

## Research Article

# Study of prescribing errors of two different prescription systems: pre-printed prescription from historical medication and hand-written prescription

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## ABSTRACT

A retrospective observational study of 1,160 prescriptions with prescribing errors from a large academic hospital in Thailand from 2014 to 2017. The aims of this study are to explore the proportion of prescribing error from pre-printed prescriptions and measure the frequency of prescribing errors in pre-printed versus hand-written prescriptions. Prescriptions with prescribing errors were stratified sampling and bootstrap resampling, then classified into 1) pre-printed historical medication prescriptions or pre-printed prescriptions 2) hand-written prescriptions. Some missed prescribing errors of each type of prescription were more identified by comparing the prescriptions with the medical records. Pre-printed prescriptions with prescribing errors constituted 767 (66%) of all collected prescriptions. The most commonly encountered prescribing error was “incomplete medication list in medical record”, while 393 (34%) hand-written prescriptions were found to have the wrong dosage strength. Hand-written prescriptions were 1.45 times more likely to have a major error compared to pre-printed prescriptions (OR: 1.45, 95%CI: 1.08-1.94, *P* 0.012). Although using pre-printed prescription can reduce some prescribing errors such as wrong dosage strength that occur with hand-written prescriptions, pre-printed prescriptions were found to have other prescribing errors. Procedures to improve the prescribing system to increase patient safety are needed.

### Keywords:

Pre-printed prescription, Hand-written prescription, Patient safety, Prescribing error

## 1. INTRODUCTION

A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer<sup>1</sup> and is associated with death and economic losses<sup>2</sup>. Medication errors can be divided into prescribing error, pharmaceutical error, and dispensing error<sup>3</sup>. The most common types of prescribing errors were omitted information. The most likely medication information to be omitted was duration, dosage form, strength, frequency, and quantity of prescribe medication<sup>4-7</sup>. However, many studies reported some clinically incorrect medication information that may be impact to potential patient safety included Nanji et al.

study revealed that 42.9 percent of prescribing error in outpatients was found in wrong route, 28.6 percent in wrong frequency, and 17.1 percent in overdose<sup>4</sup>. Al-khani et al. study has shown that 53 percent in wrong dose, 10 percent in wrong medication, and 9 percent in wrong frequency<sup>2</sup>. Shrestha and Prajapati study reported that 10.2 percent in drug-drug interaction, 0.5 percent in wrong strength, and 0.2 percent in wrong medication name which is equal to wrong dosage form<sup>7</sup>. Pum-apirat et al. studied pre-printed prescriptions inquired about history of medication use from patient and assessed the severity of adverse reactions related to prescribing errors in outpatients with diabetes. They found that prescribing errors after use pre-printed prescriptions were significantly reduced from 4.82 to 0.08 percent (*P*<0.001). The most

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common type (45.45%) of prescribing error was errors in dose or frequency. Compared to traditional hand-written prescriptions, pre-printed prescriptions reduced copying errors, were more convenient, and reduced errors from unclear hand writing<sup>8</sup>.

In 2013, the outpatient internal medicine dispensing unit at Siriraj hospital received 300,058 prescriptions. With limited staff and a heavy workload, the possibility of errors increased, so a pre-printed system of historical medication prescriptions was introduced to reduce prescription errors which were first used in March 2014. In routine works, all prescriptions with prescribing errors in the outpatient internal medicine dispensing units are collected for database without classified types of prescription. So, the incidence of prescribing errors from pre-printed prescriptions has not been collected along with there has not been any studies about this kind of pre-printed prescription yet. Therefore, we investigated the conditions that compare the different prescribing systems at Siriraj hospital in order to inform the development of strategies and procedures to reduce prescribing errors.

## 2. MATERIALS AND METHODS

### 2.1. Objectives

To explore the proportion of prescribing error from pre-printed prescriptions and measure the rate of major and minor errors from pre-printed prescriptions and compare this to hand-written prescriptions.

### 2.2. Materials and Methods

A retrospective observational study during January 2014 to December 2017 in two outpatient internal medicine dispensing units at Siriraj hospital. The ethical committee of the faculty of medicine approved the study at November 2018.

Research sample inclusion criteria is Internal medicine's prescriptions with prescribing error form of both during office hours and out of office hours collected since January the 1st of 2014 to December the 31st of 2017. An exclusion criterion is prescriptions with prescribing error of internal medicine that the patient is not made an appointment on next visit.

