Published in final edited form as:

Pediatr Emerg Care. 2019 March ; 35(3): e61–e64. doi:10.1097/PEC.0000000000001726.

The reliability of computerized physician order entry (CPOE) data for research studies

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Abstract

Objectives: In the United States, adolescents account for nearly half of the newly diagnosed sexually transmitted infections (STI) annually, and many of these infections are asymptomatic. Adolescents often seek care in pediatric emergency departments (PED), thus the ED is an important setting to implement adolescent STI screening. Before implementation, baseline data reflecting current screening rates of symptomatic and asymptomatic patients was needed. This study aimed to evaluate the accuracy of provider reported rates of symptomatic and asymptomatic chlamydia (CT) and gonorrhea (GC) testing in adolescents overall and pre- and post- electronic health record (EHR) order modification in preparation for a research intervention.

Methods: This was a one-year prospective, observational study. Provider reason for CT/GC testing was added to the existing EHR order. Chart reviews were performed to assure the accuracy of clinician CT/GC testing choices (symptomatic vs. asymptomatic). Frequencies of testing choices were obtained. Order modifications were made to further clarify the definitions. A student's t-test was used to compare data pre- and post- order modification.

Results: When relying on providers to report reasons for CT/GC testing (symptomatic vs. asymptomatic), many patients were misclassified based on a priori defined testing reasons. After order modification, rates of provider reported symptomatic testing remained unchanged ($p=0.16$). Provider reported asymptomatic testing significantly declined ($p=0.004$), however, 23.2% of those tested continued to be misclassified.

Conclusions: Provider entered EHR data is increasingly being used in research studies, thus it is important to assure its accuracy and reliability prior to study implementation.

Introduction

In the United States, approximately half of the newly diagnosed sexually transmitted infections (STI) annually are among adolescents 15 to 24 years of age, and many of these

adolescents seek care in pediatric emergency departments (PED) [1–3]. Serious reproductive morbidity, mortality, and increased transmission of disease can occur with delayed diagnosis and treatment of STIs. Among those tested with symptoms suggestive of a possible STI at our institution, rates of positive STI test results approach 30% [4, 5]. However, many who are infected with an STI are unaware as they are initially often asymptomatic.

The PED setting has been a successful screening venue for topics such as mental health, alcohol use and HIV, thus it is reasonable to assume that adolescent STI screening would be feasible in the PED [6–8]. However, relying solely on healthcare providers to screen each adolescent is unreliable, thus it is important to incorporate a systematic intervention using health informatics to assure screening is offered to every eligible patient. Using a fully computerized system including clinical provider order entry (CPOE), we plan to implement a universally offered CT/GC screening program among all 14 to 21 year olds who present to the PED. Before implementation of this program, it is important to first collect baseline data reflecting our current screening rates of symptomatic and asymptomatic patients in order to understand the effect of our future intervention on these specific adolescent populations. Our objectives were to evaluate provider reasons (symptomatic vs. asymptomatic) for ordering CT/GC screening in adolescents and modify the existing order as needed to ensure accurate data collection in preparation for a research intervention.

Materials and Methods

The PED is an urban, level 1 trauma center with approximately 70,000 patient visits annually; adolescents 14–21 years of age account for approximately 20% of the visits. The electronic health record (EHR) (Epic; Verona, WI) was implemented in 2009 and over 99% of orders are placed in the computerized provider order entry system. The PED has 41 attending physicians, 32 clinical staff physicians, 14 nurse practitioners, 12 fellow physicians, and approximately 55 resident physicians that may place orders during a patient's visit.

All patients 14–21 years who were tested for CT/GC between November 2014 and November 2015 were included in the study. Patients were excluded if they left without being seen by a physician or a nurse practitioner.

Our a priori definition of *symptomatic* patients included any genitourinary complaint in both males and females and all female patients who presented to the PED with symptoms in which an STI would be considered on the differential diagnosis. This included female abdominal pain of unknown etiology. Patients were classified as *STI exposure without symptoms* if they requested STI testing because they were concerned that they have a partner that tested positive or they have multiple partners and were concerned of a potential exposure. For study purposes, the *STI exposure without symptoms* and *symptomatic* testing categories were combined as both of the categories indicate the provider had some clinical reason or suspicion the patient may have an STI. *Asymptomatic* patients included those who presented without any symptoms or reported history suggestive of an STI. This includes patients that are treated in the ED for a chief complaint unrelated to STIs, do not report any

symptoms that could indicate an STI (i.e. abdominal pain, vaginal discharge, etc.) and do not request STI testing secondary to a recent exposure.

