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Computerized physician order entry of medications and clinical decision support can improve problem list documentation compliance

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ABSTRACT

Objective: The problem list is a key and required element of the electronic medical record (EMR). Problem lists may contribute substantially to patient safety and quality of care. Physician documentation of the problem list is often lower than desired. Methods are needed to improve accuracy and completeness of the problem list.
Design: An automated clinical decision support (CDS) intervention was designed utilizing a commercially available EMR with computerized physician order entry (CPOE) and CDS. The system was based on alerts delivered during inpatient medication CPOE that prompted clinicians to add a diagnosis to the problem list. Each alert was studied for a 2-month period after implementation.
Measurements: Measures included alert validity, alert yield, and accuracy of problem list additions.
Results: At a 450 bed teaching hospital, the number of medication orders which triggered alerts during all 2-month study periods was 1011. For all the alerts, the likelihood of a valid alert (an alert that occurred in patients with one of the predefined diagnoses) was 96 ± 1%. The alert yield, defined as occuring when an alert led to addition of a problem to the problem list, was 76 ± 2%. Accurate problem list additions, defined as additions of problems when the problem was determined to be present by expert review, was 95 ± 1%.
Conclusion: The CDS problem list mechanism was integrated into the process of medication order placement and promoted relatively accurate addition of problems to the EMR problem list.

1. Introduction

The problem list is a key and required [1] element of both the paper record and EMR. Weed [2,3] popularized the use of the problem list in an influential book and papers. Benson et al [4] have argued that the "problem list and the medication record are particularly useful for providing an overview of patients' significant diagnoses and treatments. If well-structured, reliable, and consistent, they can also contribute substantially to the quality of patient care." An accurate problem list

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facilitates automated decision support, clinical research, data mining, and patient care [4–6]. The Joint Commission on the Accreditation of Healthcare Organizations [1] mandates maintenance of a problem list. The problem list can be a useful tool in both paper records and EMRs for organizing physician notes, making patient rounds, and "signing out" patients to covering physicians [7,8].

The advent of EMRs *could* significantly increase the potential power and importance of the problem list. Database links and pointers could make the problem list a true "index" to the EMR as originally conceived by Weed [2,3]. For example, selecting a problem off the problem list (e.g. hypertension) could link to all relevant healthcare encounters for hypertension, all relevant laboratory results, and radiology reports that mention the diagnosis of hypertension, or link to all drugs that treat hypertension. Furthermore, detailed electronic problem lists can facilitate the development of CDS, patient registries and research. There is little information on the accuracy of problem list maintenance at either teaching or non-teaching hospitals. A limited study in the adoption of EMRs revealed that users produce more complete problem lists in an EMR than in the paper medical record [9]. However, in a study of the Veterans Administration EMR [10], the sensitivity of the electronic problem list for the diagnosis of hypertension was only 49%. Campbell [11] has attributed poor clinician compliance with the problem list to "minimal rewards for the clinician".

In an audit of 105 outpatients seen in the Neurology Clinic at the University of Illinois Medical Center in 2002, 19% of the medical records had no problems of any kind listed on the electronic problem list and 39% had no problem on the electronic problem list related to the current visit [12]. Furthermore, 47% of the problems were entered as "free text" rather than as codified discrete ICD-9-CM [13], ICD-10 [14], or SNOMED® [15] codes. In an audit of inpatient medical records we compared the problem list as reported in the medical record with the problem list as ascertained by chart review [12]. The number of problems on the problem lists was roughly only a quarter of those found by auditing the chart, while 46% of the charts had an empty problem list. Problem list under documentation is certainly not unique to our institution, a recent study from intermountain health care also reported that their problems lists are "*Usually incomplete and inaccurate, and are often totally unused*" [16].

One of the potential causes of poor problem list documentation is the use of controlled terminologies; ICD-9-CM [13], ICD-10 [14], or SNOMED® [15], which may not be ideal for documentation of problems in a problem list [17,18]. There are many reasons that problem list use may be underutilized [17,18] which may help explain the interest in "free text" problems by users. One of the strategies to improve the use of standardized terminologies has been the development of information technology to convert non-standardized problems into local controlled terminologies [16,19–21] as well as standard terminologies such as SNOMED® [15,22].

More accurate problem lists may lead to higher levels of patient safety and lower levels of medical error. Carpenter and Gorman [23] have tested a natural language processor that detects medication errors based upon a mismatch between the drug ordered and problems that reside on the problem list. For example, if a drug does not match up with a problem, either the problem list is deficient and needs to be updated or the drug has been ordered in error and needs to be deleted. A theoretical CDS prototype [24,25] has been tested and suggested that integration of problem list maintenance into CPOE workflow may promote better problem list documentation. In this study, we have tested a CDS system that helps maintain the electronic problem list in a real-time clinical environment. The CDS system is triggered by drug orders in CPOE to generate alerts to providers who then have the option to update the electronic problem list by a simple automated process.

2. Methods

2.1. EMR, CPOE, CDS and problem list environment

The University of Illinois Hospital, a 450-bed teaching hospital, utilizes a commercially available EMR (*Millennium*®, Cerner Corporation, Kansas City, MO) which is used as the primary repository for all results, problem lists, clinical notes, medication lists, and orders. All inpatient medication orders are placed using CPOE. The commercially available CDS (*Discern Expert*®, Cerner Corporation) has been previously described [26–28].

Our problem list is multidisciplinary, allowing any clinician to enter problems either codified or as free text. Codified problems could use either ICD-9 CM [13], ICD-10 [14], or SNOMED® [15] codes.

2.2. Development of alerts

A system of alerts are delivered to clinicians during medication CPOE. These alerts prompt clincians to place a diagnosis on the problem list as a pop-up when the medication order is initiated. For each medication ordered, one or more diagnoses can be proposed. The clinician can place more than one diagnosis if desired. An example alert is triggered by the ordering of levothyroxine (Fig. 1). Placing a diagnosis requires 3 mouse clicks, while not placing a diagnosis requires 2. This is significantly less than is required to place a diagnosis in this EMR without this type of alert.

The particular combinations of diagnosis to medications associations were chosen based on associations which were likely to yield accurate additions to the problem list. This was determined by choosing medications whose use was limited to a small number of specific indications, whether Food and Drug Authority (FDA) approved or not. Medications with very broad and unpredictable indications, or whose use was not indicative of useful diagnoses were not chosen. An example of an excellent medication would be an oral antidiabetic medication like a *sulfonyuria* which is almost always used in diabetes mellitus, while a medication that would perform very poorly would be acetaminophen, which is used to treat the pain or fever associated with likely hundreds of diagnoses.

There was a single gender difference in all the alerts, the alert based on an order for metformin allowed for addition