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THE IMPACT OF EDUCATIONAL INTERVENTION STRATEGIES IN REDUCING PRESCRIBING ERRORS IN A PUBLIC HOSPITAL

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ABSTRACT

The aim of this study was to evaluate the effectiveness of educational interventions in reducing prescribing errors. The study was carried out at Kuala Kangsar Hospital with 136 beds. A prospective study reviewing newly written prescriptions between May 1, 2009 and June 30, 2009 was conducted after a 4-month period of educational interventions which included providing feedback to the doctors, academic detailing, drug bulletins and reminders from the hospital director to evaluate the effectiveness of the improvement plan. The reduction of prescribing errors was measured to identify the effectiveness of the interventions. Chi square was used to evaluate the significance of the effectiveness of the intervention which was considered successful if there was a 95% confidence interval ($p<0.05$) in the difference before and after the intervention from the total baseline of prescribing errors. The intervention strategies significantly helped to reduce the incomplete prescription information and the underlying cause of prescribing errors. It also increased the error-free prescriptions by 3.5%. However, it did not significantly reduce potential clinical prescribing errors. The educational interventions provided a positive outcome to improve the prescribing errors. On-going interventions are important because educational interventions highly depend on the responsiveness of prescribers and the cumulative effect of the interventions. Most of the prescribing errors were clinical potential prescribing errors and continuous educational interventions may help to reduce these errors.

Keywords: Educational interventions, Malaysia, Prescribing errors, Public hospital, Secondary care setting

INTRODUCTION

Prescribing errors can be reduced by implementing educational interventions in the health care institute. Educational interventions are a cost effective approach of changing the prescribers' prescription writing behavior and increasing their awareness, and medication knowledge. For example, a study conducted in 2005 in a health care institute in the United States showed a successful decline by 24.6% of the inappropriate prescribing with an interactive, case-based educational program (Juzych *et al*, 2005).

Studies (Bregnhøj *et al*., 2009; Burmester *et al*., 2008; Meyer, 2000) showed that educational interventions provide an opportunity for prescribers to learn from their mistakes and increase the efficiency of learning (Juzych *et al*, 2005) especially with the combined educational interventions. Educational interventions may be combined with providing feedback to the prescribers as Franklin et al. (2007) found that feedback is providing an opportunity for the prescribers to learn from their mistakes and it increases the efficiency of learning.

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Moreover, academic detailing is another intervention that can be combined with the educational interventions because academic detailing influences the prescribers' prescription writing process (Shaw *et al*., 2003).

In conclusion, combined educational intervention programs can help to improve patient safety in the health care institute. Therefore, the present study used multiple strategic plans to improve the prescribing errors to evaluate the effectiveness of educational intervention plans

MATERIALS AND METHOD

The study was conducted in the outpatient department of the Kuala Kangsar Hospital, a public hospital in Malaysia. It was an experimental study that involved interventions with the subjects in two phases. The pre-phase was a retrospective observation of prescriptions between April 1 and May 30, 2008 to identify the characteristics of the prescribing errors. A series of educational interventions were introduced during a four month period (between January and April 2009) to target the improvement of prescribing errors which was then followed by the post-phase, conducted from May 1 to June 30, 2009 by taking a historical prospective approach, reviewing prescriptions to evaluate the effectiveness of the outcome.

In the present study, the characteristics of prescribing errors were categorized in accordance with a study by Al Khaja et al. (2006), which divided prescribing errors into three main types: omission errors, skill-based errors and integration/knowledge-based errors. The characteristics of prescribing errors were developed based on a comprehensive review of the previous study (Burmester *et al*., 2008; Al Khaja *et al*., 2007; Dean *et al*., 2000; Devine *et al*., 2007).

The inclusion criteria included the newly written prescriptions by prescribers at the hospital, prescriptions for cardiovascular diseases, endocrine disorders and psychotropic diseases which were dispensed from the pharmacy department at the hospital and the owner of the prescriptions must be over 18 years of age. The exclusion criteria for the study were prescriptions from other hospitals or health care clinics and those prescriptions written by medical assistants.

There are around 1500 new prescriptions per month for cardiovascular diseases, endocrine disorders and psychotropic diseases that are received by the pharmacy department. It was estimated that there are 18,000 prescriptions meeting the inclusive criteria in a year. To provide a 95% chance of finding the 5% accepted error rate and to provide a 2% confidence interval, 2119 prescriptions or more needed to be reviewed (Sample size calculator, 2007). Therefore, a simple random sampling method with a lottery method was used to choose 2500 prescriptions in both phases which assumed that all prescriptions have an equal chance of being selected from the population.

