The use of a CPOE log for the analysis of physicians' behavior when responding to drug-duplication reminders

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ABSTRACT

Introduction: There is evidence that patients are being prescribed a significant number of duplicated prescriptions despite the use of computerized safety reminder systems. Nonetheless, the physicians' behavior with respect to the computer reminders has not been well studied as yet. This problem is important because drug duplication can result in patient overdose with unpredictable or undesirable effects; furthermore, it is also a waste of significant healthcare resources.

Methods: In 2005, a computerized drug-duplication reminder system on the computerized physician order entry (CPOE) was implemented at a 737-bed teaching hospital in northern Taiwan. The log file, combined with the physicians' profiles, was statistically examined using the Mantel–Haenszel technique over the second half of 2005.

Results: A total of 11,298 orders (1.26%) involved drug-duplication reminders and this was out of 896,131 orders in 188,182 order set during the study period. The physicians related variables (workload, department, educational background, years in practice at the target hospital and age), policy related variables (intervention from the insurer and hospital administration), the order itself (drug price and medication class) and patients' resistance were found to be most critically related to physicians' behaviors in terms of the reminders. Intervention by Taiwan's National Insurance reimbursement policy appeared to be ineffective as a way of affecting the physicians' behavior.

Conclusion: The log file appears to be a valuable source for analyzing physicians' behavior on reminders if well designed with the CPOE. Hospitals, clinicians and patients should pay more attention and be seriously concerned about CPOE reminders. It is also important to reexamine the physicians' workload and the insurer reimbursement policy in relation to drug duplication.

1. Introduction

Adverse drug events (ADE) are important both for patients and hospitals since ADEs can sometimes be serious and a few may result in death. Several pieces of research in the area have been conducted and these have proved that the use of a CPOE with decision support components can reduce duplicate orders, overdoses, allergic reactions and drug

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interactions; thus there is an improvement in patient safety [1–8].

Drug duplication means the prescribing and dispensing of the same drug or two or more drugs of the same therapeutic class during an overlapping time period [9]. For example, amlodipine and nifedipine are both dihydropyridine calcium channel blockers and are mainly use for the treatment of angina pectoris and in hypertension patients. When a large number of medications are used, the potential for drug duplication is high and this probably increases the risk of adverse drug effects [10]. Drug duplication can result in patient overdose with unpredictable or undesirable effects; furthermore, there is also a significant waste of healthcare resources.

Several publications have indicated that the use of multiple pharmacological agents is associated with the frequency of drug duplication and that this ranges from 11% to 61%; furthermore, computerized safety reminders are often overrode with a range between 70% and 90% [11–15]. This high rate of overriding compromises the effectiveness of the computerized reminders and good drug safety practice; therefore, a more in-depth analysis of physician's behavior when accepting or overriding a safety reminder is critical. Among research on reminders, researchers have proposed various factors that may play a role in the overriding of a clinical reminder; this research was carried out by either an online survey approach or by a designed questionnaire [14,16,17]. Factors include alert fatigue, lack of time, patient characteristics, reminder appropriateness, technological problems, unnecessary workflow interruptions and the physician's or the patient's resistance to drug change. These publications provide a good background when designing a better system for clinical reminders and do provide some insights into the physician's behavior, which could be affected by themselves, peers, patients, hospital policy and hospital administration methods. However, as described in [14,16], the approaches used in these studies were mainly those of online study and questionnaires, which do not provide sufficient information on the how and why of the physician's actions when overriding a clinical alert. Order analysis of the actual prescribing behavior (order log) should help to obtain an understanding of the real situation with the results that we will be better prepared for and eventually resolve the problem.

There have been few studies that have examined the reasons why physicians override clinical alerts that have used an analysis of the prescription orders and only one has addressed the topic of drug-duplication reminders [13]. However, the volume of orders examined in these studies was limited (4596–87,789) and because of these limited studies, it is still unclear how physicians really respond to the drug-duplication reminders. This leaves open the problem of how to design a system that prevents duplication of drug orders once it happens.

