PRESCRIPTION DRUG ERRORS IN ANAND DISTRICT

THESIS
SUBMITTED
FOR THE DEGREE
OF
DOCTOR OF PHILOSOPHY (Ph.D.)
IN MEDICAL PHARMACOLOGY
FACULTY OF MEDICINE

TO

SAURASHTRA UNIVERSITY
RAJKOT

BY
DR. ANURADHA SHARMA JATINDAR KUMAR
MBBS, MSc. (MEDICAL PHARMACOLOGY)
ASSISTANT PROFESSOR, DEPARTMENT OF PHARMACOLOGY
PRAMUKHSWAMI MEDICAL COLLEGE, KARAMSAD - 388325
GUJARAT, INDIA

UNDER THE GUIDANCE
OF
DR. J.G. BUCH, MD
PROF. & HEAD
DEPARTMENT OF PHARMACOLOGY
PANDIT DEEN DAYAL UPADHYAY GOVERNMENT MEDICAL COLLEGE
RAJKOT, GUJARAT, INDIA

DECLARATION

"I, Dr. Anuradha Sharma Jatindar kumar, hereby declare that this submission is my own original research work and that, to my knowledge, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree of the university or other institute of higher education, except where due acknowledgement has been made in the text."

Signature:

Name: Dr. Anuradha Sharma Jatindar Kumar

Registration No.: 3649

Date of Registration: 31-7-2007

Date:

CERTIFICATE

*This is to certify that the work incorporated in the thesis entitled "***PRESCRIPTION DRUG ERRORS IN ANAND DISTRICT***" submitted by Dr. Anuradha Sharma Jatindar Kumar for the award of the degree of Ph.D. in Medical Pharmacology comprises the results of independent and original research carried out by the candidate under the guidance of Dr. J.G. Buch, Prof. & Head, Department of Pharmacology, Pandit Deen Dayal Upadhyay Government Medical College, Rajkot, Gujarat, India.*

Dr. J.G. Buch (Guide)
Prof. & Head
Department of Pharmacology
Pandit Deen Dayal Upadhyay Government Medical College
Rajkot, Gujarat, India

Date:

DEDICATION

This thesis is dedicated

to my children

“ Eisha, Dhruvika and Sumaedh”

without whose support and patience

this work would not have seen the light of the day.

ACKNOWLEDGEMENTS

The fruition of a long cherished dream is a most pleasurable experience for any one and I am blessed to be experiencing just that. I am also blessed to be surrounded by such learned and kind teachers who have supported me and lit the path of knowledge for me at times when all seemed lost.

In my guide, Dr. J.G. Buch, I have found a thorough gentleman, and a kind teacher as well as a perfectionist. His patience and astute observations have left an indelible impression on me. I am indeed fortunate to have learnt so much under his tutelage.

I have been touched by another luminary in the field of pharmacology, Dr. Sagun Desai Sir, who suggested this study and gave shape to my academic cravings. His love for pharmacology and depth of understanding is a constant goal that I shall forever attempt to achieve.

I am indebted to all the clinicians of Anand for having so openly supported this study and allowed the use of their prescriptions and the pharmacy stores that helped me collect the same.

I thank Mr. Jatinbhai Chauhan, Amitbhai, Bhandari sahab and Mrs. Indu Omanakuttan for the endless hours spent in preparing the drafts of the manuscript and our statistician, Mr. Mayank Bhatt for making sense out of all the numbers.

I do not want to miss this opportunity to thank my loving and ever-supporting husband, Dr. Sujai Joshi for his consistent support, love and care, without his help and endearing patience, this thesis would not have seen the light of the day. I am again eternally indebted to my children, family, friends and students who have supported me whole-heartedly in completion of my thesis, especially my father Dr. J.K Sharma, Dental Surgeon and Educationist, from whom I learnt never to give up and strive for higher goals.

CONTENTS

CHAPTER – I

INTRODUCTION, AIMS AND OBJECTIVES

CHAPTER - I

INTRODUCTION, AIMS AND OBJECTIVES

Introduction:

My doctor is
A good doctor
He made me no
Iller than I was
Willem Hussem (The Netherlands) 1900-1974
Transalation: Peter Raven

As once quoted by Hippocrates, *"Primum non nocere" - in* the first place do no harm is often cited as one of the foundation stones of a sound medical care[1].

Mankind has always desired for survival of the fittest and the modern medicine, medicine health care facilities and its novel interventions have made it possible to a varied extent. While one of the most essential pillars of a responsible medical care is that of an accurate and proper prescription, there remains quite a lot of lacunae and ambiguity in this area according to various studies[2,3,4].

***Prescription order being an important therapeutic transaction between physician and patient, it brings into focus the diagnostic acumen and therapeutic proficiency of the physician with instructions for palliation or restoration of the patient's health. The most carefully conceived prescription order may become therapeutically useless, however, unless it communicates clearly with the pharmacist and adequately instructs the patient on how to take the prescribed* medication[5].** A drug prescription is often the end point of a patient's visit to a medical practitioner, as an instruction from the prescriber to a dispenser, it ought to be considered a medico-legal document that should be written legibly, accurately and completely[6].

Basic prescription writing skills is a prerequisite for a proper prescription to avoid prescription errors, as it is suppose to teach and train a budding doctor on how to write a prescription, something that he would do for decades to come. Prescribing physicians as well as those involved in the execution of the prescription hold a legal responsibility for prescription.

Although the prescription format may very slightly from one country to another, most countries agree on the core elements that should be included in prescription order. These are - prescriber's name, address, telephone number and signature, patient's name, address, age, weight (important at the extremes of age), prescription date, drug name (preferably generic), formulation, strength, dose, frequency of administration, quantity prescribed, reasons for prescribing and instructions for use. A good quality prescription is an extremely important factor for minimizing errors in the dispensing of medication and physicians should adhere to the guidelines for prescription writing for the benefit of the patient[7]. A proper documentation of the prescribing practice allows the identification of acceptable and non-acceptable prescribing habits. Such information is needed to set up continuous systems to ensure good prescribing habits and to maintain an efficient health care system. Health professionals may also utilize these informations to develop guidelines for a cost effective prescribing in their local areas. As the complexities of medication management pose a significant safety risk for the patients. Each of the phases of the medication process, namely prescribing, dispensing, administering and monitoring, provide opportunities for confusion or error. Medication errors are defined as a failure/s in the treatment process that leads to or has the potential to lead to harm to the patient frequently occur at the drug ordering or prescribing stage[8]. There are two major types of medication errors i.e. prescription errors which encompass those related to the act of prescription writing and that of prescribing faults which

encompass irrational prescribing, inappropriate prescribing, underprescribing and ineffective prescribing arising from erroneous medical judgement or decisions concerning treatment or treatment monitoring[9,10]. Such errors can occur both in general practice and hospital, although they are rarely fatal they can affect patients safety and quality of health care [3,11].

Prescription errors as defined by Dean et al using the Delphi technique is defined as a clinically meaningful prescribing error which occurs when there is an unintentional significant reduction in the probability of treatment being timely and effective or increase in the risk of harm when compared with generally accepted practice[12].

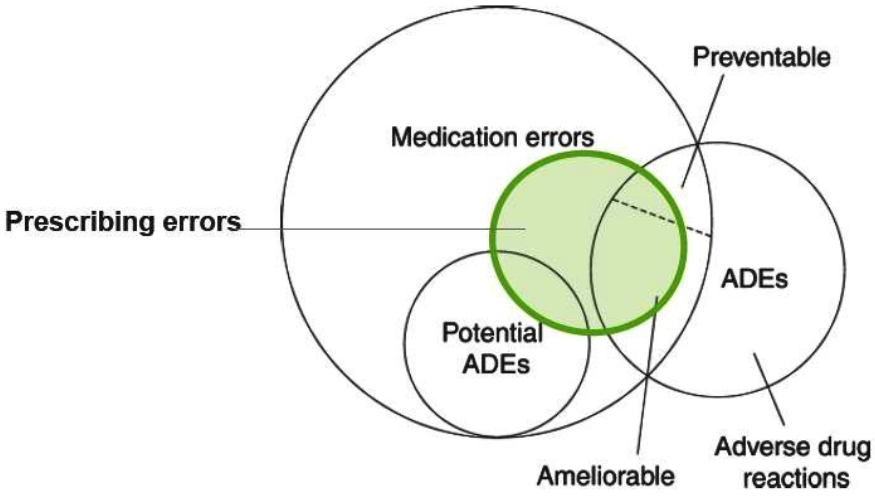


Figure-1 illustrates the relationships between medication errors, prescribing errors, adverse drug events (ADEs), potential adverse drug events (potential ADEs) and adverse drug reactions.

Therefore prescription errors are a common cause of adverse events or medication errors and may be largely preventable[13]. Although prescribing errors occur in a range between 0.56% and 9.9% of all prescriptions[14]. These error rates are dependent on the definitions and various study methods used for prescribing errors. All such errors in turn are a major component of medical errors, which are an

important factor that influences the quality of patient care. According to Barach *et al.*, nearly 100,000 individuals per year in the US die of preventable medical errors[15].

Learning about how to prescribe and prescribing skills appears to fall between two pillars: (i) it is not taught at medical school and (ii) it is assumed to be in place by the doctors of first employment. The question remains when do doctors actually receive training for effective prescription writing practices. There are other cultural factors as well which contribute to how a prescription activity is perceived among doctors. Cultural differences particularly when it involves questioning authority have led to the inability of junior doctors and nurses to question the decisions of seniors, especially that of senior doctors[16]**.** A critical outcome of such phenomenon can lead to pharmacists being seen as a line of defense against errors, or actually inhabiting that role of deciding about medication dose and frequency.

Prescribing being one of common tasks in daily general practice, there seems abundant evidence of continuous poor prescribing in the world e.g. evidence of poor prescribing in UK[17]**.** While poor prescribing is not an uncommon practice in India also[18]. In India, conventional or traditional methods of prescribing on a prescription i.e. hand written on a prescription blank are still prevalent. Physicians as well as pharmacists, however, should be exposed to alternative means of prescription e.g. prescription forms, electronically transmitted prescriptions, fax simile prescriptions, telephonic order etc. and in fact most of the doctors are willing for a shift from traditional methods. Development of the ability to write and dispense a complete and unambiguous prescription(s) consistently is an essential, yet often neglected, part of a medical care training process. Unfortunately the prescriptions written by qualified physicians suffer from serious deficiencies and are not properly written.

Prescriptions containing errors communicate incompletely or inadequately to the pharmacist and may have various detrimental consequences. There seems to be an urgent need for physician education on appropriate prescription writing and furthermore re-inclusion of tutorials on prescription writing in final clinical year and internship of medical students. Administrative monitoring of the prescription habits of physicians is needed both to improve the health care process and to maintain the improvement. This study is an effort directed to find out the errors in prescription writing and interventions to improve upon such error prone practices of prescription writing.

Given the current scenario or scale of prescription errors, a need was felt concerning lacunae's in the field of prescription writing. This study serves as an important reminder to the practicing consultants to write proper accurate prescriptions and to avoid prescription errors**.** Since writing of prescriptions is an important aspect of medical practice, there is need for physicians and the consultants in various respective areas to focus on the importance of proper prescription writing orders. By examining the various aspects of prescription writing that can cause errors and by modifying prescribing habits, accordingly, the physician can improve the chance that the patient will receive the correct prescription, whether in a hospital or in an outpatient setting. By being alert to common problems that can occur with medication orders and communicating with the patients, physician, pharmacists and other health care professional one can assist in reducing prescription errors thereby decreasing the number of medication errors.

Aims of the Study:

1. To find out the pattern or rate of prescription errors.
2. To find out whether prescription writing abides with the W.H.O. standards of prescription writing.

