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ORIGINAL ARTICLE

Assessment of legibility and completeness of handwritten and electronic prescriptions

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KEYWORDS

Medication errors;
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Abstract *Objectives:* To assess the legibility and completeness of handwritten prescriptions and compare with electronic prescription system for medication errors.

Design: Prospective study.

Setting: King Khalid University Hospital (KKUH), Riyadh, Saudi Arabia.

Subjects and methods: Handwritten prescriptions were received from clinical units of Medicine Outpatient Department (MOPD), Primary Care Clinic (PCC) and Surgery Outpatient Department (SOPD) whereas electronic prescriptions were collected from the pediatric ward. The handwritten prescription was assessed for completeness by the checklist designed according to the hospital prescription and evaluated for legibility by two pharmacists. The comparison between handwritten and electronic prescription errors was evaluated based on the validated checklist adopted from previous studies.

Main outcome measures: Legibility and completeness of prescriptions.

Results: 398 prescriptions (199 handwritten and 199 e-prescriptions) were assessed. About 71 (35.7%) of handwritten and 5 (2.5%) of electronic prescription errors were identified. A significant statistical difference ($P < 0.001$) was observed between handwritten and e-prescriptions in omitted dose and omitted route of administration category of error distribution. The rate of completeness in patient identification in handwritten prescriptions was 80.97% in MOPD, 76.36% in PCC and 85.93% in SOPD clinic units. Assessment of medication prescription completeness was 91.48% in MOPD, 88.48% in PCC, and 89.28% in SOPD.

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Conclusions: This study revealed a high incidence of prescribing errors in handwritten prescriptions. The use of e-prescription system showed a significant decline in the incidence of errors. The legibility of handwritten prescriptions was relatively good whereas the level of completeness was very low.

1. Introduction

Medication errors are one of the most common types of medical errors (Committee on Preventing Medication Errors, 2007). These errors are considered for the most preventable and common cause of iatrogenic injuries in hospitalized admission (Leape et al., 1991). Around five lakh medication errors have been estimated daily in the USA based on data collected from Florida Health Care Coalition (FHCC) and those errors contribute for 10 percent of all injuries in hospitalized patients (Florida Health Care Coalition (FHCC), 2004). The most frequent medication errors occur at the point of prescribing the medication (Delgado Silveira et al., 2007) and further due to lack of medication knowledge (Bobb et al., 2004).

Illegible and incomplete medication orders are important factors that can increase risk for medication errors and patients' harm (Winslow et al., 1997). In Winslow et al. study, 20.2% of medication orders were illegible or readable with effort (Winslow et al., 1997) and Laura Calligaris et al. reported 23.9% of prescriptions were illegible and 29.9% were incomplete (Calligaris et al., 2009). In another study it is found that 64.3% of prescriptions were illegible (Irshaid et al., 2005). However, the overall illegibility and incompleteness above 20% are unacceptably high (Calligaris et al., 2009).

Electronic prescription systems allow the prescribers to send the prescriptions directly to the pharmacy, which have immediate benefits of improving legibility and completeness and eliminating transcription errors. Some of electronic prescription systems are more advanced and assisted by decision-support tools such as drug–drug, drug–dose and drug–allergy interaction checking (Kuperman et al., 2007). Many studies have shown that electronic prescribing can reduce the incidence of medication errors by more than 50% and improve the quality of prescribing and patient safety, (Bates et al., 1998; Jani et al., 2008; Donyai et al., 2008) saving health care costs, (Fischer et al., 2008) and order-processing time (Wietholter et al., 2009).