In both phases, all the prescriptions which fulfilled the inclusive criteria were photocopied. The selected prescriptions were screened to identify the prescribing errors. Any identified error was recorded on the upper right-hand side of the prescription and in the computer, while information about the patient's demographics and the prescriber was also keyed in.

After identifying the characteristics of prescribing errors, a proper educational intervention was introduced. Table I described the intervention plan according to the month of implementation. The combined intervention plan included feedback provided to the prescribers regarding the results and severity of prescribing errors in the institute. At the same time, the results were presented in the drug and therapeutic council meeting. After the presentation, the director of the hospital sent reminder letters to all doctors to try to avoid making prescribing errors when writing prescriptions. In addition, the educational program was introduced to the prescribers. A medical bulletin was developed and divided into two

Table I: The intervention plan by month

Month	Intervention plan
January 2009	Distribution of Bulletin with information related to drug interaction management and drug dosage for the cardiovascular system, endocrine system, and central nervous system.
February 2009	• Presenting results in the Pharmacy and Therapeutic Meeting. • Providing feedback: presenting the pre-phase result. • Reminder letter from director hospital.
March 2009	• Providing feedback: The total number of prescribing errors in which the pharmacy department intervened. • Distribution of Bulletin with information related to Beers Criteria and the quality of prescription writing.
April 2009	Academic detailing

parts. The first part of bulletin discussed the management of drug–drug interactions and drug dosing information. The second part informed the prescribers about the Beer criteria, error prone abbreviations and other information. Both parts were printed and distributed to the prescribers. These bulletins were easy to keep and carry for reference during the prescribing of medications. Academic detailing was also introduced to every doctor in the institute. Each meeting spent around 10-20 minutes discussing topics including the definition of prescribing errors and the consequences and characteristics of prescribing errors. At the same time, the prescriber was shown the example of prescribing errors.

SPSS version 15.0 was used to analyse the data in the present study. The Chi square test was used to evaluate the effectiveness of the interventions as the target of reduction was 10% of the total prescribing errors after the interventions.

RESULTS

Table II shows the frequency of distribution of prescriptions by patients' demographic data in pre- and post- interventions for improving prescribing errors. It was found that the prescriptions without any errors were increased by 5.3% after the intervention plan. The intervention plan significantly helped to reduce prescribing errors with P value < 0.05.

Table III shows the frequency of the distribution type of prescribing errors before and after implementation of educational programs.

DISCUSSION

In this study, it was found that the factors which contributed to the prescribing errors included a lack of awareness about prescribing errors and their severity, and insufficient knowledge about the medications among prescribers. This is because the majority of the prescribing errors were knowledge-based errors such as inappropriate dosing, potential drug-drug interaction and contraindication. These prescribing errors happened when the prescribers did not have adequate knowledge of the medications. Errors may also have occurred because the prescribers were not aware of the severity of the complications caused by these errors, even when they knew their prescribing patterns might be contributing to the prescribing errors. The contributing factors revealed in the present study were similar to those found in other studies (Al Khaja *et al*., 2007; Bobb *et al*., 2004; Leape, 1994). The educational programs can make doctors aware of the prescription errors and may cause them to change their prescribing patterns, especially when they are familiar with the feedback data (Mirco *et al*., 2005).

The distribution of patient demographics like age and gender were similar in both phases: geriatric patients were the main clients in the outpatient department and most of the patients were female. However, lesser number of patient visited the outpatient department during post-phase as compared to that visited the pre-phase. This influenced the number of total prescriptions which fulfilled the inclusive criteria, which were 1699 instead of 2500 prescriptions. The less number of prescriptions with inclusive criteria meant that all prescriptions had to be evaluated and screened to identify prescribing errors during the post-phase. The randomized sample technique was therefore not required for the post-phase since all the prescriptions fulfilling the inclusive criteria were selected for evaluation. If the total number of prescriptions with inclusive criteria per year had remained the same, the confidence interval for the sample size of 1699 would have been 2.265% (95% confidence), which would have been slightly higher than the target (2% confidence interval, 95% confidence) but acceptable.

The intervention plan aimed to reduce prescribing errors by 10% but this was not achieved because there was only a reduction of 9.8% of total prescribing errors after the interventions. The target was based on the literature review, in which the reduction in prescribing errors varied from 7-30% for educational interventions (Burmester *et al*., 2008; Meyer, 2000; Peeters and Pinto, 2009; Thomas *et al*., 2008). There were a few reasons that the target was not achieved.