The sample size (N) was calculated using the formula,  $N = Z_{\alpha}^2 P(1-P)/d^2$ , that P is the prevalence of prescribing error of prescription as 78% which was found out by checking prescriptions in June 2017 since we couldn't find any similar study; d is the acceptable margin of error within 5%; Z is the confidence coefficient (Z=1.96 if the level of confidence is 95%). Therefore, the total sample size of prescriptions from the past 4 years was 1,160.

### 2.3. Data collection

The prescriptions were divided with stratified sampling by years. Next step, they were classified as high alert drug and non-high alert drug according to Siriraj high alert drug manual. The last step was bootstrap resampling technique. Prescriptions were classified as either pre-printed historical medication prescriptions or hand-written prescriptions. The methods began with reviewing data of medical records, identifying the prescribing error and comparing the data between pre-printed historical medication prescriptions and hand-written prescriptions by using SPSS version 18.0.

### 2.4. Definitions

A pre-printed historical medication prescription or pre-printed prescription contains patient information and medication details that the physician had prescribed to the patient during a previous visit. The medication details listed on the pre-printed prescription include the name, dosage form, strength, and administration which are the same as those printed on medication label.

#### 2.4.1. Re-medication

Re-medication is a physician's intent to prescribe the latest medication list by writing RM in the medical record.

#### 2.4.2. Prescribing error

Prescribing error is classified into two types as major prescribing error and minor prescribing error.

#### 2.4.3. A prescription with prescribing error

A prescription with prescribing error is any prescription that had found problems during dispensing process then was consulted and fixed the problems by a physician.

#### 2.4.4. A major prescribing error prescription

A major prescribing error prescription is the prescription showed at least one type of major prescribing error, included wrong medication error, wrong dosage strength, inappropriate administration, and incomplete medication list in medical record, adverse drug reaction, and incomplete medication list in prescription.

#### 2.4.5. A minor prescribing error prescription

A minor prescribing error prescription is the prescription showed at least one type of minor prescribing error without major prescribing error, included dosage

form error, improper amount of medication (omission), and other problems (wrong trade names or prescribing medications that not available in the hospital)

#### 2.4.6. Incomplete medication list in the medical record

Incomplete medication list in the medical record is defined as a prescribing error because the physician records the prescribed medication in the prescription but did not do so completely in the medical record.

#### 2.4.7. Incomplete medication list in prescription

Incomplete medication list in prescription is defined as a prescribing error because the physician recorded the prescribed medications in the medical record, but did not do so completely record in the prescription.

### 2.5. Data analysis

The Frequencies and percentages were reported for categorical variables, and the median and interquartile range (IQR) deviations were reported for continuous variables. The odds ratio (OR) was calculated, with confidence intervals (CI) of 95% and, for associations, the chi-square and Mann-Whitney tests were used. Statistical analyses were performed using SPSS version 18.0 (SPSS Co., Ltd, Bangkok, Thailand).

## 3. RESULTS

### 3.1. General characteristic data of prescriptions

**Table 1.** General characteristic data of prescriptions.

Characteristic data of prescription	No. of pre-printed (%) (n=767)	No. of hand-written (%) (n=393)	Total No. (%) (n=1,160)	p-value
Gender				
Female	480 (62.6)	242 (61.6)	722 (62.2)	0.739
Male	287 (37.4)	151 (38.4)	438 (37.8)	
Age (Median±Quartile) 65±19				
<65 years	352 (45.9)	204 (51.9)	555 (47.8)	0.128
65-80 years	321 (41.9)	142 (36.1)	463 (39.9)	
>80 years	94 (12.3)	47 (12.0)	142 (12.2)	
History of medication allergy				
No	599 (78.1)	315 (80.2)	914 (78.8)	0.417
Yes	168 (21.9)	78 (19.9)	246 (21.2)	
Patient's visit time				
During office hours	398 (51.9)	321 (81.7)	719 (62.0)	<0.001
Out of office hours	369 (48.1)	72 (18.3)	441 (38.0)	
Types of prescriber				
Medical professor	535 (69.8)	184 (46.8)	719 (62.0)	<0.001
Resident	132 (17.2)	147 (37.4)	279 (24.0)	
Fellow	100 (13.0)	62 (15.8)	162 (14.0)	
Writing in medical records				
Yes	729 (95.0)	382 (97.2)	1,111 (95.8)	<0.001
• Medication lists	421 (57.8)	321 (84.0)	742 (66.8)	
• Re-medication (RM)	308 (42.3)	61 (16.0)	369 (33.2)	
No	38 (5.0)	11 (2.8)	49 (4.2)	

\*Chi-square test and Mann-Whitney test

A total of 1,160 prescriptions with prescribing error were studied. The pre-printed prescriptions are 767 (66%) of all collected prescriptions with prescribing error and the hand-written prescriptions are 393 (34%) percent of all ones. Gender, age, and history of medication allergy of both prescriptions were similar between each type of prescriptions. The percentage of pre-printed prescriptions in the out of office hour was higher than that found during office hour. Medical professors had higher percentage of pre-printed prescription than that of hand-written one. Writing in medical records was found that pre-printed prescriptions were used by some medical professors often write "Re-medication or RM" in higher percentage than hand-written ones. (Table 1).