3. To assess the causes of prescription writing errors in Anand district.

Objectives of the Study:

1. To reemphasize on the importance of error free prescription writing in clinicians and health care providers.
2. To increase awareness about the problems caused by errors in prescription writing and ways to minimize the same.
3. To devise novel interventions for the practicing clinicians to prevent prescription errors.

Errors will always occur in any system, but it is essential to identify causes and attempts to minimize risk. Although it is difficult to quantify precisely the extent of prescription errors, they are frequent and often avoidable representing a major threat to patient safety. Prescribers should be informed and made aware of errors that have been made in their environment and the conclusions of the analysis. Error reporting systems have been widely used both internally as well as externally in various health care institutions[19].

Hippocrates himself, in the first volume of his Epidemics, put all events better in context i.e. when dealing with the diseases has two precepts in the mind: to procure benefit and not to harm "*One must not become overly obsessed by the safety issues, but it is a necessary element in good medical care.*

So the main objective of the present study is to emphasize on the skills of prescription writing and thus create an awareness amongst the existing and future clinicians on ways and means to minimize prescriptions errors.

CHAPTER – II

REVIEW OF LITERATURE

CHAPTER - II

REVIEW OF LITERATURE

2.1 Prescription:

2.1.1 What is a medical prescription?

A prescription order is an important therapeutic transaction between the physician and the patient. It brings into focus the diagnostic acumen and therapeutic proficiency of the physician with instructions for the palliation and or restoration of the patients health. The most carefully conceived prescription order may become therapeutically useless, however, unless it communicates clearly with the pharmacists and adequately instructs the patient on how to take prescribed medications[5]**.** Thus a prescription is a health care program implemented by a physician or other medical practitioner in the form of instructions that govern the plan of care for an individual patient. Proficiency at writing a prescription accurately and speedily requires practice. Prescription writing has changed in modern medicine as a result of several developments. Most of the preparations today are compounded by pharmaceutical companies and the pharmacists current role in most cases is dispensing. The practice of writing long complex prescription orders containing many active ingredients, adjuvants, correctives and elegant vehicles has been abandoned in favor of single drugs and mixtures of drugs compounded by pharmaceutical companies. Even when combinations of several active ingredients are desirable, pharmaceutical companies often provide suitable combinations. A properly written prescription provides a primer on proper approach to medication prescribing and order process, to prevent medication misadventures and a resource for practitioners in effectively providing pharmaceutical care for their patients.

Prescription is an instruction from a prescriber to a dispenser. The prescriber is not always a doctor but can also be a paramedical worker, such as medical assistant, a midwife or a nurse. The dispenser is not always a pharmacist, but can be a pharmacy technician, an assistant or a nurse. Every country has its own standards for the minimum information required for a prescription, and its own laws and regulations to define which drugs require a prescription and who is entitled to write it. Commonly the term prescription is used to mean an order to take certain medications. Prescription orders should be written legibly while prescriptions have a legal implication as they may indicate that the prescriber takes the responsibility for the clinical care of the patient and in particular for monitoring efficacy and safety. However, as medications have increasingly become prepackaged manufactured products and medical practices have become more complex, the scope of meaning of the term prescription has also broadened to also include clinical assessments, laboratory task and imaging studies relevant to optimizing the safety or efficacy of the treatment.

The word ‘prescription’ comes from the Latin ‘Pre’ and ‘Scribo’, means literally ‘written before’ i.e. that which is ‘written before’ the application of the treatment. In its broadest sense, it includes any instructions for the benefit of the patient[20].

2.2 Prescription Writing:

2.2.1 Historical review of origin of drugs and prescription

Knowledge of ancient prescriptions can be found in both Chinese[21] and Egyptian writing[22]. The ancients started their prescriptions with an appeal to God for success, the use of the symbol Rx established centuries ago is rooted in ancient alchemical practice having an obscure origin has been carried down to the present times. ‘Rx’

may be derived from the Egyptian “Eye of Horus” symbol denoting, health or may be a symbolic appeal by physicians to the god Jupiter for a prescription’s success. More commonly, Rx is said to be an abbreviation for the Latin word recipere, meaning “take” or “take thou” as a direction to a pharmacist, preceding the physician’s “recipe” for preparing a medication. What is clear is the origin of the abbreviation “Sig” for the “Latin “Signatura”, used on the prescription to mark the directions for administration of the medication. Many ancient prescriptions were noted for their multiple ingredients and complexity of preparation. The importance of the prescription and the need for complete understanding and accuracy made it imperative that a universal and a standard language be employed. Thus Latin was continued until approximately a generation ago. Latin is no longer the international language of medicine, but a number of commonly used abbreviations are derived from old Latin usage.

The prescriptions and the treatment of disease have, with the progress of time, has gone through many evolutions. Treatment beginning occurred among our ancestors as songs, dances and various enchantations, it was learnt early that certain agents, if associated with the other efforts to drive out evil spirits, tend to produce the desired effect, and medicine soon became a partner to religious effort.

Before the days of the priestcraft, the wise man or woman of the tribe whose knowledge of the healing properties of the plants had been gathered through experience or handed down by word of mouth was called upon to attend to the sick or the wounded and prepare the remedy. It was in preparation of the medicinal materials that the art of the apothecary was originated. The art of apothecary has always been associated with mystery, and its practitioners were believed to have

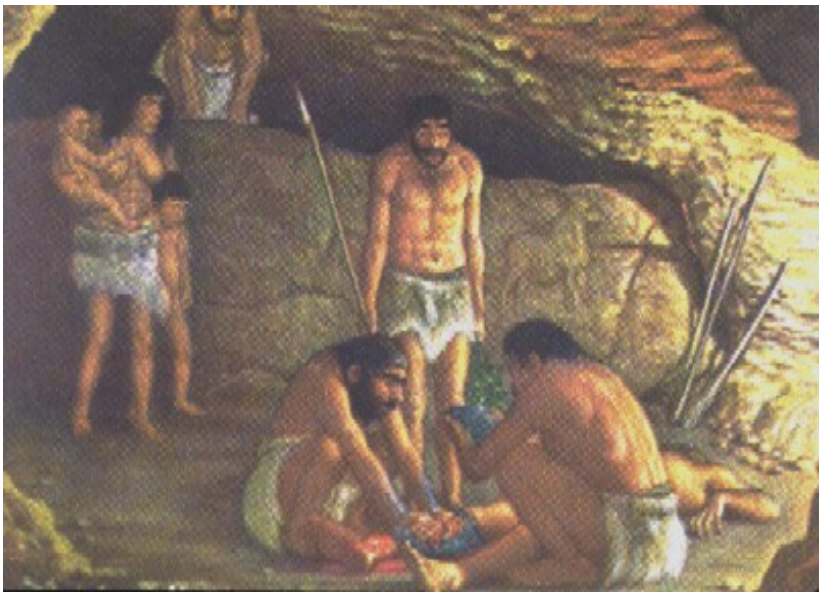
connection with the world of spirits and thus performed as intermediaries between the seen and the unseen.

The concept of prescriptions dates back to the beginning of history, so long there were medications, a writing system to record directions for preparation and usage, there were prescriptions. Thus the history of prescription writing is almost as old as the history of man. Among the most ancient inscriptions, now being deciphered are found formulae for preparing medicines. Some of these show that even at the remotest times there was some knowledge of Materia Medica, that this knowledge was employed by some physicians in writing instructions (prescription) for the preparation of remedies, and there is reason to suppose that these instructions were executed by others (pharmacists).

Numerous ancient tablets, scrolls and other relics as early as 3000 BC have been uncovered and deciphered by archaeological scholars to the delight of historians of both medicine and pharmacy. One of them being the Sumerian clay tablet from the third millennium BC on which are believed to be the world's oldest written prescriptions. Among them are a preparation of a seed of carpenter plant, gum resin of markhazi and thyme, all pulverized and dissolved in beer and a combination of powdered roots of Moon Plant and white Pear tree also dissolved in roots[23].

Historical Aspects[24]:

1. Before the Dawn of History:



From beginnings as remote and simple as these came the proud profession of Pharmacy. Its development parallels that of man. Ancient man learned from instinct, from observation of birds and beasts. Cool water, a leaf, dirt, or mud was his first soothing application. By trial, he learned which served him best. Eventually, he applied his knowledge for the benefit of others. Though the cavemen's methods were crude, many of today's medicines spring from sources as simple and elementary as those which were within reach of early men.

2. Pharmacy in Ancient Babylonia:

Babylon, jewel of ancient Mesopotamia, often called the cradle of civilization, provides the earliest known record of practice of the art of the apothecary. Practitioners of healing of this era (about 2600 B.C.) were priest, pharmacist and physician, all in one. Medical texts on clay tablets record first the symptoms of illness, the prescription and directions for compounding, then an invocation to the gods. Ancient Babylonian methods find counterpart in today's modern pharmaceutical, medical, and spiritual care of the sick.

3. Pharmacy in Ancient China:

Chinese Pharmacy, according to legend, stems from Shen Nung (about 2000 B.C.), emperor who sought out and investigated the medicinal value of several hundred herbs. He reputed to have tested many of them on himself, and to have written the first Pen T-Sao, or native herbal, recording 365 drugs. Still worshiped by native Chinese drug guilds as their patron god, Shen Nung conceivably examined many herbs, barks, and roots brought in from the fields, swamps, and woods that are still recognized in Pharmacy today. In the background is the "Pa Kua," a mathematical design symbolizing creation and life. Medicinal plants include podophyllum, rhubarb, ginseng, stramonium, cinnamon bark, and, in the boy's hand, ma huang or Ephedra.

4. Days of the Papyrus Eberus:

Though Egyptian medicine dates from about 2900 B.C., best known and most important pharmaceutical record is the "Papyrus Ebers" (1500 B.C.), a collection of 800 prescriptions, mentioning 700 drugs. Pharmacy in ancient Egypt was conducted by two or more echelons: gatherers and preparers of drugs and "chiefs of fabrication" or head pharmacists.

5. Theophrastus - Father of Botany:

Theophrastus (about 300 B.C.), among the greatest early Greek philosophers and natural scientists, is called the "father of botany". His observations and writings dealing with the medical qualities and peculiarities of herbs are unusually accurate, even in the light of present knowledge. He lectured to groups of students who walked about with him, learning of nature by observing her treasurers at firsthand. In his hands he holds a branch of belladonna. Behind him are pomegranate blooms, senna, and manuscript scrolls. Slabs of ivory, coated with colored beeswax, served the students as "slates." Writing was cut into the surface with a stylus.

6. The Royal Toxicologist - Mithridates VI:

Mithridates VI, King of Pontus (about 100 B.C.), though he battled Rome for a lifetime, found time to make not only the art of poisoning, but also the art of preventing and counteracting poisoning, subjects of intensive study. Unhesitatingly he used himself as well as his prisoners as "guinea pigs" on which to test poisons and antidotes. Behind him are rhizotomists, offering fresh, flowering aconite, ginger, and gentian. At lower right is a crater - a two-piece forerunner of the champagne bucket. His famed formula of alleged panantidotal powers, "Mithridatum," was popular for over a thousand years.

7. Terra Sigillata - an early "Trademarked" Drug:

Man learned early of the prestigious advantage of trademarks as a means of identification of source and of gaining customers' confidence. One of the first therapeutic agents to bear such a mark was Terra Sigillata (Sealed Earth), a clay tablet originating on the Mediterranean island of Lemnos before 500 B.C. One day each year clay was dug from a pit on a Lemnian hillside in the presence of governmental and religious dignitaries. Washed, refined, rolled to a mass of proper thickness, the clay was formed into pastilles and impressed with an official seal by priestesses, then sun-dried. The tablets were then widely distributed commercially.

