Characteristics and override rates of order checks in a practitioner order entry system

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ABSTRACT

Order checks are important error prevention tools when used in conjunction with practitioner order entry systems. We studied characteristics of order checks generated in a sample of consecutively entered orders during a 4 week period in an electronic medical record at VA Puget Sound. We found that in the 42,641 orders where an order check could potentially be generated, 11% generated at least one order check and many generated more than one order check. The rates at which the ordering practitioner overrode 'Critical drug interaction' and 'Allergy-drug interaction' alerts in this sample were 88% and 69% respectively. This was in part due to the presence of alerts for interactions between systemic and topical medications and for alerts generated during medication renewals. Refinement in order check logic could lead to lower override rates and increase practitioner acceptance and effectiveness of order checks.

INTRODUCTION

Automated practitioner order entry systems can reduce errors[1] by reducing transcription errors and by checking orders entered by the practitioner, in real-time, for drug allergies, drug interactions, and other problems during the ordering session.

There is increasing awareness that order check alerts need to be optimally designed to achieve a balance between appropriate alerting and overalerting during the process of clinician order entry,[2] and that there be continuous scrutiny of order checks to determine if refinement of order check logic is needed.[3] This maintenance is similar to that needed for other clinical software systems.[4] In this analysis, we studied the experience using order checks within the Computerized Patient Record System (CPRS)—the automated practitioner order entry system that is part of an electronic medical record used in Veterans Health Administration hospitals—at VA Puget Sound. Our goal was to describe the order checks that were generated by orders entered into CPRS, and to determine how useful these order checks were regarded to be by ordering clinicians.

BACKGROUND

Setting

This analysis was conducted at VA Puget Sound, which consists of 2 medical centers with 512,500 outpatient visits and 10,196 discharges annually. The combined medical centers have 536 beds of which 315 are for acute care. The Seattle Division is a major teaching hospital of the University of Washington, training 485 residents and many medical students each year.

CPRS and Vista

CPRS is used in wards and clinics of VA Puget Sound to enter all orders (except for cancer chemotherapeutic agents) in all inpatient units except the Bone Marrow Transplant Unit.[5] In the outpatient setting orders can still be entered on paper. Of the 10,041 orders entered on VA Puget Sound wards and clinics each weekday, 72% of inpatient orders and 67% of outpatient orders are entered into CPRS directly by practitioners. CPRS is part of VistA, an integrated system of applications that share a common database.[6]

CPRS Order Checks

CPRS orders are defined as requests for services entered into CPRS for transmission to the filling service (such as the pharmacy or laboratory), using quick orders, order sets, or ordering dialog boxes. In most cases at VA Puget Sound, the ordering practitioner enters the order directly into CPRS. When an order is entered, it automatically triggers order check logic to determine if there is a relevant order check for the order. If there is, then the order check logic is run and may result in generation of a dialog box containing text that is displayed within seconds to the ordering practitioner. If the clinical danger level of the order check is "high," the user is required to enter text in the order dialog box in order to override the order check. No text is required if as a result of the order check the order is cancelled, or for lower danger level order checks. Order check logic, dialog box generation, and resulting user actions all occur before the order is authenticated and released to the filling service. In this study, we analyzed order checks that generated text displayed to the entering user as part of an internal quality assurance project.

CPRS includes 20 categories of order checks; most categories contain many order check rules. For example, the drug-drug interaction category includes 2,079 checks for drug-drug interactions. Each CPRS site can enable or disable categories of order checks to suit organizational preferences at system-wide, division, service, hospital location, or individual user levels. At VA Puget Sound, a committee including physicians, nurses, pharmacists and CPRS support staff determines which order check categories are enabled and disabled at the system level (Table 1), based on assessment of the utility of each category.

TABLE 1. Order Check Configuration at the system level at VA Puget Sound, May, 2001. Individual providers may also turn checks off and on for their own use. For this reason, some order checks listed as DISABLED appear in Table 5.

ENABLED
Allergy-Drug Interaction
Allergy-Contrast Media Interaction
Biochem Abnormality For Contrast Media
Critical Drug Interaction
Clozapine Appropriateness
Glucophage-Contrast Media
Lab Order Frequency Restrictions
Dangerous Medications for Patients >64
Duplicate Order
Significant Drug Interaction

DISABLED
Estimated Creatinine Clearance
Order Checking Not Available
CT & MRI Physical Limitations
Recent Barium Study
Recent Oral Cholecystogram
Duplicate Drug Order
Duplicate Drug Class Order
Aminoglycoside Ordered
Renal Functions Over Age 65
Missing Lab Tests For Angiogram Pro
Error Message
Polypharmacy
Dispense Drug Not Selected
Glucophage-Lab Results

METHODS

Our objective was to sample orders from a typical period of CPRS use to study the number, type, and usefulness of order checks generated. We extracted the data shown in Table 2 from 50,000 consecutively entered orders selected from the Vista database containing all CPRS orders written at VA Puget Sound. To do this, we used a small custom program to identify these orders using the unique order identifier (OrderKey) that is assigned to each order at the time it is entered. We stored these extracted data in a separate database used for this analysis. The patient identifiers were scrambled to mask patient identity. No data in this extract can be used to identify individual practitioners or patients.