For these reasons, we conducted this study by implementing a drug-duplication reminder system and parallel with this an analysis of the order log behavior. In Taiwan, our National Health Insurance pays prescription and certain OTC drugs and thus there has been a tendency for medications to be highly prescribed. Moreover, in our healthcare delivery system, patients are free to go to a number of hospitals or clinics for any one episode of a disease and be admitted to multiple outpatient services over a very short time. Physicians mostly have at least tens but sometimes even more than two hundred patients per 3 h session. Therefore, a high level of drug duplication is often observed and this situation appeared to be a good starting point to study physicians' behavior and their response to computerized drug-duplication reminders.

2. Materials and methods

The log file of the physicians' responses to the drug-duplication reminders was analyzed from a 737-bed teaching medical center, which serves 1.3 million outpatient visits and has 6000 emergency room visits per year. The computerized physician order entry system (CPOE) had been implemented for 6 years and more than 95% of the orders are prescribed electronically. Over the duration of this research, 3% of patients encountered potential duplicated prescriptions before electronic reminders. The implemented reminder system recorded the entire physicians' behavior when modifying orders as part of the integrated log system after a reminder had been given. Thus, this research was capable of analyzing the acceptance behavior of physicians when they received a drug-duplication reminder and the relationship between this and a wide range of different variables.

The rule for a reminder of drug duplication involved the calculation of the number of days of overlap between prescriptions. Sometimes patients go to hospital to continue their previous prescription, especially patients with chronic diseases. These continuing orders can vary in duration, frequency and dosage, sometimes even in product name, due to policy or clinical requirements. This generates false positives when detecting duplicated prescriptions. In order to minimize false positives, this research set some rules to exclude possible false positives.

(1) The system only gives pop-up reminders when the overlap is greater than 7 days if the duration of new order is longer than 7 days or when the overlap is greater than 3 days if the new order is for less than 7 days;
(2) STAT and PRN prescriptions from the Emergency Department are excluded;
(3) the same order from the same physician with the same frequency, dosage and duration are excluded;
(4) traditional Chinese herbal prescriptions are excluded;
(5) a reminder for each duplicated medication only pop-up once for each patient with each drug.

The drug-duplication reminder only shows after the physician has finished the order if the order involves duplication of a medication or medication class (Fig. 1). If the physician recognizes the reminder and wish to review their order, they click no to stop the entry process and go back to review the order (they accept the reminder). If they click yes to proceed, it means that they intend the drug duplication to stand and it remains unchanged (they override the reminder). According to experience with the drug–drug interaction reminders, we found that physicians exhibited fatigue with an online survey approach and for this reasons ignore clinical reminders. Therefore we have only provide a yes or no selection.

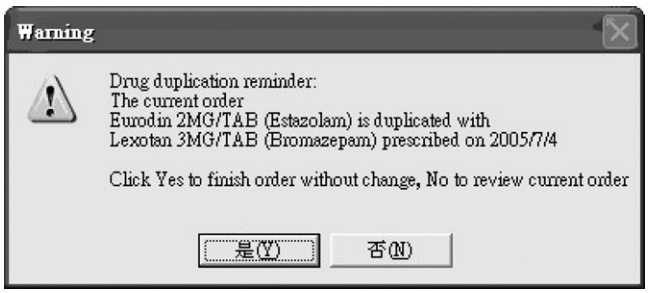

Fig. 1 – Reminder provided before an order is completed when duplicated drug prescription are detected.

The system recorded the log of prescription behavior in a single table. Every time the system triggered a drug-duplication reminder, the first response (yes or no), the profile of prescribing physician, the patient and the dosage, frequency and duration of the previous order and current order were saved. The final order was not part of the log system, but was confirmed and saved to the hospital information system.

