

Overview of the Leapfrog Group Evaluation Tool for Computerized Physician Order Entry

December 2001



Report By
Peter Kilbridge, Emily Welebob,
and David Classen
First Consulting Group

The Leapfrog Group is promoting three patient safety practices as the initial focus for consumer education and information and hospital recognition and reward. One of these is the use of computerized physician order entry (CPOE) in hospitals to prevent serious medication errors.

First Consulting Group (FCG) has developed the methodology to help hospitals evaluate whether their CPOE systems meet the Leapfrog standard. The methodology and this report describing it were developed by Peter Kilbridge, M.D., Emily Welebob, R.N., and David Classen, M.D., of FCG. They were assisted by a team of physician project advisors – David Bates, M.D.; Marc Overhage, M.D.; and Thomas Payne, M.D. – and by Michael Cohen, R.Ph., D.Sc., and Allen Vaida, Pharm.D., of the Institute for Safe Medication Practices and Rainu Kaushal, M.D., of the Brigham and Women’s Hospital.

The project has been funded through a grant from the California HealthCare Foundation’s Quality Initiative directly to FCG and through a Robert Wood Johnson Foundation grant to the Academy for Health Services Research and Health Policy, host organization to The Leapfrog Group.

The Leapfrog Group is a growing consortium of more than 90 Fortune 500 companies and other large public and private health care sector purchasers working to mobilize employer purchasing power to improve the safety and overall value of health care. It was founded by the Business Roundtable, a national association of Fortune 500 CEOs. The Leapfrog Group receives additional support from the National Health Care Purchasing Institute. More Information can be found at www.leapfroggroup.org.

First Consulting Group is a leading provider of information-based consulting, integration, and management services for health care, pharmaceutical, and other life sciences organizations in North America and Europe. More information about FCG is available at www.fcg.com.

The Institute for Safe Medication Practices (ISMP) is a nonprofit organization that works closely with healthcare practitioners and institutions, regulatory agencies, professional organizations, and the pharmaceutical industry to provide education about adverse drug events and their prevention. More information can be found at: www.ismp.org.

The California HealthCare Foundation (CHCF) is an independent philanthropy committed to improving California’s health care delivery and financing systems. Our goal is to ensure all Californians have access to affordable, quality health care. The Quality Initiative seeks to improve the quality of medical care in California through aggressive reporting of quality of care measures and support of accountability and improvement efforts. More information about CHCF and the Quality Initiative can be found at www.chcf.org.

The Robert Wood Johnson Foundation, based in Princeton, New Jersey, is the nation’s largest philanthropy devoted exclusively to health and health care. The Foundation’s web address is www.rwjf.org.

©First Consulting Group. All rights reserved. Permission is granted to copy this work in its entirety only; use of any part or excerpt must be by permission. For permission contact Jane Metzger, First Consulting Group, 781-402-2520.

This report can be found on the following web sites: www.leapfroggroup.org and www.fcg.com

Introduction

Leapfrog Group Standard for Computerized Physician Order Entry

A 1999 report by the Institute of Medicine (IOM) found that up to 98,000 Americans die every year from preventable medical errors in hospitals. [1] The report recommended that large health care purchasers provide more market reinforcement for quality and safety. The Leapfrog Group is a growing consortium of more than 90 Fortune 500 companies and other large private and public health care purchasers, founded by The Business Roundtable. In November 2000, The Leapfrog Group launched a national effort to reward hospitals for advances in patient safety and to educate employees, retirees, and families about the importance of hospitals' efforts in this area.

The Leapfrog Group's goal is to mobilize employer purchasing power to initiate breakthrough improvements in the safety and overall value of health care to American consumers. The program is voluntary, aimed at mobilizing large purchasers to alert the health care industry that big leaps in patient safety and customer value will be recognized and rewarded with preferential use and other intensified market reinforcement.

The Leapfrog Group has identified three initial patient safety standards as the focus for consumer education and information and hospital recognition and reward: Computer Physician Order Entry (CPOE), ICU Physician Staffing, and Evidence-based Hospital Referral. The intent of the CPOE standard is to encourage use of CPOE with clinical decision support that can intercept dangerous orders. Specifically, it requires that physicians enter orders electronically and that the system be able to intercept at least 50 percent of common serious prescribing errors.