### 3.2. Prescribing errors

The most common major errors in pre-printed prescriptions were "incomplete medication list in medical record" 342 (22.4%) and "improper amount of medication" was the most reported minor error at 464 (30.4%) (Table 2). In hand-written prescriptions, "wrong dosage strength" was the most common major error 149 (21.7%) and "improper amount of medication" was the most common minor error 161 (23.4%).

### 3.3. Incidence of major errors

Major errors occurred in 555 (72.4%) of pre-printed prescriptions and 311 (79.1%) of hand-written prescriptions. Hand-written prescriptions had 1.45 times more major errors compared to pre-printed prescriptions (OR:

**Table 2.** Type of prescribing error and number of medication lists of two type prescriptions.

Type of prescribing error	No. of drug lists of pre-printed (%) (n=1,526)	No. of drug lists of hand-written (%) (n = 688)	p-value
Major severity			<0.001
Incomplete medication list in medical record	342 (22.4)	101 (14.7)	
Inappropriate administration	310 (20.3)	113 (16.4)	
Wrong dosage strength	205 (13.4)	149 (21.7)	
Incomplete medication list in prescription	70 (4.6)	47 (6.8)	
Wrong medication error	33 (2.2)	25 (3.6)	
Adverse drug reaction	14 (1.0)	13 (1.9)	
Minor severity			
Improper amount of medication	464 (30.4)	161 (23.4)	
Other problem	69 (4.5)	63 (9.2)	
Dosage form error	19 (1.2)	16 (2.3)	
Total	1,526 (100)	688 (100)	

\*Chi-square test

**Table 3.** Relationships between types of prescriptions and severity levels of prescribing errors.

Types of prescription	No. of prescription	Level of severity		p-value	OR (95%CI)
		Minor (%)	Major (%)		
Pre-printed	767	212 (27.6)	555 (72.4)	0.012	1.45 (1.08-1.94)
Hand-written	393	82 (20.9)	311 (79.1)		
Total	1,160	294	866		

\*Chi-square test

**Table 4.** The association between drug groups and prescribing errors.

Drug groups	No. of prescription	Level of severity		p-value	OR (95%CI)
		Minor (%)	Major (%)		
<b>Cardiovascular</b>	471	124 (42.2)	347 (40.1)	0.525	0.92 (0.70-1.19)
Pre-printed	329	94 (75.8)	235 (67.7)		
Hand-written	142	30 (24.2)	112 (32.3)		
<b>Endocrine</b>	246	73 (24.8)	173 (20.0)	0.077	1.38 (0.97-1.98)
Pre-printed	162	52 (71.2)	110 (63.6)		
Hand-written	84	21 (28.8)	63 (36.4)		
<b>CNS</b>	218	45 (15.3)	173 (20.0)	0.079	0.76 (0.55-1.03)
Pre-printed	147	34 (75.6)	113 (65.3)		
Hand-written	71	11 (24.4)	60 (34.7)		

1.45, 95%CI: 1.08-1.94, *P* 0.012) (Table 3).

### 3.4. The association between drug groups and major errors

The most of drug groups were cardiovascular drugs, endocrine drugs and CNS drugs, respectively. The major errors of all collected prescriptions were reported cardiovascular drugs (40.1%) that higher than endocrine drugs (20%) and CNS drugs (20%). Subgroup of cardiovascular drugs, pre-printed prescriptions were higher major error (67.7%) than hand-written prescriptions (32.3%) (Table 4).

