

Identifying opportunities in EHR to improve the quality of antibiotic allergy data

RECEIVED 13 April 2015
REVISED 29 July 2015
ACCEPTED 30 July 2015

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ABSTRACT

Background Antimicrobial resistance is a growing, global public health crisis, due in large part to the overuse and misuse of antibiotics. Understanding medication allergy data and allergy reactions that are documented in electronic health records (EHRs) can help to identify opportunities to improve the quality of documentation of beta-lactam allergies, thus potentially reducing the prescribing of alternative antibiotics.

Methods Medication allergies and allergy reactions recorded in the EHR for 319 051 patients seen across 32 community health centers were reviewed. Patients with a beta-lactam allergy recorded in their EHR were identified. Free text, as well as standardized allergy and allergy reaction fields, were analyzed.

Results Among patients, 9.1% ($n = 29\,095$) had evidence of a beta-lactam allergy recorded in their EHR. Women, white, and non-Hispanic patients were more likely to have a documented allergy compared to men, black, and Hispanic patients. Among all patients with a documented beta-lactam allergy, 36.2% had an empty or missing allergy reaction description in their EHR.

Conclusions Findings suggest that current EHR documentation practices among the health centers reviewed do not provide enough information on allergic reactions to allow providers to discern between true allergies and common, but anticipated, drug side effects. Improved EHR documentation guidance, training that reinforces the use of standardized data and more detailed recording of allergic reactions, combined with initiatives to address patient barriers including health literacy, may help to improve the accuracy of drug allergies in patients' records. These initiatives, combined with antimicrobial stewardship programs, can help to reduce inappropriate prescribing of alternative antibiotics when beta-lactam antibiotics are first-line and can be tolerated.

Keywords: electronic health record, drug allergy, beta-lactam antibiotics, antibiotic resistance, community health centers

BACKGROUND

The emergence and propagation of antimicrobial-resistant organisms is one of today's top global public health crises.^{1–3} The prescribing of inappropriate antibiotics relative to a diagnosis contributes greatly to this ongoing problem.⁴ One instance in which such prescribing can occur is when a patient self-reports an allergy to a first line antibiotic when, in fact, the patient does not have a true allergy. The most commonly reported antibiotic allergy is to that of beta-lactams (which include all penicillins and cephalosporins).⁵ Patients who self-report beta-lactam allergies are often treated with alternative antibiotic groups.⁶ Therefore, the rise in bacterial resistance to many antibiotics may be due, in part, to the use of alternative antibiotics in patients who self-report beta-lactam allergies. It is estimated that ~11% of individuals have a self-reported allergy to penicillin^{7,8}, however, studies consistently show that as many as 90% of patients who self-report an allergy to penicillin are actually able to tolerate the drug following confirmatory testing.^{9–13}

Electronic health records (EHRs) can be valuable tools to support the prescribing of appropriate antibiotics in the inpatient and outpatient settings, but this depends on the quality of the data in the EHR.¹⁴ In order to encourage quality data, recording patient medication allergies is a required core measure for eligible providers certifying for “meaningful use” of EHR systems under the Centers for Medicare and Medicaid Services Health EHR incentive program.¹⁵ The guidance for EHR documentation of allergies does not, however, currently include specific instructions for distinguishing between suspected allergies versus adverse drug reactions, nor for distinguishing between a patient self-reported allergy versus a laboratory or physician confirmed

drug allergy. Given the increasing adoption of EHR and the opportunity for longitudinal record-keeping that follows patients between care settings, there is now a greater need to properly document drug allergies with detail beyond that which is generally current practice.

In this study we examined current practices for documenting beta-lactam allergies in the EHR using data obtained from Health Choice Network, Inc., a health center controlled network of 48 community health centers in 9 states who were early adopters of EHR. We investigated beta-lactam allergies in the EHR amongst a large and diverse primary care patient population in order to identify 1) the current prevalence of documented beta-lactam allergies in our population; 2) the quality of the documentation in the EHR of beta-lactam allergies, and 3) opportunities to improve the quality of documentation of beta-lactam allergies in primary care.

METHODS

Population

The population for the study was identified from the Vitera Intergy EHR System at Health Choice Network, Inc. (HCN), a health center controlled network located in Miami, Florida. Health Choice Network provides core information technology services to health centers, including EHR implementation, hosting, and data management. The EHR system in use across the health centers includes both practice management software where patient demographic information is recorded, as well as an allergy module where patient allergies are recorded.

