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Development and Usage Patterns of a Home-Grown Drug Information Tool

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Abstract. Drug information tools help avoid medication errors, a common cause of avoidable harm in health care systems. We sought to describe the design, development process and architecture of an electronic drug information tool, as well as its overall use by health professionals. We developed a tool that can be accessed by all health professionals in a tertiary level university hospital. The functionalities of eDrugs are organized into two main parts: Drug Summary sheet, and Prescription Simulator. Most users accessed eDrugs to use the Drug summary sheet. Clinical information and antimicrobial drugs were the most accessed drug information and drug group. The analysis of log data provides insights into the information priorities of health professionals.

Keywords. Drug Information Services, Drug Database, Clinical Decision Support

1. Introduction

Medication errors are the leading cause of injury and avoidable harm in health care systems worldwide [1, 2]; the majority occurring at the drug prescription stage [3, 4]. These errors are largely due to lack of knowledge about drugs [5] especially new ones; highlighting the relevance of drug information tools [6].

Healthcare providers use various drug information sources to satisfy their health information needs[7]. Information on some knowledge domains might be difficult to find [7].

Prescription quality increases when physicians have access to independent sources of information [8]. Web applications can integrate different information sources and optimize their visual representation [9]: preliminary evidence suggests that electronic information tools can improve both clinical decision-making and patient outcomes [10]. Access to drug information can enhance prescription quality, reduce length of hospital stay and lower risk-adjusted mortality rates [8,11].

eDrugs is an interactive drug information tool, which offers information on drugs, and a drug interactions checker (prescription simulator). It retrieves information from a homegrown Pharmacologic Knowledge Base (PKB) [12]. Here, we describe the development of eDrugs, its architecture and usage patterns in a tertiary level academic hospital.

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We sought to describe the design, development and architecture of an electronic drug information tool integrated into the health information systems.

2. Methods

2.1. *Study design*

Cross-sectional study of eDrugs usage recording user characteristics, access to specific sections, and most frequently consulted drug categories during its implementation.

2.2. *Settings*

The Hospital Italiano de Buenos Aires (HIBA) integrates a network of two non-profit academic hospitals and 25 outpatient clinics in the Buenos Aires metropolitan area, employing 7400 healthcare professionals.

HIBA is a HIMSS Stage 7 organization with an in-house-developed health information system. It features web-based, problem-oriented EHRs; a terminology server referenced to SNOMED CT; and a PKB.

2.3. *Population*

All users accessing eDrugs between September 3rd and November 4th 2019.

2.4. *Pharmacologic knowledge base*

Drug information displayed on eDrugs is entirely retrieved from the hospital's homegrown PKB, containing structured information on more than 1200 drugs, including family, therapeutic action(s), and general information[12]. All structured fields are referenced to SNOMED CT, allowing pharmacologic clinical decision support systems (CDSS) and enhancing eDrugs information representation.

2.5. *eDrugs design*

eDrugs was developed using Nielsen's heuristics, general principles for interaction design [13]. The layout consists of a series of cards (modules and header), which allows its adaptation to multiple screens. Each card contains a title, content information and a representative image. The design of these cards aimed at displaying drug information in an agile and action-oriented way. All iconography and references are color-coded according to severity. Adobe XD software was used for design and prototyping.

2.6. *Architecture*

It comprises 3 layers: The first layer is the view built on Bootstrap. The second layer contains the application business logic grouped in two main components: (1) the Drug summary sheet and (2) the Prescription Simulator. The third layer contains four services used by diverse information systems including eDrugs: (1) Information retrieval service enables searching drugs by name, therapeutic actions, and generic or brand names; (2)

RESTful resources that represent Drug's information content; (3)FHIR service that creates a collection of resources (Bundle) and sends it to the CDS Service; (4) CDS Services with pharmacological alerts and recommendations for the CDS Client (eDrugs).

2.7. Implementation, usage data and analysis

eDrugs was deployed in July 2019**.** user interactions were logged in a relational database. Queries to Drug information tools are reported using descriptive statistics. We used R software v. 3.6.0.

