- to Pre- Intervention: CDS and Feedback
AOM Antibiotic Appropriately Not Prescribed	-4.6%	0.1%	-2.4%	-0.8%
AOM Adequate Diagnostic Documentation Done	5.6%	-4.3%	1.2%	4.3%
AOM PCN Allergic Patient Received Most Appropriate First Line-Antibiotic Done	n/a	2.6%	5.2%	8.4%
AOM Non-PCN Allergic Patient Prescribed Amoxicillin as First-Line Therapy Done	0.0%	1.7%	4.0%	6.2%
AOM High Dose Amoxicillin Prescribed	-4.2%	15.3%	10.7%	9.9%
OME Adequate Diagnostic Documentation	0.4%	-2.3%	3.6%	2.4%
OME Appropriate Non-Use of Antihistamines, Decongestants, or Oral Corticosteroids	2.1%	-3.0%	-0.5%	0.2%
OME Diagnosis Confirmed with pneumatic otoscopy and tympanometry	0.6%	-2.6%	3.2%	2.4%
OME Antibiotic Not Prescribed	0.6%	-2.6%	3.2%	2.4%
OM Pain Documented Done	-0.1%	2.9%	0.6%	0.6%
OM Pain treated with analgesics	6.2%	9.9%	14.9%	8.5%
OM 3rd Generation Cephalosporin Used (decreased desired)	-4.4%	-2.3%	0.3%	-1.0%

Figure 7 shows the unadjusted temporal change in appropriate use of high-dose amoxicillin for acute otitis media across the 33 month study period. This quality metric experienced marked improvement post-intervention. All groups, with the exception of the control only group, performed better.

Figure 7. Appropriate use of high dose amoxicillin for acute otitis media



Next we performed a series of mixed effects regression analyses to account for the longitudinal study design. We fit mixed effects models (using the statistical package R) that included random intercepts and slopes for each practice (random slopes substantially improved model fit according to both the AIC and BIC statistics). Controlling on patient covariates, the odds of prescribing high dose amoxicillin during the post-CDS phase were increased 3.7 fold for the CDS only group and 1.9 fold for the CDS+Feedback group, which were significantly higher than the control groups. [These results are in preparation for a manuscript that will be submitted during the summer, 2011.]

Secondary Outcomes: Adoption

The OM CDS tool was used in 18% of visits. Tool use was defined as using any component of the tool including the structured H&P form, the guideline-based recommendations, any part of the automated progress note, or patient instructions. Interestingly, providers preferred using the tool for patient instructions (72% of visits where tool was used) rather than any of the components of the progress note. Tool use varied greatly among providers. While some providers were never users (7%), heavy users used the tool on over 50% of visits (18%), and 75% were intermediate users.

Figure 8 below shows the tool use over the 21 month Post-Intervention phase.

Figure 8. Tool use over time



December 2008 through February 2009 was a “wash-out” period, and is indicated by the light blue line. During this period the CDS intervention was turned off twice due to technical difficulties and required enhancements.

There was rapid decline in tool use during the first 3 months and then a plateau thereafter.

Discussion

We successfully created and implemented an episode grouper and clinical decision support system designed to improve evidence-based care in 24 primary care practices. This fulfills our plan that was developed for Aim 1. It is our intent to make the design of this intervention freely available through publication in the peer-reviewed press.

As a test of our hypothesis (Aim 2), we found that practices that received the clinical decision support performed better than those randomized into the control group for some but not all quality metrics. (We just learned that this work was selected as abstract of the year at the 2011 AcademyHealth meeting.)

We have studied patterns of usage of the CDS system and found highly variable adoption. These patterns have been evaluated both qualitatively and quantitatively. These results form the basis of a manuscript that is in preparation. Qualitative feedback from providers regarding the CDS indicated that one of the features they most liked about the tool was its ability to calculate weight-based dosing. A primary complaint was that the CDS required “double documentation.” Although the tool automatically created a progress note for otitis media, if the child had any other medical problems, providers had to go back and create another note for those conditions or edit the otitis media note. Other factors mentioned by providers that led to non-use included: change in workflow and disagreement with the guidelines. Features providers liked included the episode timeline and clickable photos that they could use for parental education and resident teaching.

