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Cost-Effectiveness of a Computerized Provider Order Entry System in Improving Medication Safety Ambulatory Care

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ABSTRACT

Background: Computerized provider order entry (CPOE) is the process of entering physician orders directly into an electronic health record. Although CPOE has been shown to improve medication safety and reduce health care costs, these improvements have been demonstrated largely in the inpatient setting; the cost-effectiveness in the ambulatory setting remains uncertain. **Objective:** The objective was to estimate the cost-effectiveness of CPOE in reducing medication errors and adverse drug events (ADEs) in the ambulatory setting. **Methods:** We created a decision-analytic model to estimate the cost-effectiveness of CPOE in a midsized (400 providers) multidisciplinary medical group over a 5-year time horizon— 2010 to 2014—the time frame during which health systems are implementing CPOE to meet Meaningful Use criteria. We adopted the medical group's perspective and utilized their costs, changes in efficiency, and actual number of medication errors and ADEs. One-way and probabilistic sensitivity analyses were conducted. Scenario analyses were explored. **Results:** In the base case, CPOE dominated paper prescribing, that is, CPOE cost $18 million less than paper prescribing, and was associated with 1.5 million and 14,500 fewer medication errors and ADEs, respectively, over 5 years. In the scenario that reflected a practice group of five providers, CPOE cost $265,000 less than paper prescribing, was associated with 3875 and 39 fewer medication errors and ADEs, respectively, over 5 years, and was dominant in 80% of the simulations. **Conclusions:** Our model suggests that the adoption of CPOE in the ambulatory setting provides excellent value for the investment, and is a cost-effective strategy to improve medication safety over a wide range of practice sizes.

Keywords: adverse drug events, ambulatory care, computerized physician order entry system, cost-benefit analysis (cost-effectiveness), medication errors.

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Introduction

In 2009, United States Congress passed the American Recovery and Reinvestment Act, a seminal piece of legislation focused on health care reform [1]. The act includes the $19 billion Health Information Technology for Economic and Clinical Health provision, which has spurred electronic health record (EHR) adoption [2]. Also promoting EHR adoption are financial incentives from the Centers for Medicare & Medicaid Services (CMS) to providers who demonstrate Meaningful Use [3]. At the top of the list of stage 1 Meaningful Use criteria is implementation of the computerized provider order entry (CPOE) system.

Published systematic reviews suggest that CPOE is associated with a 13% to 99% reduction in medication errors and a 30% to 84% reduction in adverse drug events (ADEs) [4,5]. In the ambulatory setting, our group found that CPOE, even with limited clinical decision support alerts to guide ordering, is associated with a 55% reduction in errors [6]. Although early problems with drop-down boxes [7], resistance to adoption [8], workflow disruption [9–11], increased workload [9–11], and even increased numbers of errors [12] have been reported, CPOE has gained traction over the past 5 years and is now an integral part of the learning health care system [13,14]. Current research is addressing alert fatigue using methods of human factors engineering [15,16]. Workflow has emerged as an area of focus [17]. Work continues to iteratively improve CPOE systems with clinical decision support alerts to further reduce medication errors and improve prescriber adherence to guidelines [18–20].

One of the major barriers to the adoption of CPOE (and EHRs) has long been the large up-front investment. Meaningful Use incentives reduce this cost barrier, thereby promoting increased uptake, with the ultimate goal of improving patient safety. However, few studies have estimated the long-term costs of CPOE relative to its safety benefits. Studies conducted in the ambulatory setting have demonstrated a positive return on investment in an EHR [21,22], and similar findings have been noted in inpatient settings when evaluating CPOE [23,24]. One study estimated the cost-effectiveness of an electronic

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medication ordering system in reducing ADEs in the inpatient setting [25], but we found no such study in ambulatory care. Our objective was to estimate the cost-effectiveness of CPOE versus traditional paper-based prescribing in reducing medication errors and ADEs in the ambulatory care setting of a midsized (400 providers) medical group.

