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Prevalence of Prescribing Errors in Treating Children with Asthma in Major State Hospitals in a District of Sri Lanka: A Cross-Sectional Study

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Abstract

Objective: Due to the complexity of medical management, errors are common in medical prescriptions. The objective of the study was to describe the prevalence of prescribing errors related to hospitalized children with asthma in major state hospitals in a district in Sri Lanka.

Methods: This was a descriptive cross-sectional study carried out in paediatric units of state hospitals of a district in Sri Lanka. The study population comprised of 577, 2-12-year-old children receiving treatment for acute exacerbation of asthma. Different types of prescribing errors were defined. A record sheet was used to extract relevant information from the Bed Head Tickets (BHT). The prevalence of prescribing errors was calculated for each type of error.

Results: Overall prevalence of prescribing errors was 12.9 (95% confidence interval 12.4%-13.3%) per hundred drug orders. The prevalence of different types of prescribing errors showed a high variation ranging from 0% to 65.2%. There was zero prevalence of prescribing of the wrong drug, and omission of drug without indicating it in the BHT. Other types of prevalence of prescribing errors were inadequate dilution of a drug (65.2%), inadequate route of administration of a drug (37.6%), omission of time of administration (28.0%), wrong dose and units (11.9%), wrong dosing interval of a drug (2.9%), illegible handwriting (3.7%), and recording the drug in the drug chart without being prescribed (1.3%).

Conclusion: The frequency of prescribing errors for asthma among paediatric cases was high. A systems approach to minimize the errors leading to the improvement of patients' safety is recommended.

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Background

To prescribe is to give advice and/or authorize the use of a medicine or treatment for a patient. Although there is a standard method of writing a prescription, many physicians use their own style when prescribing medicine. Committing errors is human, and due to the complexity of medical management, errors are common in medical prescriptions as they are written by humans. A report by the Institute of Medicine titled "To Err is Human" reveals that significant amounts of medical errors are preventable [1]. Clinically meaningful prescribing errors occur because of a prescribing decision or the prescription writing process [2]. As a result, there is an unintentional significant reduction of treatment effect or an increase in the risk of harm when compared to the generally accepted practice [2].

A systematic review revealed that the prevalence of prescribing errors ranged from 0.24 to 89.6 errors per 100 orders of high risk medicines [3]. However, there was a great variation in the rates of prescribing errors as the definitions, study settings, and method of data collection differed [4]. In a study conducted in the UK, the incidence of prescribing errors was 20% for inpatient prescriptions. Most of the errors (54%) were associated with the choice of dose [2]. A study conducted in Italy found that the prevalence in prescribing errors among paediatric patients was 11.4% [5]. In another study the prevalence of prescribing errors was found to be 10% [6]. A study conducted in England found that 43.8% of prescriptions contained at least one error [7]. The overall prevalence of prescribing errors ranged from 20% to 60% across hospitals [7]. The most common types of errors were omission of medications (26.9%), writing errors (20.7%) and dosing errors (20.6%) [7]. A study conducted in a neonatal intensive care unit of a Brazilian university hospital found 43.5% prescribing errors [8]. The percentage of prescribed drugs with one or more errors was 36.7%.

Countries which adopt advanced technology as common practice use computer-based methods for prescriptions which are designed to minimize errors. In Sri Lanka however, paper-based methods are still practiced, and only limited information are available to assess the prevalence of prescription errors in healthcare settings using paper prescriptions. Prescribing errors are also considered to be a component of medical errors which is in turn related to patient safety. Probability of committing prescribing errors by physicians with regard to dosage occurs especially when the dose has to be computed based on the body weight. Specifically when using drugs with narrow therapeutic doses, a change in small doses could result in drastic adverse outcomes. The objective of the study was to describe the prevalence of prescribing errors related to hospitalized children with asthma in major state hospitals in a district in Sri Lanka.

