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Evaluation of popular drug information resources on clinically useful and actionable pharmacogenomic information*†

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Background: Pharmacogenomics is the study of how genes affect a person's response to drugs. This descriptive study assessed whether popular drug information resources provide clinically useful pharmacogenomic (PGx) information.

Methods: Four resources (package inserts, Lexicomp, Micromedex 2.0, and Epocrates) were evaluated for information about twenty-seven drugs.

Results: There was wide variability of PGx information. Whereas Lexicomp included relevant PGx biomarker information for all 27 drugs, Epocrates did in less than 50% of the drugs. None of the resources had monographs that fully incorporated Clinical Pharmacogenomics Implementation Consortium (CPIC) recommendations in more than 30% of the drugs.

Conclusion: Lexicomp appears to be most useful PGx drug information resource, but none of the resources are sufficient.

Keywords: Pharmacogenomics, Biomarkers, Drug Information Services, Genetic Testing

Pharmacogenomics is the study of how genes affect a person's response to drugs [1]. A study evaluating the presence or absence of pharmacogenomic biomarkers in 5 popular drug information resources showed wide variability, from 68% to 95%, in the inclusion of such information [2]. However, it is unknown whether they provide clinically useful pharmacogenomic information such as biomarker effect, population prevalence, testing recommendations, and interpretation of the test result.

The Clinical Pharmacogenomics Implementation Consortium (CPIC), a shared project between Pharmacogenomics Knowledgebase (PharmGKB) and the Pharmacogenomics Research Network, has published peer-reviewed guidelines for drugs with pharmacogenomic data to help clinicians interpret genetic test results to optimize drug therapy. These guidelines are intended to translate laboratory test results into clinically actionable prescribing decisions [3]. Since some drug information resources have incorporated key clinical guideline recommendations, it would be helpful for clinicians if CPIC guidelines are incorporated into these drug information resources [4].

Therefore, the purpose of this study was to evaluate which popular drug information resources provide clinically useful pharmacogenomic information with CPIC guidelines incorporated. This would help health sciences and clinical librarians assist clinicians in utilizing pharmacogenomics information to optimize patient care.

METHODS

The authors selected twenty-seven drugs that had CPIC guideline recommendations at the time of this study (between April 1 and August 31 of 2014) [5]. Lexicomp, Micromedex, Epocrates, and the Food and Drug Administration (FDA)–approved package

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inserts were selected as drug information resources [6–9]. No institutional review board approval was needed.

We assessed the pharmacogenomic information content in the four drug resources based on four target clinical questions: (1) biological effect of a biomarker, (2) population prevalence, (3) testing recommendations, and (4) interpretation of the test result. For each question, we categorized the answer as either "complete," "partial," or "not answered." We also rated the drug resources on how completely they incorporated CPIC recommendations for this last question and calculated the total number of "complete" answers for each of the four target questions in each of the drug resources. We used Fisher's exact or Wilcoxon rank sum tests to examine the completeness determinations and incorporation of CPIC guidelines among the four drug information resources.

RESULTS

Relevant pharmacogenomic biomarker information was not consistently provided by the 4 drug information resources for the 27 study drugs. Only Lexicomp included relevant pharmacogenomic biomarker information for all 27 drugs, and Lexicomp has a separate pharmacogenomic section for relevant biomarkers. In contrast, Epocrates included relevant information for less than 50% of the drugs.

The number of complete answers varied among the resources (Figure 1). The drug information resources were more complete regarding biomarker clinical effects and prevalence in major races than regarding testing recommendations and interpretation of results. Specifically, on average, 54% of the 27 drugs had a "complete" answer for biological effect of a biomarker, 43% for population prevalence, 29% for testing recommendations, and 19% for interpretation of the test result.

Overall, CPIC guideline recommendations were not well incorporated. Only 19% of the total drug monographs had complete incorporation of CPIC recommendations. Even Lexicomp, which had the highest complete incorporation rate, provided CPIC recommendations for only 8 out of the 27 drugs. Of the 27 drugs, only 3—abacavir, clopidogrel, and rasburicase—had full incorporation of CPIC guideline recommendations across the 4 drug information resources.
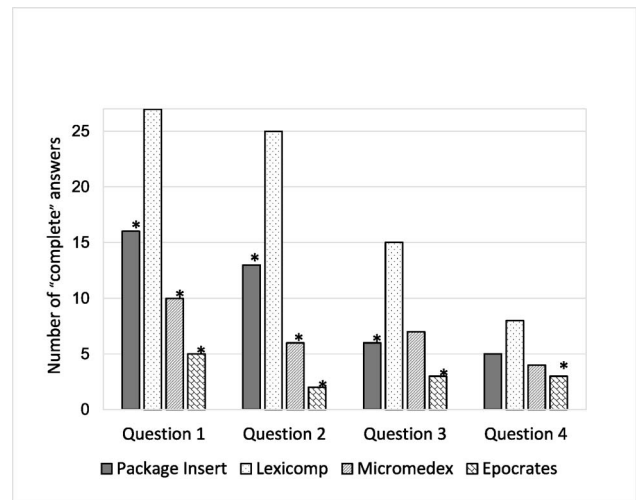
Question 1 for the biological effect of biomarker: Package insert (PI)=16, Lexicomp=27, Micromedex=10, Epocrates=5.
Question 2 for the population prevalence: PI=13; Lexicomp=25, Micromedex=6, Epocrates=2.
Question 3 for testing recommendation: PI=6; Lexicomp=15, Micromedex=7, Epocrates=3.
Question 4 for interpretation of the test result: PI=5, Lexicomp=8, Micromedex=4, Epocrates=3.
* $P<0.05$ as compared to Lexicomp as the reference resource.

Figure 1
Total number of complete answers in response to 4 target questions, by drug resource (n=27)

DISCUSSION

Overall, Lexicomp better provided pharmacogenomic information for the twenty-seven drugs than the other three resources, consistent with results of a previous study [2]. Lexicomp was the only commercial drug information resource that included a separate pharmacogenomics section. However, it incorporated CPIC guideline recommendations into information about only eight out of twenty-seven drugs. Therefore, health sciences librarians and clinicians should be aware that the majority of CPIC recommendations have not been incorporated in popular drug information resources, and therefore, they should directly consult CPIC guidelines.

It is surprising and alarming that only a few CPIC recommendations have been incorporated into drug resources. Lexicomp currently references the best evidence-based clinical practice guidelines (CPGs) for their dosing and drug interactions. Like other well-respected guidelines, CPIC meets all the standards of CPG development [10, 11]. They are particularly useful resources given that many health

care providers may not be comfortable with interpreting pharmacogenomic test results in practice. In one study, only 37% of primary care physicians, cardiologists, and psychiatrists were strongly or somewhat confident in their knowledge of the influence of genetics on drug therapy, and only 13% of them felt comfortable ordering pharmacogenomic tests [12, 13]. Therefore, incorporation of CPIC guidelines into drug information resources can help bridge pharmacogenomic knowledge gaps and allow health care providers to make better-informed decisions regarding pharmacogenomic testing.

The strength of our study is that it is the first to extensively evaluate clinically useful pharmacogenomic information, including the extent of incorporation of CPIC guidelines.

Our study has several limitations. First, we included only four drug information sources. However, we selected popular and reliable resources based on the ease of access and degree of meeting certain quality indicators [14]. Second, we studied only twenty-seven drugs. These were drugs having the best information to date on interpretation of pharmacogenomic test results at the time of the study. Third, there is no currently published consensus on how to rate clinically useful drug resources, so the criteria that we used may not be universal.

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