We analyzed the system log for a 6-month period between July 2005 and December 2005 for outpatient orders and compared the physician variables (age, sex, specialty, years at the target hospital), the patient variables (average visits per year, sex, age), the order variables (average drug price, drug class), the clinic variables (total patients and orders) between the group that accepted the reminders and the group that overrode reminders. Odds ratios (OR) and 95% confidence interval (CI), as well as *p* values, were calculated for each variable using the Mantel–Haenszel technique and multiple logistic regression analysis (PROC FREQ and LOGISTIC, SAS). Level of significance was considered when *P* value <0.05.

This study defined workload as orders and visits per 3 h clinic session. Patients who left the hospital without any prescription from a physician were not included in the study.

3. Results

During the study period, there were 221,898 outpatient visits and the patients ranged in age from 0 to 94 years with an average of 61.9 years (S.D. 19.7). All visits were collected with the complete orders, medical history and selected covariates during baseline investigation. Mean utilization in terms of hospital visits for the target group was 15.7 visits (S.D. 12.5). A total of 188,182 order sets involving 896,131 orders were entered through the CPOE system with 4.76 medication orders per patient.

There were a total of 11,298 orders that initiated a drug-duplication reminder during our 6-month study period. Of these reminders, 33.71% were accepted: 0.7% to adjust medication frequency (for example, QID to BID), 4.77% to adjust duration (for example, 7–2 days), 0.42% to adjust dosage (for example, 1–0.5) and 27.82% just to remove the order.

A total of 187 physicians were involved in our 6-month study and 165 of them accepted a drug-duplication reminder at least once. During the study period, 65 of them accepted half (50%) of the reminders. In the log, the number of drug-duplication reminders per session varied from 1 to 16 (mean = 2.2, S.D. = 1.8), approximately 5.6%–15.5% of orders per session.

A mean of 38.4 (S.D. 24.8) order sets per session was observed in the study. Physicians with orders per session between 50 and 100, between 100 and 200 and more than 200 were significantly less likely to accept drug-duplication reminders (Table 1). It seems that physicians were less likely

Table 1 – Comparison of the number of reminders accepted and overrode with workload (orders per clinic session), professional training, years serving at the target hospital and the age of the physician

	Accepted (*n* = 3588)	Overrode (*n* = 7710)	Adjusted OR	Accepted rate (%)
Orders per session				
<50 orders	2470	4886	Reference	33.6
50 ~ 100 orders	935	2300	0.85 (0.77–0.93)	28.9
100 ~ 200 orders	106	301	0.70 (0.51–0.97)	26.0
>200 orders	77	223	0.58 (0.33–1.03)	25.7
Professional preparation[a]				
MD	2646	5748	Reference	31.5
MS	399	1010	0.82 (0.72–0.94)	28.3
PhD	543	952	1.26 (1.10–1.43)	36.3
Years at target hospital				
Practicing > 6 years	2624	6089	Reference	30.1
Practicing between 3 and 6	672	1179	1.34 (1.19–1.51)	36.3
Practicing < 3 years	292	442	1.65 (1.39–1.95)	39.8
Age of physician				
Age < 40	1254	2734	Reference	31.4
Age 40–50	1747	3876	1.11 (1.00–1.23)	31.1
Age > 50	587	1100	1.49 (1.30–1.69)	34.8
Average drug price per visit (NT)				
Drug price < 50	3277	6504	Reference	33.5
Drug price 50–100	138	483	0.64 (0.53–0.78)	22.2
Drug price > 100	173	723	0.54 (0.46–0.64)	19.3

[a] Physicians in Taiwan need to receive graduate training to earn a MS or Ph.D. degree.

Table 2 – Relationship between medication class and reminder acceptance behavior

Drug class	% Reminder orders	Accepted rate (%)	OR	95% CI	*p* value
Laxatives	4.07	39.1	0.95	0.83–1.09	0.4448
Analgesics	0.57	55.4	1.85	1.3–2.61	0.0004 *
NSAIDs	4.85	34.6	0.77	0.68–0.88	<0.0001 *
Diuretics	2.62	40.6	1.01	0.86–1.19	0.9768
Hypnotics	7.28	31.0	0.65	0.58–0.72	<0.0001 *
Antipsychotics	1.71	43.3	1.14	0.93–1.39	0.9858
Antacids	5.66	46.9	1.33	1.19–1.49	<0.0001 *
Antihistamines	2.35	40.5	1.01	0.85–1.2	0.9163
H_2O/E^- nutrient	0.94	43.5	1.14	0.87–1.5	0.9918
Vitamins	1.96	36.7	0.86	0.7–1.04	0.1212
Antidiarrheals	0.03	33.3	0.74	0.14–4.04	0.7279

