Nature of dispensing errors in selected hospitals providing free healthcare: A multi-center study in Sri Lanka

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Abstract

Background

Dispensing errors may result in patient harm. Dispensing errors are preventable if we knew its nature, but only very little information is available on these errors that occur in limited resourced settings where healthcare is provided free of charge. Therefore, the purpose of this study was to determine the types and prevalence of dispensing errors in selected hospitals in Sri Lanka.

Methods

A prospective, cross sectional and multi-centered study (in one tertiary care and two secondary care hospitals) was conducted among 420 patients attending medical, surgical, diabetes and pediatric clinics of study hospitals, proportioned according to population size, and selected through a systematic random sampling. A prescription audit was conducted. Dispensing errors were categorized as content, labelling, documentation, concomitant, and other errors based on definitions developed in-house. The total number of dispensing errors identified was used as the denominator for calculating percentages.

Results

A total of 420 prescriptions (1849 medicines) were analyzed (Hospital-01, 248 prescriptions with 1010 medicines; Hospital-02, 84 prescriptions with 400 medicines; Hospital-03, 88 prescriptions with 439 medicines), where 16,689 dispensing errors were detected. However, most frequent were labelling errors (63.1%). There were 4.9% content errors, 21% concomitant errors, 10.6% documentation errors, and 0.4% of other errors. No omissions or deteriorated medicines were detected.

Conclusions

Dispensing errors happen in Sri Lankan hospitals that operate with limited resources and provide free healthcare to citizens. However, most were labeling errors with little chance of immediate harm. Content errors were minimal. More emphasis on error-proofing the dispensing process could improve medication safety in these hospitals.

Background

The treatment process is complex, and involves several healthcare professionals with diverse knowledge and skills. Once a patient is diagnosed accurately, the medication use process begins, where medication needs to be prescribed, dispensed and administered correctly to achieve desired therapeutic outcomes. During this process, unintentional errors which are harmful or life-threatening to patients may happen and are termed as medication errors. Medication errors are defined as “failures in the treatment process that leads to or has the potential to lead to harm to patients” (1).
Dispensing itself is a complicated process (2) and involves receiving the prescription, interpreting and reviewing the appropriateness of prescribed medications, calculating required doses, preparing dispensing labels, retrieving and preparing medications, double checking against the prescription, and handing over to patient with required instructions and counseling. The dispensing process could be carried out by a single pharmacist or by a team depending on the available resources. Either way, there is a possibility of errors occurring of which the impact could be numerous (3, 4, 5). There are accepted standards which should be maintained in each dispensing step to prevent errors (6). These standards vary depending on the country, where the process may be automated, semi-automated or manual. In most countries, it is a legal requirement for dispensing to be performed under the supervision of a registered pharmacist though there could be an involvement of dispensers or automation (7, 8, 9).

Dispensing errors have been identified all over the world and published in literature (2). Errors have even been detected within automated systems (10, 11). Although dispensing errors are unintentional, it is important to identify their prevalence and types, in order to minimize if not to prevent them (12). Globally several studies have been carried out to investigate factors that causes dispensing errors (2, 12, 13) which has helped some countries to improve medication safety and implement preventive measures. However, it must be emphasized that the nature of dispensing errors and their casualties may differ by the type of healthcare setting and should not be generalized.

Dispensing errors cause an additional burden to healthcare systems (4). Middle-income developing countries such as Sri Lanka, lacks adequate resources both financial and human to co-op with this additional demand caused by dispensing errors and adverse drug events.

Healthcare services in Sri Lanka are provided free of charge. More than 80% of the population benefit from this free service, where 54 million patients attend the outpatient departments and 25.8 million patients attend various clinics conducted by State hospitals, annually (14). However, given the economic status and non-profit services provided, the Sri Lankan healthcare system operates with resource limitations, including medicines limited to an Essential Medicines List (15, 16, 17). As the pharmacist is the last healthcare professional outpatients encounter, and a dispensing error committed at this stage is bound to reach the patient, error-proofing and strengthening the dispensing process in outpatient care is an absolute necessity in these hospitals.

