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Clinical Usefulness of Drug-Disease Interaction Alerts from a Clinical Decision Support System, MedGuard, for Patient Safety: A Single Center Study

Tahmina Nasrin Poly[a,b,c], Md. Mohaimenul Islam[a,b,c], Yu-Chuan (Jack) Li[a,b,c*]

[a] *Graduate Institute of Biomedical Informatics, College of Medical Science and Technology, Taipei Medical University, Taipei, Taiwan*
[b] *International Center for Health and Information Technology, Taipei Medical University, Taipei, Taiwan*
[c] *AESOP technology, Taipei Medical University, Taipei, Taiwan*

Abstract

Clinical decision support systems have been widely used in healthcare, yet few studies have concurrently measured the clinical effectiveness of CDSSs, and the appropriateness of alerts with physicians' response to alerts. We conducted a retrospective analysis of prescriptions caused disease-medication related alerts. Medication orders for outpatients' prescriptions, all aged group were included in this study. All the prescriptions were reviewed, and medication orders compared with a widely used medication reference (UpToDate) and other standard guidelines. We reviewed 1,409 CDS alerts (2.67% alert rate) on 52,654 prescriptions ordered during the study period. 545 (38.70%) of alerts were overridden. Override appropriateness was 2.20% overall. However, the rate of alert acceptance was higher, ranging from 11.11 to 92.86%. The MedGuard system had a lower overridden rate than other systems reported in previous studies. The acceptance rate of alerts by physicians was high. Moreover, false-positive rate was low. The MedGuard system has the potential to reduce alert fatigue and to minimize the risk of patient harm.

Keywords:

Clinical decision support; disease-drug interaction; alert fatigue; patients safety.

Introduction:

The main and foremost purpose of the hosptial is to ensure patient safety and to deliver quality care [1]. Patient safety refers to reduce and prevent risk, errors and harm when patient visit hospitals for health. Unfortunately, hospital causes more harm than good which has raised mental, social, and financial burden. Recent evidence shows that many patients are harmed from their healthcare, resulting in potential injuries, unnecessary hospitalizations, or even deaths [2, 3]. However, medication erros have appeared as one of the main contributor to patients harm. Evidence from previous studies indicated that as many as 32.1% [4] to 94% [5] patients receive inappropriate treatment. In the USA, medication errors are the third-highest cause of death after heart diseases and cancer [6].

However, integration of clinical decision support systems (CDSS) into computer provider order entry (CPOE) help to improve patients safety and reduce medication errors [7]. CDSS helps physicians taking appropriate clinical decision by providing patient-specific recommendations. Previous studies reported that the rate of medication errors have significantly reduced after implementing CDSS with CPOE [8, 9]. In practice, up to 96% of alerts are overridden, raising fundamental questions about the actual effectiveness of CDSS in patient safety [10]. In fact, inappropriate override of clinically important alerts might cause potential harms to the patients. A significant number of studies reported a positive association between "alert fatigue" and override rate [11-13].

The objectives of this study were a) to characterize the frequency of alerts in different departments, b) to calculate the percentage of overriden alerts, c) to evaluate the appropriateness of overriden alerts.

Methods:

Data collection: We collected CDS alert data and response of physicians against alerts at the time of prescription from a university teaching hospital, Taipei, Taiwan over a period of one month from January 1, 2021 to January 31, 2021. We collected only drug-disease alerts from 27 different departments. Patients with all aged group with an outpatients ordering during the study were included. Data included number of alerts, frequency of alert overrides, frequency of accepted alerts and change the medication, and the number of accepted alerts and not change the medications. Alerts that were triggered more than once for the same order (duplicate alerts) were excluded from this study.

Appropriateness criteria: Two pharmacists (TNP, MMI) developed review criteria and reviewed overridden alerts. They idependently review random sample of 250 overrides from various department for appropriateness. The inter-rater reliability was greater than 90%.

Outcomes: Our primay outcome was the rate of overide alerts in the outpatient clinical settings. Secondary outcome was to check agree rate of triggered alerts and evaluate appropriateness of overide alerts.

Statistical analysis: We examined and compared MedGuard alert override rates and the appropriateness of overrides among different departments. Comparisons are presented as counts

with percentages, and p values were calculated using the $\chi 2$ test.

Results:

A total of 1,409 alerts triggered in 52,646 prescriptions (2.67% alert rate) during the one-month study period. A higher number of alerts were triggered in the cardiovascular medicine department (221), followed by neurology department (141) and gastroenterology department (104). However, the rate of overridden was higher in the division of Rheumatology (23 out of 27, 85.19%), followed by urology department (49 out of 76, 64.47%) and Rehabilitation section (21 out of 37, 56.76%) (Table 1).

Table 1: Breakdown of alert overrides in various department.