*Significance of a p value < 0.05.

to accept safety reminders as the orders per clinic session increased. There were only a few sessions with more than 200 orders but the result were still statistically significant at the 95% confidence interval. Sessions with 200 patient visits over 3 h indeed do happen in Taiwan. The physician-population ratio for Taiwan is 1.33/1000 while that of the USA is 2.79/1000 [19]. Americans have only 5.8 outpatient visits per capita per year on average and this compares with 13.4 visits in Taiwan, which is relatively high [20]. Moreover, doctor-shopping and the one stop shopping phenomenon have resulted in Taiwanese physicians having to accept a lot of visits during their outpatient sessions. Sometime physicians work more than 3 h to finish so many patient visits (>200 for some popular physicians) and normally are able to be finished after two extra hours of work.

It is clear that physicians with a Ph.D. degree were more likely to accept safety reminders than physicians with a bachelor degree or a master degree. Physicians with a master degree were strangely less likely to accept safety reminders than physicians without a higher degree. The physicians in this study had a mean 7.8 (S.D. 2.3) years in practice at the target hospital. As expected, we found that physicians who had practiced fewer years at the target hospital were more likely to review orders after safety reminders and accept the recommendation. The mean age of the physicians in this study was 43.6 (S.D. 6.4) years. We found that physicians more than 50 years old were more likely to accept safety reminders than physicians less than 50 years old (both the less than 40 years old and between 40 and 50 years old groups together).

The mean average price of the drugs prescribed in this study was 26.1 (S.D. 96.4) NTD and we found that orders with a lower average drug price were more likely to be modified when duplicated than orders with a higher average drug price (Table 2). A total of 78 drug classes were involved in the study. The control group was all accepted reminders and overrode reminders. We have listed the drug classes that Cooper [21] and Tozaw et al. [10] defined as the most frequent drug classes involved in duplication. We found acceptance of drug duplicated reminders was significant affected by the drug class of the drugs ordered. There were only four drug classes that were statistical significant ($p < 0.05$) and it was not possible to identify a behavior associated with the acceptance of the safety reminders that was positively related to drug class.

While a total of 29 departments were involved in the study, in Table 3 we listed only the 16 departments where the OR was statistically significant. The control group was all accepted reminders and overrode reminders. Over half of the depart-

Table 3 – Relationship between specialty of the physician and reminder acceptance behavior

Specialty	*N*	Accepted rate (%)	OR	95% CI	*p* value
ED	115	7.0	0.20	0.10–0.40	<0.0001
Ophthalmology	631	8.4	0.23	0.17–0.30	<0.0001
Psychiatry	886	15.7	0.47	0.39–0.56	<0.0001
Oncology	115	18.3	0.59	0.37–0.95	<0.0275
Immunology	289	19.7	0.64	0.48–0.86	<0.0031
Neurosurgery	508	20.9	0.69	0.55–0.86	<0.0007
Nephrology	542	23.1	0.79	0.64–0.96	<0.0208
Gastroenterology	807	24.2	0.83	0.71–0.99	<0.0333
Dermatology	352	33.5	1.35	1.08–1.69	<0.0085
ENT	456	33.6	1.36	1.11–1.66	<0.0025
Cardiology	1739	33.1	1.39	1.24–1.55	<0.0001
Chest medicine	234	35.0	1.44	1.10–1.90	<0.0078
Urology	287	48.4	2.57	2.03–3.25	<0.0001
Cardiac surgery	82	50.0	2.68	1.73–4.14	<0.0001
Orthopedics	343	51.3	2.91	2.35–3.62	<0.0001
Vascular surgery	32	71.9	6.83	3.16–14.77	<0.0001