Methods

This was a descriptive cross-sectional study carried out from September to December 2010. The study was conducted in paediatric units of all state hospitals in the Gampaha district which were managed under a consultant paediatrician. In the district, there are four hospitals with such paediatric units; namely Colombo North Teaching Hospital Ragama (CNTHR), District General Hospital Gampaha (DGHG), District General Hospital Negombo (DGHN) and Base Hospital Wathupitiwala (BHW). These four hospitals serve a population of 2,304,833 [9]. The CNTHR has three paediatric units, whereas the other three hospitals have only one each.

The study population was children aged 2-12 years diagnosed with asthma by a consultant paediatrician and admitted with an acute exacerbation to paediatric units of the said hospitals. Children with congenital heart or other lung diseases were excluded from the study.

In Sri Lanka, prescribing errors in an inpatient setting among hospitalized children has not been previously studied. Therefore, the expected prevalence of prescribing errors was considered as 50% to obtain a maximum sample size. It was calculated based on the critical value of 1.96 corresponding to a confidence level of 95% and precision of 0.05. Each unit was considered as a cluster due to variations in individual management practices. Therefore, the sample size was inflated by applying a design effect of 1.5 which gave a final sample size of 576.

All children who were admitted for any respiratory tract infection were first identified from the unit admissions register. Among them, children with an acute exacerbation of asthma were selected based on the diagnosis written on the Bed Head Tickets (BHT). The objective of the study was explained to the caregivers, and informed written consent was obtained. All eligible children with the consent of caregivers were recruited consecutively from the commencement of the study until the sample size was fulfilled.

An Interviewer-Administered Questionnaire (IAQ) was used to obtain information regarding personal information about the child, current and past history of asthma and treatment s/he is on. The questionnaire was administered to the caregivers on the day of the discharge. A record sheet was used to extract relevant information on prescribing errors from the BHT. Pretesting of the record sheet was done using the BHTs of a similar group of children at the CNTHR. After the pretesting of record sheet, necessary adjustments were made and finalized. It included the following information: history of illness and prescribed medications, weight of the child, name of the drugs, whether the drugs were indicated for asthma, their dose and the units, route of administration of the drugs, frequency of administering the drugs, whether each drug prescribed has been entered in to the drug chart, any prescribed drug that has been omitted from the drug chart without written instructions in the BHT for discontinuing the drug , time related to administration of the drugs, whether dilution is clearly stated for drugs which need to be diluted before use, whether infusion rate is clearly stated for infused drugs, and whether the prescribed drug is written legibly. Above information was collected in relation to all the drugs prescribed on the BHT from admission to discharge regardless of the status of the medical officer who prescribed it. With regard to drugs that were repeated, this information was collected only in relation to the initial prescription made.

Determining the prevalence of prescribing error was based on the "American Society of Health System Pharmacist's Standard Definition of Medication Errors" [5]. This includes 10 types of errors which could be committed during prescribing. Error 1: "Prescribing wrong medication" was defined as a drug that is contraindicated for the patient. This was assessed according to Sri Lankan Guidelines on Asthma [10]. Error 2: "Wrong dose" which was defined as a) inaccurate total daily dose according to weight (over/under dosing), b) using wrong units or c) lack of documentation of the dose. The weight-based doses were calculated according to the child's weight on admission recorded in the BHT. The doses of the drugs were checked against the British National Formulary (BNF) for children [11]. Error 3: "Inadequate route of administration" was defined as not docu-

menting the route of administration in the BHT or prescribing the inaccurate route according to BNF [11]. Error 4: "Wrong dosing interval" was defined as the frequency of the drug being incorrectly stated or, not stated according to the BNF [11]. Error 5: "Omission of time" which was defined as non-inclusion of the time of administration of the drug when writing the prescription in the BHT. Error 6: "Omission of a written prescription" was defined as non-inclusion of a prescription in the BHT, although the drug has been listed in the drug chart (prescription based only on verbal orders). Error 7: "Omission of a drug" was defined as a drug that had been administered and then omitted without indicating in the BHT. Error 8: "Inadequate dilution of a drug or solution" was defined as over dilution or under dilution of a drug [11]. Error 9: "Inadequate intravenous infusion rate" was defined as infusion rate not being clearly documented. Error 10: "Illegible handwriting" was defined as inability to read the prescription by both the first author and the research assistant.