Department	Total alerts	Override alerts	Percentage
Cardiovascular medicine	221	70	31.67
Cardiovascular surgery	22	3	13.64
Dermatology	87	22	25.29
Division of Rheumatology	27	23	85.19
Endocrinology	25	11	44.00
Family medicine	36	16	44.44
Gastroenterology	104	30	28.85
Gynecology	71	25	35.21
Hematology oncology	91	37	40.66
Infectious disease	39	7	17.95
Nephrology	20	11	55.00
Neurology	141	69	48.94
Neurosurgery	57	18	31.58
Ophthalmology	20	7	35.00
Orthopedic	68	30	44.12
Otolaryngology	38	15	39.47
Pediatrics	33	17	51.52
Plastic surgery	15	4	26.67
Psychiatry	21	5	23.81
Radiation oncology	11	2	18.18
Rectal surgery	25	6	24.00
Rehabilitation Section	37	21	56.76
Surgical	8	4	50.00
Thoracic medicine	80	29	36.25
Thoracic surgery	14	1	7.14
Urology	76	49	64.47
Others	21	13	61.90

Table 2 shows the physicians response against alerts. The rate of acceptance was higher in Thoracic surgery (92.86%), followed by cardiovascular surgery (86.36%) and infectious disease (74.36%). However, physicians accepted the alerts but did not change drugs, higher in the department of thoracic surgery (92.86%), cardiovascular surgery (86.36%), plastic surgery (73.33%), and infectious department (71.79%).

Table 2: Breakdown of alert acceptance rate.

Department	TA	A/C	%	A/NC	%	TAC	%
Cardiovascular medicine	221	10	4.52	70	31.67	80	36.20
Cardiovascular surgery	22	0	0	19	86.36	19	86.36
Dermatology	87	9	10.34	42	48.28	51	58.62
Division of Rheumatology	27	0	0	3	11.11	3	11.11
Endocrinology	25	1	4.00	13	52.00	14	56.00
Family medicine	36	10	27.78	7	19.44	17	47.22
Gastroenterology	104	6	5.77	63	60.58	69	66.35
Gynecology	71	4	5.63	38	53.52	42	59.15
Hematology oncology	91	3	3.30	28	30.77	31	34.07
Infectious disease	39	1	2.56	28	71.79	29	74.36
Nephrology	20	0	0	5	25.00	5	25.00
Neurology	141	3	2.13	46	32.62	49	34.75
Neurosurgery	57	1	1.75	36	63.16	37	64.91
Ophthalmology	20	0	0	10	50.00	10	50.00
Orthopedic	68	1	1.47	28	41.18	29	42.65
Otolaryngology	38	6	15.79	17	44.74	23	60.53
Pediatrics	33	3	9.09	3	9.09	6	18.18
Plastic surgery	15	0	0	11	73.33	11	73.33
Psychiatry	21	0	0	11	52.38	11	52.38
Radiation oncology	11	2	18.18	5	45.45	7	63.64
Rectal surgery	25	2	8.00	15	60.00	17	68.00
Rehabilitation Section	37	3	8.11	8	21.62	11	29.73
Surgical	8	1	12.50	3	37.50	4	50.00
Thoracic medicine	80	2	2.50	34	42.50	36	45.00
Thoracic surgery	14	0	0	13	92.86	13	92.86
Urology	76	4	5.26	8	10.53	12	15.79
Others	21	0	0	7	33.33	7	33.33

Table 3 shows that the examples of five overridden alerts. A 52 years female patients with cardiac arrhythmia, unspecified was given almodipine. MedGuard triggered alert for amlodipine-cardiac arrhythmia, unspecified. However, physician override alert. Amlodipine is a calcium channel blocker, prescribe for angina and hypertension. It can also be prescribed in Raynaud phenomenon as a off-label indication.

Table 3: Examples of five override alerts.

Id	Age	Gender	Claimed disease	Ordered drugs	Disease-drug interaction alert
1	52	Female	Cardiac arrhythmia, unspecified	Amlodipine	Cardiac arrhythmia, unspecified-Amlodipine
2	69	Male	|Cervical root disorders, not elsewhere classified |Occlusion and stenosis of right carotid artery	|Paracetamol |Chlorzoxazone |Amlodipine |Celecoxib	Occlusion and stenosis of right carotid artery-Amlodipine
3	69	Female	|Pneumonia, unspecified organism |Moderate persistent asthma, uncomplicated	Alprazolam	Pneumonia, unspecified organism-Alprazolam Moderate persistent asthma, uncomplicated-Alprazolam
4	58	Male	|Bronchopneumonia, unspecified organism |Allergic rhinitis, unspecified |Chronic obstructive pulmonary disease, unspecified	|Acetylcysteine |Prednisolone |Amoxicillin and beta-lactamase inhibitor |Bisoprolol |Theophylline |Alprazolam	Bronchopneumonia, unspecified organism-Alprazolam Allergic rhinitis, unspecified-Alprazolam Chronic obstructive pulmonary disease, unspecified-Alprazolam
5	92	Female	|Adhesive capsulitis of unspecified shoulder |Age-related osteoporosis with current pathological fracture, unspecified site, subsequent encounter for fracture with routine healing |Colles' fracture of left radius,	|Clonazepam |Tocopherol (vit. E)	Age-related osteoporosis with current pathological fracture, unspecified site, subsequent encounter for fracture with routine healing-Clonazepam