Additional information about The Leapfrog Group CPOE standard can be found at:

- Fact Sheet: http://www.leapfroggroup.org/FactSheets/CPOE_FactSheet.pdf
- Bibliography: <http://www.leapfroggroup.org/biblios/bibliography1.htm>

For more information about The Leapfrog Group and the other two patient safety standards, please visit: www.leapfroggroup.org

Purpose of This Report

The purpose of this report is to provide hospitals with advanced information about the evaluation tool being developed to help hospitals assess the effectiveness of their CPOE systems in intercepting medication orders with errors that could harm patients. The evaluation tool will also provide hospitals with a method for reporting the effectiveness of their systems to purchasers and consumers, as part of The Leapfrog Group initiative. The Leapfrog Group will make the evaluation tool available in 2002. At that point, hospitals that wish to report to The Leapfrog Group via the voluntary online hospital survey (<https://leapfrog.medstat.com>) that they meet Leapfrog's CPOE standard will be asked to complete the evaluation as part of completing that survey.

Testing Approach

Purpose

The primary purpose of the evaluation tool is to assess the ability of implemented CPOE systems to aid in avoiding medication-related adverse events originating in orders for hospitalized patients. This is accomplished by evaluating how the system responds to medication orders entered that contain such errors. Most of the orders used in the evaluation will be of this type. To perform well, the hospital must be using features of CPOE that detect situations that could lead to adverse drug events (ADEs) and respond to them (i.e., clinical decision support that advises the physician). (For an overview of clinical decision support in CPOE, refer to the companion report, *Computerized Physician Order Entry: A Look at The Vendor Marketplace and Getting Started*.)

The evaluation also addresses two other aspects of the successful use of CPOE:

1. In implementing clinical decision support, a hospital must achieve the right balance between useful alerting and “over-alerting” or intercepting orders that have a very low risk of leading to ADEs. Such “nuisance” alerts can seriously impair physician acceptance of CPOE and, more importantly, lead users to ignore all alerts – thereby decreasing the value of clinical decision support. The reason for including orders that could generate nuisance alerts in the evaluation is to provide feedback to the hospital about this balance.
2. Although The Leapfrog Group is currently targeting medication orders, CPOE has value to the hospital beyond its ability to reduce adverse drug events. To encourage the use of other CPOE functions that improve care efficiencies, the evaluation includes two other types of orders. One is orders that require secondary or “corollary” orders (for example, recommending an order for drug levels when the user orders a medication for which the patient’s blood level should be monitored to titrate dosing). The other is duplicate orders that test the ability to alert the user that a particular diagnostic test has been ordered very recently, thus avoiding the cost and morbidity of duplicate testing.

A small number of orders in the evaluation order set address these two issues.