3. Results

eDrugs was integrated into our EHR through an icon on the EHR's heading. The functionalities of **eDrugs** are organized into two main parts: Drug Summary sheet, and Prescription Simulator.

3.1. Drug summary sheet

The Drug information tool includes a search field that allows searches by drug, brand names, and/or therapeutic action. Once the user enters three characters, preliminary results are suggested.

The Drug summary sheet comprises a Header, a Clinical Information Tab, and a Brand Names Tab (currently including brand names of Argentina, Chile, or Uruguay):

(a) *The Header* features key information on drug name, class, classification system (ATC and SNOMED), therapeutic actions, teratogenic and breastfeeding risk. Specific iconography and a chromatic scale were used to indicate risk severity. The header can contract to remain visible.

(b) *The Clinical Information tab* contains information about mechanism of action, spectrum and resistance, pharmacokinetics, medical use and dosage, and interactions, among others.

(c) *The Brand Names Tab* includes information about generic drugs, brand names, and frequent dosage of each generic drug.

The interface of the Drug summary sheet is available at: http://bit.ly/eDrugs2

3.2. Prescription simulator

Provides clinical information about potential pharmacological alerts in simulated prescription scenarios. Inputs include: drug prescriptions; patient characteristics (such as gender, pregnancy or breastfeeding status, age, weight, and height); patient laboratory results; pathologies and allergies.

With this information, the tool shows interaction alerts such as drug-drug (DDI), drug-allergy, drug-food, drug-pathology, drug-potassium blood level, drug-creatinine clearance, and maximum daily dose.

A total of 1,435 identifiable users who accessed eDrugs between September 3rd and November 4th 2019 were included in the study. Most of them were physicians (n=728, 51%) and nurses (n=341, 29%). During the study period, a median of 81 daily users accessed eDrugs (range: 15 - 106).

Most users accessed eDrugs to use the Drug summary sheet (97.0%). Accesses to the Prescription simulator represented 2.9% of all.

Table 1 shows the use of the main functionality of drugs. The use is represented according to sections of the drug summary sheet. Antimicrobial drugs were the most accessed drug group, followed by drugs acting on the Nervous System. The most searched-for drug categories were: antimicrobials; drugs acting on the nervous system; cardiovascular system and gastrointestinal system - 18%, 15%, 12% and 9%, respectively.

Table 1. eDrugs Logs

	Drug searches by identifiable users (n = 5692)		
Accessed sections	**Clinical information tab only**	**Brand name tab only**	**Both**
n (%)	4870 (85.56 %)	488 (8.57 %)	334 (5.87 %)
Total modules accessed - n	10858	789	1623
Distinct modules accessed per drug search (mean)	2.05	2.05	4.3
Most accessed modules	▸ Mechanism of action and Header (48.3 %) ▸ Medical use / dosage (17.9 %) ▸ Adverse reactions (6.3 %) ▸ DDI (5.3 %) ▸ Pharmacokinetics (4.6 %) ▸ Other (17.5 %)	▸ Brand names (97.0 %) ▸ Frequent dosage (2.0 %) ▸ Generic drugs (1.0 %)	▸ Brand names (34.4 %) ▸ Mechanism of action and Header (20.6 %) ▸ Medical use / dosage (16.8 %) ▸ DDI (4.7 %) ▸ Pharmacokinetics (4.6 %) ▸ Other (19.0 %)

4. Discussion

This article describes the development and architecture of a drug information tool integrated into the health information system of a tertiary level university hospital, linked to the institutional PKB, which is constantly reviewed and updated by specialists. The eDrugs development process followed principles of service-oriented architecture and is based on international interoperability standards, as well SNOMED CT. This adds to the generalizability and replicability of the development process.

Most eDrugs users were physicians and they frequently sought information on drug dosage. Previous studies have reported that health professionals seek information about drug interactions, dosage and adverse reactions [14-16]. Professionals in our institution prioritize these topics as well. The most searched-for drug groups were antimicrobials and drugs acting on the nervous system. These are consistent with previous reports exploring drug information queries [15, 16].

