Bridging the Gap Between Electronic Health Records and the Clinical Evidence Literature

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Abstract – By facilitating access to information and improving data quality, electronic health records (EHR) are expected to achieve better quality in the treatment of patients than paper-based systems. Another way that information technology is expected to improve patient assistance is by supporting evidence-based practice, in which the health professionals are able to access evidence databases containing synthesized and appraised medical literature. Nevertheless, these two uses of health information technology are usually disjoint, since there is a large semantic distance between bibliographic classification headings and clinical terms used in health records. This study offers a review on efforts to integrate EHR and evidence databases, and the justification to use a framework and free tools in order to find a conceptual distance.

Keywords – Clinical Decision Support Systems, Evidence-Based Practice, Electronic Health Records.

1. Introduction

With the progress of medical knowledge and technology around the world, a great deal of new literature and other evidences about medical treatments are being published. These recent publications provide the methods or evidences to support clinicians' decisions, which is the essence of Evidence-Based Medicine (EBM). Stored in knowledge repositories known as evidence databases, they help to improve medical quality and promote competitive advantage in the health industry. When these databases are available in the point of care, physicians may access crucial evidence-based literature that helps to take a clinical decision based on their experience and supported by the best available evidence. By computerizing the access to health information, it is possible to avoid dangerous medical mistakes, reduce costs, and improve assistance care. However, it is rarely practiced because few physicians have time to critically appraise the medical literature and to access evidence databases.

Actual practice of EBM would require clinicians to formulate carefully structured questions about clinical problems related to specific patients, and then to perform medical literature searches to find valid clinical studies, such as randomized controlled clinical trials, containing individuals who are representative of the patient being treated. Obviously, this is a very time-consuming process which rarely is performed.

One important positive aspect of EBM realization is to encourage physicians to convert their tacit knowledge and clinical experience into explicit knowledge, as well as to help to create a shared language where physicians easily reach consensus and eliminate dispute among them. EBM also provides a novel learning way based on continuing education, since it is continuously developed. However, physicians need efficient tools for retrieving the knowledge and to solve the problems. Such needs are expected to increase with the integration of genomic information to electronic health records (EHR) in the near future [6].

2. Proposal

To analyse the terminological characteristics present in EHRs and in evidence synopsis, to explore the possibility of using a common framework to capture the relevant aspects (for the purpose of searching the literature for each patient) from both, and to evaluate the performance of the search of evidence from EHR for a specific field of application (primary care). These will give us the possibility to find a conceptual distance between the information from the EHR and from evidence databases.

3. Literature Review

The literature review was performed based on the principles of systematic reviews, as stated in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework [7]. The first step in this framework is to define relevant con-

cepts for this work. In this case, there were two concepts.

- **Electronic Health Records:** In the scope note associated to this MeSH heading, the U.S. National Library of Medicine defines this as the "media that facilitate transportability of pertinent information concerning patient's illness across varied providers and geographic locations. Some versions include direct linkages to online consumer health information that is relevant to the health conditions and treatments related to a specific patient." [9] International Organization for Standardization (ISO) provides a more comprehensive definition: "a repository of information regarding the health status of a subject of care in computer processable form, stored and transmitted securely, and accessible by multiple authorised users. It has a standardised or commonly agreed logical information model which is independent of EHR systems. Its primary purpose is the support of continuing, efficient and quality integrated health care and it contains information which is retrospective, concurrent, and prospective." [3]

- **Evidence-Based Medicine:** In this case, the NLM reports to the literature to provide a definition for this MeSH heading: "An approach of practicing medicine with the goal to improve and evaluate patient care. It requires the judicious integration of best research evidence with the patient's values to make decisions about medical care. This method is to help physicians make proper diagnosis, devise best testing plan, choose best treatment and methods of disease prevention, as well as develop guidelines for large groups of patients with the same disease. (from JAMA 296 (9), 2006)"

3.1. Methods

The next step is to evaluate whether there are synonym terms that should be included in the search queries, as a strategy to avoid missing relevant results. In this case, "electronic patient health record" was considered to be equivalent to electronic health record, and "evidence-based practice" was considered equivalent to evidence-based medicine. After establishing these definitions, the searches are performed in the selected bibliographic databases. In this study, PubMed (http://www.ncbi.nlm.nih.gov/pubmed/) and IEEExplore (http://ieeexplore.ieee.org/) were selected. The search itself is structured by combining the synonym terms in lists with the OR logical connector, and then grouping these lists with the AND logical connector, taking in account the rules for each engine search. For example, for the PubMed bibliographic database, the structured query was: *("electronic health record" OR "electronic patient health record") AND ("evidence-based medicine" OR "evidence-based practice").*

From these searches, 172 articles were retrieved from PubMed, 27 from IEEExplore, and 2 from other sources (ACM Digital Library), totaling 201 papers. One of these papers appeared in two databases; with the duplicate removal, 200 papers were left for consideration. At this point, the next step in the PRISMA framework is to screen the results to verify how many articles are indeed related to the search goals. This was performed initially by screening over the paper titles, which yielded to the exclusion of 176 papers. From the remaining 22 articles, 11 were excluded after reading the abstract and 3 because the full paper was not available. To the remaining 8 articles, 2 were added from previous manual searches.

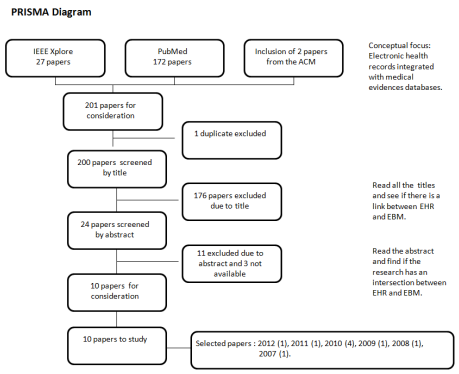

Figure 1. summarizes the application of the PRISMA framework in this study.