Patient drug allergy data from 32 health centers were included in the study. Drug allergy data is stored in the Patient Active Allergy List,

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which is available from the Patient Summary page in the EHR chart. From the Patient Summary page, providers click on the “Allergies” icon to open options that include adding a new allergy, running a drug utilization report, or indicating that the patient has “no known allergies.” If the provider selects to add a new allergy, they are brought to an “Add Patient Allergy” window where they then select the type of allergy from the following options: non-drug allergens, drug classes, specific drugs, or user defined. After selecting the type of allergy, they are brought to a subsequent window to record the specific allergy by selecting a drug class code, a specific drug or a user-defined drug, status (active, inactive), onset date, and reaction.

The general process flow for recording allergies is that the medical assistant reviews allergies with all new and existing patients during the intake process (which includes temperature, vitals, review of patient history, and other information) and updates the patient chart as appropriate. Then providers (e.g., physicians, nurse practitioners, physician assistants) review the patient chart during their patient encounter. Prior to prescribing any medications, providers are trained to review the allergy list and discuss any potential medication allergies with patients, updating the patient chart accordingly. Though all of the health centers are member of HCN and therefore have access to the same EHR training, each health center is an independent entity. Therefore, staff responsible for updating allergies and the frequency for updating allergies may vary across health centers. In addition, the list of user-defined allergies in the EHR may also vary by health center.

The study sample included all active drug allergies in the EHR that had a review date (an EHR system-generated field) between June 1, 2012 and May 31, 2013 for all patients (18 and older) who had a primary care visit at one of 32 health centers during the same period. The review date indicates the date that the specific allergy list was reviewed.

Data collection

Data extracted from the EHR included demographic characteristics (gender, age, race, and ethnicity) and allergy information (drug allergy code, drug allergy description, allergy type, allergy reaction code, and allergy reaction description). The initial data file included 406 444 total allergy records, reflecting 319 051 unduplicated patients, 29 094 of whom had a documented beta-lactam allergy in their EHR chart. The extracted data file included a numeric variable for drug allergy code (RxNorm), a string variable for user-defined drug allergy description, and a string variable for drug allergy reaction description. We used the drug allergy description string variable to identify beta-lactam allergies because that field was more complete than the drug allergy code. Upon initial file review, we determined that 35.0% of all drug allergy code fields were empty, while the drug allergy description field was 99.9% populated.

There were 5148 unique drug allergy descriptions on the data file, of which 199 unique descriptions were deemed to designate “beta-lactam sensitivity.” Beta-lactam allergies were identified by one of the investigators, a Doctor of Osteopathic Medicine (J. Moskow), by reviewing all 5148 descriptions for membership in the beta-lactam class (all penicillins, carbapenems, cepheems, monobactams, beta-lactamase inhibitors, and combination beta-lactams). Both generic and brand name beta-lactams were included, as were misspellings of each when such misspelling could not reasonably be identified as anything other than a specific beta-lactam. For example, we included penicillin ($n = 109$), Penicillin ($n = 15\,549$), PENICILLIN ($n = 269$), and pennicillin ($n = 50$) as an indication of beta-lactam allergy, as it was clear that this was the intention of the user.

In addition to assessing drug allergy to beta-lactam antibiotics, we also described reactions documented in the drug-allergy reaction description field.

Statistical Analysis

Statistical analyses were performed using SPSS V 22.0. Descriptive statistics including frequencies and cross-tabulations were used to assess the estimate of current prevalence for documented beta-lactam allergies in the dataset, as well as to describe documentation practices of drug allergies and reactions. Pearson chi-square, two-tailed tests ($P < 0.05$) were used to assess differences in reported allergy by gender, race, and ethnic group.

The research was approved as Exempt by Nova Southeastern University’s Institutional Review Board.

RESULTS

Among the 406 444 total drug allergy description fields, 37 788 had evidence of a beta-lactam allergy. In terms of unique patients, there were 319 051 patients whose allergies were reviewed and recorded in the EHR; 9.1% ($n = 29\,095$) of whom had a documented allergy to one or more beta-lactam antibiotics. The same unique patient could have multiple fields documenting an allergy.

Women were more likely to have a documented beta-lactam allergy than men (10.4% vs 7.0%, $P < 0.001$). White patients had higher rates of documented beta-lactam allergy compared to black patients and patients of more than one race (10.7% vs. 6.5% and 8.0%, respectively, $P < 0.001$). Hispanic patients were less likely to have a documented beta-lactam allergy than non-Hispanic patients (7.6% vs. 10.0%, $P < 0.001$). Table 1 shows characteristics of patients and documented beta-lactam allergies by gender, race, and ethnicity.