As decisions about computerized prescribing are made, a better understanding of the relative benefit and acceptability of basic systems versus more advanced systems is needed (Gandhi et al., 2005). Nevertheless, the drug prescription and administration process in most hospitals worldwide is still based on handwritten medical chart entries (Ash et al., 2002; Nightingale et al., 2000). Therefore, there is a need to critically address the legibility of prescription, correct spelling of drugs, authorized abbreviations and all other information of a prescription concerned with patient, prescriber and drugs to minimize the occurrence of medication errors (Ansari and Neupane, 2009). Also, there have been fewer studies that addressed the incidence and extent of prescribing errors in the Gulf region (Khoja et al., 2011). Therefore, the objectives of the study were to assess the legibility and completeness of handwritten prescriptions and further to compare with electronic prescription system for medication errors.

2. Methodology

The study was conducted in the outpatient and inpatient pharmacies at the King Khalid University Hospital (KKUH), Riyadh, Saudi Arabia from October 2011 to November 2012. The study received ethical approval from the ethics committee of King Saud University. Most handwritten prescriptions were received from clinical units of Medicine Outpatient Department (MOPD), Primary Care Clinic (PCC) and Surgery Outpatient Department (SOPD). This was a prospective study consisting of two sections. The first section was a randomized collection of handwritten prescriptions during two weeks on the spot of dispensing in the outpatient pharmacy. The data collection has been organized to receive prescriptions in the morning and in the afternoon of all the five working days to avoid elimination of any department from the sample. These prescriptions were checked for completeness using a checklist based on the KKUH hospital prescription form (e.g., patient's name, hospital number). The pharmacist's assistance was utilized in determining the presence of the items in the prescription.

The prescriptions were then assessed for prescribing errors such as patient identification errors using a checklist of errors adapted from previous studies (Delgado Silveira et al., 2007; Bobb et al., 2004; Al-Jeraisy et al., 2011). The pharmacists could only find some of the errors such as dose errors, while the investigators themselves could identify omitted items.

At the end of the 2 week period, the prescriptions were evaluated for legibility by two pharmacists according to a 3-point legibility scoring Likert scale similar to the previous study (Mendonca et al., 2010). Each pharmacist was chosen based on the different levels of experience (one is expert and the other non-expert pharmacist) and scored the prescriptions independently. Each prescription was scored twice by two pharmacists.

The second section was a randomized collection of all electronic prescribed orders from two pediatric wards, inpatient pharmacy for 1 week. The orders from the two pediatric wards in one-week period were assessed with the help of a pharmacist for prescribing errors using the same error checklist used for handwritten prescriptions.

For handwritten prescriptions, no more than two prescriptions were taken from the same patient to avoid bias in the departments because some patients had more than 6–8 prescriptions from one department. Refill prescriptions were excluded. Regarding electronic prescriptions, due to the small numbers of daily prescriptions, all of the orders of that day were included in the study.

Data were analyzed using statistical package for social sciences version 18. For the incidence and comparison of

prescribing errors in handwritten and electronic prescriptions, frequencies and chi-square were used. Crosstabs were used for the correlation between types of errors and the different outpatient departments producing the errors. Regarding legibility, frequencies were used and the average of the two scales was calculated.

3. Results

In the present study, 398 prescriptions were analyzed. Of these, 199 were handwritten and 199 were electronic prescriptions (Table 1). The single unknown prescription was excluded in the analysis. With regard to patient identification completeness in the handwritten prescriptions, almost 99% were found with patient's name, file number and hospital number in all prescriptions of different departments. The gender and diagnosis were found in the majority of the prescriptions while the age was missed in more than 50% of the prescriptions among the three departments. The rate of incompleteness in handwritten prescriptions was 19.02% in MOPD, 23.63% in PCC and 14.06% in SOPD clinic units (Table 2).

In the medication identification, the generic name was included in 62.2% of MOPD prescriptions, 56.71% and 43.75% of PCC and SOPD prescriptions respectively. The frequency and duration of medication were missed in less than 5% among all outpatient clinics. The completeness of variable, route of administration identified in MOPD, PCC and SOPD were 88.9%, 77.61% and 93.75% respectively. The overall completeness of medication prescription was 91.48% in MOPD, 88.48% in PCC, and 89.28% in SOPD (Table 3). There was no agreement between the expert pharmacist and the non-expert pharmacist regarding legibility scoring of prescriptions (Kappa = 0.0096) (Table 4).