There are several studies in Sri Lanka reporting on prescription errors and medication errors (15, 18, 19, 20, 21) but only a few on dispensing errors, their types and prevalence. The study by Hettihewa et al., 2011 (22) reported a low dispenser-patient ratio and the need for introducing a well-prepared medicine labeling system but they did not look for all types of dispensing errors. Hence we still do not have a comprehensive account of dispensing errors that is possible in resource limited settings like Sri Lanka.

Therefore, this study is directed towards acquiring much needed information on types and prevalence of dispensing errors prevalent in resource limited, free of charge healthcare systems like Sri Lanka.

**Methods**

Study design and setting
This study was a prospective cross-sectional and multi-centered study. Three State hospitals representing three different Provinces in Sri Lanka were selected for study. Study hospital 1 (SH1) is the largest tertiary care hospital in the Uva Province with 1493 beds, and 40 medical consultants, serving 295 daily inpatient admissions, 810 daily outpatients and 424,024 annual clinic visits. Study hospital 2 (SH2) is a Type B Base Hospital (A hospital with all basic specialties, medical, diabetic, psychiatric, pediatric and several other clinics) in the Sabaragamuwa Province with 325 beds, and 12 medical consultants serving 120 daily inpatient admissions, 700 daily outpatients, and 126,272 clinic visits per year. Study hospital 3 (SH3) is a Type A Base Hospital (A hospital with all basic specialties, medical, diabetic, psychiatric, pediatric and several other additional specialties like dermatology, ophthalmology) in the North Western Province with 374 beds and 19 medical consultants, serving 175 daily admissions, 740 daily outpatients, and 132,000 annual clinic visits.

Study participants

Men and women, attending medical, diabetic, psychiatric or pediatric clinics in selected study hospitals, prescribed with at least one medicine from the relevant clinic, and obtaining medicines from the study hospital pharmacy were selected for study. Caregivers or family members of patients who had come to collect medicines from the pharmacy and possessed the prescription in hand were also eligible. Those prescribed with external preparations and medical devices only, and patients attending only for counselling sessions at psychiatric clinics were excluded. The population size was approximately 52,942 patients (SH1, 31,336; SH2, 10,606; SH3, 11,000) per month.

Sample size calculation and sample selection

The required sample size was calculated using the Raosoft on-line sample size calculator (Raosoft. Inc), considering a 5% margin of error, 95% confidence level, 50% response distribution and a population size of 52,942. The calculated sample size was 420 patients after accounting for 10% missing data. The calculated sample size was proportioned to the three hospitals based on the outpatient participation of each hospital in each month (SH1, N = 248; SH2, N = 84; SH3, N = 88). The sample size allocated for each hospital was further proportioned to each clinic based on the number of registered clinic attendees in each month.

Data collection

A systematic random sampling method was used to select patients from each hospital. Data were collected on every clinic day, on a selected month, in the morning from 10.00 a.m. to 12.00 noon for morning clinics and 2.00 p.m. to 4.00 p.m. for evening clinics until the sample size was achieved. At 10.00 a.m. the first patient available at the first dispensing counter was selected, and the next available patient in the adjacent counter at the time of completing the review of the first patient, was selected next.

Study process

The prescription of a patient was matched with the corresponding dispensing labels and dispensed medicines to detect dispensing errors. In-house definitions for dispensing errors were developed according to published literature and to suite the study setting (Supplementary Table 1) [See Supplementary Table 1, Additional file 1] as a guide for identification of dispensing errors. Three different pharmacists collected data in the three study settings but all were pre-trained on identification of dispensing errors using hypothetical cases to ensure uniformity. The British National Formulary (23), Australian Medicines Handbook (24), Australian Pharmaceutical
Formulary and Handbook (25) and an online drug interaction checker (26) were used as references when collecting data.

**Statistical analysis**

Data were analyzed using the statistical data analysis package, SPSS (Version 25.0). Results were presented as frequencies and percentages. The denominator used for calculating percentages was the total number of dispensing errors of each category. Dispensing errors of the three hospitals were not compared as it was not an objective of our study. Chi square was used to compare proportions of dispensing errors among clinic types.