First, it was impossible to preclude knowledge-based prescribing errors because of the limitations for assessing the patients' information: the patients' kept their own medical records so as to convince them to visit any health care clinic. Therefore, most of the important laboratory results were untraceable at this hospital. This may have caused the majority of prescribing errors to appear to be knowledge-based, as it was impossible to rule out even some of them as unlikely to cause error. Thus, these errors were categorized as potential prescribing errors. Subsequently, the intervention plan was unable to reduce the baseline prescribing errors as targeted.

Second, the time between implementing the intervention plan and assessing its effectiveness was too short. Educational interventions take time to convince doctors to change their prescription writing behaviors or treatment management plans (Gill *et al.,* 1999). These interventions need to continue increasing prescribers' awareness of potential problems and convincing them to change their prescription writing behavior in order to obtain the highest quality prescription writing process. It is believed that the reduction target may be achieved

with on-going educational interventions, as these interventions are highly dependent on the responsiveness of the prescribers (Mirco *et al*., 2005) and the cumulative effect of the interventions (Burmester *et al*., 2008). This was shown by Meyer (2000), who found that two years ongoing education program resulted in an improvement in the quality of prescription writing.

No doubt, it is not easy to convince doctors to change their prescription writing behavior. Gill's findings showed the studies with education interventions provided positive findings and none of the previous studies showed a negative effect on changing behavior (Gill *et al*., 1999). However, it has been shown that educational interventions are unable to provide a high rate of reducing prescribing errors, unlike electronic prescribing. Jani et al. (2007) found that the implementation of electronic prescribing in a pediatric renal out-patient clinic helped to increase the number of error-free visits by nearly 69%, while Thomas et al. (2008) found that there was only a reduction in the number of errors between 2-13% after the first educational intervention plan and 16% at the final audit. Furthermore, educational programs took time to reduce prescribing errors. In conclusion, there was not an immediate, dramatic decrease in prescribing errors immediately following the educational intervention.

The intervention plan for the present study had three main aims: 1) to make prescribers aware of prescribing errors, 2) to educate them, and 3) to enhance the interventions. The reminder letter and the provision of feedback were aimed at making prescribers aware of the severity of prescribing errors in the institute. The letter, written by the hospital director, was sent to every prescriber in the health care institute. There does not appear to have been any previous studies that have attempted to reduce the number of prescribing errors by means of a reminder letter. However, a reminder letter from the director of the hospital is helpful, especially when the hospital setting is small. In the present study, the hospital only had seven general practitioners and the director of the hospital was in charge of them. The letter described the increasing trend of prescribing errors and reminded them of this issue. Reminder letters helped them keep this in mind during the prescription writing process. However, especially in a tertiary or secondary hospital, a reminder letter may not be successful because it may not reach every doctor if there are a large number of them.

Providing feedback was a method tried by Franklin et al. (2007) and which was presented systematically according to clinical specialty and sent to the clinicians. The response was good. The present study presented the feedback report in two parts: the total number of prescribing errors according to their characteristics, and the graph showing error-free prescriptions versus prescriptions containing at least one error. This presentation was similar to that used by Franklin et al. (2007), who used graphic summaries and lists of errors identified. The hospital in the present study was a non-specialty hospital. Therefore, it was not necessary to compare prescribing errors between different specialties. From the findings, the feedback helped to increase the prescribers' awareness on prescribing errors, especially omission and skill-based errors. It was suggested that it was necessary for the health care institute to provide routine feedback to its practitioners because this keeps them informed about prescribing errors.

Educational programs are always discussed as a means of reducing prescribing errors (Burmester *et al*., 2008; Meyer, 2000; Thomas *et al*., 2008; Velo and Minuz, 2009). Different types of educational programs were implemented in these studies, depending on the study location. In the present study, the educational programs were focused on providing information to the prescribers. Educational programs such as continuing professional education talks (CPEs) were not considered; it was impossible to gather all the prescribers together since at least two of them were on duty every day. This decision was based on previous attendance at CPE talks in the hospital. Instead, bulletins were introduced. The bulletin could be distributed and read in the prescribers' own time. It was also easier to use as a reference during the prescription writing process.

