ASSESSMENT OF PRESCRIBING AND ADMINSTRATION ERRORS IN PEDIATRIC INPATIENTS IN BLACK LION SPECIALIZED HOSPITAL AND ZEWDITU MEMORIAL HOSPITAL, ADDIS ABABA, ETHIOPIA

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Abstract

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Medication errors are cause of patient morbidity and mortality. The implication on the health care organization and the cost confirmed its importance as global problem. The aim of this study was to assess the type and frequency of prescribing and medication administration errors (MAEs) in the pediatric wards of Black Lion Specialized Hospital and Zewditu Memorial Hospital in Addis Ababa, Ethiopia. Facility based cross-sectional study was conducted. Retrospective data from 2008-2010 G.C of 2401 medical records to assess prescribing error and prospective observation on 27 nurses administering drug to pediatric inpatients was done. Five thousand eleven prescribing errors were documented in the indicated period. The prescription writing error were the most frequent 2386 (99.4%), followed by wrong dose 1673 (69.67%), drug-drug interaction 767(31.9 %) and wrong frequency 185(7.7%). The most frequently occurring drugs involved in wrong dose and frequency was ceftriaxone (586 times). The most frequent drug-drug interaction was the concurrent prescribing of ampicillin and gentamicin (610 times). More than two diagnoses (AOR = 1.66 95% CI= 1.32- 2.13) was significantly associated with wrong dose. Two (AOR=1.87 95%CI=1.39- 2.52) and more than two diagnoses (AOR=6.00, 95% CI 4.64- 7.77) were significantly associated with drug-drug interaction. Age group and number of diagnoses were not found to have a statistically significant effect on prescription writing error. The frequency of medication administration errors were 71 (35.5%). Wrong dose administration 50 (70.4%), omitted drug 18(25.4%) and wrong

timing 3(4.2%) were the types of medication administration errors occurred**.** Ceftriaxone was the most commonly involved drug in all the three errors. Frequency of occurrence of prescribing and administration error was high. Awareness creation, continuing medical education and comprehensive researches on medication errors should be done to know more about it and improve the situations.

Keywords: Medication administration error, prescribing error, medication errors, inpatient, pediatrics.

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Acronyms

A&E	Accident and Emergency
AAU	Addis Ababa University
ACE	Angiotensin Converting Enzyme
AOR	Adjusted Odds Ratio
CI	Confidence Interval
CNS	Central Nervous System
CSA	Central Statistical Agency of Ethiopia
FDREMOH	Federal Democratic Republic of Ethiopia Ministry of Health
FMHACA	Food, Medicine and Healthcare Administration and Control Authority
IV	Intravenous
JUSH	Jimma University Specialized Hospital
MAE	Medication Administration Error
MSH	Management Science for Health
NCCMERP	National Coordinating Council for Medication Error Prevention and Control
NHS	National Health Service
NPSA	National Patient Safety Agency
OR	Odds Ratio
PI	Principal Investigator
SOP	School of Pharmacy
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization

1. Introduction

1.1. Background

Medication usage is a multidisciplinary process, which begins with the doctor's prescription, followed by the review and provision of medications by a pharmacist, and ends with the preparation and administration of the medication to the patient by a nurse (Khowaja et al., 2008). These multiple steps in the medication chain leads to significant scope for error and overwhelming consequences for the patient and for the career of the healthcare professional (MSH, 2009; Khowaja et al., 2008).

Patient safety must be the primary aim in every clinical setting. Medication errors have important implications for patient safety and their identification is a main target in improving clinical practice errors including prevention of adverse events (Montesi and Lechi , 2009).

Hospitalized children are more susceptible to experiencing complications as a result of medication errors than adults, but, again, the adverse event rates seem to be similar. The reason is that adult patients receive standard doses, whereas newborns and children are medicated according to their weight and clinical condition. This requires several calculations by the physician who writes the prescription, which increases the likelihood of errors. Moreover, most medicines are intended for adults and are presented as dosage forms that are in unsuitable concentration for children. As a result, clinicians who assist neonates, often extremely small, premature infants, have to adapt these drugs for children who cannot take adult dosage forms. This requires a number of steps that increase the likelihood of mistakes (Otero et al., 2008).

1.1.1. Definition of Medication Errors

There is inconsistency in defining medication errors as well as lack of agreed up on definitions. Most of the definitions were profound, including minor deviations as well as

fatal errors, whereas a single definition was restricted to harmful or potentially harmful errors (Lisby et al., 2010). However, the broadly accepted one is any error in the prescribing, dispensing, or administration of a drug, irrespective of whether such errors lead to adverse consequences or not, are the single most preventable cause of patient harm (Williams, 2007).

The US National Coordinating Council for Medication Error Reporting and Prevention defines a "medication error" as

"Any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use." (NCCMERP, 2005).

1.1.2. Types of Errors

There is no universal classification for different types of medication errors. However, it is common to classify based on psychological approach, the stage at which error occur during medication use. Numerous types of medication errors occur. For research purposes, the errors are subdivided and classified in different ways. However, the classification is not universal (Kozer et al 2006, Williams, 2007).

Based on a psychological approach, medication error divides into mistakes, slips, or lapses. Mistakes defined as errors in the planning of an action and may be knowledge-based (e.g. giving a medication without having established whether the patient is allergic to that medication) or rule-based. Rule based errors can further be classified as either the misapplication of a good rule (e.g. injecting a medication into the non-preferred site) or

the application of a bad rule or the failure to apply a good rule (e.g. using excessive doses of a drug). Slips and lapses are errors in the performance of an action – a slip through an erroneous performance (e.g. writing the more familiar 'chlorpropramide' instead of 'chlorpromazine') and a lapse through an erroneous memory (giving a drug that a patient is already known to be allergic to). Technical errors are the result of a failure of a particular skill (e.g. in the insertion of a cannula) and are therefore a subset of slips (skill-based errors) (Williams, 2007).

Medication errors may also be classified according to where they occur in the medication use cycle, i.e. at the stage of prescribing, dispensing, or administration of a drug. Prescribing errors may be defined as the incorrect drug selection for a patient. Such errors can include the dose, quantity, indication, or prescribing of a contraindicated drug (Williams, 2007).

Dispensing errors occur at any stage of the dispensing process, from the receipt of the prescription in the pharmacy to the supply of a dispensed medicine to the patient. And include selection of the wrong strength or product. (Williams, 2007).

Administration errors occur when a discrepancy occurs between the drug received by the patient and the drug therapy intended by the prescriber. Drug administration has long been associated with one of the highest risk areas in nursing practice, with the 'five rights' (giving the right dose of the right drug to the right patient at the right time by the right route) being the cornerstone of nursing education. Drug administration errors largely involve errors of omission where the drug is not administered for a variety of reasons. Other types of drug administration errors include an incorrect administration technique and the administration of incorrect or expired preparations (Williams, 2007).