**Ethical consideration**

Ethics approval for this study was obtained from the Ethics Review Committee of the University of Sri Jayewardenepura (Ref:85/17). Permission was obtained formally from all study hospitals. Written informed consent was obtained from study participants. Confidentiality of the data and the privacy of the participants were maintained through anonymity.

**Results**

A total of 420 prescriptions and 1849 medicines were evaluated from all three hospitals (SH1, N = 248; SH2, N = 88; SH3, N = 84). A mean of 4.4 medications (SD 2.3) were found in a prescription which ranged from 1–12 medicines (Table 1). A total number of 16,689 dispensing errors were identified. However, the most prevalent dispensing error categories were labeling errors (63.1%) and concomitant errors (21%) which were responsible for 84.1% of the total dispensing errors detected (Table 2).

### Table 1

Summary of prescriptions and medications analyzed

|                | SH1    | SH2    | SH3    | Total  |
|----------------|--------|--------|--------|--------|
| Number of prescriptions | 248    | 84     | 88     | 420    |
| Number of medicines     | 1010   | 400    | 439    | 1849   |
| Mean number of medicines per prescription (SD) | 4.1 (2.3) | 4.7 (2.5) | 5.0 (2.3) | 4.4 (2.3) |
| Total number of dispensing errors detected | 9326   | 3036   | 4327   | 16689  |

*(Total number of prescriptions analyzed was used as the denominator to analyze average dispensing errors per prescription. SD, Standard Deviation)*
Table 2
Summary of different types of dispensing errors in study hospitals

|                | SH 1 (N = 248) | SH 2 (N = 84) | SH 3 (N = 88) | Total (N = 420) |
|----------------|----------------|---------------|---------------|-----------------|
| **Content errors, N (%)** | 477 (5.0%) | 87 (3.0%) | 248 (5.7%) | 812 (4.9%) |
| **Labelling errors, N (%)** | 6146 (65.0%) | 1644 (56.5%) | 2733 (63.2%) | 10523 (63.1%) |
| **Documentation errors, N (%)** | 948 (10.0%) | 400 (13.7%) | 424 (9.8%) | 1772 (10.6%) |
| **Concomitant errors, N (%)** | 1878 (19.9%) | 771 (24.4%) | 858 (19.8%) | 3507 (21.0%) |
| **Other errors, N (%)** | 6 (0.1%) | 9 (0.3%) | 60 (1.4%) | 75 (0.4%) |
| **Total** | 9455 (56.7%) | 2911 (17.4%) | 4323 (25.9%) | 16689 (100.0%) |

(Total number of errors encountered from each hospital was used as the denominator to calculate column percentages. N, Number of prescriptions analyzed. Other errors = Errors made in the dispensing process which are not content, labelling, documentation or concomitant errors)