In total 71 (35.7%) and 5 (2.5%) errors were identified in handwritten and electronic prescriptions, respectively. The major type of errors was the incidence of improper or omitted route of administration (15.1%) and improper or omitted dose (12.1%) in handwritten prescription. In comparison between the incidence of prescribing errors in handwritten and electronic prescriptions dose and route of administration were found to be statistically significant (Table 5).

Table 1 Characteristics of inpatient and outpatient pharmacy prescriptions.

Department or ward	Outpatient pharmacy *n* (%)
Medicine outpatient department (MOPD)	99 (47.8)
Primary care clinic (PCC)	67 (33.7)
Surgery outpatient department (SOPD)	32 (16.1)
Unknown	1 (0.5)
Total	199 (100)
	Inpatient pharmacy *n* (%)
Pediatric ward	199 (100)

4. Discussion

Medical prescription errors by health professionals cause a serious public health problem and these errors sometime become a threat to patient's life. It is known that incomplete or omitted information in the prescription and poor handwriting leads to numerous errors (Brennan et al., 1991; Baker et al., 2002). In the present study, we analyzed the legibility and completeness of handwritten prescription and further compared with electronic prescription for medication errors. It was suggested that an overall illegibility or incompleteness of more than 20% is unacceptably high (Calligaris et al., 2009). In our study, we found handwritten prescription completeness of 80.97%, 76.36%, and 85.93% whereas incompleteness of 19.02%, 23.63%, and 14.06% in MOPD, PCC and SOPD, respectively (Table 2). Most of the incompleteness was found in primary care clinic. All of the prescriptions in our study included the patient's name and hospital number, unlike the results of other studies that demonstrated an omission of patient's name in 5% and 14.5% of the prescriptions (Irshaid et al., 2005; Balbaid and Al-Dawood, 1998). On the other hand, a large number of gender and age are missing in the prescriptions and showed higher percentage of incompleteness of age when compared to the other study (Irshaid et al., 2005; Bawazir, 1993) The WHO recommends the presence of the age in the prescriptions especially for children and elderly (de Vries et al., 1994). However, we believe that the patient's age can be prevented at the dispensing of the pharmacy by asking the holder of the prescription or by patient itself. This is extremely significant in order to have right drug prescription to the right aged person (Maxwell, 2006). In addition; our findings showed most of the diagnosis prescription are missing and

Table 2 Assessment of patient identification handwritten prescription completeness.

Different variables	MOPD (*n* = 99)				PCC (*n* = 67)				SOPD (*n* = 32)			
	Completeness		Incompleteness		Completeness		Incompleteness		Completeness		Incompleteness	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Prescription number	99	100	0	0	67	100	0	0	32	0	0	0
Patient name	99	100	0	0	67	100	0	0	32	0	0	0
Hospital number	99	100	0	0	67	100	0	0	32	0	0	0
Gender	57	57.57	42	42.42	49	73.13	18	26.86	28	87.5	4	12.5
Age	39	39.39	60	60.60	12	17.91	55	82.08	15	46.87	17	53.12
Diagnosis	88	88.88	11	11.11	45	67.16	22	32.83	26	81.25	6	18.75
Total[a]	481	80.97	113	19.02	307	76.36	95	23.63	165	85.93	27	14.06

[a] Frequencies and percentages were calculated from the total number of handwritten prescription completeness.

Table 3 Assessment of medication prescription completeness.