How the Evaluation Will Be Conducted

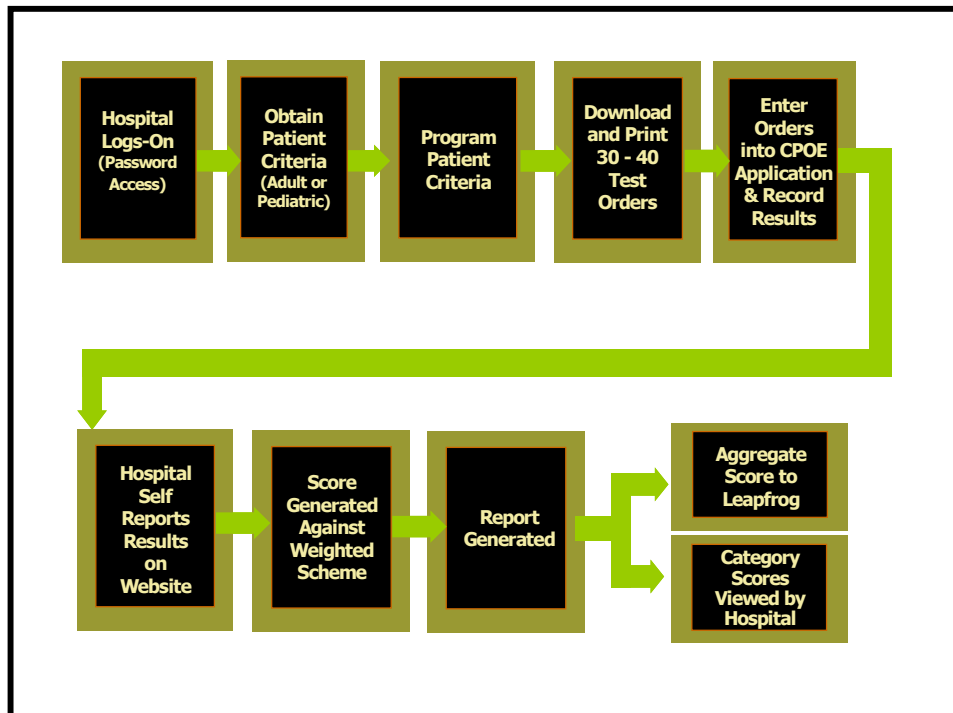
The Leapfrog Group is in the process of finalizing the process by which hospitals will conduct the evaluation and report their reports. The overall design is illustrated in Figure 1. The host Web site will contain two master order sets: one for adults, one for pediatric patients. An individual hospital will receive a subset of the master orders for use in the evaluation. The sequence of events is as follows:

1. A representative of the hospital registers on the Web site, obtains a user identification and security code, applies to evaluate the hospital’s CPOE system, and receives a set of test patient characteristics to pre-program. A pediatric specialty hospital will receive test patients appropriate to pediatrics; an adult care hospital will receive test patients appropriate to that care environment. A hospital that serves both pediatric and adult patients will conduct the evaluation twice.
2. When the hospital is ready to perform the evaluation, the responsible hospital representative returns to the Web site to download a randomly generated set of pediatric or adult orders from the master order set. The set of orders will cover all of the different order categories being evaluated. The hospital representative proceeds to enter the test orders into the CPOE system against the test patients, noting the system responses, according to the instructions provided.
3. Once the evaluation has been completed, the hospital representative records the system responses to each test order on the host Web site, where results are evaluated and scored.

4. The hospital receives feedback on their CPOE system's performance in each of the order categories tested and overall.
5. A composite score is used for public reporting.

Time constraints are associated with each stage of the download and evaluation reporting process. There is also a mandatory lockout time between attempts to conduct the evaluation.

Figure 1. Example Evaluation Procedure



Methodology Development

Order sets for pediatric and adult patients for the evaluation were developed, combining knowledge from published research with the experience and knowledge of the Institute for Safe Medication Practices and four nationally recognized experts in the field of CPOE:

- Dr. David Bates (Partners Health care),
- Dr. David Classen (FCG, formerly Intermountain Health Care),
- Dr. Marc Overhage (Regenstrief Institute), and
- Dr. Thomas Payne (University of Washington).

The order sets and evaluation methodology were piloted at six hospital sites in June-August 2001 to assess usability and format (time required for programming test patients and completing the evaluation, possible response types that are appropriate for different categories of orders, etc.) The first hospital has a CPOE system developed in-house. The other five hospitals use a commercial CPOE solution in a hospital-wide implementation that includes both medication orders and clinical decision support. The following hospitals participated in the pilot:

- Brigham and Women's Hospital (Boston)
- Ohio State University (Columbus)

- University of Illinois (Chicago)
- Montefiore Medical Center (New York City)
- Children’s Hospital of Wisconsin (Milwaukee)
- California Pacific Medical Center (San Francisco)

Pilot testing was very valuable, leading to refinement of both the order set and the evaluation methodology and related tools. The time required for pre-programming of the test patients was modest (less than two hours for most pilot sites), and the time required to enter a representative set of test orders and record results was about one hour. Additional testing of the methodology *and* Web site is planned before release.