1.1.3. Causes of Medication Errors

Many factors are associated with drug errors including verbal and written communication problem, knowledge deficit, verbal order incorrect, illegible handwriting, failure to comply with policies, look-alike drug names (e.g. Lasix® (furosemide) and Losec® (omeprazole)) and calculation error (Hickner et al., 2010).

Abbreviations instead of full names of drugs and similar names of drugs found to be the most common causes of medication errors in a study done in Tehran, Iran (Cheragi et al., 2013). IU (International Unit) may be mistaken as IV (intravenous) or 10(ten) µg Mistaken for "mg" (milligrams) resulting in an overdose.

System related factors include complex and poorly designed systems, poor teamwork, and psychological and environmental stressors such as fatigue, anxiety, poor lighting, and noise are the causes for medication errors (Kaushal et al., 2001).

The World Health Statistics Report of 2012 showed that among the total population of Ethiopia estimated at about 83 million in the year 2010; people aged less than 15 years old constituted 41% (WHO, 2012).

1.2. Statement of the Problem

Most studies done on medication error in different countries showed that prescribing errors and administration errors were important errors to consider (Pote et.al., 2007;Sujata et.al., 2011).

The incident rate of medication errors varies between 2 and 14% of patients admitted to hospital, with 1–2% of patients in the US being harmed as a result, and the majorities are due to poor prescribing (Williams, 2007). In 2007, National Patient Safety Agency (NPSA) statistics showed that 59.3% of medication errors occurred during the

administration stage (Kumar et.al, 2011). The human and societal burden is even greater with many patients experiencing costly and prolonged hospital stays and some patients never fully recovering to their premorbid status. Finally, the psychological impact of errors should not be ignored. Errors erode patient, family, and public confidence in healthcare organizations. Memories of error can haunt providers for many years (Moyen et al., 2008).

Since majority of medications are developed in concentrations appropriate for adults, determining pediatric dosages can be complicated and liable to prescribing and administration errors (kozer et al., 2006). As a result, pediatric patients are at higher risk of encountering such errors than adults. Despite the fact that medication errors result in harm to the patient and also have related costs, little studies are done on the extent of prescribing and administration errors in general and in pediatric inpatients in particular in Ethiopia. This study aims at filling this gap in information regarding the extent of prescribing and administration errors in pediatric inpatients in Addis Ababa.

2. Literature Review

Standard prescription in Ethiopia contains institution name, code, patients full name, sex, age, weight, card number, region, town, woreda, kebele, house number, telephone number. Moreover, it should be indicated that, the patient is outpatient or inpatient, diagnosis, drug name, strength, dosage form, dose, frequency, duration, and quantity. Prescribers' full name, qualification, signature and date are also part of it (FMHACA, 2010).

Medication errors are a widespread problem that can sometimes cause harm to patients, which is preventable. Moreover, errors can be corrected if documented and evaluated as a part of quality improvement (Knudsen et al., 2007).

In recent years, a considerable increase in the number of studies about patient's safety led to greater knowledge about the topic, thus confirming its importance as a global problem **(**Silva, 2009**).**

2.1. Rates of Prescribing and Administration Errors

A prospective cohort study conducted at two urban teaching hospitals in USA, on medication errors and adverse drug events in pediatric inpatients detected 616 (5.7%) medication errors of 10778 medication orders. Most of medication errors was dosing error 175(28%) followed by route 109(18%), medication administration record and transcription 85(14%), no or missing date74 (12%), and wrong frequency 58(9.4%). Among the drugs involved in medication errors electrolytes and fluids 162(26%) followed by antibiotics 120(20%), analgesics and sedatives 101(16%), and bronchodilators 44 (7.1%). (Kahushal et al., 2001).

A prospective baseline study of medication error rates at Baylor University medical center, USA in 2004, in preparation for implementation of a computerized physician

order entry system, which tries to determine baseline levels of medication errors and their root causes, has found that baseline medication error rate was 111.4 per 1000 orders. Most common were dosing errors (43.4 per 1000 orders), followed by frequency errors (19.7 per 1000 orders) and unavailable drug errors (12.8 per 1000 orders). Of the 113 total errors found, 52 (46%) had a transcription-based cause, i.e., an error in inputting the handwritten physician order into a computer system. System or process-related root causes (such as duplicate orders or lack of crossover from one information system to another) accounted for 35.4% of the errors, and prescribing based causes (such as wrong dosage or non formulary drugs) accounted for 18.6% of errors (Seeley, 2004).

In a study that aimed to identify and quantify the most frequent prescription errors in inpatients' medical prescriptions at Israelita Albert Einstein Hospital in Brazil , a total of 9.2% error was found from prescriptions and among the total errors, the most frequent occurrences were lack of information which includes dose and administration route, 18.2% and 7.2% respectively; 12.4% of wrong transcriptions to the information system and 8.3% were due duplicate drugs, 6.6% due to doses higher than recommended and 8.0% of prescriptions were with indication but not specifying allergy (Silva, 2009).

A descriptive and retrospective study conducted to analyze and assess the drug prescription patterns and errors in elderly outpatients attending public health care centers in Mexico City, Mexico, potential prescription error was found to be high (53% of total prescriptions). Most of the prescription errors were due to omissions of dosage, administration route, and length of treatment and may potentially cause harm to the elderly outpatients (Corona Rojo et al., 2009).

A pre intervention and post intervention cross-sectional study conducted on medication error in department of pediatrics of the Hospital Italiano de Buenos Aires, a tertiary care

university hospital found that omission of time of prescription 42%, error in dosing interval 22%, omission of prescription 13%, wrong dosing 10% and illegible order 9% in prescription error. Administration error included omission (dose not delivered directly to the patient) 47%, wrong dosing 30%, wrong infusion rate 13%, wrong frequency 4% and wrong delivery 6% (Otero et al., 2008).

In a prospective study, which was conducted on the incidence of prescribing errors at an eye Hospital (inpatients and outpatients, accident and emergency (A&E), day case centers including day-case theatres and laser rooms) in UK, determine that 8% prescription sheets had errors. Out of which 7% were errors of prescription writing while 1% was drug errors. The majority of errors were made by junior Doctors and no drug errors were made by senior doctors (Mandal and Fraser, 2005).

A study done across five hospital in the London area, UK to determine the incidence and nature of prescribing and medication administration errors in pediatric inpatients by prospective review of drug charts to identify prescribing errors and prospective observation of nurses preparing and administering drugs to identify medication administration errors has found that 391 prescribing errors giving an overall prescribing error rate of 13.2% of medication orders. Incomplete prescriptions were the most common type of prescribing error, and dosing errors the third most common.429 medication administration errors were identified; giving an overall incidence of 19.1% erroneous administrations. Errors in drug preparation were the most common, followed by incorrect rates of intravenous administration (Ghaleb et al., 2010).