Table 2. Data extracted for each order.

Event type	Number
IDREF	Scrambled patient identifier
OrderKey	Unique order identifier
OrderDate	Order date and time
OrderCheck	Type of order check, if any
ClinicalSeverity (Danger Level)	1=High, 2=Medium, 3=Low
OverrideReason	Entered by clinician to override (Required to override critical order checks)
Message	Message displayed in the order check window when it appeared during the ordering process

To classify order checks according to indicators of their usefulness to clinician decision-making, we reviewed each order check in 3 categories (Allergy-Drug Interaction, Critical Drug Interaction, and Significant Drug Interaction) to determine if alerts in these 3 categories were generated during medication renewal or for prescription of topical medications (Table 3). We also determined the percentage of order checks in 2 high severity order check categories that were overridden by the ordering clinician.

TABLE 3. Criteria used to classify order checks in this analysis.

Field	Text within field
Message field	Contains 'renew,' indicating order check generated by a renewal order
OverrideReason	Contains text, indicating ordering practitioner overrode order check

Message field	Contains 'oint', 'top', or 'shampoo,' indicating that one of the interacting pair of drugs was a topical medication

RESULTS

Of the 50,000 orders extracted, 7,359 orders included a date, but not a time in the OrderDate field. These orders were those entered by pharmacists in a batch process, and were excluded from further analysis because they would not generate an order check visible to the ordering practitioner. Of the remaining 42,641 orders, most were entered between August 1, 2001 12:10 am and August 8, 2001 at 3:45 pm. (Because they were extracted using sequential values of the OrderKey, 776 were entered between January 4, 2001 and August 1, 2001, we believe this is because they were signed after August 1, 2001.) These 42641 orders were written for 6716 patients. The majority of these orders were for medications and laboratory tests. Each entry in the extract represented either a single order (if that order did not generate an order check) or each of the order checks generated by an order (if that order generated one or more order checks). Of the 42,641 orders, 4,861 (11.4%) generated at least one order check. There were a total of 9,660 order checks generated by these 4,861 orders. Table 4 shows the distribution of the number of order checks per order.

Table 5 shows how the order checks were distributed between the order check categories.

Of the 108 order checks for CRITICAL DRUG INTERACTION, 95 (88%) had override text entered indicating that the ordering practitioner continued with the order despite the order check. In only 13 (12%) was the order not overridden. In 16 (15%) the order check was triggered by a renewal of a medication, suggesting that the 2 drugs were already actively being taken by the patient despite the presence of the critical drug interaction. In each of these 16 cases, the alert was overridden. In 31 of the 108 (29%) CRITICAL DRUG INTERACTION alerts, one of the 2 interacting drugs contained 'TOP " or "oint" or "shampoo" in the prescription, indicating that the drug was to be given topically, not orally or parenterally. In all but 3 of these 31 orders, the override field contained text, indicating that the ordering practitioner overrode the alert.

Of the 105 order checks for ALLERGY-DRUG INTERACTION, 72 (68.6%) contain text in the Override Reason field, indicating that the ordering practitioner wished to override the order check. This means that in only 31.4% of these order checks resulted in the ordering practitioner canceling the order.

TABLE 4. Distribution of number of order checks.

Number of order checks	Number of orders
1	3,058
2-5	1,488
6-10	285
11-15	22
>15	8
TOTAL:	4,861

TABLE 5. Types of order checks occurring in order sample. Severity value of 1 is most severe, 3 list least severe. No severity value assigned for 'Renal functions over age 65' or 'Polypharmacy.'

Order check type	Severity	Number
Duplicate order	3	7,636
Significant drug interaction	2	703
Duplicate drug order	3	666
Duplicate drug class order	3	399
Critical drug interaction	1	108
Allergy-drug interaction	1	105
Renal functions over age 65		24
Dangerous meds for pt > 64	3	10
Polypharmacy		7
Clozapine appropriateness	1	2
TOTAL		9,660

Of the 703 order checks for SIGNIFICANT DRUG INTERACTION, 131 (19%) contain 'Renew' in the message field, indicating that the order check was triggered by a renewal of a medication that the patient was already taking. An order check would have already been triggered when either of the interacting drugs was originally prescribed.

TABLE 6. Rates of clinician order check override, and order checks triggered by topical medications and medication renewals for selected order check types. Override rates for 'Significant drug interactions' and renewal rates for 'Allergy-drug interactions' could not be determined in this study.

