Pattern of medication errors among inpatients in a resource-limited hospital setting

M Thirumagal,[1] M A R Ahamedbari,[1] N R Samaranayake,[2] C A Wanigatunge[3]

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[1]Ministry of Health, Nutrition & Indigenous Medicine, Baddegama Wimalawansa Thero Mawatha, Colombo, Sri Lanka
[2]BPharm Degree Program, Department of Allied Health Sciences, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Soratha Mawatha, Nugegoda, Sri Lanka
[3]Department of Pharmacology, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Soratha Mawatha, Nugegoda, Sri Lanka

Correspondence to
Dr N R Samaranayake, Department of Allied Health Sciences, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Soratha Mawatha, Nugegoda 10250, Sri Lanka.; nithushr@sjp.ac.lk

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ABSTRACT

Purpose of the study There are limited studies on medication errors in South Asian and South East Asian regions. To bridge this gap, we assessed prescribing errors and selected medicine administration errors among inpatients, and the level of acknowledgement of prescribing errors by specialist physicians in a resource-limited hospital setting.

Study design The study was conducted in two medical wards of a hospital in Sri Lanka. Prescribing errors were identified among medicines prescribed in the latest prescription of randomly selected inpatients. Medical notes, medication histories and clinic notes were information sources. Consistency of medicine administration according to prescribing instructions was assessed by matching prescriptions with medicine charts. The level of acknowledgement of prescribing errors by specialist physicians of study wards was assessed by questionnaire.

Results Prescriptions of 400 inpatients (2182 medicines) were analysed. There were 115 patients with at least one medication error. Among the 400 patients, 32.5% (n=130) were prescribing errors. The most frequent types of prescribing errors were 'wrong frequency' (10.3%, n=41), 'prescribing duplications' (10%, n=40), 'prescribing unacceptable medicine combinations' (6%, n=24) and 'medicine omissions' (4.3%, n=17). Medicine charts of 10 patients were inconsistent with prescribing instructions. Wrong medicine administration frequencies were common. The levels of acknowledgment of prescribing errors by the two specialist physicians were 75.5% and 90.9%, respectively.

Conclusions Prescribing and medicine administration errors happen in resource-limited hospitals. Errors related to dosing regimen and failing to document medicines prescribed or administered to patients in their records were particularly high.

INTRODUCTION

Medication errors are a serious problem all over the world.[1] They are preventable errors that cause unnecessary burden to patients and healthcare cost.[2] Medication errors are commonly classified according to the stage of the medication use process in which it occurs: prescribing errors, transcribing errors, dispensing errors and medicine administration errors.[3] The pattern of medication errors reported previously has shown that prescribing errors occur more frequently, followed by medicine administration errors and dispensing errors.[4 5] Although there is ample information on the types and frequencies of medication errors, a clear drawback is that most of these studies are reported from the West.[6–8] The lack of studies related to medication errors in South Asian and South East Asian regions has been clearly highlighted in the literature.[6]

To address this research gap, we studied the types and frequency of occurrence of prescribing errors and medicine administration accuracy according to prescribing instructions in a resource-limited hospital setting. We also assessed the level of acknowledgment of prescribing errors by specialist physicians in charge of the study wards.

METHODS

The study setting was a state sector secondary care hospital in Sri Lanka, a lower middle income country in South Asia. State sector hospitals in this region operate with limited resources. The study hospital has 370 beds but usually patient admissions exceed bed capacity. Medicines available in the hospital are based on the National Hospital Formulary and are distributed to wards through a floor stock system. Therefore, pharmacists have limited involvement in dispensing medicines to inpatients.[9] The medication order is written by the prescriber on the patients' clinical note (bed-head ticket) which is manually transcribed by the nurse to the 'medicine chart'. The latter is used to chart medication administrations. Professional clinical pharmacy services do not exist and hence there is no orderly system of screening for medication errors.

A cross-sectional prospective study was conducted in two medical units under two specialist physicians (two male wards and one female ward operated with shared nursing staff but separate medical staff) and the total bed strength of the medical wards was approximately 110. The admission rate was about 30–40 patients per day. While admission to each unit took place every other day, each ward had daily admissions.