Order Set Development

Nine categories of erroneous medication orders were selected for use in the evaluation based on prior work by ISMP and project advisors. These categories are fairly comprehensive and span the spectrum of order-related adverse drug events:

1. Therapeutic duplication
2. Single and cumulative dose limits
3. Allergies and cross allergies
4. Contraindicated route of administration
5. Drug-drug and drug-food interactions
6. Contraindication/dose limits based on patient diagnosis
7. Contraindication/dose limits based on patient age and weight
8. Contraindication/dose limits based on laboratory studies
9. Contraindication/dose limits based on radiology studies

As discussed previously, additional categories address corollary orders, cost of care (duplicate checking), and nuisance alerting. Table 1 lists the order categories included in the test set, providing a description and examples. (Example orders are given for general illustration only and do not reflect actual orders in the test set.)

Table 1. Description of Order Categories in the Leapfrog CPOE Evaluation

Order Category	Description	Examples
Therapeutic duplication	Medication with therapeutic overlap with another new or active order; may be same drug, within drug class, or involve components of combination products	Codeine AND Tylenol #3
Single and cumulative dose limits	Medication with a specified dose that exceeds recommended dose ranges or that will result in a cumulative dose that exceeds recommended ranges	Ten-fold excess dose of Methotrexate
Allergies and cross-allergies	Medication for which patient allergy has been documented or allergy to other drug in same category has been documented	Penicillin prescribed for patient with documented Penicillin allergy
Contraindicated route of administration	Order specifying a route of administration (e.g., oral, intramuscular, intravenous) not appropriate for the identified medication	Tylenol to be administered intravenously
Drug-drug and drug-food interactions	Medication that results in known, dangerous interaction when administered in combination with a different medication in a new or existing order for the patient or results in an interaction in combination with a food or food group	Digoxin AND Quinidine

Order Category	Description	Examples
Contraindication/dose limits based on patient diagnosis	Medication either contraindicated based on patient diagnosis or diagnosis affects appropriate dosing	Nonspecific beta blocker in patient with asthma
Contraindication dose limits based on patient age and weight	Medication either contraindicated for this patient based on age and weight or for which age and weight must be considered in appropriate dosing	Adult dose of antibiotic in a newborn
Contraindication/dose limits based on laboratory studies	Medication either contraindicated for this patient based on laboratory studies or for which relevant laboratory results must be considered in appropriate dosing	Normal adult dose regimen of renally eliminated medication in patient with elevated creatinine
Contraindication/dose limits based on radiology studies	Medication contraindicated for this patient based on interaction with contrast medium in recent or ordered radiology study	Medication prescribed known to interact with iodine to be used as contrast medium in ordered head CT exam
Corollary	Intervention that requires an associated or secondary order to meet the standard of care	Prompt to order drug levels when ordering aminoglycoside
Cost of care	Test that duplicates a service within a timeframe in which there is typically minimal benefits from repeating the test	Repeat test for Digoxin level within two hours
Nuisance	Order with such a mild or typically inconsequential interaction that clinicians typically ignore the advice provided	Lasix AND Digoxin in patient with normal potassium

An initial set of orders for adult patients was obtained from ISMP. Designed primarily for evaluation of pharmacy information systems, this order set was extensively modified. Several categories of orders were removed that do not apply to CPOE, and other categories were added. The orders were then modified to fit a format appropriate for CPOE.

A separate pediatric order set was developed based upon the literature and expert input. Literature sources used included a recent publication on ADEs in pediatric hospitals [2] and statistics supplied by the Harvard Risk Management Foundation. [3] In addition the order set was reviewed by Rainu Kaushal, M.D., primary author of the above study. [3]

Orders for the additional order categories were developed as follows:

- Orders designed to trigger *corollary orders* (prompts for a secondary order) were selected based upon a publication by Overhage [4], which identifies a series of corollary orders shown to significantly improve adherence to the standard of care.
- *Cost of care* orders focused on duplicate orders for the same laboratory test; these were selected from a study [5] that identified expensive tests for which there is minimal additional benefit of repeating the test within a certain period of time.
- *Nuisance orders* (orders that might trigger an interaction alert, where the interaction is so rare or mild as to be clinically insignificant) were created based upon the experience of the advisors who have implemented CPOE systems at their organizations and, therefore, have familiarity with nuisance alerts. These orders were given a moderate weight in the scoring scheme, as too many nuisance alerts can significantly impair a system's usability and effectiveness.