Data collection was performed by the first author and four research assistants who were pre-intern medical officers. The first author conducted a two-day training programme for the research assistants prior to conducting the study. One research assistant was allocated to each hospital. They visited the paediatric wards daily and study participants were chosen according to the selection criteria stated above. The first author collected data related to the record sheets by visiting two hospitals per day. The BHT of the remaining two hospitals were kept in the unit (on request) for the data to be collected on the following day. Interruptions for routine activities due to data collection procedures were kept minimal. Data collectors were instructed to maintain confidentiality and privacy of the caregiver and child at all times.

Data entry and analysis were done by using SPSS version 16. Subsequent to data entry, frequency distributions of variables were also carried out. The discrepancies of data and missing entries were rectified by referring to the original questionnaire. Prevalence of medication errors is the proportion of the number of medication errors that are present during the hospital stay out of all medication orders. The prevalence of prescribing errors was calculated for each type of error in relation to each medication. Then the prevalence of prescribing errors was calculated for each type of error in relation to all the medications. Finally, overall prevalence of prescribing errors and its 95% confidence interval was calculated.

The Ethics Review Committee of the Faculty of Medicine, University of Kelaniya granted ethical clearance (P45/05/2010). Informed written consent was obtained from the parents prior to data collection. Administrative clearance for the data collection was obtained from Regional Director of Health Services of the Gampaha District.

Results

Five hundred and seventy seven children aged 2–12 years admitted to all paediatric wards of Gampaha district for the treatment of asthma during the study period were recruited to the study. An almost equal number of study participants were included from the CNTHR (n=149, 25.8%) and the BHW (n=148, 25.6%) and from the DGHN 142 (24.6%) and from the DGHG 138 (23.9%). Age of the children ranged from 24 months to 143 months. The mean age was 60.6 months (SD=28.7 months). The highest proportion (43.7%, n=252) of study participants were in the 24-48 months age group. The lowest proportion (3.6%, n=21) of study participants belonged to 10-12 years of age. Male and female proportions were almost equal being 49.7% (n=287) and 50.3% (n=290) respectively.

Of all the participants, 568 (98.4%) children had a past history of asthma and the remaining nine (1.6%) were diagnosed for the first time. Thirty (5.2%) children had developed asthma before the age of 12 months and the highest number of 330

Table 1: Distribution of hospitalized children with asthma by the drugs they received.

Drugs received	Number of children N=577	%
Nebulizer medications		
Salbutamol	563	97.6
Ipratropium	209	36.0
Bronchodilators		
Oral Salbutamol	238	41.2
Oral etophylline and theophylline	313	54.2
Oral Terbutaline	114	19.7
Steroids		
Oral Prednisolone	423	73.3
IV hydrocortisone	113	19.6
Antibiotics		
Oral Antibiotic	315	54.6
IV Antibiotic	24	4.2
Other drugs		
Paracetamol	264	45.7
Chlorpheniramine	119	20.6

(57.6%) had developed asthma between the ages of 13 to 36 months. Mean age at the onset of asthma was 35.9 (SD=20.2) months and median 30 months.

None of the children belonged to the "mild" category of asthma according to acute asthma classification. Moderate and severe categories of asthma were observed in 88.6% (n=511) and 11.4% (n=66) respectively. Based on chronic asthma classification, majority belonged to mild persistent asthma (81.3%, n=469) whereas moderate persistent asthma was11.3% (n=65). Severe persistent asthma was observed only in a minority of 1% (n=6) and mild intermittent asthma among 4.9% (n=28) of the study population.

All drugs prescribed for the children from the time of admission to the time of discharge is presented in Table 1. The most used drug was nebulized salbutamol followed by oral prednisolone.