Table 4 shows the example of five accepted alerts. A 59 year female patient with chronic maxillary sinusitis was given.

acetylcystein, betahistine, alprazolam, and mometason. MedGuard triggered alert for alprazolam

Table 4: Examples of accepted alerts.

Id	Age	Gender	Claimed disease	Ordered drugs	Disease-drug interaction alert
1	59	Female	|(Chronic) maxillary sinusitis	|Acetylcysteine |Betahistine |Alprazolam |Mometasone	(Chronic) maxillary sinusitis -**Alprazolam**
2	64	Male	|Enlarged prostate without lower urinary tract symptoms |Retention of urine, unspecified	Atorvastatin	Retention of urine, unspecified -**Atorvastatin**
3	55	Male	|End stage renal disease	Bisoprolol	|End stage renal disease -**Bisoprolol**
4	67	Male	|Calculus of ureter |Calculus of kidney with calculus of ureter |Urinary tract infection, site not specified |Enlarged prostate with lower urinary tract symptoms	|Pentoxifylline |Tamsulosin and dutasteride	Calculus of ureter-Pentoxifylline Calculus of kidney with calculus of ureter-**Pentoxifylline** Urinary tract infection, site not specified-**Pentoxifylline** Enlarged prostate with lower urinary tract symptoms-**Pentoxifylline**
5	73	Female	|Polycythemia vera |Hyperlipidemia, unspecified |Atherosclerotic heart disease of native coronary artery without angina pectoris	Heparin	Polycythemia vera-**Heparin** Hyperlipidemia, unspecified-**Heparin** Atherosclerotic heart disease of native coronary artery without angina pectoris-**Heparin**

Appropriateness of override alerts: 500 override alerts were evaluated for appropriateness. However, 489 of 500 alerts were inappropriately overridden. The rate of the appropriateness of override alert was only 2.20%. Few examples of appropriate overridden alerts were: clonazepam & occipital neuralgia; amlodipine & Pure hypercholesterolemia; amlodipine & Raynaud's syndrome without gangrene; quetiapine & Anxiety disorder, unspecified.

Discussion

Our study illustrates that physicians inappropriately override the vast majority of alerts during prescriptions at a university hospital. However, the rate of acceptance was higher in different departments, ranging from 11.11 % to 92.86%. The rate of false-negative was very low that indicates the potentiality of MedGuard for ensuring patients safety and reducing adverse effects.

In practice, CDSS triggers alerts at the point of prescribing can lessen medication errors and potential harms [14, 15]. In practice, however, CDSS generate an excessive number of alerts, and the majority of alerts are not clinically important. Therefore, a clinician's likelihood of accepting alerts has been decreased, and 49–96% of alerts are overridden by physicians during ordering [16]. Previous studies found no association between override rate and physician workloads, such as the number of patients seen and number of encounters [17]. It is mainly due to excessive and repetitive alerts. A significant number of studies suggested that reduction of repetitive alerts could be a promising target for lessening alert override rates and alert fatigue [17, 18].

MedGuard had lower alerts and higher acceptance rate than previously reported in various studies [13, 19]. Moreover, false-negative alerts were very low that ensures the overall effectiveness of MedGuard in the real-world clinical setting. However, the acceptance rate was lower in several departments, and MedGuard system needs to find an effective way to increase trust among physicians who had accepted alerts but did not change the medications. Providing monthly report indicating inappropriate override can help to shape physicians prescribing behaviors and improve acceptance rate.

Conclusion

The findings of this study show that lower number of MedGuard alerts were overridden by physicians and the rate of appropriateness of overridden alerts were low. Moreover, acceptance rate of MedGuard alerts were higher in all departments. Implementation of MedGuard (https://www.aesoptek.com/) could reduce alert fatigue and improve patient safety by reducing potential harms.

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Address for correspondence

Yu-Chuan (Jack) Li, MD, PhD

Graduate Institute of Biomedical Informatics, College of Medical Science and Technology, Taipei Medical University, Taipei, Taiwan.

Email: jaak88@gmail.com/ jack@tmu.edu.tw