Scoring

The goal was to develop a representative order set, with adult and pediatric versions, and scoring methodology that would emphasize interception of those orders most likely to cause harm to patients.

The intent was to target both those orders that contribute to the most frequent kinds of adverse events, as well as those that may be less frequent but would result in more severe harm if the medication reaches the patient.

To accomplish this, each order was assigned a score for likely severity of the interaction, and another for frequency of the adverse event. Frequency scoring was based upon published and unpublished large-scale studies that employed automated surveillance to detect adverse drug events [6, 7, 8]. Severity was described according to a commonly used ranking [9] as life threatening, severe, significant, or not significant. Rankings were based on the opinions of expert advisers, in particular Michael Cohen and Allan Vaida of ISMP, because there is no definitive literature upon which to base these rankings. Orders ranked “not significant” were eliminated from the master order set. Both sets of scores were circulated among all advisors for review.

A two-dimensional matrix was used to assign to each order a single weighted score, representing the combined frequency and severity scores (Table 2) [10].

Table 2. Severity vs. Frequency Matrix

Severity vs. Frequency	3 (Most Frequent)	2 (Less Frequent)	1 (Least Frequent)
3 (Life-Threatening)	3	3	3
2 (Serious)	3	2	1
1 (Significant)	2	1	1

Based on this methodology, each hospital will receive feedback on performance in each order category *and* overall. This feedback to hospitals can help guide ongoing efforts to implement CPOE tools. For example, very low scores may identify areas where the hospital has only begun to leverage CPOE tools. This in turn can lead to investigating the possibilities for improvement, or, if lack of decision support tools is a barrier, negotiating with the CPOE vendor to enhance the CDS toolset. In other cases, low or zero scores for a category such as contraindication/dose limits based on laboratory studies, may lead to prioritizing this area for further work.

The Leapfrog Group will use composite (overall) scores in public reporting on the hospital’s ability to meet the Leapfrog CPOE standard.

References

1. Institute of Medicine. *To Err is Human, Building a Safer Health System*. Kohn LT, Corrigan JM, Donaldson MS, Eds. National Academy Press, Washington, DC, 1999.
2. Kaushal R, Bates DW, Landrigan C, et al. Medication Errors and Adverse Drug Events in Pediatric Inpatients. *Journal of the American Medical Association* 285:2114-2120, 2001.
3. Kaushal, R, personal communication, August 2001.
4. Overhage JM, Tierney WM, Zhou A, McDonald CJ. A Randomized Trial of "Corollary Orders" to Prevent Errors of Omission. *Journal of the American Medical Informatics Association* 4:364-375, 1997.
5. Bates DW, Kuperman GJ, Rittenberg E, Teich JM, et al. A Randomized Trial of Computer-based Intervention to Reduce Utilization of Redundant Laboratory Tests. *American Journal of Medicine* 106:144-150, 1999.
6. Classen DC, Pestotnik SL, et al. Computerized Surveillance of Adverse Drug Events in Hospital Patients. *Journal of the American Medical Association* 266(20):2847-2851, 1991.
7. Jha AK, Kuperman GJ, et al. Identifying Adverse Drug Events. *Journal of the American Medical Informatics Association* 5(3), 305-314, 1998.
8. Classen DC, unpublished data, Intermountain Health Care
9. Folli HL, Poole RL, Benitz WE, Russo JC. Medication Error Prevention by Clinical Pharmacists in Two Children's Hospitals. *Pediatrics* 79:718-722, 1987.
10. Bagian JP, Lee CZ, and Cole JF. A Method for Prioritizing Safety Related Actions.. In Scheffler AL, Zipperer LA (eds.). *Proceedings of Enhancing Patient Safety and Reducing Errors in Health Care*. Chicago, IL. National Patient Safety Foundation, 1999.