8. Dioscorides - a Scientist Looks at Drugs:

In the evolution of all successful and enduring systems of knowledge there comes a time when the observations of many men, or the intensive studies of one, transcend from the level of trade or vocation to that of a science. Pedanios Dioscorides (first century A.D.), contributed mightily to such a transition in Pharmacy. In order to study materia medica, Dioscorides accompanied the Roman armies throughout the known world. He recorded what he observed, promulgated excellent rules for collection of drugs, their storage and use. His texts were considered basic science as late as the sixteenth century.

9. Galen - Experimenter in Drug Compounding:

Of the men of ancient times whose names are known and revered among both the professions of Pharmacy and Medicine, Galen, undoubtedly, is the foremost. Galen (130-200 A.D.) practiced and taught both Pharmacy and Medicine in Rome; his principles of preparing and compounding medicines ruled in the Western world for 1,500 years; and his name still is associated with that class of pharmaceuticals compounded by mechanical means - galenicals. He was the originator of the formula for a cold cream, essentially similar to that known today. Many procedures Galen originated have their counterparts in today's modern compounding laboratories.

10. Damian and Cosmas - Pharmacy's Patron Saints:

Twinship of the health professions, Pharmacy and Medicine, is nowhere more strikingly portrayed than by Damian, the apothecary and Cosmas, the physician. Twin brothers of Arabian descent, and devout Christians, they offered the solace of religion as well as the benefit of their knowledge to the sick who visited them. Their twin careers were cut short in the year 303 by martyrdom. For centuries their tomb in the Syrian city of Cyprus was a shrine. Churches were built in their honor in Rome and other cities. After canonization, they became the patron saints of Pharmacy and Medicine, and many miracles were attributed to them.

11. Monastic Pharmacy:

During the middle ages remnants of the Western knowledge of Pharmacy and Medicines were preserved in the monasteries (fifth to twelfth centuries). These scientists are known to have been taught in the cloisters as early as the seventh century. Manuscripts from many islands were translated or copied for monastery libraries. The monks gathered herbs and simples in the field, or raised them in their own herb gardens. These they prepared according to the art of the apothecary for the benefit of the sick and injured. Gardens such as these still may be found in monasteries in many countries.

12. The First Apothecary Shops:

The Arabs separated the arts of apothecary and physician, establishing in Bagdad late in the eighth century the first privately owned drug stores. They preserved much of the Greco-Roman wisdom, added to it, developing with the aid of their natural resources syrups, confections, conserves, distilled waters and alcoholic liquids. The apothecary is examining logs of sandalwood offered by a traveling merchant, while children indulge their taste for sweets with stalks of sugar cane.

13. Avicenna - the "Persian Galen":

Among the brilliant contributors to the sciences of Pharmacy and Medicine during the Arabian era was one genius who seems to stand for his time - the Persian, Ibn Sina (about 980-1037 A.D.), called Avicenna by the Western world. Pharmacist, poet, physician, philosopher and diplomat, Avicenna was an intellectual giant, a favorite of Persian princes and rulers. He wrote in Arabic, often while secluded in the home of an apothecary friend. His pharmaceutical teachings were accepted as authority in the West until the 17th century; and still are dominant influences in the Orient.

14. Separation of Pharmacy and Medicine:

In European countries exposed to Arabian influence, public pharmacies began to appear in the 17th century. However, it was not until about 1240 A.D. that, in Sicily and Southern Italy, Pharmacy was separated from Medicine. Frederick II of Hohenstaufen, who was Emperor of Germany as well as King of Sicily, was a living link between Oriental and Occidental worlds. At his palace in Palermo, he presented subject pharmacists with the first European edict completely separating their responsibilities from those of Medicine, and prescribing regulations for their professional practice.

15. The first Official Pharmacopoeia:

The idea of a pharmacopoeia with official status, to be followed by all apothecaries, originated in Florence. The Nuovo Receptario, originally written in Italian, was published and became the legal standard for the city-state in 1498. It was the result of collaboration of the Guild of Apothecaries and the Medical Society - one of the earliest manifestations of constructive interprofessional relations. The professional groups received official advice and guidance from the powerful Dominican monk, Savonarola, (seated foreground) who, at the time, was the political leader in Florence.

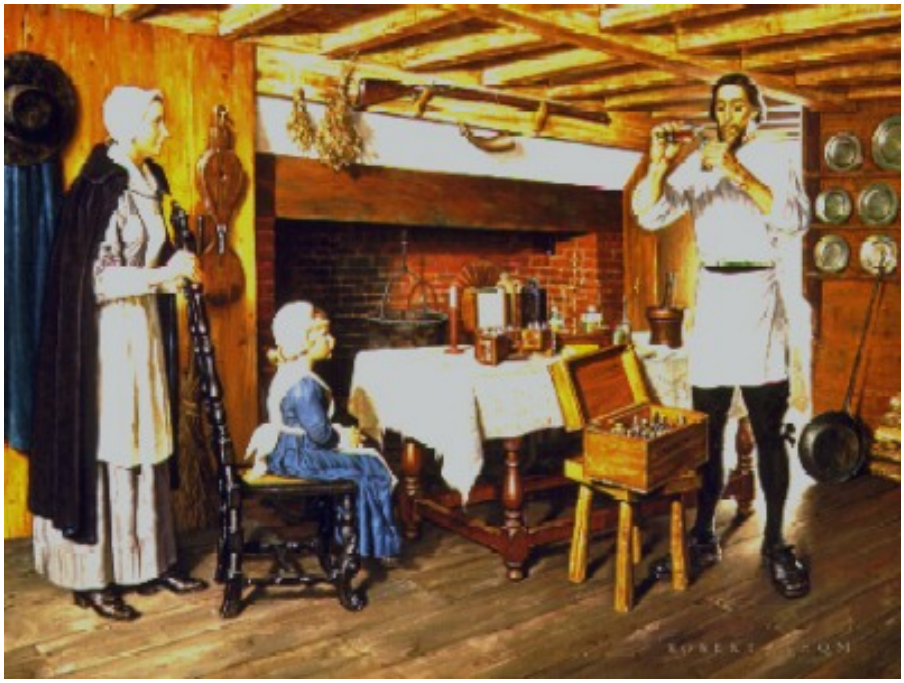
16. The Society of Apothecaries of London:

Trade in drugs and spices were lucrative in the middle ages. In the British Isles, it was monopolized by the Guild of Grocers, which had jurisdiction over the apothecaries. After years of effort, the apothecaries found allies among court physicians. King James I, flanked by two "Beefeaters" wore heavily padded attire because of fear of stabbing. Upon persuasion by the philosopher-politician, Francis Bacon, the King granted a charter in 1617 which formed a separate company known as the "Master, Wardens and Society of the Art and Mystery of the Apothecaries of the City of London" over vigorous protests of the grocers. This was the first organization of pharmacists in the Anglo-Saxon world.

17. Louis Hébert, Apothecary to New France (Canada):

Young Parisian Apothecary Louis Hébert answered the call of the New World in 1605, when he helped de Monts and Champlain build New France's first settlement, the Habitation at Port Royal (Nova Scotia, Canada). Hébert looked after the health of the pioneers, cultivated native drug plants, and supervised the gardens. At the waterfront, he examined specimens of drug plants offered by Micmac Indians. These included Arum, (Jack-in-the-Pulpit), Eupatorium (Boneset), Verbascum (Mullein) and Hydrastis (Golden Seal). When the Habitation was destroyed by the English in 1613, he returned to his Parisian apothecary shop. The lure of Canada was strong, however, and in 1617, he and the family returned with Champlain to Quebec, where Hébert's "green thumb" gained him lasting fame as the first successful farmer in what is now Canada.

18. The Governor who healed the Sick:



Many Europeans "of quality and wealth, particularly those who were non-conformists in religion" were attracted to the possibilities of the American Colonies. From Britain came John Winthrop, first Governor of Massachusetts Bay Colony and founder of Boston. Governor Winthrop, unable to induce professionals to the Colony, sought advice from English apothecaries and physicians, and added to his small store of imported drugs those derived from plants native to New England. In his home (about 1640), he made available as best he could the ‘art and myslay’ of the apothecary for his citizens.

19. The Marshall Apothecary:

Christopher Marshall, an Irish immigrant, established his apothecary shop in Philadelphia in 1729. During 96 years, this pioneer pharmaceutical enterprise became a leading retail store, nucleus of large-scale chemical manufacturing; a "practical" training school for pharmacists; an important supply depot during the Revolution; and finally, it was managed by granddaughter Elizabeth, America's first woman pharmacist. Christopher earned the title of "The fighting Quaker" during the Revolution; his sons, Charles and Christopher, Jr. (shown as youths with their father, about 1754) earned individual fame and carried on his fine traditions.

20. The First Hospital in Colonial America:

Colonial America's first hospital (Pennsylvania) was established in Philadelphia in 1751; the first Hospital Pharmacy began operations there in 1752, temporarily set up in the Kinsey house, which served until the first hospital building was completed. The ingenuity of Benjamin Franklin was helpful in both. First Hospital Pharmacist was Jonathan Roberts; but it was his successor, John Morgan, whose practice as a hospital pharmacist (1755-56), and whose impact upon Pharmacy and Medicine influenced changes that were to become of importance to the development of professional pharmacy in North America. First as pharmacist, later as physician, he advocated prescription writing and championed independent practice of two professions.

21. Scheele - Greatest of the Pharmacists-Chemists:

During his few short years, Carl Wilhelm Scheele gave to the world discoveries that have brought its people incalculable advantages. Yet he never forgot that he was, first of all, a pharmacist. Encouraged by enlightened preceptors, all of his discoveries were made in the Swedish pharmacists in which he worked, as apprentice, as clerk, and finally as owner, in Köping. He began in a corner of the stock room of Unicorn Apothecary in Gothenburg. With rare genius, he made thousands of experiments, discovered oxygen, chlorine, prussic acid, tartaric acid, tungsten, molybdenum, glycerin, nitroglycerin, and countless other organic compounds that enter into today's daily life, industry, health, and comfort.

22. Craigie - America's first Apothecary General:

First man to hold the rank of a commissioned pharmaceutical officer in an American army was the Bostonian apothecary, Andrew Craigie. First appointed commissary of medical stores by Massachusetts' Committee of Safety, April 30, 1775, he was present at the Battle of Bunker Hill, June 17, 1775, and probably assisted in taking care of the sick and wounded there in a makeshift station back of the lines. When Congress reorganized the Medical Department of the Army in 1777, Craigie became the first Apothecary General. His duties included procurement, storage, manufacture, and distribution of the Army's drug requirements. He also developed an early wholesaling and manufacturing business.

23. Sertürner - First of the Alkaloid Chemists:

Swedish pharmacist Scheele paved the way for isolating organic plant acids; but it remained for a young German apothecary, Friedrich Wilhelm Adam Sertürner, to give the world opium's chief narcotic principle, morphine and to recognize and prove the importance of a new class of organic substances: alkaloids. His first announcements challenged, Sertürner in 1816 conducted a new series of bold, startling experiments in his apothecary shop in Einbeck, including a series of physiologic tests on himself and three young friends.

24. Caventou, Pelletier and Quinine:

Taking their cue from Sertürner's alkaloidal experiments, two French pharmacists, Messrs. Pierre-Joseph Pelletier and Joseph-Bienaimé Caventou, isolated emetine from ipecacuanha in 1817; strychnine and brucine from nux vomica in 1818 then, in their laboratory in the back of a Parisian apothecary shop, they tackled the problem that had baffled scientists for decades - wrestling with the secrets of the Peruvian barks that were so useful against malaria. In 1820 Caventou and Pelletier announced the methods for separation of quinine and cinchonine from the cinchona barks prepared pure salts, had them tested clinically, and set up manufacturing facilities. Many other discoveries came from their pharmacy-laboratory high honors were accorded them.