Conclusions

Prospectively assigning encounters to a treatment episode allows for decision support at the point-of-care to account for past treatment decisions; however, developing these methods is highly resource intensive and requires analysis of both structured and unstructured (free text) data. Providing decision support at the point-of-care is an effective strategy for improving adherence to quality metrics where treatment is encouraged. Retrospective performance feedback significantly impacted only one quality metric, but did halt decreasing tool use. Simply making decision support available to clinicians does not assure its usage.

Significance & Implications

Creating flexible decision support systems that provide needed knowledge at the point-of-care to improve quality will require substantial investments in clinical informatics. Careful attention to overcoming barriers to physician adoption must be addressed as these new systems are produced and disseminated to encourage meaningful use of health information technology

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List of Publications and Products

Presentations at Scientific Meetings

Gerber A, Fiks A, Alessandrini E, Forrest CB. Impact of Clinician Computer Skill and Practice Style on Pediatric Primary Care Acute Visits Conducted With Electronic Health Records (EHRs), Presented at the 2nd Congress of the European Academy of Pediatrics- EAP, Nice, France; September, 2008.

Fiks A, Gerber A, Khan S, Lofland J, Forrest C, Alessandrini E. Impact of clinician computer skill on pediatric primary care acute visits conducted with electronic health records (EHRs). Platform presentation at the Easter Society for Pediatric Research Annual Meeting, Philadelphia, PA; March 2009.

Fiks A, Gerber A, Khan S, Lofland J, Forrest C, Alessandrini E. Impact of clinician computer skill on pediatric primary care acute visits conducted with electronic health records (EHRs). Poster presentation at the Academic Pediatric Association Region II and III Meeting, Philadelphia, PA; March 2009.

Fiks A, Gerber A, Khan S, Lofland J, Forrest C, Alessandrini E. Impact of clinician computer skill on pediatric primary care acute visits conducted with electronic health records (EHRs). Poster presentation at the 2nd Annual Healthcare Informatics Symposium, Philadelphia, PA; April 2009.

Fiks A, Alessandrini E, Khan S, Forrest CB. Impact of clinician computer skill on pediatric primary care acute visits conducted with electronic health records (EHRs). Presented at the Pediatric Academic Societies Meeting, Baltimore, MD; May, 2009.

Fiks AG, Gerber A, Khan, S, Alessandrini E, Forrest CB. Impact of Clinician Computer Skill on Pediatric Primary Care Acute Visits Conducted with Electronic Health Records (EHRs). Presentation at the Agency for Healthcare Research and Quality 2009 Annual Meeting, Rockville, Maryland; September, 2009.

Forrest CB, Fiks A. Improving Otitis Media (OM) Care with EHR-Based Clinical Decision Support and Feedback. Presented at the 2010 Agency for Healthcare Research and Quality Health Information Technology Meeting, Washington, D; June, 2010.

Forrest CB, Fiks AG, Alessandrini EA, Grundmeier R, Khan S, Localio R, Bailey C. Improving the Quality of Otitis Media Care with EHR-based Clinical Decision Support and Performance Feedback: A Cluster Randomized Controlled Trial. Selected as the Abstract of the Year for the 2011 AcademyHealth Meeting, Seattle, WA; June, 2011.

Manuscripts Published

Fiks AG, Alessandrini EA, Forrest CB, Khan S, Localio AR, Gerber A. Electronic medical record use in pediatric primary care. *J. Am Med Inform Assoc* 2011 Jan 1; 18(1):38-44.

Manuscripts in Preparation

Forrest CB, Fiks AG, Alessandrini EA, Grundmeier R, Khan S, Localio R, Bailey C. Improving the Quality of Otitis Media Care with EHR-based Clinical Decision Support and Performance Feedback: A Cluster Randomized Controlled Trial.

Fiks AG, Khan S, Localio R, Grundmeier R, Bailey C, Alessandrini EA, Forrest CB. Adoption of an Electronic

Medical Record-based Clinical Decision Support System to Foster Guideline-based Otitis Media Care.

Bailey C, Grundmeier R, Richards T, Fiks AG, Alessandrini EA, Forrest CB. Development of a Real-time Clinical Episode Grouper for EHR-based Decision Support.