## 4. DISCUSSION

Randomly sampled 1,160 prescriptions with prescribing error from two outpatient internal medicine dispensing units since January 2014 to December 2017

were classified into 2 types of prescriptions, i.e. pre-printed prescriptions and hand-written prescriptions. The proportion of pre-printed prescription errors is 66 percent more than that of hand-written prescription at 34 percent because the data used in this study were selected from the first year since March 2014 that pre-printed prescriptions were applied and the results of this research shown that most patients were patients who came by appointment, thus can use a pre-printed prescription. However, the percentage of "adverse drug reaction" was less when pre-printed prescriptions were used, namely 1 percent found in pre-printed prescription and 1.9 percent found in hand-written prescription as shown in Table 2. Also, the most prescribing error found in pre-printed prescriptions was "improper amount of medication" which is a minor severity error. These agreed with the study of Pum-apirat et al<sup>8</sup>. While the hand-written prescriptions are not similar to the findings of other studies, which found that it was not appropriately prescribed in

different ways. The route of administration, frequency of administration, and duration were the most common type of prescribing errors<sup>5,9</sup> while this study has found that the most prescribing error is improper amount of medication. The difference in our result from other studies may be due to several reasons, included we studied the prescriptions from the Department of Internal Medicine which has more medication list per prescription than other departments therefore there is a chance to be inaccuracies in determining the amount of the medication that was not similar to other studies which collect prescriptions from various departments. In some cases the physician prescribes medication to relieve symptoms which do not use continuously is found that the physician specifies as the duration of following instead of specifying the amount of each medication. This made it impossible to calculate the proper amount of medication. This study was judged to be an error from improper amount of prescribing medication. In routine work, prescriptions are sent to the pharmacy department before making an appointment is completed. In some patients who were made the appointment time is longer than the physician intended to make an appointment because each physician has many patients to take care of, so it made patient appointments to exceed the daily limit set by the appointment function on the computer program. Therefore, the appointment date has to be postponed. As a result, the amount of medications prescribed by the physician in the prescription is not enough to reach the actual appointment date. We couldn't compare the results from any studies to this study by using percent of prescribing errors because those studies had different denominator which some study explored the error rate by using error divided by total number of prescription<sup>5,6,9</sup>, error divided by total number of prescribing error<sup>2,4</sup>, or error divided by total number of medication dispensed<sup>7</sup> and may be due in part to differences in definition of prescribing errors.

Hand-written prescriptions increased the rate of major errors compared to pre-printed prescriptions due to problems with unclear hand writing. These agreed with the study of Sanguansak et al. is found that comparison of error rates between pre-printed and hand-written prescriptions showed a 10-fold reduction in the overall error rate using pre-printed prescription<sup>9</sup>. Prescribing errors in pre-printed prescriptions may arise from physicians' misunderstanding that information in pre-printed prescription is complete, accurate and up to date. This also included RM specifying, not detailing the adjusted dose or new medication instruction in the medical record and be supposed that the old medication list can be viewed from the historical patient's medication database was recorded by the dispensing unit. Therefore, the error might occur when the physician did not observe if it were the complete list.

Cardiovascular drugs group was the highest drug groups in prescribing error because these groups had a variety of drugs, including anti-hypertensive drugs, anti-coagulant, anti-platelets and etc. However, cardiovascular drugs, endocrine drugs and CNS drugs groups weren't associated with major errors.

The limitation of this study need to be addressed. First, despite the fact that retrospective study may not have all the information such as drug administration methods, dosage form, and an amount of medicines on the medical record. In addition, including medicine left amount, visiting at another health care unit, the patient's request for medication beyond the indications. Second, this study is unable to find the incidence of prescribing error from pre-printed historical medication prescriptions because the database used in the study used to be not classified as the two types of prescriptions and there are a lot of prescriptions. Therefore, it needed to random sample from all prescriptions to study. The possible study results are determining the proportion of the study sample. Third, there is a limit that the database did not have the total number of each type of prescription. This made the proportion of studies from each type of prescription may not close to reality.

Based on this finding study, the role of pharmacists should be ensured for the appropriate dispensing of medicines by medication reconciliation and patient counseling. In addition, the hospital systems increase awareness with warning signs when the physician prescribes. Error reduction strategies, such as an error reporting system and computerized prescription system, may be implemented to avoid preventable medication errors. Moreover, the hospital encouraged the patients and caregivers to validate the medications.

## 5. CONCLUSION

Pre-printed historical medication prescriptions can reduce major errors compared to hand-written prescriptions. However, pre-printed historical medication prescription systems still produce some major errors, and minor errors that distinct from those of hand-written prescriptions. Due to the fact that, the use of pre-printed prescription provides quick and easy procedure for the physicians, but it may cause them to be less cautious and lead to other prescribing errors. The hospital has to develop and improve prescribing system in order to increase the safety of patients.

## Author contribution

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**Conflict of interest**

None to declare

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**Ethics approval**

Siriraj institutional review board approved the study at November 2018.

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