A Cross-sectional study done on medication administration errors in old-age psychiatric inpatients of an independent UK psychiatric hospital using direct observation, medication chart review and incident reports has found that 369 errors in using

observation method in 1423 opportunities for errors were detected versus chart review detected 148 errors and incident reports none. Most errors were of doubtful or minor severity. The commonest errors observed were unauthorized tablet crushing or capsule opening (30.1%), omission without a valid reason (27.1%) and failure to record administration (23.6%) (Haw et al., 2007).

A study conducted to identify the frequency of medication administration errors as well as their potential risk factors in nursing homes using a distribution robot which was a prospective, observational study conducted within three nursing homes in the Netherlands caring for 180 individuals. Administration errors were found to be 21.2%. The most frequently occurring types of errors were use of wrong administration techniques (especially incorrect crushing of medication and not supervising the intake of medication), and wrong time errors (administering the medication at least 1 hour early or late) (Van Den Bemt et al., 2009).

Another study done on drug administration errors and their determinants in pediatric in-patients in France, which is a prospective direct-observation study, has found that 538 administration errors involving timing (36%), route (19%), dosage (15%), unordered drug (10%), or form (8% form) errors from 1719 observed administrations to 336 patients by 485 nurses. Intravenous drugs were associated with fewer errors and error rates were higher for cardiovascular and central nervous system drugs (Prot et al., 2005).

Another retrospective cohort study conducted on medication prescribing errors in a pediatric inpatient tertiary care setting in Saudi Arabia, determine the overall error to be 56 per 100 medication orders (95% CI: 54.2%, 57.8%). Dose errors were the most prevalent (22.1%). These were followed by route errors (12.0%), errors in clarity (11.4%)

and frequency errors (5.4%). Other types of errors were incompatibility (1.9%), incorrect drug selection (1.7%) and duplicate therapy (1%). The majority of orders (81.8%) had one or more abbreviations. Error rates were highest in prescriptions for electrolytes (17.17%), antibiotics (13.72%) and bronchodilators (12.97%) (Al-Jeraisy et al., 2011).

A prospective study done on medication prescribing errors in medical wards of a public teaching hospital in India using observation, found 157 errors. Drug-drug interactions were the most frequently (68.2%) occurring type of error, which was followed by incorrect dosing interval (12%) and dosing errors (9.5%). The medication classes involved most were antimicrobial agents (29.4%), cardiovascular agents (15.4%), GI agents (8.6%) and CNS agents (8.2%). The moderate errors contributed maximum (61.8%) to the total errors when compared to the major (25.5%) and minor (12.7%) errors (Pote et al., 2009).

A study was conducted in inpatient wards of general medicine and surgery departments of multispecialty tertiary care teaching hospital in India. In this study, medication records of 286 patients were reviewed and 218 medication administration errors were observed. The frequency rate of medication administration errors was found as 15.24%. Out of 218 medication administration errors, 112 errors (51.37%) were observed in surgery department and 106 errors (48.62%) were observed in medicine department. The most common types of errors observed were omission errors (failure to administer or failure to record the administration, (33.02%) and improper dose (over dosage 17.43%), followed by wrong time (12.84%), wrong strength (e.g. dose was given in noon instead of morning dose (9.63%), wrong rate (IV infusion rate was too fast, (8.25%), wrong drug (drug other than the prescribed one, (5.5%), and others (Patients refusal to take medication/not bought the medication), (6.42%)(Kumar et al., 2011).

A retrospective study conducted in India on drug prescribing pattern and prescription error of elderly inpatients has identified that 1233 errors occurred in prescription writing. Moreover, route, ending date of therapy, and signature of prescribing doctor were most missed items (missing in 10.2%, 7%, and 12% of drug prescribed respectively). Use of error prone abbreviations, symbols and dose designations was 0.27% per prescribed items and 5% of drugs names were written with unacceptable abbreviations (Sapkota et al., 2011).

2.2. Studies on Medication Error and Prescribing Practice in the Pediatrics in Ethiopia

A study done on pediatric patients in Ethiopia so far, found during literature search, have addressed administration error. Prospective case-based observational study was done in the pediatric ward of Jimma University Specialized Hospital (JUSH), Ethiopia, to assess the type and frequency of medication administration errors. A total of 196 (89.9 %) medication administration errors were identified from the 218 observations made. From these, 178 (90.8 %) occurred with intravenous (IV) bolus medications while 16 (8.2 %) of them pertained to oral medications. The most frequent of the medication administration errors observed was wrong time error 55(28.1 %) of the total, while 52 (26.5 %) were dose errors and 42 (21.4 %) were due to drugs omitted during drug administration. Furthermore, wrong administration technique errors and unauthorized drug errors were 41 (20.9 %) and 6 (3.1 %), respectively. The drug mostly associated with error was gentamicin with 29 errors (31.2 %) (Feleke and Girma, 2010).

Another study assessed drug prescribing practices in Pediatrics ward of JUSH. Three hundred eighty four cards were sampled. 224 antibiotics (44.9%) and analgesic/antipyretics 98 (19.2%) were the most commonly prescribed category of drugs. Paracetamol 86 (18.86%), cotrimoxazole 79 (15.5%) and amoxicillin 53 (10.39%) were

the most frequently prescribed drugs. About 261 (67.97%), 265 (51.82%), 63 (12.35%) and 176 (37.51%) of the drugs were prescribed with correct indication, frequency, duration and dose respectively. Drugs prescribed by generic name and from essential drug list of Ethiopia were 82% and 89.8%, respectively (Agalu and Mekonnen, 2012).

Besides these, there are no studies done on the prescribing error only and both prescribing and administration error together in the pediatric patients in hospital settings so far based on the literature searches performed. So, this study is aimed at contributing to narrow the information gap in the area.

3. Objective of the Study

3.1. General Objective

- To assess prescribing and medication administration errors in pediatric inpatients of selected public hospitals in Addis Ababa.

3.2. Specific Objectives

- To determine the frequency of prescribing and medication administration errors.
- To identify type of prescribing and medication administration errors.
- To identify top ten drugs involved in prescribing errors.
- To identify determinants of prescribing errors.

4. Methodology

4.1. Study Area and Setting

The study was conducted in Addis Ababa which is the capital city of Ethiopia. It covers a total area of 54,000 hectares. Based on 2007 census, the projected population of the city were 3,103,673; of whom 1,478,890(47.6%) were men and 1,624,783 (52.4%) women (CSA, 2008). The city had 10 governmental hospitals, from which five hospitals are managed under Addis Ababa City Regional Health Bureau, four hospitals under Federal Ministry of Health and one university hospital (Black Lion Specialized Hospital). Among these hospitals, Black Lion Specialized Hospital was selected purposively due to high number of physicians and patients served. Moreover, it is a teaching hospital. Zewditu Memorial Hospital was selected randomly from the remaining hospitals.