All patients who were admitted to medical wards and had been seen by a ward doctor at least once, received at least one prescription medicine, and in conscious status were included in the study. Patients of all age groups, gender and all disease conditions were considered.

A representative sample from eligible patients was calculated to be 384, considering a confidence level of 95% and proportion of medication errors from past studies as 50% (as there were no previous studies to indicate medication error rates in Sri Lanka). Therefore, 400 patients were selected using a systematic random sampling method. Patients in every other bed who were admitted to the respective wards were included until the minimum sample size was achieved. Floor patients were excluded.

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Table 1 Demographic characteristics of study participants

Characteristic	Total (n=400)	Men (n=237)	Women (n=163)	p Value**
Mean age (SD)*	52.5 (19.0)	51.3 (18.7)	54.3 (19.3)	0.97
Age groups in years (%)				
<20	7.0	8.0	5.5	–
21–40	20.0	21.1	18.4	–
41–60	35.0	36.7	32.5	–
61–80	31.8	29.5	35.0	–
>80	6.2	4.7	8.6	–
Total number of medicines analysed	2182	1245	937	<0.001
Mean (SD) number of medicines per prescription	5.5 (3.0)	5.2 (3.0)	5.8 (3.0)	–
Maximum – minimum medicines per prescription	Min –1 Max –15	1 14	1 15	–

*SD, standard deviation; **p<0.05 was used to compare men and women.

The study spanned a period of 1 month. Two research pharmacists visited the wards every day in the afternoon to collect data.

The research pharmacists used the latest prescription and the related medicine administration chart in the medication records of a patient as the main source for identifying prescribing and medicine administration errors. A detailed medication history and clinic records were used as supplementary sources of information. The information gathered was transferred into a predetermined data collection format. Other than the medicines information obtained from the latest prescription of the patient, supplementary information such as demographic data, social history, presenting complaint/s, past medical history, allergy and sensitivity status, current medications taken by the patient (at home), other medications (over-the-counter medicines and herbal medicines) and relevant laboratory tests were recorded. The prescribing instructions in the prescription were matched with the corresponding medicines chart to ensure medicines were administered accurately. A prescribing error not detected at the medicines administration stage is usually taken as two medication errors (one prescribing and one medicine administration error) in previous studies. However, we did not follow this methodology as nurses in Sri Lankan hospitals would mostly follow prescribing instructions with minimal interference with prescribing accuracy. Hence, an unintercepted prescribing error was only counted as one error. Informed consent was obtained from patients before data were collected.

In-house definitions and criteria used for identification of prescribing and medicine administration errors are detailed in online supplementary table 1. The British National Formulary[10] and Australian Medicines Handbook[11] were used as the main reference sources when suspected scenarios were matched with the above definitions. Each patient entry and all prescribing and medicine administration errors identified by research pharmacists were reviewed and endorsed by a senior clinical pharmacologist and a senior pharmacist. Clinical judgement, evidenced-based literature and support of a reliable online interaction finder (drugs.com) was used when determining whether an interaction was clinically significant.

Prescribing errors identified were sent in statement form to the two specialist physicians in charge of the wards and their level of acknowledgement of prescribing errors (yes/no) and additional comments were requested. The errors were sent to the physicians as a batch after completing the data collection period. Prescribing errors acknowledged with a 'yes' by specialist physicians were considered as acceptance of the need to correct.

SPSS Version 19 was used for analysis. The number of patients was used as the denominator when calculating percentages. A χ^2 test was used to compare categorical data. Pearson's correlation coefficient was used to assess the relationship between the number of medicines in a prescription and the number of medication errors. A 5% significance level was used to determine significant p values.

RESULTS

We assessed prescriptions of 400 inpatients which included the analysis of 2182 medicines. There were 237 (59.2%) men and 163 (40.8%) women. Their demographic data are shown in table 1. The mean (SD) age of the study participants was 52.5 (19.0) years. The majority of men and women were above the age of 40 years. The mean (SD) number of medicines in a prescription was 5.5 (3.0).

Among the 400 patients the total number of errors found was 142 (35.5%), with 130 (32.5%) errors related to prescribing and 12 (3%) errors related to medicine administration. There were 115 (28.8%) patients with at least one medication error. No significant differences were observed between the error type in men and women (p=0.22), although errors related to men were higher in number. A significant correlation (p<0.001) was seen between the total number of medicines in prescriptions and the total number of medication errors.