25. American Pharmacy Builds and its Foundations:

Faced with two major threats deterioration of the practice of pharmacy, and a discriminatory classification by the University of Pennsylvania medical faculty, the pharmacists of Philadelphia held a tempestuous protest meeting in Carpenters' Hall, February 23, 1821. At a second meeting, March 13, the pharmacists voted formation of: an association, which became The Philadelphia College of Pharmacy, a school of pharmacy and a self-policing board.

26. The Shakers and Medicinal Herbs:

First U.S. industry in medicinal herbs was carried on by the United Society of Believers in Christ's Second Appearing, commonly known as the Shakers. Begun about 1820, and commercially important by 1830, the medicinal herb industry grew, hit its peak in the 1860's, then waned at the close of the century. The Shakers gathered or cultivated some 200 varieties dried, chopped, and pressed them into "bricks" wrapped, labeled, and sold them to pharmacists and physicians world-wide. Tons of solid and fluid extracts also were produced. The Shaker label was recognized for reliability and quality for more than a century.

27. The American Pharmaceutical Association:

Need for better intercommunication among pharmacists; standards for education and apprenticeship; and quality control of imported drugs, led to calling of a convention of representative pharmacists in the Hall of the Philadelphia College of Pharmacy, October 6 to 8, 1852. Under leadership of its first President, Daniel B. Smith, and first Secretary, William Procter, Jr., the twenty delegates launched The American Pharmaceutical Association, mapped its objectives; and opened membership to "All pharmaceutists and druggists" of good character who subscribed to its Constitution and to its Code of Ethics. The Association continues to serve Pharmacy today.

28. European and American Pharmacy Meet:

Over the years, no real discord has existed between representatives of European and American Pharmacy so far as ethical and scientific aims are concerned. But when the groups met for the first time, at the Second International Congress of Pharmacy in Paris, France, August 21 to 24, 1867, there was a great divergence of opinion on the subject of compulsory limitation of pharmacies. William Procter, Jr., leading the delegates of The American Pharmaceutical Association, told the international body that "Public opinion is in America a forceful agent of reform," and that, in his country, "there is not the slightest obstacle toward a multiplication of drug stores " & this declaration vividly documented the American Way of Pharmacy.

29. The Father of American Pharmacy:

Rarely has a titular distinction been so deserved. William Procter, Jr., graduated from The Philadelphia College of Pharmacy in 1837 operated a retail pharmacy served the College as Professor of Pharmacy for 20 years was a leader in founding The American Pharmaceutical Association served that organization as its first secretary; later, as its president; served 30 years on the U.S.P. Revision Committee; was for 22 years Editor of the American Journal of Pharmacy. In 1869, though retired, Procter continued to edit the Journal in a small publication office located besides the College's Tenth Street building.

30. A Revolution in Pharmaceutical Education:

When Dr. Albert B. Prescott launched the pharmacy course at the University of Michigan in 1868, critical attention was aroused because he abandoned the traditional requirement of pre graduation apprenticeship. At the 1871 convention of the American Pharmaceutical Association, he was denied credentials and ostracized. However, the Michigan course pioneered other major changes: laboratory pharmacy, a definite curriculum that included basic sciences, and a program that demanded students' full-time attention. During the next thirty years, Dr. Prescott had the satisfaction of seeing his once revolutionary innovations generally adopted by pharmaceutical faculties.

31. The Pharmacopoeia Comes of Age:

The first "United States Pharmacopoeia" (1820) was the work of the medical profession. It was the first book of drug standards from a professional source to have achieved a nation's acceptance. In 1877, the "U.S.P." was in danger of dissolution due to the lack of interest of the medical profession. Dr. Edward R. Squibb, manufacturing pharmacist as well as physician, took the problem to The American Pharmaceutical Association convention. Pharmacists formed a "Committee on Revision" whose chairman was the hospital pharmacist Charles Rice, assisted by pharmacist-educator Joseph P. Remington, and by Dr. Squibb, their indefatigable collaborator.

32. The Standardization of Pharmaceuticals:

Despite the professional skill and integrity of 19th-century pharmacists, seldom did two preparations of vegetable drugs have the same strength, even though prepared by identical processes. Plant drugs varied widely in active alkaloidal and glucosidal content. The first answer to this problem came when Parke, Davis and Company introduced standardized "Liquor Ergotae Purificatus" in 1879. Dr. Albert Brown Lyons, as the firm's Chief Chemist, further developed methods of alkaloidal assay. Messrs. Parke and Davis recognized the value of his work, and in 1883, announced a list of twenty standardized "normal liquids." Parke-Davis also pioneered in developing pharmacologic and physiologic standards for pharmaceuticals.

33. Wresting the Jungle's Secrets:

Expeditions in search of new medicinal plants probably are as old as Pharmacy. Scientific adventurers, such as Henry Hurd Rusby (1855-1940), opened vast new horizons for the advancement of Pharmacy and Medicine, late in the nineteenth century. Sent by Parke, Davis and Company in 1884 to Peru for supplies of coca leaves, Dr. Rusby crossed the Andes and journeyed down the Amazon to the Atlantic amid incredible hardships. He returned with 45,000 botanical specimens. Among them were many new drug plants, including cocillana bark, pharmaceutical preparations of which are still important to Medicine. Dr. Rusby later became Dean of the College of Pharmacy of Columbia University.

34. Stanislas Limousin - Pharmacal Inventor:

One of those men singularly gifted in combining scientific knowledge with technical skill and with inventive genius was the French retail pharmacist, Stanislas Limousin (1831-1887). Among the many devices which he introduced to Pharmacy and Medicine were the medicine dropper; the system of coloring poisons (such as corrosive sublimate) and wafer cachets (which found favor prior to mass production of the gelatin capsule). His greatest contributions, however, were the development and perfection of apparatus for the inhalation and therapeutic administration of oxygen; and invention of glass ampoules that could be sealed and sterilized for preservation of solutions for hypodermic use.

35. The Era of Biologicals:

When, in 1894, Behring and Roux announced the effectiveness of diphtheria antitoxin, pharmaceutical scientists both in Europe and in the United States rushed to put the new discovery into production. Parke, Davis and Company was among the pioneers. The serum became available in 1895, and lives of thousands of children were saved. Inoculation of horses with diphtheria toxin was the first step of many in producing antitoxin. In 1903, Parke-Davis received U.S. Biological License No. 1. New, improved biological products have continued to become available, climaxed in 1955 by poliomyelitis vaccine.

36. The Development of Chemotherapy:

One of the successful researchers in the development of new chemical compounds specifically created to fight disease-causing organisms in the body was the French pharmacist, Ernest Francois Auguste Fourneau (1872-1949), who for 30 years headed chemical laboratories in the world-renowned Institute Pasteur, in Paris. His early work with bismuth and arsenic compounds advanced the treatment of syphilis. He broke the German secret of a specific for sleeping sickness paved the way for the life-saving sulfonamide compounds; and from his laboratories came the first group of chemicals having recognized antihistaminic properties. His work led other investigators to broad fields of chemotherapeutic research.

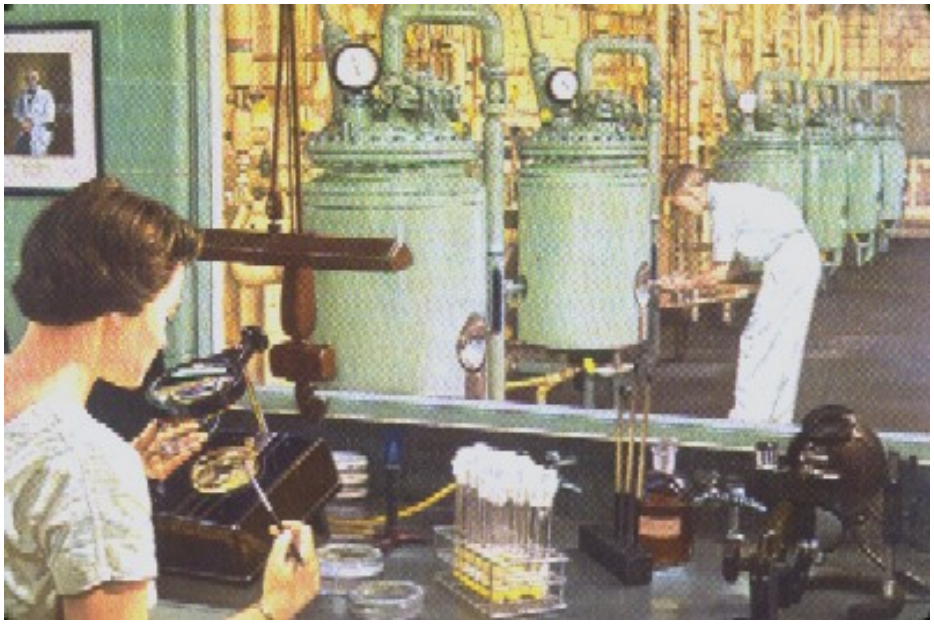
37. Pharmaceutical Research:

Research in some form has gone hand in hand with the development of Pharmacy through the ages. However, it was the chemical synthesis of antipyrine in 1883 that gave impetus and inspiration for intensive search for therapeutically useful compounds. Begun by the Germans, who dominate the field until World War I, the lead in pharmaceutical research passed thereafter to the United States. Research in Pharmacy came into its own in the late 1930's and early 1940's has grown steadily since, supported by pharmaceutical manufactures, universities and government. Today it used techniques and trained personnel from every branch of science in the unending search for new life-saving drug products.

38. Pharmaceutical Manufacturing Comes of Age:

Pharmaceutical manufacturing as an industry apart from retail Pharmacy had its beginnings about 1600; really got under way in the middle 1700's. It developed first in Germany, then in England and in France. In America, it was the child of wars - born in the Revolution grew rapidly during and following the Civil War became independent of Europe during World War I, came of age during and following World War II. Utilizing latest technical advances from every branch of science, manufacturing pharmacy economically develops and produces the latest and greatest in drugs in immense quantities, so that everywhere physicians may prescribe them and pharmacists dispense them for the benefit of all mankind.

39. The Era of Antibiotics:



Antibiotics are not new. Their actions probably were first observed by Pasteur in 1877. However, the second quarter of the 20th century marked the flowering of the antibiotic era - a new and dramatic departure in the production of disease-fighting drugs. Fleming's discovery of penicillin in 1929 went undeveloped and Florey and Chain studied it in 1940. Under pressure of World War II, the pharmaceutical manufacturers rapidly adapted mass production methods to penicillin have reduced costs to $1/1000^{th}$ the original. Antibiotic discoveries came rapidly in the '40's. Intensive research continues to find antibiotics that will conquer more of men's microbial enemies.

40. Pharmacy Today and Tomorrow:

Pharmacy, with its heritage of 50 centuries of service to mankind, has come to be recognized as of the great professions. Like Medicine, it has come through many revolutions, has learned many things, had to discard many of its older ways. Pharmacists are among the community's finest educated people. When today's retail pharmacist fills a prescription written by a physician, he provides a professional service incorporating the benefits of the work of pharmacists in all branches of the profession - education, research, development, standards, production, and distribution. Pharmacy's professional stature will continue to grow in the future as this great heritage and tradition of service is passed on from preceptor to apprentice, from teacher to student, from father to son.

As already stated prescriptions being one of the most important therapeutic transactions between physician and the patient. The art of prescription writing is an ancient inheritance, its origin is lost in antiquity, but its importance through the

centuries has made it, one of the most significant written communications of the human race.