There were five incidents of dispensing wrong medicines where famotidine was dispensed when omeprazole was written on the prescription but on verbal instructions by the prescriber. The prescription was not corrected accordingly and there was no systematic procedure to record verbal instructions received from the prescriber in this set up. The wrong strength of medicine was dispensed to 62 patients including dispensing of hydrochlorothiazide 25 mg when ‘1 tab’ (one tablet) was written on the prescription. Further examination of patient records revealed that it was intended to be 50 mg and not 25 mg. It was later found that hydrochlorothiazide 50 mg tablets were out of stock and was replaced with 25 mg tablets in the selected hospitals but the prescribers were unaware of this change. The pharmacists had also not verified the prescription with prescribers. Wrong dosage form errors were mainly due to dispensing of modified dosage forms instead of normal release forms which were expected to be administered by breaking or crushing (N = 62). Aspirin 150 mg enteric coated tablets were dispensed instead of aspirin 75 mg tablets (to be broken in half), and sodium valproate 200 mg enteric coated tablets were dispensed instead of 100 mg tablets (to be broken in half). Dispensing the wrong number of medication units was the most prominent content error recorded in all three hospitals. One or two tablets/capsules were issued in excess to the prescribed amount in many instances (Table 3) [See & insert Results (Table 3), Additional file 2].
| Content errors | Example                                                                 | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|----------------|-------------------------------------------------------------------------|----------------|---------------|---------------|------------------|
| Wrong medications | Dispensing of famotidine instead of omeprazole at verbal request of the prescriber but not corrected in the prescription | -              | -             | 05            | 05 (0.6%)       |
| Medication omissions | [No errors detected]                                                | -              | -             | -             | -                |
| Wrong strength | Dispensing of hydrochlorothiazide 25 mg tablets instead of 50 mg when prescribed as 1 tablet in the prescription | -              | 02            | 60            | 62 (7.6%)       |
| Wrong dosage form | Dispensing a slow release form of ISMN 60 mg SR instead of normal release ISMN 30 mg. (Patient was advised to crush it and take the half from ISMN 60 mg SR) | 15             | 07            | 44            | 66 (8.1%)       |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)
| Example | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|---------|----------------|---------------|---------------|------------------|
| Wrong number of units | Issuing 31 tablets of atorvastatin 10 mg instead of 28 tablets (03 tablets were issued in excess) | 462 | 78 | 139 | 679 (83.6%) |
| Deteriorated medicine | [No errors detected] | - | - | - | - |
| Total | 477 | 87 | 248 | 812 (4.9%) |
| Labelling errors | No label with dispensed medicine | Paracetamol 12 tbs SOS was prescribed and 20 paracetamol tablets were dispensed in an envelope with no written information on the envelope. Same was observed with salbutamol and beclomethasone tablets. Insulin 12 IU mane and 10 IU nocte was prescribed and 1 vial of insulin has dispensed in a container without a dispensing label. | - | 21 | 153 | 174 (1.7%) |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)
| Example                                                                 | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|------------------------------------------------------------------------|----------------|---------------|---------------|-----------------|
| Medicine name not indicated on dispensing label (neither generic nor brand) | Verapamil 40 mg tds was prescribed and 84 tablets of verapamil was dispensed with directions to be used, but without indicating the medication name on the dispensing label. | 514 | 34 | 198 | 746 (7.1%) |
| Was commonly observed with paracetamol and chlorpheniramine as well. | Indicating paracetamol as PCM, carbamazepine as CBZ on dispensing label. | 508 | 221 | 288 | 1017 (9.7%) |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors.)
| Example                                                                 | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|------------------------------------------------------------------------|----------------|---------------|---------------|------------------|
| Medicine strength not indicated on dispensing label                    | 907            | 61            | 284           | 1252 (11.9%)     |
| Prescribed aspirin 75 mg nocte and dispensed 28 tablets of aspirin 75 mg tablets in dispensing label indicating only 'aspirin 01 at night' instead of 'aspirin 75 mg take 01 tablet at night' |
| Incorrect or incomplete medicine strength on dispensing label          | 906            | 96            | 278           | 1280 (12.1%)     |
| Indicated thyroxin 50 mg instead of 50 micrograms on dispensing label  |
| Dosage form is not indicated on dispensing label                      | 777            | 221           | 286           | 1284 (12.2%)     |
| Dispensed amoxicillin 125 mg chewable tablets and indicated amoxicillin 125 mg instead of amoxicillin 125 mg chewable tablets on the dispensing label |
| Incorrect or incomplete dosage form on dispensing label               | 233            | 179           | 153           | 565 (5.4%)       |
| Indicating ISMN 60 mg only instead of ISMN 60 mg SR tablet on dispensing label |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)
| Example                                      | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|----------------------------------------------|----------------|---------------|---------------|------------------|
| Failing to attach auxiliary labels           | 127            | 83            | 73            | 283 (2.7%)       |

Additional labels of “Shake the bottle” and “Store in refrigerator” was not attached to reconstituted cephalexin syrup container (Cephalexin was reconstituted in bulk and the required volume was dispensed in a different container without original label indicating these information).