Black Lion Specialized referral and teaching Hospital, is located at the center of Addis Ababa and has a total bed capacity of 626. It is also the only public hospital offering oncology service. It operates daily close to 100% bed occupancy. During the study period there were 112 specialists, 19 general practitioners, 20 pharmacists, 512 nurses, 34 laboratory technicians and 12 health assistants. The services given are internal medicine, surgical, orthopedics, gynecologic, maternal and children healthcare, pediatrics, HIV/AIDS guidance and diagnostic and medical services (Black Lion Specialized Hospital Statistics and Information Office, 2012).

Zewditu Memorial Hospital was established in 1925 E.C. It had a bed capacity of 189. The services given in this hospital includes internal medicine, surgery (general, plastic & neurosurgery), gynecology and obstetrics, pediatrics, special clinics (dermatology, psychiatry & neurology), dental, TB/HIV, Maternal and child Health (MCH) and diagnostic service. The hospital had 11 specialists, 26 general practitioners, 205 nurses,

12 pharmacists, 20 laboratory technicians, 5 dentists, 1 health assistant. It also serves as training center for medical professionals from public university and private college (Zewditu Memorial Hospital Statistics and Information Office, 2012).

4.2. Study Design

Facility based cross sectional study was conducted to assess the prescribing error from 2008 to 2010G.C, and medication administration error from April 21, 2012 – May 9, 2012G.C.

4.3. Population

Source Population: all pediatric inpatients treated and nurses involved in medication administration in Black Lion Specialized Hospital and Zewditu Hospital were source to asses prescribing and medication administration error respectively.

Study Population: pediatric inpatients who were treated between 2008-2010 G.C to asses prescribing error and nurses who were involved in medication administration at the day time administering drugs between April 21, 2012 – May 9, 2012G.C at Tikur Anbesa Specialized Hospital and Zewditu Hospital.

4.4. Sample Size Determination and Sampling Procedure

To determine the number of medication records to be reviewed in assessing the prescribing errors, single population proportion formula was used (Lwanga and Lemeshow, 1991). It was assumed that the proportion of medication charts with prescribing error in the pediatric hospitals to be 50%, sampling error to be 2% and with 95% confidence interval.

$N= (Z)\ 2 \times P\ (100-P)/\delta 2$

N = the number of medical records of pediatric patients to be sampled (sample size).

Z = Z score at 95% CI

P = the proportion of medical records with prescribing error.

δ = Margin of error

A proportion of 50% was used in the sample size calculation to ensure maximum sample size because no previous study done in our country which reported the prescribing error in pediatric patients was found. Based on this, the sample size was calculated to be 2401. Adding 5% as a contingency for incomplete and/or illegible records, the total sample size became 2522 medical records of pediatric inpatients.

For assessing administration error, a total of 100 observations were done in each facility (WHO, 1993).

The total number of medical records to be reviewed in each Hospital was selected proportional to the number of pediatric beds available in both hospitals and then the medical records were selected first by including the card numbers available on the nurse recording sheet from January 1, 2008- January 2, 2010 G.C. Total number of cards were counted and divided to their respective cards needed in each hospital to find the interval to select the cards systematically. Medical records without diagnosis, weight and also repeated cards were excluded from the study in assessing prescribing error. Regarding administration errors, twenty seven nurses and sixty pediatric patients who were available at the day time from April 21, 2012 – May 9, 2012G.C were observed.

4.5. Study Variables

4.5.1. Prescribing Error

Independent variables

- Age of the patient
- Diagnosis
- Sex of the patient
- Types of drug
- Dose of the drug
- Frequency of drug
- Route of administration of the drug
- Dosage form of the drug

Dependant variables

- Wrong dose
- Wrong frequency
- Drug-drug interaction
- Dose not written
- Frequency not written
- Duration not written
- Dosage form not written
- Route of administration not written
- Signature of prescriber

4.5.2. Administration Error

Independent variables

- Administered drug
- Administered dose of a drug

- Administration time
- Age of the patient
- Diagnosis
- Sex of the patient

Dependant variables

- Wrong dose administration
- Timing error
- Omitted drug error

4.6. Data Collection and Management

4.6.1. Data Collection Techniques and Tools

Data abstraction form was prepared to abstract data from medical records that was used to asses prescribing error and observation guide was used to assess medication administration errors. All abstracted and observed data were checked for errors by the Micromedex Drug-Reax database, guidelines, and drug formularies for pediatric use in Ethiopia (MICROMEDEX (R) Healthcare Series, 2012; FDREMOH &WHO, 2010; Sileshi 2007).

4.6.2. Data Collectors

Two data collectors who had diploma in Pharmacy were trained for two days on the data collection tools**.**

4.6.3. Pretest

Pretest was done prior to the actual data collection in Yekatit 12 hospital (ten observations and 20 medical records review) and appropriate modifications of data collection format were made based on findings from the pretest.

4.6.4. Data Entry and Analysis

The data collection formats have been checked for completeness and accuracy by the principal investigator and data entry was done using Epi-Data Version 3.1.2. A double data entry scheme was employed to ensure accuracy of data entry. Data were cleaned using simple frequency and sorting, and data analysis was done using statistical package for social sciences version16 (SPSS ver.16).

To obtain a summary measure of each type of errors code (0, 1) was used, where category 0 represents no error and category 1 represents an error. The sum of each type of error, then, was found by doing simple frequency. A drug involved in a particular type of error was coded and again simple frequency was done to obtain the most involved medicines in a particular type of error. Sex, age, number of diagnosis and weight were used as independent variable, while presence of drug-drug interactions, prescription writing error, wrong dose and frequency were included as dependent variables.

Frequencies were used to summarize descriptive statistics of the data and tables were used for data presentation. Bivariate analysis was used primarily to check which variables had association with the dependent variable. Finally the variables which had significant association were identified on the basis of OR, with 95%CI and p-value.

4.7.Operational Definitions

Pediatrics: Age less than 15 years old.

Medication administration error (MAE): A medication error that occurs while administering a medication to a patient.

Wrong dose adminstration: Medication dose administered different from standards.

Timing error: Administration of medications 1 hour earlier or later than what was prescribed.

Omitted drug error: Failure to administer the prescribed medication to the patient.

Prescription writing errors: Dosage, frequency, duration, dosage form of the drug, route of administration was not mentioned and missing signature of the prescriber.

Drug related errors: Wrong dose, frequency and ignored drug- drug interactions.