Different variables	MOPD (n = 99)				PCC (n = 67)				SOPD (n = 32)			
	Completeness		Incompleteness		Completeness		Incompleteness		Completeness		Incompleteness	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Prescription number	99	100	0	0	67	100	0	0	32	100	0	0
Generic name	62	62.62	37	37.37	38	56.71	29	43.28	14	43.75	18	56.25
Frequency	98	98.98	1	1.01	65	97.01	2	2.98	32	0	0	0
Dose	91	91.91	8	8.08	59	88.05	8	11.94	28	87.50	4	12.5
Duration	97	97.97	2	2.02	67	100	0	0	32	0	0	0
Route	88	88.88	11	11.11	52	77.61	15	22.38	30	93.75	2	6.25
Clinic	99	100	0	0	67	100	0	0	32	0	0	0
Total[a]	634	91.48	59	8.51	415	88.48	54	11.51	200	89.28	24	10.71

[a] Frequencies and percentages were calculated from the total number of handwritten prescription completeness.

Table 4 Evaluation of handwritten prescriptions legibility by pharmacist.

Scale	Pharmacist 1[a] *n* (%)	Pharmacist 2[b] *n* (%)
Legible, scale 1	156 (78.4)	195 (98.0)
Legible with effort, scale 2	27 (13.6)	3 (1.5)
Illegible, scale 3	16 (8.0)	1 (0.5)

[a] Expert pharmacist.
[b] New pharmacist.

are in contrast to few similar studies, which also reported the missing of diagnosis within the prescription (Irshaid et al., 2005; Balbaid and Al-Dawood, 1998; Bawazir, 1993). According to the hospital prescription regulations, it was recommended to include the diagnosis of the patient in the hospital prescription list. However, there were no recommendations from the WHO regarding the presence of the diagnosis (de Vries et al., 1994). Therefore, our study results demonstrate to the hospital management to emphasize the necessity of writing clear and complete prescriptions in order to interpret correct patient information.

In the assessment of medication prescription completeness we found generic name was missing in most of the prescriptions with the highest missing from the surgery outpatient department prescriptions (56.25%) when compared to other clinics (Table 3). The present study findings showed generic names missing was worse than those reported previously (Irshaid et al., 2005). Further our study in contrast to other study reported that all the prescriptions had their generic names (Mendonca et al., 2010). Even though the WHO recommended and in particular, the hospital managements the use of generic name in the prescription, many physicians showed little or no interest in it. The use of generic names will enable the pharmacist to maintain more limited stock of drugs and avoid the unnecessary expensive drugs for the patient. Our findings showed that above 90% of the prescriptions have frequency, dosage, duration and name of the clinic written on the prescription. In other study, it was shown deficient in lower percentage (Balbaid and Al-Dawood, 1998; Bawazir, 1993) We found that medication prescription of route of administration was incomplete in MOPD (11.11%), PCC (22.38%) and SOPD (6.25%), respectively with highest missing in Primary care clinic. Similar results showed that 20% of the drugs prescribed had only the route of administration written in outpatient department (Ni et al., 2002). However, stress is needed to emphasis to complete the medication prescription so that the pharmacist can have absolute information about the drug, its frequency and exact period of taking medication.

Illegible prescription is one of the factors, which can increase the risk for medication errors regardless of the accuracy, and completeness of the prescription (Mendonca et al., 2010). In the current study legibility assessment was done by two pharmacists by scoring likert scale and thus may be biased in the study. The handwriting in the prescription by the prescriber will indicate the patient information and medication prescription. This kind of handwritten information can be understood by pharmacist such as generic name and dose specification and will not be able to identify by the researchers. In the present study we have chosen two pharmacists one with experience (expert pharmacist) and other one newly appointed (non expert pharmacist). Results showed that the legible with effort was 13.6% and illegible was 8.0% by non-expert pharmacist whereas 1.5% and 0.5% by expert pharmacist respec-

Table 5 Error distribution.