*(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)*
| Example | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|---------|----------------|---------------|---------------|------------------|
| Total quantity of medication dispensed not indicated on dispensing label | 84 tablets of metformin (500 mg tds for 4/52) was dispensed without indicating the total number of tablets (84) on the dispensing label. | 958 | 216 | 416 | 1590 (15.1%) |
| | 56 beclomethe some capsules (400 microgram BD 01 month) was dispensed without indicating the total number of capsules as 56 on the dispensing label. | | | | |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)
| Example                                                                 | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|------------------------------------------------------------------------|----------------|--------------|--------------|-----------------|
| Dosing intervals and frequency not indicated on dispensing label       | 09             | 16           | 40           | 65              |
| Paracetamol two tablets’ written instead of ‘paracetamol two tablets to be taken every 6 hrly |
| Dry powder capsules of salbutamol and beclamethasone as prescribed as 1 capsule bd and it was dispensed to patients without any dosing interval or frequency of administration |
| Was not with dry powder capsules of salbutamol (Asthelin)              |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)
| Example | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|---------|----------------|--------------|--------------|-----------------|
| Duration of medications not indicated on dispensing label | Diclofenac sodium tablets 50 mg bd for 3 days was prescribed. Six tablets were dispensed with directions to be used (one tablet two times per day) but without indicating that the treatment should continue for 3 days. | 966 | 379 | 413 | 1758 (16.7%) |
| Special instructions not provided where necessary | Instruction of 'Take at least half an hour before food' was not on the dispensing label for omeprazole. Swallow whole (Do not crush or chew) for enteric coated tablets such as erythromycin and omeprazole was absent. | 241 | 117 | 151 | 509 (4.8%) |
| Total | | 6146 | 1644 | 2733 | 10523 (63.1%) |

*(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)*
| Documentation errors | Example | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|----------------------|---------|----------------|---------------|---------------|-----------------|
| Pharmacist who dispensed the medications were not indicated on label | - | 948 | 400 | 424 | 1772 (100%) |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)
| Example                                                                 | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|------------------------------------------------------------------------|----------------|---------------|---------------|-----------------|
| Concomitant errors                                                    |                |               |               |                 |
| Clinically significant drug interactions on prescription missed by pharmacist | 38             | 26            | 18            | 82 (2.3%)       |
| Medicines have been dispensed without detecting the drug-drug interactions (Table 4) in the prescription |                |               |               |                 |
| Eg: Both enalapril and spironolactone were prescribed together and the interaction was not detected by the pharmacist. Both medicines were dispensed to be used together |                |               |               |                 |
| Patient name and age not indicated in prescription but ignored by pharmacist | -              | -             | 48            | 48 (1.4%)       |
| Medicine name, route, dosage form not indicated in prescription but ignored by pharmacist | Losartan 1 bd was written instead of losartan 50 mg tablet bd for 1/12 | 922           | 381           | 418             | 1721 (49.0%)     |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)
| Example                                                                 | SH1 (N = 1010) | SH2 (N = 400) | SH3 (N = 410) | Total (N = 1849) |
|------------------------------------------------------------------------|----------------|---------------|---------------|------------------|
| Prescriber not identified in prescription but ignored by pharmacist  | -              | 918           | 316           | 422              | 1656 (47.2%)     |
| Total                                                                  | 1878           | 771           | 858           | 3507 (21.0%)     |
| Other errors                                                           |                |               |               |                  |
| Medications dispensed to wrong patient                                 | Patient was found carrying medications which were left behind in the counter by the previous patient | -              | 1              | -                | 1 (1.3%)         |
| Medications dispensed in unsuitable packaging                           | Glyceryl trinitrate (GTN) and thyroxin were dispensed in a container without light protection | 6              | 8              | 60               | 74 (98.7%)       |
| Total                                                                  | 6              | 9             | 60            | 75               | (0.4%)           |

(Total number of dispensing errors in each category was used as denominator to calculate column percentage. N, Number of dispensing errors)

Prevalence of labeling errors were significantly higher (P < 0.001) in pediatric clinics compared to other types of clinic (Supplementary Table 2) [See Supplementary Table 2, Additional file 3]. It was observed that labelling errors like missing name of the medicine and missing dosage form reduced significantly when using printed labels as opposed to handwritten ones (P < 0.001). However, errors like missing duration of medications prevailed (P = 0.171) even with printed labels.