To avoid undesirable and or serious adverse effects on the patient, both the physician and the pharmacist must render the highest professional service. Accurate diagnosis, proper selection of medications, dosage form and route of administration, proper size and timing of dose, precise dispensing, accurate labeling and correct packaging all must be provided.

2.2.2 General aspects of practical prescription writing:

One of the primary communication links between the prescriber, pharmacist and patient is a complete safe and accurate prescription. Completion of all essential elements of a prescription will assure that it is accurately interpreted and is not subject to alteration[6].

Although perceived as a mundane component of the work of most clinicians, the process of good prescribing requires significant skills and care which should be undertaken with due thought and consideration. Good prescribing involves the recommendations of the correct dose and formulation of an appropriate drug, accompanied by clear instructions regarding, when how and for how long the drug is taken. A prescription should be a written clinical information about the patient and the symptoms and ideally following solicitations of the patient preferences and discussion of alternative treatment strategies. Prescriptions are handwritten on preprinted prescription form that are assembled into pads or alternatively printed onto similar forms using a computer printer. Preprinted on the form is the text that identifies the document as prescription, the name , address of the prescribing

provider and any other legal requirement such as registration number or e.g. DEA (Drug enforcement Administration) number in United States. Unique for each prescription is the name of the patient. Literally the word, recipe means simply take or take thou and when a medical practitioner writes a prescription beginning with Rx, he or she is completing the command. This was probably originally directed at the pharmacist who needed to take a certain amount of each ingredient to compound the medicine rather than at the patient who must take the medicine in the sense of consuming it. The word prescription can be decomposed into 'pre' and 'script' and literally means to write, before a drug can be prepared. Modern prescriptions are actually 'extemporaneous prescriptions from the Latin extempore i.e. extempore = composed, performed or uttered on the spur of the moment. Thus extemporaneous means the prescription is written on the spot for a specific ailment. This is distinguished from a nonextemporaneous prescription which is a generic recipe for a general ailment.

Modern prescriptions evolved with the separation of role of the pharmacists from that of physicians. Predating the modern legal definition prescriptions traditionally were composed of 4 parts " a superscription", an "inscription", subscription and signature and even today the prescription consist of the superscription, the inscription, the subscription the signa, the name and signature of the prescribe, all contained in a single form.

A complete, safe and an accurate prescription writing is one of the primary communications links between the prescriber, pharmacist and patient. This in turn is an efficient resource for practitioners in effectively providing pharmaceutical care for their patients.

Superscription:

The superscription includes the Date of the prescription and the patient information (for identification) name, age, address, weight of the patient, with the treatment symbol Rx. The symbol Rx separates the superscription from the inscription section. In this arrangement of prescription the Rx symbol for recipe, is an exhortation to the pharmacist by medical practitioner, that I want the patient to have the following medication, or it means in other words, take the following components and compound this medication for the patient.

Where Rx came from?

The Eye of Horus

The Rx symbol share similar elements

The symbol for Jupiter

The symbol *Rx* is derived from the major lines in the symbol of the Eye of Horus. Horus was an Egyptian God. Horus's eye also called the Wadjet Eye, became a symbol for health. The Egyptians considered it a symbol of good and restored health.

The symbol was passed along through the ages. As William Osler wrote in 1910, "In a cursive form it is found in mediaeval translations of the works of Ptolemy the astrologer, as the sign of the planet Jupiter. As such it was placed upon horoscopes and upon formula containing drugs made for administration to the body, so that the

harmful properties of these drugs might be removed under the influence of the lucky plant." There is another theory of *Rx*'s origin. In that version, *Rx* is an abbreviation for the Latin word *recipere*, which means "take" or "take thou". Long ago, this would not have been a direction to a patient but to a pharmacist, preceding the physician's "recipe" for preparing a medication. That may be, but the shape of the symbol is a strong argument in favour or the Eye and Horus as its origin. If you look closely at the major lines of the eye of Horus, you can see the elements of the symbol *Rx*.

Inscription:

The body of the prescription or inscription contains the name and strength of the drug to be dispensed, or the amount of each ingredient to be compounded. Earlier in ancient times the inscription section was further composed of one or more of the following:

- A basic or chief ingredient intended to cure.
- An adjuvant to assist its actions.
- A corrective or a corrigent to prevent or lessen the undesired effect and decrease the disagreeable odour of ingredients.
- A vehicle or a excipient to make suitable for administration and which is pleasant to the patient.

In writing inscription following points should be observed:

a) Each ingredient should be written on a separate line.

b) Always begin each line with capital letter.

c) The name of active ingredients should be written first, and solids should come before that of liquid.

d) While writing the names of preparations of drugs use correct, english names of abbreviated Latin names, preferably the former, as have been recommended by the pharmacopeias as that can lead to confusion e.g. BID in Latin is two times a day rather than before dinner as thought by the patient.

e) The quantity of each drug ordered should follow the name of each ingredient and while writing the doses it is desirable be that the prescriber follows metric system.

Subscription:

The subscription is the instruction to the pharmacist usually consisting of a short sentence such as - make a solution, mix and place into 30 capsules, or dispense 30 tablets. The subscription section contains dispensing directions to Pharmacists. - i.e. compounding instruction or quantities to be dispensed.

Signature:

The signature section contains directions to the patient such as' Take one teaspoonfull 3 times a day before meals' and is often abbreviated as *sig* or *signa*. It is also helpful to include the indication for one medication, for example for ulcers. Wherever possible instructions of general nature such as take as directed should be avoided since the patient may misunderstand or forget oral directions given by the physician. In addition to these basic parts of a prescription it should have the patients name and also signature of the prescribing medical practitioner. This is written either in English or in vernacular language. The prescribers name or initial and the date are written at the bottom. Some state laws require that if substitution is

to be prohibited, the physician must actually write Dispense as written or a similar phrase. In case of addiction producing drugs like narcotic analgesics e.g. morphine and pethidine, barbiturates and certain poisonous drugs, the registration number of the prescriber should also be written at the bottom and address of the patient at the top.

Although every country has its own standards for prescriptions, there are many practical issues for prescribing doctors to master, one of them which is very important is concerned with the writing of Prescriptions. There are four common types of prescriptions namely:

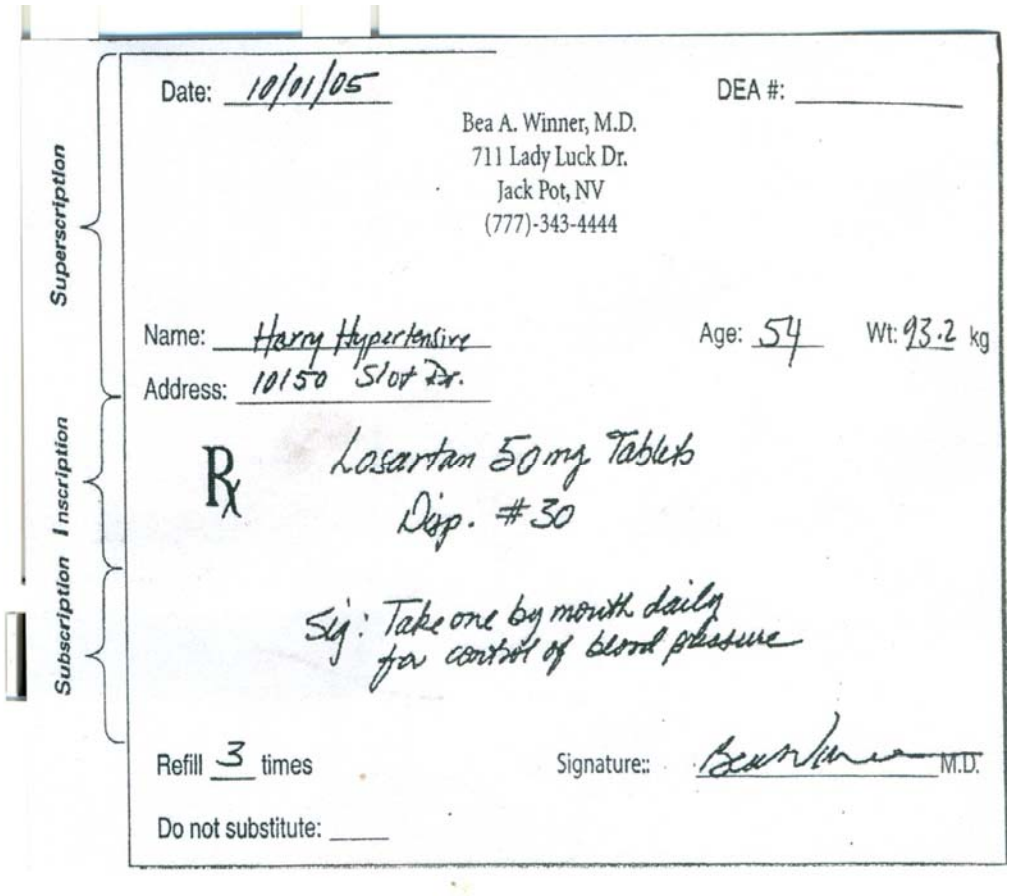
- Prescription in general practice.
- Hospital prescriptions for in patients.
- Hospital prescriptions for a non-hospital pharmacy.
- Private prescriptions.

In all cases certain principles should be followed. A prescription should be a precise, accurate, clear and readable set of instruction/s. The instructions should be sufficient for a pharmacist to provide a patient with both the correct drug and the instructions on how to take it and also for the nurse to administer a drug accurately in hospital.

Construction of the Prescription Order:

Since traditions, a prescription order follows a definite pattern that facilitates its interpretation. While only one prescription should be written on an order blank all prescriptions should be written in ink, this practice is compulsory for schedule II drugs under the controlled substances act of 1970 as erasures on a prescription easily can lead to dispensing errors or diversion of controlled substances Prescription pad blanks normally are imprinted with a heading that gives the name of the physician

and the address and phone number of the practice site. Following issues in prescription writing are a cause of major concern. The figure below shows elements required for prescription writing[5].



A sample of an ideal prescription.

The prescription must be carefully prepared to identify the patient and the medication to be dispensed, as well as the manner in which the drug is to be administered. Accuracy and legibility are essential. Use of abbreviations, particularly Latin, is discouraged, as it leads to dispensing errors. Inclusion of the purpose of the medication in the subscription (e.g. ‘for control of blood pressure’) can prevent errors in dispensing. For example, the use of losartan for the treatment

of hypertension may require 100 mg/day (1.4 mg/kg per day), whereas treatment of congestive heart failure with this angiotensin II-receptor antagonist should not generally exceed 50 mg/day. Including the purpose of the prescription can also assist patients in organizing and understanding their medications. Including the patient's weight on the prescription can be useful in avoiding dosing errors, particularly when drugs are administered to children.

When using institutional blanks that do not bear the physicians information, the physician should always print his or her name and phone number on the face of the prescription to clearly identify the prescriber and facilitate communication with other health care professionals if question arises. As stated earlier according to United States law requires that the prescription for controlled substances include the name address and the Drug Reinforcement Agency (DEA) registration number of the physician. The medicolegal significance of mentioning registration number of the qualified medical practitioner cannot be overemphasized besides being a legal requirement to be fulfilled by doctors as well as registered medical practioners by the director General of health[23]. This again indicated a need for Pharmacy and medical educators to further emphasize the importance of writing complete prescriptions and also calls for implementation of educational and monitoring Programmes to bring more awareness to all concerned so as to reduce the rate of non compliance in prescription writing and hence minimizing chances of Prescription errors. Moreover according to information regarding Medical council registration number, doctors are required to quote their registration number on all medical prescriptions, reports and all other documentation and records, whether in paper or electronic format relating to their medical practice thus prescribing doctor should put his rubber stamp bearing his full name, qualification and registration number.