Table 4 – Specialty of the physician stratified by attributes from Table 1

Specialty	Average orders per session	Average years at target hospital	Average age of physician	Average drug price	Average duration of orders
ED	37.8	7.4	57.1	33.2	7.6
Ophthalmology	47.4	8.8	40.2	193.2	19.4
Psychiatry	34.4	7.3	41.1	24.4	21.8
Oncology	12.5	8.4	41.8	118.1	11.0
Immunology	60.5	9.5	45.8	13.7	20.4
Neurosurgery	45.4	8.3	47.4	12.1	19.2
Nephrology	30.4	7.1	43.0	9.1	21.7
Gastroenterology	49.3	9.3	46.1	6.1	18.3
Dermatology	40.6	7.4	42.0	27.0	9.0
ENT	42.1	7.3	41.8	14.8	9.8
Cardiology	64.6	7.9	42.3	11.1	23.9
Chest medicine	28.5	6.5	42.5	37.3	14.3
Urology	50.1	9.3	46.4	12.0	15.7
Cardiac surgery	25.1	3.9	52.0	6.8	18.3
Orthopedics	6.8	6.3	48.1	23.1	5.5
Vascular surgery	25.1	3.9	52.0	6.8	18.3

ments within the hospital were significantly more or less likely to accept safety reminders (OR > 1 or OR < 1).

Table 4 shows that the average orders per session, the years at target hospital, the age of the physician, the average drug price and the average duration of orders for each physician specialty. The duration of orders prescribed to the patients in this study had a mean 20.7 (S.D. 11.6) days at the target hospital. Reasons why some specialties have significantly difference will be discussed in the next section.

4. Discussion

Workload significantly affected the physicians' ordering behavior. As the visits per session increased, physicians probably are less likely to review an entire patient history as well as any safety reminder. The result of this study is consistent with those from questionnaire studies [14,16,18,22] with respect to behavior when overriding clinical reminders. To minimize the effect of workload and to optimize clinical reminders, it is important to adjust the physicians' workload in practice so that there is a reasonable time available to review and accept/reject each computerized clinical reminders.

The physicians' characteristics such as educational background, years in practice at target hospital and their age were also an important aspect of ordering behavior. The results of this study are inconsistent with a recent study based on completion rate, which was conducted across a large healthcare system [23]. That study showed that the completion rate was lower among residents than staff providers, which suggested that educational background and years in practice were correlated with order behavior in this particular study. We found in the target hospital that physicians with a master degree were less likely to accept reminders and review orders. Most of these physicians are managers and are less likely to be carrying out research and publishing papers, but some of them are pursuing higher degrees. These factors made the physicians much busier and therefore affect their ordering behavior. Physicians with longer years in practice at target hospital were less likely to accept reminders, perhaps because they were more resistant to innovation and did not support some policies associated with patient safety practice and computerized clinical reminders. This hypothesis is based on the idea that new physicians are more likely to have new patients during their outpatient sessions and that normally new patients are examined and treated with greater care. The physicians' age seems to be an important factor in ordering behavior. However, this would seems to have an opposite effect to that of years in practice at the target hospital because the norm would be that senior physicians are more likely to have stayed longer at the hospital. This result disproves the conception that computerized safety reminders are less likely to be accepted by senior physicians. To optimize clinical reminders, it is important to give the necessary training to physicians and obtain support from the physicians, especially senior ones. An opinion leader approach could be an effective way to obtain a consensus.

Given the increased pressure on the NHI system due to the increasing costs borne by it, behavior that accepts or overrides orders from drug-duplication reminders obviously is needed to maintain appropriate distribution of prescriptions to patients. The comparison results using the average drugs price disprove the common sense idea that drugs with a higher average price should be more likely to be carefully reviewed and modified to prevent an argument with the insurance claim reviewer. We found orders with a higher average drug price were more likely to be made to chronic patients and to be paid for by the patients. These two reasons may have resulted in the patients and physicians being more resistant to changing the order. Physicians and patients need to be better informed about patient safety practice to reduce such resistance.