Wrong dose: Medication dose prescribed different from standards.

Wrong frequency: Frequency information was incorrect as compared to standards.

Contraindicated: the drugs are contraindicated for concurrent use.

Major: the interaction may be life threatening and/or require medical intervention to prevent or minimize serious adverse effects.

Moderate: the interaction may result in the exacerbation of a patient`s condition and/or require an alteration in therapy.

Minor: the interaction would have limited clinical effects; manifestations may include an increase in the frequency or severity of side effects but generally would not require a major alteration in therapy.

4.8. Ethical Considerations

An official approval of the research was obtained from the ethics review committee of School of Pharmacy, Addis Ababa University and Addis Ababa Regional Health Bureau. Official letter was written to the selected Hospitals and permission was obtained before

conducting the data collection. The nurses who were available at the time of data collection were told that research was being conducted but not the exact nature of the study. Moreover, they were told that there is no risk associated with it regarding their work and confidentiality. In addition, verbal consent was taken. If an observer was aware of erroneous medication to the patient was going to be administered, s/he was intervening in non-judgmental manner and it was counted as an error. Any information that can potentially expose recognition of particular patient and nurse's private information was excluded from the data collection tools.

The information collected from this research was kept confidential and stored in a file, without name, but a code number assigned to it. Moreover, it was not revealed to anyone except the principal investigator and the data collectors and was kept locked with key.

4.9 Limitations of the Study

Since the study was conducted in only two hospitals, it may not represent other hospitals in Ethiopia. Evening and night shifts were not considered in the medication administration, during which more mistakes may occur. Most importantly there was no follow up both for prescribing and administration studying the clinical significance of these errors and variables related to prescribers were not considered.

5. Results

5.1. General Patient Characteristics

Of the total 2522 medical records of pediatric patients reviewed, 34 were without weight and 87 were either incomplete or repeated cards and hence were excluded.

About three-fourth of the cases 1798(74.9%) were from Black Lion Specialized Hospital and one-fourth 603(25.1%) were from Zewditu Hospital. Majority of them were males 1498(62.4%) and in the age group of less than one year old 934(38.9%) (Table 1).

The age profile showed that 934 (38.9%) were below the age of one year; 691(28.8%) patients were between 1 and 5 years; 279(11.6%) were in the range of 6-10 years and the remaining 497(20.7%) were between 11 and 15 years (Table 1). The number of patients with a single diagnosis was 1175; 420 were presented with two diagnoses and 806 had more than two diagnoses.

Table 1: Sex and age of pediatric inpatients in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, 2012. (n=2401)

Characterstics	N (%)
Sex	
Male	1498(62.4)
Female	903(37.6)
Age groups (years)	
<1	934(38.9)
1-5	691(28.8)
6-10	279(11.6)
11-15	497(20.7)

5.2. Prescribing Error

As shown in Table 2, the total number of prescribing errors detected was 5011, considering one error from each type of errors per patient chart reviewed. Out of 5011 errors, prescription writing errors accounted 2386 (99.4%) of the cases, followed by wrong dose 1673(69.7%), drug-drug interaction 767(31.9%) and wrong frequency 185(7.7%).

Table 2: Types of prescribing medication errors in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, June, 2012. (2401)

No.	Types of errors	N (%)
1.	Prescription writing errors	2386(99.4)
2.	Wrong dose	1673(69.7)
3.	Drug- drug interactions	767(31.9)
4.	Wrong frequency	185(7.7)
Total		**5011(208.7)**

Among prescription writing errors, prescritions which did not mention duration of treatment were the highest 2344 (33.3%) followed by dosage form not written 2305 (32.8%) and route not written 1246(17.7%) (Table 3).

Table 3: Prescription writing error in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, June, 2012 (n=2401).

Types of errors Not written	N (%)
Duration	2344(33.3)
Dosage form	2305(32.8)
Route of administration	1246(17.7)
Dose	566(8.1)
Frequency	539(7.7)
Signature	29(0.4)
Total	**7029(100)**

The top three medication class involved in wrong dose were ant infective for systematic use 2116(82.7%), drugs acting on cardiovascular system 181(7.1%) and nervous system 72(3.9%). Details on this are shown in Table 4.

Table 4: Medication classes involved in wrong dose in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, June 2012 (n=2401).

No	Medication Class	N (%)
1	Anti-infectives for systemic use	2116(82.7)
2	Cardiovascular System	181(7.1)
3	Nervous System	72(3.9)
4	Blood and Blood Forming Organs	68(2.7)
5	Alimentary Tract and Metabolism	60(2.3)
6	Systematic hormonal preparations,excl.sex hormones and insulins	41(1.6)
7	Antineoplastic and immunomodulating agent	8(0.3)
8	Respiratory system	5(0.2)
9	Ant parasitic Products, Insecticides and repellents	5(0.2)

The top three medication class involved in wrong frequency were ant infective for systematic use 185(90.7%), systematic hormonal preparations, excl.sex hormones and insulins 11(5.4) and drugs acting on blood and blood forming organs 2(0.98). Details on this are shown in Table 5.

Table 5: Medication classes involved in wrong frequency in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, June 2012 (n=2401).

No	Medication Class	N (%)
1	Anti-infectives for systemic use	185(90.7)
2	Systematic horomonal preparations,excl.sex horomones and insulins	11(5.4)
3	Blood and Blood Forming Organs	2(0.98)
4	Cardiovascular System	2(0.98)
5	Antiparasitic Products, Insectcides and repellents	1(0.49)
6	Nervous System	1(0.49)
7	Musculo-skeletal system	1(0.49)
8	Alimentary Tract and Metabolism	1(0.49)

Ceftriaxone (586 times) followed by gentamicin (484 times) and ampicillins (337 times) were the top three drugs involved in wrong dose. Details are shown in Table 6.

Table 6: Top 10 Drugs involved in wrong dose in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, 2012 (n=2401).

No.	Drugs	Occurrences
1	Ceftriaxone	586
2	Gentamicin	484
3	Ampicillin	337
4	Metronidazole	284
5	Cloxacillin	154
6	Furosemide	149
7	Crystalline penicillin	145
8	Vitamin K	50
9	Amoxacillin-spironolactone	46
10	Metoclopromide	41

Gentamicin (66), ampicillin (30 times) and ceftriaxone (29times) were the top three drugs involved in wrong frequency. Details are shown in Table 7.

Table 7: Top 10 Drugs involved in wrong frequency in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, 2012 (n=2401).