Date:

Date of the prescription order is an important piece of the patients medical records, and it can assist the pharmacist in recognizing the potential problems. For example, when an opioid is prescribed for pain due to an injury, and the prescription is presented to the pharmacist 2 weeks after the issuance, the drug may no longer be indicated. Compliance behavior also can be estimated using the dates when a prescription is filled or refilled .In many countries the validity of a prescription has no time limit, but in some countries pharmacists do not give out drugs on prescriptions older than three to six months.

Name, Address and Age of the Patient:

Name, address, age of patient, this information is necessary to expedite the handling of the prescriptions order and to avoid possible confusion with medications intended for someone else. The patients name and address are needed in order to assure that the correct medication goes to the correct patient and also for the identification and record keeping purposes. For medications whose dosage involves calculations a patient's pertinent factors such as weight, age, body surface area also should be listed. Prescribers often commit errors in dosage calculations that can be prevented[25]**.** When prescribing a drug whose dosage involves a calculation based on body weight or surface area it is a good practice to include both the calculated dose and the dosage formula used such as 240 mg every 8 hourly (40 mg/kg per day) to allow another health care professional to double check the prescribed dose, e.g. medication orders in hospitals and clinical settings such as those of antibiotics or antiepileptic medications that are sometimes difficult to adequately dose. It is essential for the pharmacist to verify the patients name and age, otherwise it is impossible to monitor

the prescribed dose. The pharmacist should place the name of patient on the bottle or the container exactly as the doctor has written it. Prescription orders, for schedule II drugs are required to contain the full name and address of the patient. Moreover name, initials and hospital's case number is important in hospital. If there are two patients of the same name in the ward, this should be clearly stated, to avoid confusion and error.

Drug name, strength and inert additives:

The body of prescription order contains the name, strength or dose of the desired drug. The name of the drug should preferably be given in block capitals. Moreover it is strongly recommended to use the generic (non proprietary) name because it facilitates education and information as the drugs have different kinds of brand names.

Chemical name, official name and brand name:

- The chemical names are those whose form generally follows the rules issued by the International Union of Pure and Applied Chemistry (IUPAC).
- The approved (official or generic) name, is usually the international non proprietary name, recommended by WHO, but may be some locally approved name (e.g. British approved name or United States adopted name).
- The proprietary name (Brand name or Trade name) given to it by a pharmaceutical manufacturer for example:

  Chemical name: -6 [amino (4-hydroxy phenyl) acetyl 1- amine] -3, 3 dimethyl -7 one-4- thia – 1 azabicyclo [3.2.0] heptane 2- carboxylic acid.

  Official name: Amoxicillin

  Proprietary names: Amorail, Almodan, Amox, Rimonallin, Mox.

There remains a lot of controversy regarding prescribing by proprietary or approved name. If a prescriber writes the drug by non- proprietary name, it means that he/she is not expressing an opinion about a particular brand, of drug which may be unnecessary for the patient. It also enables the pharmacist to maintain a more limited stock of drugs or dispense the cheapest drugs. However if there is a particular reason to prescribe that brand or a special brand the trade name can be added. Some countries allow generic substitution by pharmacist and require the addition, 'Do not substitute' or 'dispense as written' if that brand and none other than that brand is to be dispensed. Prescribing by proprietary name can lead to missing, and forgetting the ingredients in a particular combination or a formulation, moreover if a doctor prescribes a drug by specific brand which is unavailable at the pharmacy store, it can result in delay of treatment.

However if a doctor makes effort to prescribe where ever possible by approved name, particularly from the start of his career, he will generally find it just as easy as prescribing by proprietary name or else it is best to use the nonproprietary name followed by the name of manufacturer in parenthesis especially in cases where a specific manufacturer product has distinct advantages or if a physician wishes to prevent a change of product on subsequent refills, such a practice limits confusion of look alike names or sound alike names. So one should encourage to prescribe by non-proprietary name.

Look alike and sound alike drug names are responsible for approximately 25% of medication errors reported to USP MERP[26]. Even the drug whose name seems more distinct easily can be confused when handwriting styles and cognitive mechanisms such as confirmation bias become contributing factors[27]. Procedures exist for a

drug's generic or brand name to be changed if it repeatedly causes errors or is found to be particularly dangerous, but many errors can occur before the change is instituted by the United States Food and Drug e.g. in 1990, the trade name for omeprazole in the United states under the FDA (United States Adopted Name (USAN) Council was changed from LOSEC to PRILOSEC because of the possible confusion of LOSEC with LASIX. In 2000, Amrione was renamed Inamrione in an effort to prevent further (sometimes fatal mix ups with amiodarone, although errors between the two had been reported for a number of years. It also has been proposed that the USAN of amiodarone be changed to camiodarone[28] although this change has not yet been approved. The risk of look alike and sound alike errors can be minimized by printing the drug name and writing a complete prescription, order that includes the drug's strength, specific direction, and indication for use, as this additional information often can help differentiate between products. Including the drug's indication is particularly useful, as similar name rarely exist within the same therapeutic category. Oral orders generally are discouraged, but their safety can be increased by speaking slowly, spelling out problematic words and numbers, and having the order repeated back. For drugs having a look alike or sound alike alternate, it can be helpful to indicate both the brand and generic names. Some of the examples of sound alike drug names in Indian markets are cited below:

Brand name	Generic drug	Clinical use	Manufacture
Tab. Aldactone Inj.Aldarone	Spironolactone Amiodarone	Diuretic Anti-arrhythmic	RPG life Alidac
Inj. Amicom Inj. Amicor	Amikacin Amrinone	Anti microbial Congestive heart failure	Comed Samarth pharma
Bactroban cream	Mupirocin (2%) Ciclpirox oleamine	Topical anti-microbial	Glaxo smithklie Hoexhst marion

Batrafan		Topical anit- fungal	rouseel
Brand name	**Generic drug**	**Clinical use**	**Manufacture**
Tab. Cadolac	Katorolac	NSAID	Cadila Pharma
Tab Carloc	Carvedilol	Non selective beta blocker	Cipla
Tab Combutol	Ethambutol	Antitubercular	Lupin
Tab Carbatol	Carbamazepine	Antiepileptic	Torrent
Tab Daonil	Gilbenclamide	Sulphonylurea	Aventis
Tab Depsonil	Imipramine	Tricyclic antidepressant	SPPL
Tab Dilantin	Phenytoin	A nticonvulsant	Parke davis
Tab Dilcontin	Diltiazem	Antihypertensive	Modimundipharma
Tab Epitril	Clonazepam	Anticonvulsant	Novartis
Tab Enalapril	Enalapril	Antihypertensive	Intas
Tab Facital	Mefloquin	Antimalarial	Zydus cadila
Tab Farlutal	Medroxypro-gesterone acetate	Progesterone	Pharmacia andUpjohn
CapMoclox	Amoxacillin +Cloxacillin	Antimicrobial	Kopran
Cap Macox	Rifampicin	Antileprosy	Macleods
CAP Neurontin	Gabapentin	Anticonvulsant	Parke davis
Tab Nitrocontin	Glceryltrinitrate	Antianginal	Modi mundi pharma
Tab Opam	Pioglitazone	Antidiabetic	Wockhardt
CapOpaz	Omeprazole	Proton Pump Inhibitor	Aglowmed
Inj Oframax	Ceftriaxone	Antimicrobial	Ranbaxy
Inj Okavax	Live attenuated vaccine of varicella zoster	Vaccine	Aventis Pasteur
Tab Rapilin	Repaglinide	Antidiabietic	Azetac

Instructions about dose/strength are also an extremely important part of prescription order writing. The strength of the drug indicates how many milligrams each tablet, suppository or milliliter of fluid should contain. Internationally accepted abbreviations should be used gm for gram, ml for milliliter. It is preferable to avoid decimals and wherever necessary write words in full to avoid misunderstandings and errors e.g. Write levothyroxin 50 micrograms, not 0.50 milligrams or 50 mg. Badly handwritten, prescriptions can lead to errors, and it is the legal duty of the doctor to write legibly and clearly. Strength and its inert additives of each drug

should be placed together after drug in one line. If the number of drugs is more, in same prescription order, the name and the amount of each drug are placed together on a line directly under the preceding one.

The number of days for which medication is contemplated, the number of dose per day, and the size of each dose determines the bulk of prescription. A major factor that should be a determinant of the quantity of the drug dispensed is the mental state of the patient and the potential toxicity of the drug. If a patient is depressed or potentially suicidal he may take it all at one time, so do not prescribe the total quantities of drug to such patients. Instead of this, a convenient rule of thumb is to prescribe only enough medication for 7-14 days unless the patient will be taking the drug for an extended period of time.

In prescription for controlled drugs or those with a potential for abuse, it is safer to write the strength and total amount in words, to prevent tampering. Instruction for use must be clear and the maximum daily dose mentioned. Storage of unused portions of a prescription and sharing of prescriptions with others who were not intended to receive them should be discouraged. Frequency of administration should be clearly indicated e.g. Atenolol 10 mg once daily, Amoxicillin 250 mg three times a day, etc. Simpler the instruction the better for the patient or the recipient e.g. regarding dosage interval mentioning 6 hourly or 8 hourly, is preferable rather than three times a day.

Use of abbreviations:

It is recommended to practice use of standard abbreviations. Abbreviations are known to lead to dispensing errors[29]. Once daily dosing at the bed-time (qhs) may

be misinterpreted as (qhr) for every hour. The use of slash mark(/) to separate names and the dosages can result in incorrect drug or dose being dispensed, the slash mark may be interpreted as a letter or a number. When medications are measured in units or international units the abbreviation U or IU must NOT be used, as it leads to errors such as misinterpretation of U as 0 or four or IU as 10 or 14.The word unit should be written as such. There are many examples of confusion in interpretation of a physician order[30]. The critical message is that practitioners should write out treatment fully in English if errors are to be avoided.

Areas of particular concern in preparation of medication orders in both institutional and outpatient settings can be summarized as follows:

- Quantities of 1 gram or more should be written in grams e.g. write 2 g.
- Quantities less than 1 gram but more than 1 milligram should be written in milligrams e.g. write 100 mg not 0.1 g.
- Quantities less than 1 milligram should be written in micrograms or nanogram as appropriate. Do not abbreviate microgram or nanogram e.g. write 100 micrograms not 0.1 mg or 100 μg or 100 mcg.
- If a decimal point cannot be avoided for values under 1, write a zero before it e.g. write 0.5 ml, not 5 ml.
- Use ml for milliliters.
- For liquid medicines given orally, dose should be stated specifically as either 5 ml or 10 ml, special spoons or calibrated caps are given to the patient for measurement of the required dose[31].

Many abbreviations are derived from Latin phrases[31] e.g. ad lib (at pleasure), ac (before meals), pc (after meals), bid (twice a day), hs (at bed time), qid (four times a

day), stat (immediately), tid (three times a day), qh (every hour), Q4h (every 4 hours), Tab (tablet), gtt (drops), prn (as and when needed). However, all abbreviations carry an increased risk for confusion and misinterpretation and should be used cautiously[32].

Route:

Route and method of administration should be clearly indicated e.g. oral, sublingual, intravenous, intramuscular, subcutaneous unless the route is obvious e.g. Beclomethasone inhaler two puffs every four hourly. The use of syringe pumps is increasing and this special form of drug administration needs good communication, between nurse, doctor and the patient. Education at all levels of health care is required to avoid prescription error.

Directions to the Pharmacist:

In the prescription orders for a single drug this usually consists of "dispense 10 tablets, dispense '200 ml', dispense with oral syringes, while for 2 or more drugs, following phrases can be used 'mix', 'make a solution' etc.