We listed the drug classes that Cooper [21] and Tozaw et al. [10] defined as most frequent drug classes involved in duplication. Cooper et al. found laxatives, analgesics, NSAIDs, diuretics, hypnotics, antipsychotics, KC1 supplements, hematinics/vitamins, antacids, antinauseants and antidiarrheals to be the drug classes most often duplicated. Tozaw et al. found drug duplication was most frequently observed with calcium channel blockers, benzodiazepines and stool

softeners in chronic haemodialysis patients. We found that the drug classes most frequently involved in prescription order duplication vary with the healthcare setting. In Taiwan, NSAIDs and antacids are highest and the other drug classes showed less drug duplication. During this research, it was found that the OR for accepting a safety reminder varied and was significantly affected by the different drug classes. Although intervention by the NHI has been present in Taiwan for quite a long time, physicians seem still to be unwilling to change their orders on NSAIDs and hypnotics and to accept the reminders. The problem of overdosing of antacids seems less seriousness compared to overdosing of NSAIDs and hypnotics, but antacids have the second highest acceptance rate in responding to reminders. It seems that intervention by the NHI in some aspects has had only a minor impact on physicians ordering behavior. After examining some informal case studies, we found that NSAIDs and hypnotics were more frequently requested by patients as a prescription due to potential substance abuse and physicians were more likely to obey the patients' wishes in such cases. It is important for the healthcare insurer to look into the effectiveness of their interventions and provide both incentives and punishments for physicians and hospitals so that there is more carefully review of duplicated orders. Education of patients is also important in order to reduce patient resistance. Research on shared decision making and risk communication may be the way forward with patient education [24].

As expected, acceptance of safety reminders was significantly affected by the specialty of the physician. This may be due to variation in the patients' characteristics, variation in the workload of each department, differences in the physician's educational background as well as the practicing background of the physicians involved and the different levels of support for hospital policy from the departmental upper management and peers. For example, Emergency Department physicians were less likely to accept safety reminders due to the emergency nature of their treatment requirements [25,26]; ophthalmologists in the target hospital have more patients so prescribed more orders and have stayed in the hospital more years than other physicians; but more importantly, they prescribed higher price drugs and drugs for external use. Drugs such as ointments are prescribed with a nominal duration since it is hard to be estimated accurately. Patients then revisited to the same or different physician within very short period of time (for example 3 days) and accepted similar orders because they have consumed the drugs. Nonetheless, some cases also identified patients that revisited to receive orders in same drug class because the previous orders were ineffective or had a side effect. For example, one patient was prescribed fluorometholone for the treatment of conjunctival inflammation but revisited due to a side effect and then the physician prescribed sulfamethoazole, which triggered a reminder from the CPOE. Psychiatrists in the target hospital prescribed for longer durations and they also had the same situation as ophthalmologists since drugs such as hypnotics are prescribed as an order but sometimes patients consumed those drugs in a much shorter time than the duration inputted into the system; the patient then accepts a slightly different order set than the previous order set. From the reimbursement point of view, ophthalmologists and psychiatrists receive less intervention from NHI and are therefore less willing to change their method of practice.

Undeniably some physicians are resistant to the patient safety policy and this can increase or decrease the rate of acceptance of the reminders. Other reasons include reminder appropriateness and technological problems, which were also found during informal participant observation. However, the reason why some physicians such as cardiologists and urologists had a higher acceptance rate than other physicians under a heavy workload (mean = 64.64 and 50.1) and with more years at the target hospital than other physicians, remains unknown. Qualitative studies provide answers or insights that dealing with why and how in perceptive. Focus groups and oral history interviews need to be used too because these methods have unique strengths. Participant observation has the advantage of being the most unobtrusive method. It produces detailed descriptive accounts of what is going on [27] and has been used effectively in prior informatics studies [28,29]. One can quantitatively analyze the real situation in terms of physicians' behaviors by examining a range of additional variables and this provides insight that helps to design future research. In addition, retrospective chart review may also be able to help the examination of reminder appropriateness and override appropriateness.