No.	Drugs	Occurrences
1	Gentamicin	66
2	Ampicillin	30
3	Ceftriaxone	29
4	Cloxacillin	16
5	Metronidazole	14
6	Vancomycin	12
7	Prednisolone	7
8	Cephalexin	6
9	Ceftazidime-cotrimoxazole-dexamethasone	4
10	Metoclopromide	3

The most frequent interaction was the concurrent prescribing of ampicillin and gentamicin (610 times); followed by concomitant prescribing of furosemide and digoxin (32 times) and captopril and furosemide (27 times) (Table 8). Among interactions, 708(72.7%) were minor in their severity, 193(19.8%) moderate, 67(6.9%) major and 6(0.6%) were contraindicated based on severity classification of MICROMEDEX (MICROMEDEX (R) Healthcare Series, 2012).

Table 8: Top 10 drug-drug interactions in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, 2012.

No.	Drug combinations	Occurrences
1	Ampicillin and Gentamicin	610
2	Furosemide and Digoxin	32
3	Captopril and Furosemide	27
4	Cloxacillin and Gentamicin; Diazepam and Phenytoin	21
5	Furosemide and Gentamicin	20
6	Paracetamol and Chloramphenicol; Digoxin and spironolactone	18
7	Crystalline.penicillin and Chloramphenicol	17
8	Cisplatin and Doxorubucin	14
9	Furosemide and Aspirin; Phenytoin and paracetamol	13
10	Predinsolone and Rifampicin	11

5. 3. Factors Associated with Prescribing Errors

5.3.1. Wrong Dose

In this study, factors considered to potentially predict prescribing of wrong dose were tested using binary logistic regression analysis as the dependent variable. Based on the test, more than two diagnoses (adjusted odds ratio (AOR) = 1.66 95% CI= 1.32- 2.13) were found to be significant predictor of wrong dose. So it was predicted that pediatric patients with more than two diagnoses were more than one and half times likely to be prescribed with wrong dose compared to those with one diagnoses only controlling for other factors including age and sex (Table 9).

In contrast, pediatrics between six and ten years old were less likely to face wrong dose than eleven to fifteen years old (AOR= 0.67 95CI=0.47-0.95) (Table 9).

Table 9: Factors associated with wrong dose in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, June, 2012 (n=2401).

Variables	N (%)	Crude OR(95%CI)	Adjusted OR(95%CI)
Sex			
Male	1028(68.6)	1	1
Female	645(71.4)	1.14 (0.95,1.37)	0.10(0.91,1.32)
Diagnosis			
One	750(63.8)	1	1
Two	290(69.1)	0.5 (0.40, 0.61)	1.22(0.95,1.56)
>two	633(78.5)	0.65 (0.50, 0.85)	1.66 (1.32, 2.13)**
Age group			
<1	648(69.3)	1.53 (1.21, 1.94)	0.72 (0.43,1.20)
1-5	487(70.5)	1.11 (0.86, 1.42)	0 .74 (0.49, 1.11)
6-10	214(76.7)	0.81 (0.6,1.102)	0.67(0.47,0.95)**
11-15	324(65.2)	1	1

**p < 0.05

5.3.2. Drug-drug Interaction

It was found that two diagnoses (AOR=1.87 95%CI=1.39- 2.52) and more than two diagnoses (AOR=6.00, 95% CI 4.64-7.77) were significantly associated with drug-drug interaction. 95% CI= 1.959-8.012). Based on this, an increment by one, of the number of diagnoses the pediatric patients was predicted to increase the likelihood of the patient being prescribed medications with drug-drug interaction by nearly two times controlling

for the other variables (sex and age). The likelihood of being prescribed with drug-drug interaction, increase six times controlling other factors (sex and age) for pediatric patients with greater than two diagnoses.

On the other hand, pediatric patients who are between one and five years were less likely to face drug-drug interaction than patients from eleven to fifteen (AOR= 0.26 95CI=0.15-0.45) (Table 10).

Table 10: Factors associated with drug-drug interaction in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, June, 2012. (n=2401)

Variables	N (%)	Crude OR(95%CI)	Adjusted OR(95%CI)
Sex			
Male	463(30.9)	1	1
Female	304(33.7)	1.13 (0.95,1.35)	0.97 (0.79,1.22)
Diagnosis			
One	142(12.1)	1	1
Two	101(24.1)	0.08 (0.06, 0.09)	1.87(1.39, 2.52)**
>two	523(64.8)	0.17 (0.13,0.23)	6.00 (4.64, 7.77)**
Age group			
<1	183(19.6)	8.44 (6.33,11.24)	0.58 (0.29,1.15)
1-5	294(42.5)	1.24 (0.89,1.72)	0.26 (0.15,0.45)**
6-10	161(57.7)	1.34 (0.89,2.00)	0.69 (0.43,1.12)
11-15	129(64.8)	1	1

**p < 0.05

5.3.3. Wrong Frequency

After adjusting for other variables (sex and age), it was found that, only patients with more than two diagnoses (AOR=0.61, 95%CI=0.40- 0.91) were less likely to face wrong frequency than with only one diagnoses (Table 11).

Table 11: Factors associated with wrong frequency in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, June, 2012 (n=2401).

Variables	N (%)	Crude OR(95%CI)	Adjusted OR(95%CI)
Sex			
Male	115(7.7)	1	1
Female	70(7.8)	1.01(0.74, 1.37)	0.95 (0.69,1.30)
Diagnosis			
One	80(6.8)	1	1
Two	45(10.7)	0.92 (0.65, 1.29)	1.22 (0.81, 1.82)
>two	60(7.4)	1.31(0.86,1.98)	0.61 (0.40, 0.91)**
Age group			
<1	81(8.6)	3.05(1.86,4.98)	1.54 (0.55,4.36)
1-5	36(5.2)	1.58 (0.92, 2.73)	0.88 (0.38, 2.02)
6-10	31(11.1)	1.28 (0.64, 2.58)	0.97(0.45, 2.09)
11-15	60(7.4)	1	1

**p < 0.0

5.3.4. Prescription Writing Error

Among the variables tested sex (AOR=1.13 95% CI= 0.38- 3.35) age group and number of diagnoses were not found to have a statistically significant effect on prescription writing error (Table 12).

Table 12: Factors associated with prescription writing error in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia, June, 2012. (n=2401).

Variables	N (%)	Crude OR(95%CI)	Adjusted OR(95%CI)
Sex			
Male	1488(99.3)	1	1
Female	898(99.6)	1.2 (0.41, 3.54)	1.13 (0.38, 3.35)
Diagnosis			
One	1162(98.9)	1	1
Two	417(99.2)	0.12 (0.02, 0.94)	0.17 (0.02, 1.44)
>two	806(100)	0.26 (0.02, 2.900)	0.37 (0.03, 4.31)
Age group			
<1	930(99.6)	4.74 (0.92, 24.55)	3.20 (0.20, 50.35)
1-5	689(99.7)	0.96 (0.31, 3.07)	1.00(0.148, 6.801)
6-10	276(98.9)	2.78(0.32, 23.92)	3.02 (0.31, 29.67)
11-15	491(98.8)	1	1

5.4. Administration Errors

A total of two hundred observations were made on twenty seven nurses who administered medications (19 females and eight males) for sixteen days. The total numbers of patients included in the study were 60. Thirty eight were male patients (63.3%) and 22 were

female patients. Forty one cases (68.3%) were with one diagnosis only and 19(31.7%) were with two or more diagnoses.