Directions for the Patient:

Directions for the patient should always be written in English or vernacular language as Latin language serves no useful purpose. Directions as already mentioned, should focus on the amount of drug, frequency and time of dose. Other factors like dilution, route of administration, demonstration of device intended for use, instructions like take oral medication in upright position with a glass full of water, shake the liquid medication before use, apply lotions by not rubbing, liniment application by rubbing should be instructed to the patients in vernacular language, beforehand to avoid

possible errors. The first word of the directions to the patient should only serve as a reminder of the correct route of administration e.g. *directions for a preparation for internal use should start with the word take, for an ointment or lotion the word 'apply', for suppositories the word 'insert' and for drops 'to be placed' in conjunctiva sac, external auditory canal or nostril*. The directions to the patient should also be employed as a reminder of the intended purpose of the prescription, by including such phrases as *for relief of pain, for relief of headache, or to relieve it*. However directions that would be embarrassing to the patient if placed on the prescription order or label should be given in private.

Refill Information:

Under the Durham - Humphrey Amendment to Food, Drug and Cosmetic Act prescription orders for drugs that bear the caution legend Federal law prohibits dispensing without the prescription may not be refilled without the consent of the prescriber. Under the Drug Abuse Control Amendments i.e. prescription orders for Schedule III and Schedule IV drugs cannot be refilled for more than 5 times, and the prescription order is invalid 6 months from the date of issue. These restrictions are intended to control the overuse and abuse of such prescription medications. Physicians should make it a practice to indicate the number of refills on each original prescription order, irrespective of whether it is for controlled substance. This may be indicated by instruction to refill a number of times or not to refill. Statements such as refill ad lib are never appropriate. Such information need not be written on narcotic prescription orders for Schedule II substances, since by law these cannot be refilled. The Comprehensive Drug Abuse Prevention and Control Act, commonly referred to as the Controlled Substances Act is designed to control the

distribution of all depressant and stimulant drugs e.g. opioids, barbiturates, and Amphetamines and other drugs with abuse potential. This act requires the pharmacist to keep records of the receipt and the disposition of all controlled substances. The records must be maintained for a period of at least 2 years and be available for inspection by an authorized person. Prescription orders for controlled substances in Schedule II must be type written or written in ink and signed by the practitioner and such prescription orders cannot be refilled. The physician must write a new prescription if the administration of the drug is to be continued. Prescription orders for the drugs covered under Schedule III or IV may be issued either orally or in writing by a practitioner and may be refilled.

Physicians should do all they can do to prevent abuse of prescription orders. It is a good practice to write out the number of refills desired during a specific time period on each and every prescription order. Arabic numerals may be easily altered and, if not indicated instructions may be easily forged. Furthermore when an authorization for refill is not given on the prescription order, it cannot be refilled without personal authorization by the prescriber.

Controlled Substance:

Schedule I (examples: heroin, methylene dioxymethamphetamine, lysergic acid diethylamide, mescaline, and all salts and isomers).

1. High potential for abuse.
2. No accepted medical use in the United States or lacks accepted safety for use in treatment in the United States. May be used for research purposes by properly registered individuals.

Schedule II (examples: morphine, oxycodone, fentanyl, meperidine, dextroamphetamine, cocaine, amobarbital).

1. High potential for abuse.
2. Has a currently accepted medical use in the United States.
3. Abuse of substance may lead to server psychological or physical dependence.

Schedule III (examples: anabolic steroids, nalorphine, ketamine, certain schedule II substances in suppositories, mixtures or limited amounts per dosage unit).

1. Abuse potential less than substance in Schedule I or Schedule II.
2. Has a currently accepted medical use in the United States.
3. Abuse of substance may lead to moderate or low physical or psychological dependence relative to substance in Schedule III.

Schedule IV (example: alprazolam, phenobarbital, meprobamate, modafinil).

1. Abuse potential less than substance in Schedule III.
2. Has a currently accepted medical use in the United States.
3. Abuse of substance may lead to moderate or low physical or psychological dependence relative to substance in Schedule III.

Schedule V (examples: buprenorphine, products containing a low does of an opioid plus a non narcotic ingredient such as codeine and guaifenesin cough syrup or diphenoxylate and atropine tablets).

1. Low potential for abuse relative to Schedule IV.
2. Has a currently accepted medical use in the United States.

3. Some Schedule V products may be sold in limited amounts without a prescription at the discretion of the pharmacist; however, if a physician wishes a patient to receive one of these products, it is preferable to provide a prescription.

Prescribers Initials or Signature:

The prescription order is completed by the practitioner signing the bottom of the blank, with the appropriate professional degree following the signature.

Handwriting and Legibility of a Prescription:

Doctors are legally obliged to write clearly, as emphasized in one of the court of appeal ruling for example in one of the cases wherein a doctor had not written a clear prescription for Amoxil tablets (Amoxicillin). The court indicated that a doctor owed a duty of care to a patient to write a prescription clearly and with sufficient legibility to allow for possible mistakes by a busy pharmacist. The court concluded that the word Amoxil on the prescription could have been read as Daonil. It found that the doctor had been in breach of his duty to write clearly and had been negligent. The court concluded that the doctor's negligence had contributed to the negligence of the pharmacist, although the greater proportion of the responsibility (75%) lay with the pharmacist. On appeal the doctor argued that the word on the prescription standing on its own could reasonably have been read incorrectly but that various other aspects of prescription should have alerted the pharmacist. That the strength prescribed was appropriate for Amoxil but not for Daonil, the prescription was for Amoxil to be taken three times a day while Daonil is usually taken once a day, the prescription was for only seven days' treatment, which was unlikely for

Daonil. All of these factors should have raised doubts in the mind of the pharmacist and as a result he should have contacted the doctor. This argument was rejected in the court of appeal. The implications of this ruling are that doctors are under a legal duty of care to write clearly that is with sufficient legibility. When illegible handwriting results in a breach of that duty, causing personal injury, then the courts will be prepared to punish the careless by awarding sufficient damages.

In 1999, there was another court case involving a prescription that featured poor handwriting resulted in judgments against the physician who did not write clearly and the pharmacist who misread the prescription and did not call to question the dosage. The intended medication was ISORDIL (Isosorbide dinitrate), but PLENDIL (felodipine) was dispensed instead. The patient suffered a myocardial infraction and died several days later. The importance of preparing clear and legible prescription cannot be overstated. Poor penmanship will compound the likelihood that there will be harmful errors resulting form an already dangerous system of employing numerous overlapping and similar abbreviations, look alike and sound alike drug names, and archaic measurement and numeral systems[33,34]. In a study of physicians handwriting, it is stated that misinterpreted prescription have been cited as the second most frequent and costly type of malpractice claim[35]. Despite the widespread nature of this problem there are solutions, the easiest of which is to print orders care. Preprinted order forms are used in many inpatient setting and to lesser extent for outpatient although useful, these forms must be developed with great care or else their design may contribute to medical errors[36]. At the same time, prescriptions, when handwritten, are quite notorious for being illegible[37].

Conventions for avoiding ambiguity:

A perfectly legible prescription for the ideal drug therapy can injure a patient if its intent is not clear. An in patient order written as “Cyclphosphamide 4 g/m2 days 1-4” or “ Cyclophosphamide 1 g/m^2 each day for 4 days” could prove fatal the highly publicized death of a health care reporter in 1994 was the result of this type of misunderstanding[38]. Over the years, prescribers have developed many conventions for prescription-writing, with the goal of avoiding ambiguities or misinterpretation[39]. Omissions or contractions for the sake of expediency often are culprits behind misleading orders. Many types of medication errors can be attributed to some ambiguity in the prescription process[40].

These include:

- Careful use of decimal points to avoid ambiguity.
- Avoiding unnecessary decimal points: a prescription will be written as 5 ml instead of 5.0 ml to avoid possible misinterpretation of 5.0 as 50.
- Always using zero prefix decimals: e.g. 0.5 instead of .5 to avoid misinterpretation of .5 as 5.
- Avoiding trailing zeros on decimals: e.g. 0.5 instead of .50 to avoid misinterpretation of .50 as 50.
- Avoiding decimals altogether by changing the units: 0.5 g is less easily confused when written as 500 mg.
- "ml" is used instead of "cc" or "cm³" even though they are technically equivalent to avoid misinterpretation of 'c' as '0' or the common medical abbreviation for "with" (the Latin "*cum*"), which is written as a 'c' with a bar above the letter. Further, cc could be misinterpreted as "c.c.", which is an uncommonly used abbreviation for "take with meals" (the Latin "*cum cibum*").

- Directions written out in full in English.
- Quantities given directly or implied by the frequency and duration of the directions.
- Where the directions are "as needed", the quantity should always be specified.
- Where possible, usage directions should specify times (7 am, 3 pm, 11 pm) rather than simply frequency (three times a day) and especially in relation to meals for orally consumed medication.
- Avoiding unspecified or "as needed" instructions - instead, specific limits and indicators are provided.
- For refills, the minimum duration between repeats and number of repeats should be specified.
- Providing the indication for all prescriptions even when obvious to the prescriber, so that the pharmacist may identify possible errors.
- Avoiding units such as "teaspoons" or "tablespoons."
- Writing out numbers as words *and* numerals ("dispense #30 (thirty)") as in a bank draft or cheque.
- The use of apothecary units and symbols of measure- pints (O), ounces (oz), drams (Z), scruples (?), grains (gr), and minims(?) - is discouraged given the potential for confusion e.g. the abbreviation for a grain ("gr") can be confused with the gram, and the symbol for minims (?), which looks almost identical to an 'm', can be confused with micrograms or meters and the symbol for pint (O) can be easily read as a '0'. Given the potential for errors, metric equivalents should always be used.

- The use of the degree symbol (°), which was commonly used as an abbreviation for hours (e.g., "q 2-4°" for every 2 - 4 hours), should not be used, since it can be confused with a '0'. Further, the use of the degree symbol for primary, secondary, and tertiary (1°, 2°, and 3°) is discouraged, since the former could be confused with quantities (i.e. 10, 20 and 30, respectively).

Non-prescription drug prescriptions:

Prescriptions are also used for things that are not strictly regulated as a prescription drug. Prescribers will often give non-prescription drugs out as prescriptions because drug benefit plans may reimburse the patient only if the over-the-counter medication is taken under the direction of a medical practitioner. Conversely, if a medication is available over-the-counter, prescribers may ask patients if they want it as a prescription or purchase it themselves. Pharmacists may or may not be able to price the medication competitively with over-the-counter equivalents. If the patient wants the medication not under prescription, the prescriber should usually be careful to give the medication name to the patient on a blank piece of paper to avoid any confusion with a prescription. This is applied to non-medications as well e.g. crutches, registered massage therapy may be reimbursed under some health plans, but only if given out by a prescriber as a prescription.

2.2.3 Principles of Prescribing:

When we inscribe the symbol of Rx[41] on a prescription its modern equivalent on a prescription symbolically gives the prescription the seal of success. But are our prescriptions always successful? Unsuccessful prescribing takes several forms: underprescribing, overprescribing, inappropriate prescribing, irrational prescribing,

and prescribing errors. There is evidence that suggests that there may be international variability of this kind[42] e.g. there were marked discrepancies in a French hospital between the WHO-defined daily doses of antimicrobial drugs and the doses that were actually prescribed. This suggests that there are wide differences between prescribing habits in different countries. However in many countries it is recognized that pharmacists can play a major contribution in prevention of prescribing errors[43].

There have been previously published information on hospital prescribing errors and its predictors by Fijn R *et al.*[45]. Inappropriate prescribing and irrational prescribing also feature from time to time in the *Journal*[46]. In the UK General Medical Council's document *Tomorrow's Doctors*[47] states that 'graduate must know about and understand the principles of treatment, including the effective and safe use of medicines as a basis for prescribing, harmful interactions and be able to write safe prescriptions for different types of drugs'. This holds true for graduate doctors and any prescriber for that matter. But both in the United Kingdom[48] and elsewhere[49] medical students have said that they feel that not enough time is devoted to therapeutics teaching.