The drug allergy reaction description field was also reviewed (Table 2). In terms of allergy reactions codes, 49.1% of all reactions

Table 1: Percentage of patients with documented beta-lactam allergy by gender, race, and ethnicity.

	No. of Unique Patients	Column %	% with Reported Allergy	Chi-square P -value
All patients	319 051		9.1	
Gender				<0.001
Male	120 207	37.7	7.0	
Female	198 844	62.3	10.4	
Race				<0.01
Black	66 324	20.8	6.5	
White	182 015	57.0	10.7	
More than one race	4864	1.5	8.0	
Other/unknown	65 848	20.6	7.7	
Ethnicity				<0.01
Hispanic	144 230	45.2	7.6	
Non-Hispanic	59 765	18.7	10.0	
Other/unknown	115 056	36.1	11.0	

*Pearson chi-square; $P \leq .05$.

Table 2: Distribution of beta-lactam allergy reaction description documented in electronic health records among unique patients with a beta-lactam allergy indicated.^a

Reaction Description	Number of Beta-Lactam Reactions Documented	%
Skin Rashes/Hives	18 553	49.1
Empty or Missing	13 679	36.2
Nausea/Vomiting/Diarrhea	2533	6.7
Asthma/shortness of breath	1879	5.0
Shock/Unconsciousness	1049	2.8
Anemia/Blood disorder	95	0.3

^aThere were 29 095 unique patients with a documented beta-lactam allergy and 37 788 allergy reaction descriptions. Some patients had more than one allergy reaction to beta-lactams documented in their chart.

to beta-lactams were coded as “skin rashes/hives”. There was no information provided, or a documented “Other,” for 36.2% of reactions. Additional reactions indicted include “Nausea/Vomiting/Diarrhea” (6.7%), “Asthma/shortness of breath” (5.0%), “Shock/Unconsciousness” (2.8%) and “Anemia/Blood disorder” (0.3%). Users did not have the opportunity to enter free text for allergy reactions.

DISCUSSION

In this study of more than 300 000 underserved primary care patients, > 9.1% had a documented allergy to beta-lactam antibiotics in their EHR, though prior research suggests that as many as 90% of these patients may actually be able to tolerate these drugs.^{9–13} In the health centers included in this study, the process for documenting drug allergies in EHRs is often done by intake staff who ask patients about their allergies and subsequently record the responses in the EHR, often in a user-defined drug allergy field. As such, there is a need for improved guidance and training regarding the documentation of drug allergies in structured data format in the EHR, in order to facilitate reporting and analysis, and fully maximize drug-drug and drug-allergy interaction checks. In addition to provider and staff training, Clinical Decision Support functionality embedded in EHRs can present opportunities to enhance patient care and improve safe medication use by prompting staff and providers to both document side effects and allergies in the patient chart in greater detail, and to educate patients who are prescribed antibiotics regarding known side effects and adverse reactions.

Among patients with a documented beta-lactam allergy, > 36% ($n = 13\,679$) of patients had no defined allergy reaction in the EHR, making it difficult to know if the documented allergy is a true allergy and life-threatening (e.g., anaphylaxis); a known or anticipated, but undesirable, side effect (e.g., nausea); or a symptom of illness. As a result, many of these patients who might otherwise be able to tolerate beta-lactam antibiotics are likely to receive alternative antibiotics, thus potentially contributing to issues of antimicrobial resistance. Additionally, these alternatives are often more expensive and thus their overuse results in unnecessary healthcare costs.¹⁶ Beta-lactam alternatives also have higher rates of association with infections such as *Clostridium difficile*, Methicillin-resistant *Staphylococcus aureus*, and Vancomycin-resistant *Enterococcus* and, accordingly, patients with documented penicillin allergies have been shown to incur longer hospital stays.¹⁷

The involvement of pharmacists in the documentation of drug allergies and adverse side effects can improve the quality of data.¹⁸ Likewise, improved quality of drug allergy data stored in EHRs can help facilitate the implementation of effective antibiotic stewardship programs (ASPs) in outpatient care.¹⁹ ASPs are designed to enhance and evaluate appropriate use, including selection and duration of medications, to optimize patient care outcomes, improve patient safety, and reduce healthcare expenditures.²⁰ ASPs implemented in primary care present an opportunity to leverage the EHR to improve the identification and clarification of drug allergies, improve appropriate prescribing of antibiotics, and increase the commitment to adherence counseling and medication information provided from the community setting to patients. Such stewardship programs align with the President’s Council of Advisors on Science and Technology,²¹ which strives to implement campaigns in collaboration with the Centers for Disease Control and Prevention (CDC) regarding the collection of drug allergy data and the treatment of bacterial infections.