The bulletin was developed based on the present findings. Drug-drug interactions and dosages were discussed in the first bulletin. This provided the prescribers with information about managing drug-drug interaction. The interactions were categorized according to their severity. The dosage and frequency of drugs prescribed for cardiovascular disease, endocrine disorders and the central nervous system were in the bulletin. The first bulletin focused on providing prescribers with a quick reference regarding dosage and frequency, and even the management of drug-drug interactions, for use during the prescription writing process and while discussing treatment plans with patients.

Another bulletin was mainly focused on the importance of the prescription components and on exposing the prescribers to the Beers Criteria. In this bulletin, the reasons for filling in the prescription components and their importance were discussed. The bulletin also encouraged prescribers to avoid using abbreviations in the prescriptions by showing them examples of abbreviations prone to cause prescribing errors. Therefore, this bulletin was aimed to make the prescribers aware of the medications that should not be prescribed to elderly patients.

Academic detailing is a good way of interacting with the prescribers and understanding their prescription writing

Table II: The distribution of prescriptions by patient's demographic data

Criteria		**Frequency** (pre-phase)		**Frequency** (Post-phase)	
		N	**%**	**N**	**%**
Total prescriptions with the targetted chronic diseases		2750	100	1699	100
Total prescriptions for sample study		2500	90.9	1699	100
Total prescriptions without any potential prescribing errors		1164	46.6	851	50.1
Total prescriptions with potential prescribing errors		1336	53.4	848	49.9
Total prescriptions		**2500**	**100**	**1699**	**100**
Gender					
Male		1062	42.5	702	41.3
Female		1438	57.5	995	58.6
Total		**2500**	**100**	**1699**	**100**
Age					
<30		65	2.6	32	1.9
31-40		116	4.6	72	4.2
41-50		391	15.6	278	16.4
51-60		690	27.6	442	26.0
61-64		246	9.8	185	10.9
65-70		414	16.6	268	15.8
>70		492	19.7	417	24.5
Age not indicated in the prescription		86	3.4	5	0.3
Total		**2500**	**100**	**1699**	**100**
Indications (diseases) listed on prescription					
Yes		2381	95.2	1621	95.4
No		119	4.8	78	4.6
Total prescriptions		**2500**	**100**	**1699**	**100**
Total prescribing errors including potential prescribing errors (a prescription can contain more than 1 errors)		2748	100	1685	100
Total prescribing errors: Total prescriptions		1.1:1		0.99:1	
The rate of omission prescribing errors			4.76		0.65
The rate of skill-based prescribing errors			1.10		0.30
The rate of knowledge-based prescribing errors			94.14		99.05
	P value				
Total prescriptions containing one or more prescribing errors	0.025	1336	53.4	848	49.9
Total prescriptions with omission errors	0.000	129	5.16	10	0.6
Total prescriptions with skill-based errors	0.002	30	0.9	5	0.1
Total prescriptions with knowledge-based errors	0.51	1254	50.5	836	49.4

Note: It was estimated that total prescribing errors (post-phase) were 2479 if reviewing 2500 prescriptions. Chi square test was conducted at alpha level=0.05.

problems. It can enhance the effectiveness of the previous interventions. In addition, academic detailing is an immediate way of encouraging the prescribers to change their writing behavior and influence their clinical decision making (Shaw et al., 2003). Academic detailing also provided information about prescribing errors to the prescribers, making them aware of the problem. Each academic detailing lasted around 30 minutes, covering the complications of prescribing errors, the characteristics of prescribing errors, the common prescribing errors and the management of prescribing errors such as improving handwriting, avoiding inappropriate use of medication and prescribing the proper dosage.

Omission errors and skill-based prescribing errors with P value < 0.05 were significantly reduced after the intervention plan which helped to reduce these minor prescribing errors. The bulletin provided information about abbreviation-prone errors and the prescription components. This gave prescribers the chance to understand the consequences of using abbreviations inappropriately. Additionally, prescribers were told what

Table III: The frequency distribution of the type of prescribing errors before and after implementation of educational program