Order check type	Override	Topical	Renewal

Critical drug interaction	95/108 (88%)	31/108 (29%)	16/105 (15%)
Allergy-drug interaction	72/105 (69%)	0/105 (0%)	N.a.
Significant drug interaction	N.a.	27/703 (4%)	131/703 (19%)

DISCUSSION

Order checks are one of many tools for improving patient safety using electronic medical record systems. When a clinician enters an order directly into an automated practitioner order system, often the order is selected from a list of preconfigured, valid choices. This step alone can reduce errors, because the list of choices can reduce the risk of inappropriate doses. When the order is formulated and sent to the filling services, it appears as a legible, complete order, reducing the risk of transcription errors. After the order has been prepared, it can be checked for potential errors using 'asynchronous' decision support systems such as clinical event monitors.[7] Asynchronous decision support systems can run more complex logic, and incorporate the passage of time, since the logic does not have to run while the clinician is waiting at the workstation to enter the order.

Order checks have an important role in reducing errors, because they can be run during the golden moment when the clinician is formulating the order, and is open to suggestions. They can be thought of as a test that is applied to every order between the time it is formulated and its transmission to the order filling service. The order check 'test' is intended to determine if the order violates any rules concerning safety and efficiency of care. There is a substantial literature on how tests can be evaluated, including test characteristics such as sensitivity, specificity, positive predictive value, and negative predictive value. Others have applied this approach to evaluate software to detect significant problems with orders, such as drug-drug interactions.[8]

Does clinician override of an order check necessarily mean that there was no value to the order check? Not in every case. However if the reason for override was that the patient was already taking the medication in combination with the new drug (renewals) or that one of the 2 drugs triggering the alert was a topical medication, then the override indicates that the order check was a 'false positive' from the perspective of the ordering clinician. There may also have been other reasons that an order check should be regarded as not useful. In this analysis, we did not search for order checks that would be regarded as false positives for other reasons. The high rate of clinician override indicates that there were likely other reasons.

There is value to alerting clinicians at the time of medication renewal that a drug allergy or critical drug interaction exists. However, if the patient has already been taking the medication, it is less likely that the interaction is critical or that it is a true allergy.

There are several limitations to this analysis. First, we analyzed a relatively small sample of orders in comparison to those entered each year. It is possible that the order check checks run on this sample differed from those run on a larger sample. For example, since this sample was obtained largely from orders run in August 2001, it may be that a random sample from the entire year, or a larger sample would give different results. Second, we did not assess the 'correctness' of order checks using an independent standard, such as expert opinion or automated order check logic from another source. It would be possible to do this by checking each order, either prospectively or retrospectively, for important problems, and compare the behavior of the CPRS order check analysis with this independent standard. Third, these results are from only one VA health care facility. CPRS allows flexibility in the implementation of the order checks and it is possible that results would be different in another VA medical center.

In this analysis we did not study sensitivity or specificity of order checks. It would be useful to know how sensitive the CPRS order check logic is in detecting clinically important problems with orders. To do so would require that we study all orders using an independent standard, such as expert opinion or automated order check logic from another source. It would be possible to do this by checking each order, either prospectively or retrospectively, for important problems, and compare the behavior of the CPRS order check analysis with this independent standard.

What implications does the high override rate we found have for the overall value of CPRS order checks? We should realize that Table 6 shows that in 12% of critical drug interaction order checks, the clinician did not override the order check. Some order checks very likely prevented serious problems that may otherwise have occurred. Ideally, the override rate would be lower, but even in its current state, the order check logic has value.

Why is the override rate important? A frequently voiced concern is that if order checks or other alerts occur too frequently, or with low credibility, that clinicians will begin to disregard all alerts, even those containing important information that would otherwise result in changes in ordering behavior. To the degree that this effect is real, a lower override rate could increase the impact of all alerts and order checks. Another consequence of a high override rate is that it may lead an organization to deactivate classes of alerts that clinicians regard to generate 'nuisance' alerts, even though some alerts in that class may be helpful. At VA Puget Sound, 14 alert classes are disabled. The general credibility of CPRS order checks is reduced when the override rate is very high. In our experience, this affects clinician acceptance of practitioner order entry, even if it may not reduce the effect of some alerts.

The value of CPRS order checks could be improved in many ways, among them the following 2 changes: downgrading in severity or refining order checks that occur during medication renewal or when topical medications are ordered (in cases where the interaction of concern is for system use of the medication). Iterative review of the effectiveness of order checks and the frequency with which clinicians override them, should result in improvements to the underlying logic should result in an order check system that are more useful in preventing errors. Though others have published analyses of order checks in other practitioner order entry systems,[3] to our knowledge, this is the first published report on characteristics of order checks within CPRS, one of the most widely used practitioner order entry systems.

CONCLUSIONS

Order checks are important error prevention tools when used in conjunction with practitioner order entry. We have found that in a sample of 42641 orders, 11% generated at least one order check. However the override rate for an important subset of these order checks was high: 88% and 69% respectively for 'Critical drug interaction' and 'Allergy-drug interaction.' This was due in part to the presence of alerts for topical medications and for medication renewals. Refinement in order check logic could reduce override rates and may increase practitioner acceptance and effectiveness of order checks.

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