Methods

Setting

The Everett Clinic is the largest independent, physician-owned medical group in Washington state. Based in the North Puget Sound, The Everett Clinic is a multispecialty clinic system comprising more than 400 prescribers, approximately equally distributed between primary care and specialty physicians, with a growing number of mid-level providers. These clinicians provide care for more than 300,000 patients within 60 clinics in 16 locations, and admit to primarily one community hospital in the local market. The Everett Clinic contracts with approximately 18 health plans, each with its own formulary; clinicians order 2.7 million prescriptions annually. In 1995, The Everett Clinic developed a homegrown EHR. The system was Web-based, used point-and-click functionality, and integrated electronic prescribing into an existing EHR that included scheduling, chart notes, and laboratory and imaging reports. Basic CPOE software was designed in 2004 and rolled out from 2004 through 2006, and generated new and refill prescriptions. The drug database was provided by Multum (Cerner, Denver, CO). Clinicians selected medications from pull-down menus or "favorites" lists. Clinical decision support alerts were limited to basic dosing guidance, duplicate therapy checks, and pediatric dosing calculations. Clinic staff could queue prescriptions; prescribers signed and released them. Prescriptions could be electronically transmitted to more than 200 local pharmacies. Prescribing at the point of care demanded a fundamental shift in workflow and required a computer to be installed in each examination room. Our group has previously evaluated the effect of this CPOE implementation on medication errors and ADEs [6], and on prescriber and staff time [26].

The Model

Adding the CPOE module to an existing homegrown EHR provided a unique opportunity to estimate the cost-effectiveness of the CPOE system separate from the EHR. A decision-analytic model was created using Microsoft Excel (Redmond, WA) to conduct a cost-effectiveness analysis of The Everett Clinic's CPOE system. Although we considered modeling both the cost-benefit and the cost-utility of the CPOE system, in this case, we were interested in estimating the cost per medication error or ADE averted; hence, cost-effectiveness analysis was the method of choice. The perspective of the medical group was chosen because the medical group incurs implementation costs and realizes the benefit of improved prescription accuracy and safety. Patients benefit from improved medication safety.

The model compares prescriptions that were hand-written before CPOE implementation (paper-based) with those prescribed after CPOE implementation, and evaluates prescriptions written annually, per provider. The use of either a paper-based or a CPOE system could lead to a clinical (e.g., drug–drug interaction) or administrative (e.g., illegibility) medication error, and each medication error could lead to a potential ADE (no harm) or preventable ADE (harm) (Fig. 1) [6]. The two outcome measures were the number of medication errors avoided and the number of ADEs avoided. We chose a 5-year time horizon (2010–2014) to model the effect of CPOE in accordance with CMS Meaningful Use incentives [3]. These incentives, in the amount of $44,000 over 5 years (2011–2015), are awarded to each eligible participating provider who meets certain prescribing criteria [3]. We designed our model to reflect a medical group that anticipates meeting these criteria, and therefore, express all year 1 modeling costs in 2010 US dollars. Costs are discounted 3% annually for each of the remaining 4 years of the time horizon.

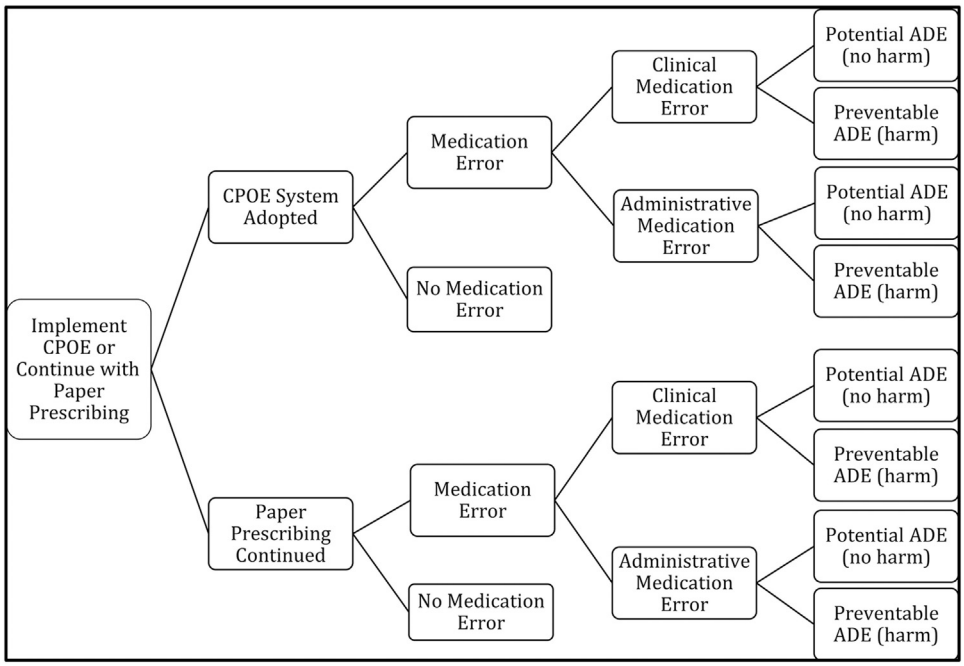

Fig. 1 – Decision analytic model. ADE, adverse drug event; CPOE, computerized provider order entry.

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