Criteria	Total prescribing errors including potential prescribing errors			
	(Pre-phase)		(Post-phase)	
	N	**%**	**N**	**%**
Omission prescribing errors				
Patient level	93	3.4	9	0.53
age	85	3.1	5	0.29
RN	2	0.1	1	0.06
Date of prescription	6	0.2	3	0.18
Prescriber level (prescriber specialty, cop and signature missing)	22	0.8	0	0
Prescription data element	16	0.5	2	0.12
Frequency of the medication	4	0.1	1	0.06
Duration of the medication	12	0.4	1	0.06
Skill-based errors				
Drug name confusion/ alike/ incomplete in the prescription, name of medicine was not clear due to bad handwriting	22	0.8	1	0.06
Inappropriate abbreviation	8	0.3	4	0.24
Knowledge-based errors				
Wrong information				
-Wrong patient	0	0	0	0
-Wrong drug	3	0.1	1	0.06
-Wrong route	0	0	0	0
-Wrong dosage form	0	0	1	0.06
-Inappropriate dose	375	13.7	199	11.81
Too high	3	0.1	0	0
Too low	372	13.5	199	11.81
-Wrong strength	9	0.3	1	0.06
-Wrong direction	0	0	0	0
-Wrong frequency	25	0.9	21	1.25
Inappropriate medication or unspecified medication (medication ordered was not appropriate for patient based on indication, patient specific variables or clinic status)	22	0.8	3	0.18
A medication without indication (a medication was prescribed without any indication)	36	1.3	6	0.35
An indicated disease without receiving medication (patient did not receive medications for his/ her disease)	16	0.6	19	1.13
A medication was ordered that was not on formulary at the institute	2	0.1	0	0
Drug-drug interaction (a medication was prescribed that had a potential interaction with current disease / drug regimen)	1857	67.6	1274	75.60
Mild	150	5.5	86	5.10
Moderate	1487	54.1	952	56.50
Severe	220	8.0	236	14.00
Medication duplication (2 or more medications in the same therapeutic class were prescribed for the patient resulting in unnecessary duplication)	13	0.5	5	0.30
Contraindication (contraindication with the disease or drug, inappropriate prescribing for a geriatric patient -Beer criteria)	229	8.3	139	8.25
Total	2748	100	1685	100

information they should include in the prescriptions and the reasons for this. Moreover, the academic detailing provided direct interaction between the pharmacist and the doctors. During academic detailing, prescribers were able to discover the common types of prescribing errors they were making.

Thomas Reuter Mobile Micromedex (Version 6.1), The British National Formulary (Version 54) and the Malaysia Index of Medical Specialties (Volume 112) were among the main references used to evaluate these errors, especially any possible drug-drug interactions. However, these errors were categorized as potential errors. The limitation of study directly contributed to the inability to preclude these errors from prescribing errors as they still have the potential for undesired and adverse effects especially in the geriatric population. The Nifedipine immediate-released tablet is a medication that should be avoided in the geriatric population (Fick *et al*., 2003). However, the Nifedipine immediate-released tablet was one of the most common dihyropyridine calcium channel blockers used in the Malaysian health care system due to the restriction of drug choice and the availability of this dosage form in the Malaysian Ministry of Health Formulary. Therefore, the intervention plan was not ineffective when it came to reducing knowledge-based prescribing errors especially in the category of drug-drug interactions and contraindications.

Contrarily, it was found that other knowledge-based prescribing errors were reduced after the intervention plan. These errors were easier to measure and preclude as prescribing errors. However, knowledge-based prescribing errors like drug-drug interactions and contraindication prescriptions required more information and the patient's laboratory results, for example, to preclude them. Therefore, many of the knowledge-based prescribing errors contributed to the potential prescribing error rate. Moreover, the self-reporting system used by the health care institute to identify adverse events caused by prescribing errors did not help to preclude these errors since it was unreliable and always provided a low reporting rate. Self-reporting leads to radical underestimation and only detects about 1 in 20 cases of adverse events (Bates, 2000).

Limited patient's information on each prescription was identified as the limitation for the present study. The limited information available to build up a clear picture of the actual situation regarding prescribing errors, together with the lack of documentation, may have contributed to an over or underestimation, especially in relation to knowledge-based prescribing errors.

The study can be improved by screening patient records instead of prescriptions. These records can provide detailed information about the prescriptions and patients. The health care institution should also ensure the educational intervention was implemented with an ongoing effort to ensure the effectiveness of the plan. At the same time, the study can be improved by evaluating and comparing the effectiveness of single interventions and combined interventions in reducing prescribing errors.

Despite the certain limitations, in this study the educational intervention strategies were found to successfully reduce the prescribing errors in the hospital. The prescribers welcomed the intervention strategies and they became more aware and concerned about this issue. A combination of educational programs provided a significant, positive outcome to improve the prescribing errors. These should become yearly routine interventions to ensure patient safety in hospital.

CONCLUSION

The intervention plans providing feedback, educational programs, and academic detailing help to improve the prescribing errors. It is believed that these interventions should be continued in order to ensure patient safety within the health care institution.

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