We performed a one-year (November 2014 to November 2015) prospective, observational study to evaluate the accuracy of the provider reported reason for CT/GC testing (symptomatic or asymptomatic) in the PED. The existing CT/GC order consisted of selecting a specimen type but did not have provider reasons for testing. To assess baseline asymptomatic screening rates for CT/GC in the PED, we modified the CT/GC order to include a primary reason for testing (Figure 1). These choices included: *symptomatic testing*, *exposure without symptoms* or *asymptomatic screening*. We performed provider education through staff meetings, email, and EHR job aids to inform providers of this new check box and order modification. The educational materials included the definitions of each of the above reasons for CT/GC testing.

After 3 months, there was a persistent misclassification rate thus we updated the order and indications for CT/GC testing to better reflect the intended definitions in an attempt to improve misclassification rates (Figure 2). The updated choices included a more detailed definition of symptomatic testing: “Symptomatic testing (any testing based on chief complaint, i.e. female abdominal pain).” Education at staff meetings, emails, and EHR job aids were repeated with the updated information.

Monthly reports of all patients between 14–21 years of age who were tested for CT/GC at the PED were obtained to identify the provider indicated reason for CT/GC testing. If the reason was missing, a chart review was performed to determine the reason for testing. We reviewed all charts for patients with whom *asymptomatic screening* or *STI exposure without symptoms* was listed as the reason for testing. The reason for testing was re-categorized if it was not consistent with the study definition.

Patients were re-categorized from *asymptomatic* or *STI exposure without symptoms* to *symptomatic* if the patient met the definition of symptomatic as defined previously. Patients were also re-categorized from *asymptomatic* to *STI exposure without symptoms* if the patient requested or the provider ordered testing due to concern for exposure. Patients who were truly asymptomatic and only receiving CT/GC screening secondary to national adolescent screening recommendations were classified as *asymptomatic*. This method was chosen as it was important to determine a data supported, accurate, baseline asymptomatic screening rate prior to the research implementation of a CT/GC screening intervention and to assure this order modification would be reliable and accurate once universally offered CT/GC screening was implemented

Misclassification rates were measured monthly. Using a student’s t-test, we compared asymptomatic and symptomatic testing rates before and after the order modifications that detailed the definition of symptomatic testing. For purposes of analysis, those who were symptomatic and those who had an STI exposure were combined into the group labeled symptomatic. This study was reviewed by the Institutional Review Board and determined to be not human subjects research.

Results

During the study period, 16,212 patient visits occurred among those 14–21 years of age in the PED with an average of 1,200 patient visits monthly.

In a review of randomly-selected charts over the first 3 month period, providers reliably identified patients presenting with a history of exposure or symptoms concerning for an STI and correctly classified these patients, but those initially labeled as asymptomatic were often misclassified. (Table 1) Among those tested in the first 3 months (n=279) providers classified 216 (77.4%) adolescents as symptomatic and 63 (22.6%) as asymptomatic when ordering testing for CT/GC. After reclassification, 274 (98.2%) were found to be symptomatic, and 5 (1.8%) were asymptomatic based on our a priori definitions. Providers were often misclassifying female patients as asymptomatic if they had abdominal pain, but did not have evidence of vaginal discharge or other additional genitourinary symptoms. After the first 3 months of data collection in February 2015, the definition of symptomatic was further clarified (as described in the methods) and the modified order was implemented as a passive decision support tool (Figure 2).

After the modification of the EHR order, among those tested (n=1042), providers classified 796 (76.4%) adolescents as symptomatically tested for CT/GC, and 246 (23.6%) adolescents as asymptotically screened for CT/GC. After reclassification, 1,038 (99.6%) were found to be symptomatic per our a priori definition.

During the entire study period, 1012 (76.6%) of the CT/GC tested subjects were classified by providers as symptomatic and 309 (23.4%) were classified as asymptomatic. When reclassifying patients after chart review, asymptomatic screening rates among patients dropped to a total of 9 subjects (range: n=0–2 per month) whereas symptomatic testing increased to total of 1312 subjects (range: n=67–123 per month).

After patients were re-classified, we examined the difference in rates of symptomatic and asymptomatic testing before and after the definition of symptomatic testing was clarified in the EHR. Rates of testing symptomatic patients remained the same ($p=0.16$) and asymptomatic testing declined ($p=0.004$), demonstrating that fewer patients needed to be re-classified from asymptomatic to symptomatic after the EHR update.

Discussion

Our goal was to develop a reliable method to categorize provider reasons for CT/GC testing after implementing universally offered CT/GC screening in the pediatric emergency department. We assumed that our asymptomatic screening rates were close to zero but needed data to support this assumption. Classifying patients based on chief complaint or a discharge diagnosis can be unreliable as patients who are seeking care for presumably non-related STI complaints may indeed have STI related symptoms when he/she is interviewed in a confidential setting other than the front desk or triage. To avoid labor intensive chart reviews of thousands of patients, this computerized order with provider selected reasons for CT/GC testing was developed.

