

Background

Numerous medication alerts within electronic prescribing applications have been developed to reduce adverse drug events and medication errors. Many of these alerts are interruptive and frequently overridden by clinicians. In an effort to decrease alert fatigue, we implemented non-interruptive medication alerts for low severity clinical recommendations into our outpatient physician workflow.

Methods

A prospective, randomized controlled trial was conducted among 31 outpatient practices affiliated with Brigham and Women's Hospital and Massachusetts General Hospital to evaluate, as a primary outcome, the receipt of recommended laboratory testing within 14 days of an outpatient clinic encounter. Prior to the study, providers sequentially entered prescriptions into the electronic record without any medication-laboratory evaluation. During the study, alerts were implemented only for the intervention arm and were displayed at the top of the medication ordering screen (Figure 1). Because the alerts were designed to be non-interruptive, providers were not required either to comply with recommendations or to justify their decision. Data was collected between 7/21/2003 and 1/20/2004. Providers were assigned to the control or intervention group based on practice. Data was logged each time any provider (control or intervention) was advised by the drug-lab alert logic to order a laboratory test when prescribing a medication. The analysis was adjusted for patient age, gender, race, and insurance status, provider age and gender, and clustered by practice.

Results

There were 3763 total events where lab ordering was recommended: 1988 events in the control group and 1685 in the intervention group. In the control group, labs were requested for 771 (39%) within 2 weeks of the visit. In the intervention group, laboratory values were ordered by clinicians in 689 (41%) of the cases. The correlation between the intervention and the rate of ordering appropriate tests was 0.0467, with a $p < 0.7815$.

Within the knowledge base, five laboratory tests generated a sufficient sample size to provide correlation estimates. No significant associations were demonstrated between the presence of level 3 alerts and whether certain types of labs were ordered more frequently.

The drugs were also classified into 23 medication classes, of which 12 classes had at least 33 or more orders placed. Again, non-significant correlations were observed (Table 1).

Figure 1: Screen-shot example of a non-interruptive drug-lab alert within the Longitudinal Medical Record (LMR), our electronic health record.

Classification	Total Labs Ordered	Total Orders Placed	Correlation Estimate	p-value
Antimanic Agents	24	71	-2.143	0.0348
Cardiotonic Agents	35	56	-1.0615	0.4352
Anticonvulsants	44	255	-0.5259	0.5032
HMG-CoA Reductase Inhibitors	295	1025	-0.4242	0.132
Antifungal Antibiotics	65	106	-0.1579	0.7846
Angiotensin-Converting Enzyme Inhibitors	289	621	0.169	0.5708
Hypoglycemics	82	177	0.1993	0.5236
Diuretics	404	799	0.2803	0.1955
Antiarrhythmics	25	103	0.2836	0.5166
Antituberculosis Agents	62	115	0.6748	0.3292
Angiotensin II Receptor Antagonists	53	130	0.9491	0.1047
Antiarrhythmic Agents	13	33	3.5708	0.0906

Table 1: By class of medication, correlation estimates between presence of non-interruptive alerts and quantity of labs ordered.

Discussion

- We found that non-interruptive drug-lab alerts had little to no significant impact on physician ordering of baseline labs in conjunction with medication orders.
- Our findings do not mitigate the overall utility of tiered alerts. As noted by Shah et al. who used the same Partners knowledge base, high acceptance of interruptive, moderate-high acuity alerts depended on a tiered alert system to limit alert burden.
- Fewer workflow disruptions may render providers more amenable to heeding alerts that warrant interruptive decision making.
- The lack of behavioral change may be a consequence of one or more of the following factors:
 1. Providers may read the warnings but choose to not order the recommended labs.
 2. Software design failed to draw the user's attention or to stimulate the user's concern.
 3. Providers felt the knowledge base's threshold for firing drug-lab reminders was too low and/or didn't agree with the recommendation.
- Altering physician behavior may require a minimal degree of interruption. Further work is necessary to optimize compliance with non-critical recommendations.

Limitations/Future Studies

Limitations include

- Limited sample size.
- Without requiring providers to justify their actions, we cannot distinguish between alerts that were appropriately or inappropriately disregarded.
- We are unable to assess the proportion human behavior versus system design contributed to the final outcome.

Future studies should include

- Repeating our study with a system that links medication order entry with lab order entry. During the study, the applications were separate.
- Examine how the presence or absence of non-interruptive alerts impacts more critical, interruptive alerts.

Selected References

Shah NR, Seger AC, Seger DL, Fiskio JM, Kuperman GJ, Blumenfeld B, Recklet EG, Bates DW, Gandhi TK. Improving acceptance of computerized prescribing alerts in ambulatory care. *J Am Med Inform Assoc.* 2006 Jan-Feb;13(1):5-11. Epub 2005 Oct 12.