Subcategories of prescribing errors are shown in table 2. Among the subcategories, wrong frequencies (n=41), prescribing duplications (n=40), prescribing unacceptable medicine combinations (n=24) and medicine omissions (n=17) were frequently

Table 2 Subcategories of prescribing errors

Subcategory	Total (n=130)	
	N	%*†
Wrong frequency	41	10.3
Prescribing duplications	40	10.0
Prescribing unacceptable medicine combinations	24	6.0
Medicine omissions	17	4.3
Wrong dose	2	0.5
Medicine missing in prescription	2	0.5
Wrong route	1	0.3
Wrong dosage form	1	0.3
Medicine interactions (clinically significant)	1	0.3
Other wrong medicines	1	0.3

*Number of patients was used as the denominator for calculating percentages (n=400).
†Percentages do not add up to 100 due to rounding.

Table 3 Description of prescribing errors

Description	Frequency (n=130)
Wrong medicine errors	
Prescribing duplications	40
Duplication of antihistamines	3
Salbutamol dry powder inhaler and nebulisation prescribed together	24
Duplication of corticosteroids	4
Duplication of beta blockers	3
Ipratropium inhaler and nebulisation prescribed together	1
Omeprazole oral and IV prescribed together	1
Duplication of antibiotics in the same group	2
Duplication of angiotensin-converting enzyme inhibitors	1
Duplication of antidiabetic drugs in the sulfonylurea group	1
Prescribing unacceptable combinations	24
Captopril and losartan	2
Ranitidine and omeprazole	8
Metoclopramide and domperidone	5
Prochlorperazine and domperidone	3
Metoclopramide and prochlorperazine	1
Famotidine and omeprazole	1
Prochlorperazine and betahistine	3
Betahistine with domperidone	1
Medicine omissions	17
Failing to prescribe folic acid for patient taking phenytoin sodium	1
Treatment given in clinic for diabetes mellitus but not continued in ward*	6
Treatment given in clinic for hypertension but not continued in ward*	5
Treatment given in clinic for asthma but not continued in ward*	3
Treatment given in clinic for ischaemic heart disease but not continued in ward*	2
Medicine missing in prescription	2
Patient taking drugs from clinic prescription but not documented in the ward prescription	1
Omeprazole given at PCU continued but not documented in ward prescription	1
Medicine interactions (clinically significant)	1
Ciprofloxacillin with theophylline	1
Other wrong medicines	1
Aspirin prescribed to a patient allergic to the drug	1
Wrong frequency	41
IV meropenem prescribed to be taken twice a day instead of 8-hourly	2
Losartan prescribed in divided dose and not as once daily dose	31
Ceftriaxone prescribed to be taken three times a day	6
Telmisartan prescribed to be given twice a day instead of daily	1
IV omeprazole 40 mg prescribed to be given twice a day instead of daily	1
Wrong dose	2
NSAIDs prescribed to a patient with chronic renal failure	2
Wrong route	1
Furosemide dose more than 50 mg not prescribed to be given as infusion	1
Wrong dosage form	1
Furosemide doses more than 50 mg not prescribed to be given as infusion	1

*It was considered as one omission error when the treatment for a disease was omitted and the exact numbers of medicines omitted were not known.
PCU, primary care unit; NSAIDs, non-steroidal anti-inflammatory drugs.

Table 4 Description of medicine administration errors

Description	Frequency
Wrong frequency	7
Ceftriaxone twice a day dose given at 14.00 and 20.00 hours	1
Paracetamol prescribed to be given six-hourly but was given three times a day	1
Ipratropium prescribed to be given six-hourly but was given three times a day	1
Salbutamol nebulisation prescribed to be given six-hourly but was given three times a day	2
Paracetamol prescribed to be given three times a day but was given twice a day	1
Metformin prescribed to be given three times a day but was given twice a day	1
Medicine missing in medicine chart	5
Diazepam 5 mg stat dose given but not documented in medicine chart	1
Morphine 2.5 mg given but not documented in medicine chart	1
Patient was taking the prescribed clinic medicines on her own but not documented in medicine chart	1
Hydrocortisone 200 mg injection stat dose given not documented in medicine chart	1
Chlorpheniramine 10 mg injection stat dose not documented in medicine chart	1