3.2. Results

In this section, we synthesize the results found in the literature as described previously. The scenario which integrates EHR and EBM might create sev-

eral expectations towards the development of better clinical decision support system and to provide cost-effective treatments for patients. November describes the Intermountain project as an example of a system that offers high-quality of care and reduce costs, after decades of using technology as an ally to their institutional health information management systems [8]. An article by Chiu [1, 2] discuss advantages and disadvantages related to the use of EBM in the daily work of the physicians. These results are summarized in Figure 2.

Advantages/Positiveness	Disadvantages/Negativism
Support: to acquire, identify and apply knowledge stored in EBM databases. **Quality:** • Breadth: diversity, internationalization and update. • Depth: the EBM databases are rigorous and systematic created. • Correctness: the EBM papers have high validity.	**Load:** of information and pressure of keep acquiring knowledge without systematic method. **Carelessness:** junior physicians put more emphasis on the best evidence, their clinical practice is almost centralized on evidences. The senior physicians, however work based on their clinical expertise. **Abuse:** some physicians, who cannot find the matched cases, carelessly apply similar cases to their patients, this may result in wrong treatment. **Information anxiety:** sometimes the physicians are afraid that the evidences they retrieved are not appropriate for the patients. **Omnipotent myth:** several physicians pointed out that there are rare cases of complete match with their patients in EBM databases.

Figure 2. Summary of advantages and disadvantages of EBM application to daily practice

3.3. Discussion

This literature review has shown that there is no clear association between the adoption of electronic health records and evidence-based practice, and that efforts to provide a seamless integration between EHR and evidence databases are still immature. Future research in this direction should address the relationship between technology adoption in health practice and the (mainly cultural) barriers pointed out in Image 2. Without attention to these issues, any technological solution to integrate EHR and EBM, as ingenious as it can be, is at risk of not being adopted.

4. Results

In this work, we will explore the integration of EHR with evidence databases. One of the main problems is the difference between the clinical terms used in EHR and the terms used for present evidences. We propose to use Unified Medical Language System (UMLS) [5]. It is a compendium of many controlled vocabularies in the biomedical sciences. It provides a mapping structure among these vocabularies and thus allows one to translate among the various terminology systems; it may also be viewed as a comprehensive thesaurus and ontology of biomedical concepts. UMLS further provides facilities for natural language processing. It is intended to be used mainly by developers of systems in medical informatics. UMLS consists of Knowledge Sources (databases) and a set of software tools. It was designed and is maintained by the NLM. Its knowledge sources are:

- Metathesaurus: is the base of the UMLS and comprises over 1 million biomedical concepts and 5 million concept names, all of which stem from the over 100 incorporated controlled vocabularies and classification systems. Some examples of the incorporated controlled vocabularies are ICD-10, MeSH, SNOMED CT. It is organized by concept, and each concept has specific attributes defining its meaning and is linked to the corresponding concept names in the various source vocabularies. Numerous relationships between the concepts are represented. Its scope is determined by the scope of the source vocabularies. If different vocabularies use different names for the same concept, or if they use the same name for different concepts, then this will be faithfully represented in the Metathesaurus. All hierarchical information from the source vocabularies is retained in the Metathesaurus.
- Semantic Network (SN): each concept in the Metathesaurus is assigned one or more semantic types (categories), which are linked with one another through semantic relationships. The SN is a catalog of these semantic types and relationships. The information about a semantic type includes an identifier, definition, examples, hierarchical information about the encompassing semantic type(s), and associative relationships.
- SPECIALIST Lexicon (SL): contains information about common English vocabulary, biomedical terms, terms found in MEDLINE and terms found in the UMLS Metathesaurus. Each entry contains syntac-

tic (how words are put together to create meaning), morphological (form and structure) and orthographic (spelling) information.

For the EHR, we plan to use GNU Health (GH). It is a free, centralized health and Hospital Information System (HIS) that provides the following functionality: EHR, HIS and Health Information System. GH goals is to contribute with health professionals around the world to improve the quality of life of the underprivileged, providing a free system that optimizes health promotion and disease prevention. Some of its focus are: specialized in family medicine and primary health care; use of ICD-10 for pathologies, diseases diagnosis; the patient history in a format that medical centers all over the world would be able to process; paperless; fast way of practicing medicine; and its data is designed in such a way that centralizes the information (no duplication occurs) which optimizes collaboration and communication between health professionals. GH is a set of Tryton modules, developed in the programming language Phython and using PostgreSQL as the database engine, its source code is available. Tryton is a three-tier high-level general purpose computer application platform, is intended to allow any of the three tiers to be upgraded or replaced independently in response to changes in requirements or technology [4].

5. Conclusions

Electronic Health Records and Evidence-Based Medicine are two contributions from information technology to health assistance and clinical practice. Nevertheless, there is not enough research to assess whether EHR adoption helps to promote EBM or whether EBM adopters favor the use of EHR. This study pointed out, through a literature review, what health practitioners envision as benefits and barriers to this integrated adoption of EHR and EBM.

Our future work will be the validation of the use of the GNU Health open source code in order to integrate their EHR with the medical evidences' databases in order to assist the clinical decisions and also to find the conceptual distance. If we found difficulties or incompatibilities our approach will be to create an environment with the standard rules (also using the UMLS resources) to accomplish our goals.

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