Error classification	Handwritten prescription *n* (%)	E-prescription *n* (%)	*P*-value
Improper or omitted dose	24 (12.1)	2 (1.0)	0.000[+]
Improper or omitted frequency	6 (3.0)	3 (1.5)	0.503
Improper or omitted route of administration	30 (15.1)	0 (0.0)	0.000[+]
Incorrect treatment duration	5 (2.5)	0 (0.0)	0.061
Medical duplication	4 (2.0)	0 (0.0)	0.123
Drug interaction	2 (1.0)	0 (0.0)	0.499
Total errors	71 (35.7)	5 (2.5)	

[+] The probability is rounded to three decimal values. The actual probability is slightly greater than zero.

tively (Table 4). In addition, both pharmacists showed the majority of the prescriptions legible. To the similar study Ni et al. showed that 28 prescriptions could not read by the researcher when compared to the pharmacist (Ni et al., 2002). Another study showed 20.2% of medication orders were illegible or readable with effort (Winslow et al., 1997). Interestingly, our study showed lower percentage of illegibility when compared to other studies (Winslow et al., 1997; Calligaris et al., 2009; Irshaid et al., 2005; Ni et al., 2002). There was no agreement between the expert and non-expert pharmacists regarding legibility scoring of prescriptions (kappa = 0.0096). The difference in legibility evaluation found between two pharmacists emphasizes the effect of experience on the pharmacist's ability to read physicians' handwritten prescriptions; the more experienced the pharmacists, the more likely they are to rate a prescription as scale 1 or legible. Hartel et al. showed a similar observation and demonstrated that there are not only considerable differences in the quality of physicians' handwriting but there is also a difference between raters' ability to read different handwritings (Hartel et al., 2011). However, it was very difficult for the new pharmacist who could not read prescriptions as compared to the expert. This indicates that the new pharmacist must double check with expert in order to make sure the right prescription of medication is given to the patient that consumes more order processing time. Therefore, the study results indicate the physicians and other health professionals as their responsibility for clarity, accuracy and precision of handwriting prescriptions.

In the present study, the error distribution between handwritten and electronic prescriptions was 35.7% and 2.5%, respectively. The major type of errors reported were the incidence of omitted route of administration (15.1%) and omitted dose (12.1%) in handwritten prescription. Further, it revealed to be statistically significant in comparison between both types of prescription. This is almost similar to the findings of Delgado Silveira et al. (2007). The results showed that the basic electronic prescription system had a lower incidence of prescribing errors compared to handwritten prescriptions. This observation was found to be comparable to the results obtained from previous studies which compared the handwritten with electronic prescriptions (Delgado Silveira et al., 2007; Gandhi et al., 2005). It is believed that lower percentage of errors in the electronic prescriptions is due to its databases containing patient, drug and clinical information within the computer system. This further prevents handwritten prescription as the physician or other healthcare professional takes printout forms directly from the computer system. Additionally, electronic prescription prevents errors that arise due to difficulties in reading or understanding handwritten prescriptions.

The study had some limitations. One of the limitations is that the prescription is collected within the single hospital. Therefore, the use of single hospital sample limits the generalization of the results and findings of the study. The other limitation is that prescription is collected during day shift and excluded night shift. We assume more chances of errors might occur during night shift.

5. Conclusion

This study revealed that the level of completeness of handwritten prescriptions was low which indicates poor commitment of the prescribers to follow the hospital guidelines of prescribing whereas the majority of the handwritten prescriptions were legible. Further, the electronic prescription showed reduction in errors compared to handwritten prescription.

6. Recommendations

The study results promote the need to move toward electronic prescribing to improve the quality of prescribing and patient safety. In addition, the study also emphasizes the importance of writing complete with clear readable prescription. It also highlights the need of more training programs and regular assessment of prescribing skills to minimize the risk of medication errors that could occur from prescribing errors. Further studies concerning prescribing errors and the impact of electronic prescribing systems are needed. In addition to that, we recommend introducing the prescribing skills to undergraduate medical students to enhance the quality of prescriptions.

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