The quality of drug allergy data in the EHR is also dependent upon the implementation of patient health literacy initiatives concerning self-reporting of medication allergies. This is particularly relevant for populations most at-risk for low health literacy, including patients with linguistic and cultural differences who comprise a large percent of the population reported in this study. Just as patients with low health literacy may need addition support understanding labeling and dosage,²² patients with low health literacy may also need support in differentiating between true drug allergies versus side effects of medications to ensure that this information is documented accurately in the patient chart.

Interoperability of EHR data is a national priority.²³ As interoperability is improved, documentation of medication and medication allergies in primary care EHR can influence prescribing habits throughout the care continuum. Initiatives to document and manage patient medications in the EHR are bolstered by federal law, including Meaningful Use, which requires providers to implement initiatives, including maintaining an active medication allergy list, developing clinical decision support for drug-allergy contraindications, and performing medication reconciliation.¹⁵ The use of appropriate antibiotics in outpatient settings is further supported by other federal initiatives, including the recently introduced National Action Plan to Combat Antibiotic-Resistant Bacteria.²⁴ These laws and initiatives, however, do not specifically address the unique challenges of accurately documenting side effects, adverse reactions, and medication allergies in EHRs in outpatient care. There are currently extensive variations in the manner in which drug allergies are recorded in the EHR.²⁵ Through a renewed focus on guidance to staff and providers, implementation of ASPs and addressing health literacy challenges with reporting side effects, and with support from federal initiatives, primary care providers can become leaders in best practices for documenting beta-lactam allergies and prescribing beta-lactams appropriately, thus contributing a crucial role towards managing the emergence of antimicrobial-resistant organisms.

LIMITATIONS

There are practical limitations when analyzing the non-standardized EHR data that was collected across 32 independent healthcare organizations. Though all of the health centers in the study utilized EHR implementation services and information technology support from HCN, each of the organizations may have slightly different EHR customization and clinical workflows, which could confound the study results. In addition, though the lead author reviewed each of the more than 5000 unique allergy descriptions multiple times in order to identify those constituting a beta-lactam allergy, it is possible that misclassification of patients without a beta-lactam allergy may have been introduced

into the study due to misinterpreting a unique descriptor field that was meant to imply a beta-lactam allergy, but could not be discerned as such through review.

Moreover, there are likely additional demographic and healthcare variables (e.g., patient visit frequency, comorbidities, and number of drug allergies reported) that may be associated with which population subgroups may be more or less likely to report a beta-lactam allergy. These variables were not part of our initial hypothesis and were not part of the data extraction, but should be considered in future studies.

Finally, it is important to note that despite the fact that a number of strategies, including patient probing and referral for various types of confirmatory testing, may support more accurate documentation of beta-lactam allergies in the EHR, due to the current environment of medical malpractice providers may be unlikely to prescribe a beta-lactam antibiotic to a patient who has at any point self-reported an allergy. Therefore, additional research is warranted regarding which strategies are most effective in the outpatient setting to guide providers to discern a true beta-lactam allergy from a misreported allergy.

CONCLUSION

This is the largest study to date conducted to understand the prevalence and documentation of beta-lactam antibiotic allergies and corresponding allergy reactions in EHRs. Given the rise in antimicrobial resistance, outpatient providers should strive to improve the documentation of beta-lactam allergies and allergy reactions in the EHR. Improving the quality of drug allergy data in the EHR has critical implications for provider practice, patient outcomes, and public health.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

COMPETING INTERESTS

Drs Moskow, Cook, Amofah, Garcia, and Student Dr Champion-Lippmann do not have any competing interests to declare.

CONTRIBUTORS

Drs Moskow, Cook, Amofah, Garcia, and Student Dr Champion-Lippmann all contributed substantially to the conception/design of this work; and to the acquisition, analysis, and interpretation of data for the work. Additionally, all parties participated in drafting this work and revising it critically for important intellectual content, were all involved in final approval of the version to be published, and have all agreed to be accountable for all aspects of this work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support of Health Choice Network, Inc. and the valuable input of the Business Intelligence and Health Solutions team in conducting the research that contributed to this manuscript including Ricardo Gomez, MBA and Andrew L. Brickman, PhD. In addition, Sasi Goldstein, MFA of the University of Tampa, and Rütli Haugen are acknowledged for their assistance with manuscript review.

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