There are a number of limitations to this study. Firstly, the results came from only one source of data and this was collected over a relatively short period of time. Secondly, the rules used in this analysis may not have filtered out all irrelevant drug-duplication reminders and therefore some false positives may have helped to confound the results of this research. Finally, we failed to log a number of variables that were not considered during the initial design of the study. Future qualitative research is thus needed in order to examine the why, the how and the context of the reasons for duplicate prescriptions that were not considered during this research.

The strengths of this study are related to its data source. Firstly, Taiwan healthcare has a serious drug-duplication problem and the use of a research hospital in this study is representative because of the volume of visits. Secondly, this research hospital has more than 95% of prescriptions ordered electronically so there is no potential for selection bias relative to the data source. Lastly, there is no potential for recall bias between cases (accepting the reminder) and the controls (overriding the reminders) as all behavior information is based on the log analysis.

5. Summary and conclusions

Drug duplication poses a critical problem in terms of healthcare cost and potential adverse drug events. This study provides the first data using a log analysis of actual prescribing behavior and the factors that might be associated with accepting or overriding a drug-duplication reminder. We compared the variables affecting acceptance of safety reminders in our study and also included factors proposed in other research that used either online surveys or designed questionnaires.

The results of this study are important because we are able to suggest several reasons why physicians may override drug-duplication reminders. Patients' resistance and workload play

Summary points

What was already known:

- Publications showed duplicated prescription with the frequency of drug duplication with a range between 11% and 61% and that computerized safety reminders are often overrode with a range between 70% and 90%.
- Research by either an online survey approach or designed questionnaire showed the reasons include alert fatigue, lack of time, reminder appropriateness, technological problems, unnecessary workflow interruptions and the physician's or patient's resistance to drug change but neglect other reasons and how and why the physicians overrode.

What this study has added to our knowledge:

- This study provides more reasons and how/why physician overrode using a log analysis of actual prescribing behavior.
- Physicians related variables (workload, department, educational background, years in practice at the target hospital and age), policy related variables (intervention from the insurer and hospital administration), the order itself (drug price and medication class) and patients' resistance were found to be most critically related to physicians' behaviors in terms of the reminders.
- Intervention by reimbursement policy appeared to be ineffective as a way of affecting the physicians' behavior.

important roles in the acceptance of safety reminders and this is consistent with the results of designed questionnaire studies. Physicians' characteristics (department, educational background, years at target hospital, age), policy (intervention by the NHI, the role of the hospital administration) and the order itself (drug price, drug class) are critical to acceptance of clinical reminders and these factors have not been proposed in the earlier studies. We also found that although intervention from NHI could be crucial, nevertheless intervention on specific drug classes seems to have only a minor impact. In our study we have integrated computerized drug-duplication reminders into the order entry workflow but left out variables such as the user interface and the number of reminders that were the same over the entire study. Some other analyses were carried out without detecting any significant factors and these included seasonal variables (holidays, winter, *etc.*) and patients' characteristics (age, gender, number of visits to hospital per year). Further variables such as team intervention and the role of the opinion leader from the social science perspective could also be included in further research [30].

The reasons that a physician may have to accept or override a drug-duplication reminder have important policy implications in terms of the patient safety practice and healthcare decision making. In order to reduce medical errors, hospitals and clinicians should be given the necessary training and support in terms of safety reminders, especially physicians with longer years in practice at the hospital and physicians in some resistant departments. Patients should be well informed about patient safety practice to reduce their resistance to changes in prescription orders. It is also important for the hospital administration to examine workload at clinics to see whether time can be made to allow proper checking of the computerized clinical reminders. Given the increasing cost pressure on the healthcare insurance system, interventions to reduce drug duplication need to be improved by coordination within the hospital administration. Further research is needed to find the best approach that will influence positively those groups less likely to accept a safety reminder.

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