Eighteen (2.3%) clinically significant drug interactions were detected among 82 prescribed medications (Table 4) and most were related to the psychiatry clinics (N = 49, 63.6%). Only one incident of dispensing to a wrong patient was detected where a patient had picked a medication pack accidently left behind by another patient.
**Table 4**

| Interacting medicine pair               | Severity of interaction* | Frequency |
|-----------------------------------------|--------------------------|-----------|
| Clopidogrel, omeprazole                 | Major                    | 3         |
| Fluoxetine, clopidogrel                 | Major                    | 1         |
| Haloperidol, promethazine               | Major                    | 2         |
| Olanzapine, clonazepam                  | Major                    | 11        |
| Enalapril, spironolactone               | Major                    | 1         |
| Amitriptyline, fluoxetine               | Major                    | 3         |
| Losartan, spironolactone                | Major                    | 2         |
| Imipramine, haloperidol                 | Major                    | 1         |
| Pioglitazone, clopidogrel               | Major                    | 1         |
| Haloperidol, lithium                    | Major                    | 2         |
| Haloperidol, chlorpromazine             | Major                    | 2         |
| Sodium valproate, lamotrigine           | Major                    | 1         |
| Haloperidol, fluphenazine               | Major                    | 3         |
| Captopril, potassium chloride           | Major                    | 1         |
| Imipramine, fluoxetine                  | Major                    | 1         |
| Enalapril, potassium chloride           | Major                    | 1         |
| Olanzapine, topiramate                  | Major                    | 3         |
| Clonazepam, topiramate                  | Major                    | 1         |

*Severity of interactions as denoted in the Drugs.com (26), drug interaction checker

**Discussion**

We assessed 420 prescriptions (1849 medicines) and a total of 16,688 dispensing errors were detected. However, most of these dispensing errors were related to labelling errors where immediate harm was not expected. In this study at least, one dispensing error was detected in all 1849 prescriptions (100%) like a study done in Brazil by Anacleto et al., (27) who also reported that 81.8% prescriptions (among 345 prescriptions) had at least one dispensing error. Most studies have reported a lower rate of dispensing errors than we have. An American study in 2003 reported a dispensing error rate of 3.6% (among 5,075 prescriptions, 140,755 medication doses) (4), a study in France in 2009, a rate of 2.5% (among 734 unit dose medication cassettes) (28), and a study in UK in 2002, a rate of 2.1% (among 849 dispensed items) (12). However, it was difficult to assess if all these studies had used the same explicit definitions as we did to justify comparison. A review on dispensing errors also revealed that dispensing error rates varied between countries (0.015–33.5%) depending on the dispensing...
system, research method, and classification of dispensing error types (29). Our study looked at the full range of errors that could take place in the dispensing process.

Labeling errors, documentation errors, content errors and concomitant errors were the dispensing error types assessed by most other studies (27, 29, 30, 31). While content errors were most frequent in other reported studies (4, 28, 29) labelling errors (63.1% n = 10523) were the highest in ours. Nevertheless, findings like our study have also been reported by developed countries like USA where Flynn and Breger (1999) (32) reported 80% of dispensing errors to be wrong labelling information in the ambulatory care setting, and James et al. (2), reported a labeling error rate of 58.2% followed by 41.8% of content errors in a Welsh (UK) national hospital setting.

All content errors could cause serious harm to patients. In this study, among the 4.9% content errors, most were on dispensing the wrong number of medication units (83.8% (n = 540)) where one or two tablets were issued in excess to the prescribed quantity. Although this seems a trivial mistake, consequences of dispensing extra doses to patients could be harmful. Besides, wastage of medicines will undoubtedly add to the healthcare cost especially in limited resource settings like Sri Lanka. A similar pattern was also reported by Cina et al., (4) from USA (2006) where highest dispensing errors reported were related to supply of the wrong quantity of medications (59%, n = 2970). Even among the few content errors found in this study, wrong medications and wrong strength errors were minimal (9% and 11% respectively) (4). In contrast, most common content errors reported in UK were wrong medications (23.0%), wrong strength (23.0%), wrong directions (10.0%) or wrong quantity (10.0%) errors in 2002 (33). Another UK study by Beso et al., in 2005 found missing doses as the highest (n = 16) followed by incorrect strength (n = 15) and incorrect drug (n = 11) among a total of 70 (54%) content errors and 130 dispensing errors (12). In Thailand, the dispensing error rate was 1.68 per 10,000 prescriptions in State hospitals and 55.7% of them were wrong medications, 19.4% were wrong strength and 10.0% were wrong dosage form errors (31).