The prevalence of inadequate dilution of nebulized drugs (Error 8) was highest for salbutamol (76.19%) followed by Ipratropium (59.8%). Furthermore, inaccurate dosing (Error 2) and omission of time of administration of the drug when writing the prescription in the BHT (Error 5) were observed to be the next highest occurring prescribing errors (Table 2).

Inadequate route of administration (Error 3) was commonly observed for oral bronchodilator drugs. The highest prevalence was for salbutamol (51.3%) followed by combined etophylline and theophylline (50.5%) and terbutaline (38.6%) (Table 3).

With regard to the steroids, the prevalence of inadequate route of administration (Error 3) was highest for oral prednisolone (58.1%) followed by intravenous hydrocortisone (12.6%). Prevalence of omission of time of administration of the drug when writing the prescription in the BHT (Error 5) was 27.0% for hydrocortisone and 22.2% for oral prednisolone (Table 4).

For the oral antibiotics, the prevalence of inadequate route of administration (Error 3) was 43.9% followed by the prevalence of (23.4%) omission of time of administration of the drug (Error 5). Considering the intravenous antibiotics, Error 5 was observed in only 12.5% of the prescriptions (Table 5).

There were no recorded instances in the BHT of using wrong medications for any of the drugs (Error 1). The prevalence of total daily dose and units of the drug that were incorrectly stated (Error 2) for both nebulizing drugs (>38%) with the prevalence of prescribing error 2 was 11.9% (Table 6). Stating the inadequate route of administration (Error 3) was high for most of the drugs, except for intravenous antibiotics (0%) and Ipratropium nebulization (4.3%) with the prevalence of prescribing error 3 of 37.7%. Wrong dosing interval of administering the drug (Error 4) was mostly observed for salbutamol nebulization (7.99%) and Chlorpheniramine (5.0%) with the prevalence of prescribing error 4 of 2.9%. Omission of time of administration of the drugs (Error 5) was highest for oral terbutaline (39.47%), and paracetamol (38.6%), and lowest among intravenous antibiotics (12.5%) with the prevalence of prescribing error 5 of 28.0%. Omission of a written prescription (Error 6) was comparatively low among all drugs and mostly observed for Chlorpheniramine (2.5%) and oral antibiotics (2.2%) with the prevalence of prescribing error 6 of 1.3%. Omitting the drug without instructions in the BHT to discontinue the drug (Error 7) was not observed. Inadequate dilution of a drug (Error 8) was only relevant for three drugs, where salbutamol nebulization recorded the highest (76.19%) with the prevalence of prescribing error 8 of 65.2%. Inadequate intravenous infusion rate (Error 9) was not relevant for any of the drugs. With regard to illegible prescriptions (Error 10), intravenous hydrocortisone recorded the highest error (6.1%) with the prevalence of prescribing error 10 of 3.8% (Table 6). Overall prevalence of prescribing errors was 12.9 (95% confidence interval 12.4%-13.3%) per hundred drug orders.

Table 2: Distribution of nebulizer medications prescribed to asthmatic children by types of prescribing errors.

	Salbutamol nebulization		Ipratropium nebulization	
Prescribing errors	N=563		N=209	
	n	%	n	%
Error 1 Wrong medication	0	0%	0	0%
Error 2 Wrong dose	214	38.01%	81	38.75%
Error 3 Inadequate route of administration	19	3.37%	9	4.30%
Error 4 Wrong dosing interval	45	7.99%	0	0.0%
Error 5 Omission of time of administration	182	31.50%	67	32.05%
Error 6 Omission of a written prescription	2	0.35%	3	1.40%
Error 7 Omission of a drug without indicating in the BHT	0	0%	0	0%
Error 8 Inadequate dilution of a drug	429	76.19%	125	59.80%
Error 9 Inadequate intravenous infusion rate	NR	NR	NR	NR
Error 10 Illegible handwriting	18	3.10%	11	5.20%

NR: Not Relevant

Table 3: Distribution of oral bronchodilator drugs by types of prescribing errors.