Out of 200 observations, 71 (35.5%) medication administration errors were identified. The top error was wrong dose administration 50 (70.4%) followed by omitted drug 18(25.4%) and timing error 3(4.2%).

The top three drugs involved in wrong dose administration error were ceftriaxone (26 times), cloxacillin (7 times) and ampicillin (5 times). Ceftriaxone (9 times), tramadol (3 times) and Cloxacillin (2 times) were the top three drugs omitted. Cetriaxone (2 times) and Cloxacillin (1 times) were the only two drugs involved in timing error.

Table 13: Types of medication administration errors observed in Black Lion Specialized Hospital and Zewditu Memorial Hospital, Addis Ababa, Ethiopia,June, 2012.

No.	Medication administration error	N (%)
1	Wrong dose	50(70.4)
2	Omitted drug	18(25.4)
3	Timing error	3(4.2)
	Total	**71(100)**

6. Discussion

The result showed that, the total percentage of prescribing errors were above hundred (i.e.208). This implies that more than one type of error occurred per patient.

Among prescribing errors, the most frequently detected error were prescription writing errors. This is in line with the study in London, UK by Ghaleb et al. (2010) but of higher percentage (99.4%). This difference might be because of the difference in sample size (i.e. UK-441), and the difference in variables included in the study as prescription writing errors.

The reason that prescription writing errors were more frequent than drug related error (i.e. wrong dose, frequency and drug-drug interaction) might be due to the fact that there are a number of ways to write prescription wrongly but two or three to commit drug related errors. Preferably, no information should be missed; omitting the necessary information may result in occurrence of more serious errors. In addition, consecutive errors in dispensing and administration errors might be the case unless tracked by pharmacists and nurses, respectively.

Among the prescription writing error, the most frequent one was omitting the duration of treatment followed by dosage form, route, dose, frequency and signature. This result was consistent with the findings in Saudi Arabia. (Al-Jeraisy et al., 2011) in terms of rank, but it had a lower percentage in this study. The reason for this may be the difference in patient load.

Prescriptions with wrong doses were the second most frequent errors mentioned. A study carried out in UK by Ghaleb et al. (2010) showed that wrong dose was the third most common type of error occurring next to prescription writing error and use of

abbreviations. Abbrevatiations errors were not counted as errors in this study; therefore the present result was consistent with this in terms of rank but differs in percentage. The difference might be because of sample size (444 versus 2401), patient load, and difference in the number of specialists (pediatricians). Parihar and Passi (2008) a study done in India, found that dose errors were the most common medication related error. In order to assure the correct dose of a drug prescribed, the significance of checking manuals/guidelines containing information about drugs was noted. From the prescribers' point of view, this practice may be hindered by lack of time, excessive work load and the time spent at work in the hospitals. Death was a consequence reported in USA because of overdoses (FDA, 2012).

Among the top ten drugs involved in wrong dose, majority of the drugs were ceftriaxone, ampicillin, gentamicin, Cloxacillin, crystalline penicillin and amoxicillin. Previous study by Kahushal et al. (2001) in USA also reported electrolytes and fluids and antibiotics as the major drugs involved in wrong dose.

Antimicrobial resistance is an issue when antibiotics are raised, especially when lower doses of antibiotics are used (WHO, 2001). It is difficult and more expensive to treat a variety of common infections, causing delays in effective treatment, or in worst cases, inability to provide appropriate therapy. The predictable consequence of resistance is increased morbidity, prolonged illness, a greater risk of complications, and higher mortality rates (WHO, 2012).

Drug-drug interaction was very small in countries like Saudi Arabia and United Kingdom, (Al-Jeraisy et al. 2011; Ghaleb et al. 2010) respectively, where it was classified as miscellaneous (<1%). But in this study, it was the third most common types of prescribing error. This might be because of the difference in the prescribing habit of

the hospitals studied (i.e. the number of drugs prescribed per prescriptions). The most frequent interaction was ampicillin with gentamicin (610) which was minor in severity, followed by furosemide and digoxin.

Majority of the interaction (708) were minor in their severity. Among these, concurrent prescribing of ampicillin and gentamicin took greater part. With good documentation, it is known that, concomitant use of ampicillin and gentamicin results in loss of gentamicin efficacy, in turn, resulting in under treatment of the patient (MICROMEDEX (R) Healthcare Series, 2012).

This study found that, there were six contraindicated drug-drug interactions which were contributed by concurrent use of calcium gluconate and ceftriaxone that may result in fatal reactions. This is because of the formation of ceftriaxone-calcium precipitates in the lungs and kidneys. Health care providers can prevent this by not mixing or administering ceftriaxone concurrently with calcium-containing IV (intravenous) solutions in the same IV administration line in neonates. In patients other than neonates, ceftriaxone and calcium-containing solutions can be administered sequentially if the infusion lines are thoroughly flushed between infusions with a compatible fluid (MICROMEDEX (R) Healthcare Series, 2012).

Simultaneous use of furosemide and gentamicin was the largest part contributors among the sixty seven major drug-drug interactions. This interaction may result in increased gentamicin plasma and tissue concentrations and additive ototoxicity and/or nephrotoxicity (MICROMEDEX (R) Healthcare Series, 2012).

Among the moderate drug-drug interactions concurrent use of furosemide and digoxin were the most contributors, which may result in digoxin toxicity (nausea, vomiting, cardiac arrhythmias). Next to it, captopril and furosemide is the second contributor of

moderate interaction that may result in postural hypotension. This can be prevented by discontinuing the diuretic two to three days prior to adding an angiotensin converting enzyme (ACE) inhibitor. Then, if blood pressure or heart failure is not controlled with the ACE inhibitor alone, the diuretic may be restarted or else start with a very low dose of the ACE inhibitor in the evening and close monitoring of blood pressure for a severe hypotensive response for four hours after the initial dose and monitoring for hypotension, fluid status, and body weight regularly for up to two weeks after dose adjustments is the way to prevent postural hypotension (MICROMEDEX (R) Healthcare Series, 2012).

Concurrent use of phenytoin and diazepam may result in alterations in serum phenytoin concentration. When increased serum level is the case, the patient will experience headache, nystagmus (rapid involuntary movements of the eye), double vision, and ataxia. As we can see from the above statements, it is possible to prevent some of the drug-drug interactions.