It is also noteworthy that the labeling errors we found were mostly missing information compared to incorrect information reported by others (2, 3, 4, 12). Of the missing information, duration of treatment (N = 1758, 16.7%), quantity of medication dispensed (N = 1590, 15.1%), dosage form (N = 1284, 12.2%) and medication strength (N = 1280, 12.1%) were the most frequent. In contrast, other studies mostly reported wrong medicine details on the label (34, 35). Hettihewa et al., 2011 reported that pharmacists in Sri Lanka spent less than a minute (0.81 minutes) on dispensing medicines to a patient and this could be the major reason for many labelling errors (22). A single pharmacist must cater for many patients which limits the time spent on one patient (36) and can be a reason for omitting details on handwritten medicines labels. Although labeling errors cannot cause direct harm, such malpractices could lead to issues such as patient non-compliance, overdose due to duplications and even sub therapeutic outcomes. Hence system errors of this nature must be given due importance to minimize dispensing errors.

Prescribing errors which were not detected by pharmacists, categorized as concomitant errors, are also important as they have penetrated through two barriers, the prescriber and the pharmacist. We reported 20 clinically significant drug interactions which were missed by pharmacists which is serious issue. In addition, this category also contained errors with no immediate harm such as incompleteness of prescriptions which the pharmacist ignored (N = 3427/3507). Silva et al. (2008) (37) too found 615 (87.9%) medicines dispensed without the dosage form being specified in a Brazilian hospital. While the prescriber could not be identified in 8.4% of prescriptions dispensed in Brazil (37), we reported similar results where 10.4% of prescriptions had missing prescriber
identification. Potential errors such as missing information should be corrected through system improvement as it could turn into a fatal error someday.

This study was a multi-centered study but the three hospitals were selected through convenience sampling, thus limiting the generalizability of results. Three pharmacists independently collected data in the three study settings and slight variations were inevitable when collecting data, despite an initial training given to minimize such variations. It was also possible that most of the missing instructions in dispensing labels were given verbally (only the written instructions were considered) by pharmacists which were not assessed during the study and was a marked limitation. Harm caused by dispensing errors were not monitored, hence harm that could occur after a period, incapacities and related hospitalizations are not reported in this study. Though this was a multi-centered study results of each study setting were not compared as our objective was only to stage the prevalence and types of dispensing errors that takes place in hospitals in Sri Lanka

Conclusions

This study was on dispensing errors conducted in three State hospitals in Sri Lanka using explicitly detailed definitions and methodology to cover all aspects of dispensing errors. Many dispensing errors were observed in these selected Sri Lankan hospitals but most were labeling errors with no immediate harm expected. Content errors were minimal in contrast to other published research on dispensing errors.

It is highly recommended that all pharmacists should be made aware of dispensing errors that happen including the system related errors that could lead to patient harm. Even dispensing errors that leads to medication waste cannot be justified in resource limited healthcare systems such as Sri Lanka. Streamlining and formalizing the dispensing process is a must for developing countries as this could filter out many of the dispensing hazards that could arise due to limited resources. The standard of the prescriptions should also be improved thorough continuous awareness programs. We recommend national guidelines on dispensing medicines to be developed to suit resource limited settings and to implement these guidelines throughout the country.

Abbreviations

UK
United Kingdom
USA
United State of America

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the Ethics Review Committee of the University of Sri Jayewardenepura (Ref:85/17). Permission was obtained formally from all study hospitals. Written informed consent was obtained from study participants.

Consent for publication
All authors consent for publication

**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

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Study was conducted through self-funding of the authors.

**Authors’ contribution**

R.A.N. Dilsha was involved in data analysis, results interpretation and major contribution in writing the manuscript. H.M.I.P. Kularathne was involved in data collection (Study Hospital 02), data analysis, results interpretation and drafting the manuscript. M.T.M. Mujammil and S.M.M. Irshad was involved in the data collection (Study Hospital 01 and Study Hospital 02 respectively) and data analysis. N.R. Samaranayake as the supervisor of this research guided and contributed to conception, designing the study, results interpretation and correcting the manuscript.

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