Prescribing errors	Oral Salbutamol		Oral etophylline and theophylline		Oral Terbutaline	
	N=238		N=313		N=114	
	n %		n %		n %	
Error 1 Wrong medication	0	0%	0	0%	0	0%
Error 2 Wrong dose	3	1.26	0	0	2	1.75
Error 3 Inadequate route of administration	122	51.26	158	50.47	44	38.59
Error 4 Wrong dosing interval	6	2.52	3	0.95	0	0
Error 5 Omission of time of administration	59	24.78	59	18.84	45	39.47
Error 6 Omission of a written prescription	0	0	0	0	0	0
Error 7 Omission of a drug without indicating in the BHT	0	0	0	0	0	0
Error 8 Inadequate dilution of a drug	NR		NR		NR	
Error 9 Inadequate intravenous infusion rate	NR		NR		NR	
Error 10 Illegible handwriting	13	2.50	17	5.40	6	5.20

NR: Not Relevant

Table 4: Distribution of corticosteroids prescribed for children with asthma by types of prescribing errors.

Prescribing errors	Oral Steroid		IV Hydrocortisone	
	N=423		N=113	
	n %		n %	
Error 1 Wrong medication	0	0%	0	0%
Error 2 Wrong dose	9	2.12%	2	1.80%
Error 3 Inadequate route of administration	246	58.15%	14	12.60%
Error 4 Wrong dosing interval	6	1.41%	3	2.70%
Error 5 Omission of time of administration	94	22.20%	30	27.02%
Error 6 Omission of a written prescription	0	0%	0	0%
Error 7 Omission of a drug without indicating in the BHT	0	0%	0	0%
Error 8 Inadequate dilution of a drug	NR		23	20.72%
Error 9 Inadequate intravenous infusion rate	NR		NR	
Error 10 Illegible handwriting	13	3.00	7	6.10

Table 5: Distribution of antibiotics, paracetamol and Chlorpheniramine prescribed to children with asthma by types of prescribing errors.

Prescribing errors	Oral Antibiotics		Intravenous Antibiotics		Paracetamol		Chlorpheniramine	
	N=321		N=24		N=264		N=119	
	n %		n %		n %		n %	
Error 1 Wrong medication	0	0%	0	0%	0	0%	0	0%
Error 2 Wrong dose	5	1.55%	0	0%	3	1.13%	3	2.52%
Error 3 Inadequate route of administration	141	43.92%	0	0%	189	71.50%	74	62.18%
Error 4 Wrong dosing interval	6	1.86%	0	0%	5	1.89%	6	5.04%
Error 5 Omission of time of administration	75	23.36%	3	12.5%	102	38.63%	39	32.77%

Error 6 Omission of a written prescription	7	2.18%	0	0%	20	7.50%	3	2.52%
Error 7 Omission of a drug without indicating in the BHT	0	0%	0	0%	0	0%	0	0%
Error 8 Inadequate dilution of a drug	NR		NR		NR		NR	
Error 9 Inadequate intravenous infusion rate	NR		NR		NR		NR	
Error 10 Illegible handwriting	11	3.40%	0	0	3	1.13%	3	2.52%

NR: Not Relevant

Table 6: Summary of types of prescribing errors related to medications prescribed for children with asthma.

	Error 1	Error 2	Error 3	Error 4	Error 5	Error 6	Error 7	Error 8	Error 9	Error 10
	%	%	%	%	%	%	%	%	%	%
Salbutamol nebulization	0	38.01	3.37	7.99	31.50	0.35	0	76.19	NR	3.10
Ipratropium nebulization	0	38.75	4.3	0	32.05	1.4	0	59.8	NR	5.20
Oral Salbutamol	0	1.26	51.26	2.52	24.78	0	0	NR	NR	2.50
Oral etophylline and theophylline	0	0	50.47	0.95	18.84	0	0	NR	NR	5.40
Oral Terbutaline	0	1.75	38.59	0	39.47	0	0	NR	NR	5.20
Oral prednisolone	0	2.12	58.15	1.41	22.20	0	0	NR	NR	3.00
Intravenous Hydrocortisone	0	1.8	12.6	2.7	27.02	0	0	20.72	NR	6.10
Oral antibiotic	0	1.55	43.92	1.86	23.36	2.18	0	NR	NR	1.55
IV antibiotic	0	0	0	0	12.50	0	0	NR	NR	0
Oral paracetamol	0	1.13	71.5	1.89	38.63	7.5	0	NR	NR	1.13
Oral Chlorpheniramine	0	2.52	62.18	5.04	32.77	2.52	0	NR	NR	2.52
Overall prevalence of error %	0	11.9	37.7	2.9	28.0	1.3	0	65.2	NR	3.8