observed. A summary of the descriptions of prescribing errors is shown in table 3. There were 44 drug interactions that were considered clinically insignificant. The majority were related to the use of enoxaparin, clopidogrel and aspirin together. Losartan tablets 25 mg/50 mg (n=31), salbutamol dry powder inhaler (n=24), injection ranitidine 50 mg (n=8), injection ceftriaxone 1 g (n=6) and metoclopramide tablets (n=5) were medicines frequently associated with prescribing errors.

There were 12 instances where the medicine chart did not match the prescribing instructions. The most frequent were wrong frequencies (n=7) and failing to enter administered medicines into the medicine chart (n=5). Descriptions of medicine administration errors are shown in table 4.

The levels of acknowledgement of prescribing errors by the two specialist physicians were 75.5% and 90.9% respectively. There was no significant difference between the responses of the two specialist physicians (p=0.1850). However, they disagreed in 21.2% of instances (n=7). Both specialist physicians disagreed that concomitant use of ranitidine or famotidine with omeprazole was inappropriate.

DISCUSSION

Our study highlights a serious issue, both in terms of healthcare cost and patient safety, which may have dangerous consequences if ignored. Most hospitals in low income countries have limited resources for providing healthcare which may affect patient safety in many ways. In Sri Lanka, which is a lower middle income country with limited resources, a large number of patients are cared for in state sector hospitals, and usually this number exceeds the number of beds available. Patients with milder ailments have to occupy benches or the floor, and more serious ones have to share beds. There is high potential for 'mix-up' of medication records or medicines among these patients. Due to the limited number of healthcare professionals available to treat a large number of patients, most are overworked and are compelled to spend very little time with a patient, a potential cause for medication errors. In addition, medication safety

screening methods such as computerised prescription order entry with clinical decision support systems and clinical pharmacy services are not available in most of the hospitals operating with limited resources.[9] Our research was carried out among 400 inpatients and aimed to find the occurrence of prescribing errors and selected medicine administration errors in such a resource-limited healthcare setting. We encountered at least one medication error in 115 patients. There were 130 prescribing errors and 12 medicine administration errors. There was a significant relationship between the number of medicines prescribed and the number of medication errors (p<0.001).

There are very few studies that report prescribing error rates in resource-limited settings.[9 10] We conducted a random review on prescribing error rates reported in countries classified by the World Bank as high income countries (online supplementary table 2) for comparison.[11–28] We selected 15 studies conducted in the UK (n=7),[12 14 19 22–25] USA (n=1),[13] Denmark (n=1),[16] Spain (n=1),[26] Belgium (n=1),[18] Croatia (n=1),[17] France (n=1)[27] Singapore (n=1)[15] and Australia (n=1)[20] and found that prescribing error rates ranged from 1.5% to 43.8% in the different settings, compared with 32.5% in our study. However, nine of these 15 studies reported a prescribing error rate below 15%. Two other studies from Malaysia[27] and Indonesia,[28] both middle income countries like Sri Lanka, reported prescribing error rates of 7.0% and 9.7%, respectively, which are also considerably different from the rates reported by us. It was difficult to identify a trend in the occurrence of prescribing errors among countries categorised into different income levels due to high variability of studies published. Study settings, population, research design and denominator used for statistical analysis varied considerably between studies. Nevertheless, the fact that prescribing errors occur at this rate is alarming and needs to be given much attention in healthcare systems. Notably, errors related to dosing regimen were frequently observed in most settings.[12 15 17 22–24 26]

It is difficult to compare medicine administration error rates against other countries as we only assessed if medicines were administered according to prescribing instructions. However, it may be closely related to the 15% of transcription errors reported by Ernawati *et al*.[28] The majority of transcribing errors (55.2%) reported by Ernawati *et al* involved medicines needed by patients not being transcribed onto the medication chart. Similarly, nearly half of the medicine administration errors reported in our study involved failing to enter medicines into the medicines chart, especially IV electrolyte supplementation and stat doses of medicines. Another study conducted by us among an elderly community showed that patients either did not possess their medicines records or had incomplete medicines records which was a particular hindrance to assess the appropriateness of their medication.[29] These findings highlight poor documentation practices that persist in this region and the potential for serious medication errors.