We found a relatively low use of the prescription simulator. Moreover, the clinical information tab accounted for more than 90% of the drug summary sheet use. In our institution, DDI alerts operate as components of the EHR, without the need to use a stand-alone CDSS like eDrugs. Similarly, our hospital's EHR already displays brand names as the CPOE form is completed, which might partially explain these results.

Our findings on users' information priorities are strengthened by the quantitative analysis of structured log data, which provides reliable information on drug searches. A potential limitation of this study is that the design process did not include all UXD steps.

However, Nielsen's heuristics were taken into account. Furthermore, this study did not include an assessment of user satisfaction. Finally, like most single-center studies, this report is not free of generalizability concerns.

5. Conclusions

In this study of the usage patterns of a drug information tool, most of its users were physicians, and the most accessed drug groups were antimicrobials and drugs acting on the central nervous system. The design and development of electronic drug information tools poses various challenges on health informatics teams. Future research should include assessments of user satisfaction and links between drug information tools and prescription errors. Log data provide insights into the information priorities of health professionals, allowing further improvements to the way information is organized and displayed.

References

[1] Bates DW, Boyle DL, Vander Vliet MB, Schneider J, Leape L. Relationship between medication errors and adverse drug events. J Gen Intern Med. 1995 Apr;10(4):199–205.

[2] WHO | The third WHO global patient safety challenge: medication without harm. 2019 Sep 10; Available at: https://www.who.int/patientsafety/medication-safety/en/

[3] WHO, Others. Medication errors: technical series on safer primary care. 2016.

[4] Poon EG, Keohane CA, Yoon CS, Ditmore M, Bane A, et al. Effect of bar-code technology on the safety of medication administration. N Engl J Med. 2010 May 6;362(18):1698–707.

[5] Tully MP, Ashcroft DM, Dornan T, Lewis PJ, et al.. The causes of and factors associated with prescribing errors in hospital inpatients. Drug Saf. 2009 Oct 1;32(10):819–36.

[6] Tariq RA, et al. Medication errors.In: StatPearls. Treasure Island (FL):StatPearls Publishing; 2020.

[7] Raal A, Fischer K, Irs A. Determination of drug information needs of health care professionals in Estonia. Medicina. 2006;42(12):1030–4.

[8] Figueiras A, et al. Influence of physician's education, drug information and medical-care settings on the quality of drugs prescribed. Eur J Clin Pharmacol. 2000 Dec;56(9-10):747–53.

[9] Grandy CA, Donnan JR, Peddle JT, Romme K, Kim S, Gamble JM. A systematic assessment of the availability and clinical drug information coverage of machine-readable clinical drug data sources for building knowledge translation products. J Am Med Inform Assoc. 2019 Jan 1;26(1):91.

[10] Sackett DL. Finding and applying evidence during clinical roundsthe "evidence cart". JAMA. 1998, 280:1336.

[11] Isaac T, et al. Use of UpToDate and outcomes in US hospitals. J Hosp Med. 2012 Feb;7(2):85–90.

[12] Zapico V, Rubin L, Díaz S, et al. Decision support tools for drugs prescription process in a hospital in Argentina. Stud Health Technol Inform. 2019 Aug 21;264:903–7.

[13] Nielsen J.10 heuristics for user interface design. Nielsen Norman Group, Available at: https://www.nngroup.com/articles/ten-usability-heuristics/, Accessed Mar 2, 2020

[14] Lewis PJ, Dornan T, Taylor D, Tully MP, Wass V, Ashcroft DM. Prevalence, incidence and nature of prescribing errors in hospital inpatients: a systematic review. Drug Saf. 2009;32(5):379-89.

[15] Pohjanoksa-Mäntylä MK, et al. Utilization of a community pharmacy-operated national drug information call center in Finland. Res Social Adm Pharm. 2008 Jun;4(2):144-52.

[16] Tefera YG, et al.. The characteristics of drug information inquiries in an Ethiopian university hospital: A two-year observational study. Sci Rep 2019 Sep 25;9(1):13835.