NR: Not Relevant

Discussion

Prevalence of prescribing errors showed a high variation, ranging from 0% to 65.2%. Prescribing the wrong drug and omission of drugs without written instructions in the BHT was 0% which are encouraging findings. The prevalence of other errors were; 65.2% for not stating the dilution, 37.6% for not stating the route of administration, 28.0% for not stating time of administration of drugs, 11.9% for inadequacies in dose and units, 3.7% for illegible handwriting, 2.9% for stating incorrect dosing interval of the drug, and 1.3% for entering the drug in the drug chart without a prescription being written in the BHT.

The study by Tully [4] found the prevalence of prescribing errors to be 15% and Paula found it to be 11.4% [5]. In two more studies, [2,12] the prevalence of prescribing errors was 1.5% and 3.33%. In two studies [7,13] in England prescribing errors were identified in 14.7% and in 43.8% of the prescriptions. In a Brazilian study, [8] the prevalence of prescription errors was 43.8% at a neonatal intensive care unit and in a study done in a Saudi Arabian hospital [14] revealed that the prescription error rate was 56% among the paediatric inpatient admissions.

For the purpose of determining prescribing errors primarily three types of study settings, namely wards, emergency departments [6,7,8,13,14] and pharmacies [2] are used. The definition of prescribing errors was not consistent across the studies. Tully stated that due to unknown reasons different researchers use different definitions for their studies, and some of them develop their own definitions [4]. The current study used American Society of Health System Pharmacist's Definition of Prescribing Errors, [5] which was thought to be more relevant for the study design and setting concerned. In the study done in England, EQUIP error classification with ten types of errors, was used[6] and in the study by Machado, Neofax database was used [8].

A study conducted in Spain [15] found the prevalence of 15% for illegible handwriting and a prevalence of 11.4% in Saudi Arabia [14]. Although the prevalence of illegible handwriting (Error 10) was low in the present study, it is still a concern when considering the safety of the patients. In the hospital setting this may not be a major issue as it can be clarified. However, with outdoor prescriptions this can lead to a serious situation putting the safety of the patient at stake. The best solution is to computerize the process and failing that, to make it compulsory for the physicians to write prescriptions using block letters so that the name of the drug can be read clearly. The error rate in relation to dosage was low (10.1%) in the present study in comparison to 22.1% reported by Al-Jeraisy, [14] and 20.6% reported by Sedan [7]. Incorrect dosage can lead to over or under dosing both having its adverse consequences. Overdosing can lead to increase in side effect/ adverse reactions and signs of toxicity,

whereas under dosing can prolong the illness and cause doubts about the diagnosis. Franklin has reported a low error rate (4%) than that of the present study [13].

The findings can only be generalized with respect to the treatment of asthma among paediatric cases admitted to the state hospitals in the district studied.

In relation to ten different prescribing errors varied from 0% to 65%. Improvement in prescribing drugs for the treatment of asthma among hospitalized pediatric patients is necessary. A document containing details including date, time, drug, dose, route, dilutions and infusion rates with the name and the signature of the prescribing medical officer should be made available to all doctors in the pediatric wards.

Declarations

Competing interest

"The authors declare that they have no competing interests" in this section.

Authors' contributions

NP participated in the design of the study, coordinated data collection, performed the statistical analysis and helped to draft the manuscript. CA participated in the design of the study, performed the statistical analysis, interpreted the data and drafted the first version of the manuscript. All authors read and approved the final manuscript.

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