In our findings, wrong frequency was found to be the least common error detected (7.7%). This result was similar with the findings in UK and Saudi Arabia Ghaleb et al. (2010) and Al-Jeraisy et al. (2011) with a percentage of 6.6% and 5.6%, respectively. The most drugs involved in wrong dose were also presented in wrong frequency. This might imply that these drugs were more prone to errors and also mostly used in these hospitals.

A study done in Spain to evaluate the effect of educational sessions, for fully qualified health professionals on the number and type of prescription errors had found that prescription error rate reduced from 21% to 3% (Campino et al., 2009).

Pharmacist roles to identify prescribing errors and to stop those reaching patients were also indicated. This can be achieved through visiting wards to review charts and provide advice to prescribers about individual patients, reconciling the medicines patients usually

take with what they are prescribed in hospital and providing medication reviews upon discharge (The Health Foundation of UK, 2012). A study done in Spain showed the importance of an intervention by clinical pharmacists in reducing prescribing error (Fernández-Llamazares et al., 2013). The need for more teaching in this area is also appreciated in countries where healthcare professionals other than doctors are involved in prescribing (Schachter M, 2009).

In our findings, the percentage of medication administration errors identified was 35.5%. This result is much lower than the findings of Feleke and Girma (2010) (89.9%) study done in Jimma, Ethiopia. The possible source of variation could be the definition used in medication administration error. In our study, wrong dose administered, omitted drug and timing error were included but wrong administration technique, unauthorized drug used additionally in study conducted by Feleke and Girma.

The most frequent type of medication administration error was wrong dose in our study 50(70.4%). This seems very high as compared to Prot et al. (2005) (15%) (1719 observations) and 52(26.5%) (218 observations) a study done in JUSH. This might be because of performance and knowledge deficits (FDA, 2012). Educating and updating staffs working on this area will be the right decision.

The drugs failed to be administered to the patient was the second most medication administration error 18(25.4%). As compared to study done by Otero et al. (2008) in Buenos Aires, that the most common medication administration error was omission 47%, followed by incorrect dosing 30% and then incorrect infusion rate 13%. This difference might be because of the difference in working environment and coordination/information exchange among nurses at the day and night shifts.

The reason for one of the omission errors was patients who are free of payment get medication for free and the nurse at that time failed to give the drug. This is because the nurse did not know that there was sufficient ceftriaxone (i.e. the information gap between day and night shift nurses) and the patient miss the whole night medication, but there was adequate ceftriaxone.

In this study timing error was found to be 4.2%, the third most common error. This is different from the study conducted in France by Prot et al. (2005) (36%) and Feleke and Girma (2010) (28.1%) which found that timing error to be the most frequent error. This might be because of the difference in information gap between nurses working on the case.

The most drug involved in the three types of medication administration errors was ceftriaxone. This might implies that ceftriaxone was more commonly administered and prone to errors than other drugs. Moreover, omission of ceftriaxone might result in resistance development, which is a major issue nowadays, which had serious implications for public health, as well as for the care of individual patients (Chiu et al., 2007).

A study done in Rabat, Morocco showed that pharmacovigilance centers can detect, identify, analyse, and classify medication errors and carry out root cause analysis, which is an important tool in preventing medication errors (Bencheikh and Benabdallah, 2009). This was supported by another study done in Malta (Tanita et al., 2013).

7. Conclusions

Prescribing and administration error were significant problem in the selected hospitals in Addis Ababa. Of these, prescription writing error and wrong dose were the two most frequent types of prescribing and administration errors, respectively. More than two diagnoses were significantly associated with wrong dose. Two and more than two diagnoses were significantly associated with drug-drug interaction. Sex, age group and number of diagnoses were not found to have a statistically significant effect on prescription writing error. Ceftriaxone, Gentamicin, Ampicillin were the top class of drugs involved in both prescribing and administration errors. In general, it can be said that medication errors were common in pediatric inpatients.

8. Recommendations

- Awareness creation about medication error prevalence and their damage should be given to healthcare providers.
- Continuing Medical Education in relation to medication errors should be organized by the hospital and other stakeholders.
- Systems should be developed by hospital officials to facilitate communication among nurses, pharmacists, and prescribers for the reduction of medication errors caused by miscommunication.
- Pharmacovigilance centers should be strengthened to alert healthcare professionals by disclosing information regarding the most frequent drug-related problems and making them aware of the factors that cause them through bulletins.
- Appropriate training should be given for future prescribers, healthcare professionals other than doctors by universities and colleges.
- The Hospital should consider and facilitate involvement of clinical pharmacist in inpatients for tracking medication errors.
- The hospitals and the pharmacy departments should facilitate the effective functioning and utilization of the drug information center in these hospitals.
- Comprehensive researches on medication errors should be done, to understand more about their cause, frequency and clinical significance of these errors and find out the way to tackle them.

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Annexes

Annex I: Data Collection Tools

Annex IA: Data abstraction form for prescribing error

Name of the Hospital____ Card no.____ Age____ Weight ____ Sex M ☐ F ☐

Body surface area ____ Height____ Presence of prescriber signature Yes☐ No ☐

No.		
1	Patient Information	Past Medical History
		Sign and symptoms
		Major diagnosis: Co morbid conditions:
2	Prescribed Medication	Date____ Drug ____ Dose ____ Dosage form ____ Frequency ____ Duration ____ Date____ Drug ____ Dose ____ Dosage form ____ Frequency ____ Duration ____ Date____ Drug ____ Dose ____ Dosage form ____ Frequency ____ Duration ____ Date____ Drug ____ Dose ____ Dosage form ____ Frequency ____ Duration ____ Date____ Drug ____ Dose ____ Dosage form ____ Frequency ____ Duration ____ Date____ Drug ____ Dose ____ Dosage form ____ Frequency ____ Duration ____ Discontinued date ____ Discontinued drug ____ Discontinued date ____ Discontinued drug ____

Name of data collector signature

Annex IB: Medication administration data collection format

Name of the Hospital _____ Ward _____ Bed no_____ Sex _____ Age _____

Height _____ weight _____ Body Surface area _____ Initial of the patient _____

Diagnosis and prescribed drugs	Date	Administered			
		Drug	Dose	Dosage form	Time

Code of administrator sex

Name of data collectors Signature

Annex I C: Prescribing error check format

no	**Drug related error**						**prescription writing error**											
	Wrong dose	Wrong route	Wrong frequency	Drug- drug interaction			Dose		frequncy		duration		dosage form		route		signatur	
				maj	Mi	Mo	y	N	Y	N	Y	N	Y	N	Y	N	Y	N
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Y=Yes N=No

Annex I D: Drug administration error check format

Date of admin	Wrong dose	Wrong time error	Omitted drug error