Implementation of the CT/GC order with provider selected reasons for CT/GC testing in adolescents was presumed to be a basic, reliable approach. However, these results demonstrate the lack of understanding of the order button definitions despite efforts to thoroughly educate users of the intended definitions. This consequently necessitated chart review to accurately classify the data. This highlights the importance of EHR implementation data accuracy and supports previous studies demonstrating that there are frequent, unintentional consequences to EHR order implementation even with presumed well-understood language and concepts [9, 10]. After a shortened definition was added, misclassification rates significantly improved, however the overall accuracy of provider classification failed to be reliable.

CPOE implementations can result in unintended consequences in clinical care, and while these can be significant, in this implementation, they only impacted data collection and not patient care [9, 11]. The testing was performed regardless of the “correct” classification; however, reclassification and chart review was required prior to using the data for a research study. This highlights one of the dangers of using EHR data in research studies that was originally collected for clinical purposes. While these errors initially appear as execution and goal mistakes, additional detailed definitions improved correct classification rates [12]. However, in the order modification, we were unable to vary the location of the “Primary Reason for Testing” buttons, which may have inadvertently biased our results towards symptomatic testing.

Our study also reinforces previous literature suggesting that it is important to thoroughly and prospectively examine data to assure accuracy and reliability when using the EHR to collect data [13]. If we had made the assumption that providers would accurately document the reason for CT/GC testing, we would have misclassified patients, and our baseline data would have been inaccurate.

These data support that the EHR update and additional provider education improved healthcare provider’s appropriate classification of the indication for STI testing among ED adolescents, but the overall health IT intervention is still unreliable. Future steps may include improved labels and/or definitions as well as provider qualitative data that can inform future modifications. Therefore, when EHR data is being used for research studies, it is important to assure data is examined closely, and the reliability of the data is confirmed.

Acknowledgments

Funding: Supported by NIH Award Number K23HD075751 from the Eunice Kennedy Shriver NICHD.

Abbreviations:

AAP	American Academy of Pediatrics
PED	Pediatric Emergency Department
STI	Sexually Transmitted Infection
GC	gonorrhea

CT	chlamydia
IT	information technology
EHR	electronic health record
CPOE	computerized physician order entry

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Figure 1:
The initial order screen for CT/GC Orders

Chlamydia and GC DNA by TMA: Spec Type - ✓ Accept ✗ Cancel

Priority:

Frequency:

Starting: At:

First Occurrence: **Today 1609**

Scheduled Times: [Hide Schedule](#)

7/26/18 1609

Class:

Process Inst.: [PROCESS INSTRUCTIONS for the endocervical swab, urethral swab, pharyngeal swab, rectal swab and vaginal swab: The APTIMA Unisex swab...](#)

Reference Links: [1. GPC Protocol](#)

❗ Select specimen type

❗ Primary Reason for Testing

Asymptomatic screening

Comments: [Click to add text \(F6\)](#)

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Figure 2.

The order screen after changes were made to clarify the meaning of symptomatic.

Table 1.

Rates of patients tested based on the EHR data and those tested after re-categorization^a (n=total number of patients 14–21 years of age tested per month)

Total tested per month (n= 1321))	Symptomatic screening in EHR [n(%)] ^b	Asymptomatic Screening in EHR [n(%)]	Symptomatic Screening after re-classification using a priori definition [n(%)]	Asymptomatic Screening after re-classification using a priori definition [n(%)]
Nov 2014 (n= 68)	55 (80.9)	13 (19.1)	67 (98.5)	1 (1.5)
Dec 2014(n=106)	81 (76.4)	25 (23.6)	104 (98.1)	2 (1.9)
Jan 2015 (n=105)	80 (76.2)	25 (23.8)	103 (98.1)	2 (1.9)
*Feb 2015 (n=91)	74 (81.3)	17 (18.7)	90 (98.9)	1 (1.1)
Mar2015 (n= 118)	85 (72)	33 (18)	118	0
Apr 2015 (n= 123)	91 (74)	32 (16)	123	0
May 2015 (n= 96)	77 (80.2)	19 (19.8)	96	0
June 2015 (n= 98)	74 (75.5)	24 (24.5)	98	0
July 2015 (n= 104)	74 (71.2)	30 (28.8)	103 (99)	1 (1)
Aug 2015 (n= 105)	85 (81)	20 (19)	105 ()	0
Sept 2015 (n= 106)	87 (82.1)	19 (17.9)	105 (99)	1(1)
Oct 2015 (n= 101)	76 (75.2)	25 (24.8)	101 ()	0
Nov 2015 (n= 100)	73 (73)	27 (27)	99 (99)	1 (1)

^a Rates of patients tested at the visit level

^b Patients who tested due to known STI exposure were included as symptomatic.

* Modification of the order information selection buttons to include an a priori definition for symptomatic.