The need to manually transcribe prescribed medicines to the medicine administration chart is still a potential cause of medication errors in low resource settings. Most hospitals in the West have overcome this problem through computerised prescription order entry,[30] using carbon copies of medication orders (written by the prescriber) for charting administered medicines, or by using a common form for both prescribing and charting administered medicines.[20 31] The latter practices are cost-effective ways of alleviating transcribing errors and may be adopted by hospitals with limited resources.

Duplication of medicines (10%, n=40) and unacceptable medicine combinations (6%, n=24) were also observed, and these errors could directly impact patient safety and healthcare expenditure. For example, salbutamol dry powder inhaler was prescribed with salbutamol nebulisation in 24 prescriptions. We observed wrong frequencies prescribed for some antibiotics such as IV meropenem prescribed twice a day instead of 8-hourly (n=2) and ceftriaxone prescribed three times a day (n=6), which could promote antibiotic resistance.

The level of acceptance of the need to correct prescribing errors by both specialist physicians in charge of the study units were satisfactory. It was evident from their comments that some prescribing errors were due to violation of instructions by junior prescribers. There were also prescribing errors that the specialist physicians accepted as mistakes which needed to be rectified. Disagreements were mostly related to unacceptable medicine combinations and medicine omissions, which indicated deviations from adherence to treatment guidelines and evidence-based prescribing practices.

These findings indicate the need for introducing the concept of medication safety as early as undergraduate level. Healthcare professionals need to be trained to make decisions based on reliable and current evidence. Although clinical pharmacology and therapeutics is taught at undergraduate level, this knowledge is not reinforced in a regular manner nor assessed after qualifying. Continuous efforts should be made to disseminate up-to-date evidence-based treatment guidelines among healthcare professionals and conduct audits to ensure implementation of these in order to ensure safe medication practices. We also propose to invest in clinical pharmacy services in hospitals as it would help ensure medication safety among patients[32] and maximum utilisation of available resources.[33]

There are some strengths in our study. The study was carried out among 400 inpatients which included 2182 drugs, which is a large sample. We also used direct reviewing of prescriptions which is more reliable than studies based on incident reports. However, there are limitations that need to be acknowledged. This study was only carried out in one secondary care hospital in Sri Lanka, so the findings may not be generalisable. Similar multicentre studies are needed to assess the situation in the region. This study also did not include all medicine administration errors and we did not shadow medicine administration processes of nurses. The harm to patients due to identified prescribing and medicine administration errors and interventional changes resulting from specialist physicians acknowledging prescribing errors were not assessed. Furthermore, floor patients were not included which may have underestimated potential medication errors. These limitations needs to be addressed in future studies.

CONCLUSIONS

Prescribing errors and medicine administration errors occur among inpatients in low resource settings as commonly as in the West. Among them, errors related to dosing regimen were particularly high, which was similar to reports by most resource rich settings. Failing to enter medicines prescribed or administered

Main messages

- Prescribing errors and medicine administration errors occur in low resource settings as commonly as in the West.
- Similar to reports from the West, errors related to dosing regimen are common.
- Hospitals in low resource settings can ensure patient safety and maximise benefit from available resources by investing in eradicating these medication errors.

Current research questions

- Are resource limitations in hospitals a significant cause for some medication errors?
- Are medication errors a significant burden to the healthcare cost in low and middle income countries?
- Are healthcare professionals aware of medication errors that happen and of unsafe practices that potentiate medication errors?

to patients in their medicines records was a commonly observed drawback that led to both prescribing and administration errors. These are important findings for hospitals in low and middle income countries as eradicating these errors will ensure patient safety and save resources for the country.

Correction notice This paper has been amended since it was published Online First. Owing to a scripting error, some of the publisher names in the references were replaced with 'BMJ Publishing Group'. This only affected the full text version, not the PDF. We have since corrected these errors and the correct publishers have been inserted into the references.

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Patient consent Obtained.

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