Before prescribing:

As stated earlier the word prescribe comes from a Latin word meaning to write in advance of giving a medicine. But the actual writing is a late event in the prescribing process. It must be preceded by a number of other processes. First, the diagnosis must be accurately made and underpinned by an understanding of the basic

pathophysiology. If a drug is not appropriately matched to the pathophysiology of the disease the wrong choice may be made. For example, one would not use digoxin to treat atrial fibrillation if thyrotoxicosis was the cause – a beta-blocker would be preferred and although some forms of hypokalaemia respond to spironolactone, others do not[50]. Secondly, the prescriber must assess the balance of benefit to harm of a particular form of treatment (i.e. whether to treat or not treat at all).

Thirdly, practical matters related to the choice of drug must be addressed, these include picking the right drug from a range of alternatives (for example, an ACE inhibitor *versus* a beta-blocker, atenolol *versus* bisoprolol), designing the dosage regimen, considering the susceptibilities of a patient that might lead to adverse drug reactions, and remembering possible interactions with other drugs, including herbal formulations and foods.

Lastly, the prescriber and patient need to discuss the proposed treatment and its potential effects, the beneficial and adverse effects and the need for careful monitoring and dosage adjustment. All of this demands a thorough understanding of the pathophysiology of the problem and the pharmacology of the drug, including its pharmaceutical, pharmacokinetic, and pharmacodynamic properties, and how those properties are translated into a therapeutic effect via a chain of biochemical and physiological events[51].

Non-medical prescribing:

Traditionally, prescribing has been limited to doctors and dentists, but in recent years this right has been extended to nurses, pharmacists, and in some circumstances other health-care workers, as both dependent and independent prescribers. In some

countries this has been part of a governmental effort to give patients readier and more rapid access to medicines, and it has also led to the system known as Patient Group Directions. In this system a nurse or pharmacist, working to a plan described in a written statement formulated by the prescriber, can supply medicines to specific types of patients e.g. since 2000 levonorgestrel-only emergency contraception has been available from Patient Group Direction in some countries. This scheme allows pharmacists to supply such contraception to women over 16 years of age without a prescription, and although it is labeled as a form of supply, it can be regarded as a form of self-prescribing, since any young woman of the appropriate age and competence can obtain emergency contraception on demand. Furthermore, since 2001 levonorgestrel-only has been available to purchase from a pharmacist over the counter, although it is expensive. It was found that emergency contraception was available much more quickly from pharmacies than from family planning clinics. There was a mean of 10% increase in the number of prevented pregnancies. However, what was not assessed was the potential harms of this system[52]. For example, if more young women have unprotected intercourse because they know that emergency contraception is available, the total number of unwanted pregnancies could actually increase. They might also refrain from using barrier methods, exposing themselves to the risk of sexually transmitted diseases.

Guidelines and computerized prescribing:

In recent years many types of guidelines have been formulated to help prescribers choose appropriate therapy for specific conditions. Some have been very successful, such as the British Thoracic Society's Asthma Guidelines[53] and the UK

Resuscitation Council's Guidelines on Advanced Life Support[54]. Other guidelines, such as those formulated by the National Institute for Health and Clinical Excellence (NICE) and the UK's National Service Framework, have been specifically commissioned.

There is direct evidence that guidelines are ineffective unless they are accompanied by either education or financial incentives[55], e.g. in a retrospective chart review of Canadian patients with acute stroke the use of antihypertensive medications during the first 7 days was not in accord with recommended expert guidelines, and there was considerable variation in practice[56]. While, education about the use of guidelines on prescribing nutritional supplements in the UK significantly reduced total prescribing by 15% and reduced inappropriate prescribing from 77% to 59%[57] and in Australia the extent of use of antibiotics for upper respiratory tract infections prompted a study of an educational intervention based on prescriber feedback and management guidelines[58]. There was a reduction in antibiotic prescribing for upper respiratory tract infections and a more appropriate choice of antibiotic for tonsillitis or streptococcal pharyngitis. However, it was not clear whether this was the direct result of the educational intervention, or other influences on prescribing such as participation in vocational training for general practice, pressure from patients, and the perceived non-applicability of general guidelines in individual patients.

Computerized prescribing by the physicians may reduce inappropriate prescribing[59,60] and cost savings may be possible[61]. However it is too soon to evaluate the potential impact of computerized methods in prescribing, while some studies have shown reduced prescribing errors[62] others have not[63], and studies have not been powered to detect differences in adverse events[64]. Furthermore, when

computers are used to aid in decision-making, the warnings that they give may be so numerous that prescribers become immune to them [65,66]. In one study the computerized provision of patient profiles actually resulted in an increase in the number of prescriptions of two interacting drugs, although the durations of drug-drug interaction episodes were significantly shorter, the authors concluded that prevention of prescribing errors would require more and urgent emphasis on an educational or monitoring programme[67] and that to improve prescribing we should begin with education.

Teaching good prescribing:

The results of a study of how well final-year medical students performed in a prescribing exercise suggested that the root cause of prescribing errors was lack of a knowledge base that integrated scientific knowledge with clinical know-how[68]. The clinical section of the British Pharmacological Society has developed a curriculum that lays down guidelines for teaching safe and effective prescribing[69]. It develops the premise that a thorough understanding of basic principles translates into good prescribing, and lists essential attributes for prescribers under three headings concerning the use of drugs***: knowledge and understanding, skills, and attitudes.***

A few years ago, interactive case-based and interactive, case based evidence-based prescribing modules, adapted for computerized learning, were introduced into Australian teaching programs for senior medical students, funded by the National Prescribing Service, and following the tenets of the World Health Organization's ‘Guide to Good Prescribing. It includes the establishment of local student formularies as a teaching tool, a concept that could be extended to the training of junior hospital doctors and other prescribes.

Teaching prescribing has become increasingly difficult, as drug therapy has become more complex and errors more common[70]. A proper curriculum, taught at the bedside or in the clinic by skilled practitioners (because good prescribing habits should be reinforced by practical example), and supplemented by computer-based material, properly funded, could help to mitigate this. Special study modules in prescribing would allow some students to expand their knowledge. Formal assessment of prescribing ability in final examinations would add incentive to the learning process.

The question remains that who should undertake such a programs on prescribing issues? e.g. if one were to ask who should lead the way in teaching electrocardiography, the answer would be cardiologists, even though interpreting the electrocardiogram is a skill that all doctors should acquire and one that all doctors should be prepared to teach. ***Similarly, where prescribing is concerned, clinical pharmacologists should lead the way. However, despite calls for increased numbers[71,72], there are still too few of them to undertake the whole burden of undergraduate teaching in practical drug therapy[73]. The aim therefore should be to recruit and train enthusiastic physicians, general practitioners, and specialist nurse prescribers to help. Clinical pharmacists and pharmacist prescribers, in partnership with clinicians, could also make a valuable contribution.***

Good prescribing is a means to avoid prescribing faults, at the same time is not an easy discipline to master. Good prescribing means prescribing the appropriate drug, in the correct, dosage of an appropriate formulation, at the correct frequency administration, and for the correct length of time. This definition includes not prescribing any drug at all if no prescription is called for e.g. someone can only

prescribe “counseling needed”. To achieve this requires, detailed knowledge of the pathophysiology of the diseases one intends to treat.

The benefit: risk ratio in prescribing:

Drugs are prescribed because of their potential benefit to the patient, but in every case this is accompanied by the risk of adverse effects. Before prescribing, the potential benefits from the treatment should be weighed against the risks. There are five factors for assessing the relative benefit and risk of a particular treatment according to the data on efficacy and adverse effects of the drugs:

1. The seriousness of the problem to be treated,
2. The efficacy of the time you intend to use,
3. The seriousness and frequency of possible adverse effects,
4. The safety of other drugs that might be used instead,
5. The efficacy of other drugs that might be used instead.

The benefit: risk ratio will be high if the disease is life-threatening, and the drug is highly effective and the only one available, and the risk of serious adverse effects is negligible. At the other end of the spectrum, the benefit risk ratio will be low if the disease is trivial, the drug poorly effective with more effective and safer competitors and the risk of serious adverse effects high e.g. Phenylbutazone is a highly effective non-steroidal anti-inflammatory drug, which was used for many years in the treatment of acute and chronic inflammatory conditions, such as acute gout, acute and chronic rheumatoid arthritis, and ankylosing spondylitis. However, the incidence of marrow aplasia in patients taking phenylbutazone is at the higher end of this range in old people and during prolonged therapy. While no other non-steroidal anti-

inflammatory drugs of equal efficacy were available, the therapeutic benefit from taking phenylbutazone was-considered large enough to outweigh the relatively high risk of marrow aplasia. However, once other equally good drugs with fewer adverse effects became available, the risk of the adverse effects of phenylbutazone were seen to outweigh whatever benefit its use carried. It was therefore decided that it should no longer be prescribed as a first-choice anti-inflammatory drug.

It may not always be possible to know what the relative benefits and risks are before giving a patient a drug. For example, there may be no published figures on the size of a particular risk and different patients maybe at different risk of the same adverse effect (for example in the case of an adverse effect that is genetically determined). Furthermore, the extent of therapeutic benefit due to a drug, particularly in the case of symptomatic relief, varies widely from patient to patient and often one's appreciation of the potential benefit only come after one has tried the treatment and assessed its effects. Nevertheless, one should always try to assess the likely benefit: risk ratio before instituting therapy. To illustrate some of the difficulties that can arise in assessing the benefit risk ratio, consider the following problems:

1. Is the benefit likely to be gained from a course of an antibiotic in treating urinary tract infection in a woman who is 2 months pregnant likely to be outweighed by the risk to the fetus? This will depend on whatever information is available at the time about the actual risk of teratogenesis from the antibiotic compared with the risk to the mother of renal damage due to an untreated infection, added to this will be the relative risks to the fetus of her antibiotics. The antibiotic to be prescribed will depend on the causative organism and its

sensitivities e.g. Amoxicillin appears to be safe, but Trimethoprim should be avoided.

2. Is the benefit to be gained from treating an old lady with giant cell arthritis with the corticosteroid prednisolone likely to be greater than the risks of making her osteoporosis worse, of increasing the difficulty of treating her diabetes mellitus, and of exacerbating her hypertensive heart disease because of sodium and water retention? Here, apart from the pain that giant cell arthritis can cause, the main problem is that there is a high risk of blindness from untreated giant cell arteritis affecting the retinal arteries. The decision on whether or not to offer treatment in such a case will depend on the severity of the arteritis, the vessels it is affecting, the severity of the complicating conditions and the ease with which they too can be treated. However, by thoughtful prescribing, it may be possible to lessen the risks of drug therapy and prescription errors while maintaining a high degree of efficacy.

How to choose drug and is drug therapy indicated?

This comprises of two parts: Is the intended treatment necessary? Is the potential benefit likely to be greater than the risk? Unnecessary prescribing is not uncommon, e.g.

1. Acute bacillary dysentery due to *Shigella* infection is usually self-limiting and oral fluids are usually sufficient. The use of antibiotics is associated with the emergence of resistant strains, which are already a problem worldwide. If the condition is due to *Shigella dysenteries* type 1 or is severe or prolonged, the

choice of antibiotic depends on local sensitivities. Ciprofloxacin is often effective.

2. The prescription of cerebral vasodilators for patients with senile dementia. There is very little evidence that this type of drug (cerebral vasodilator) confers any benefit at all, and there is evidence that they may do harm by diverting blood flow from compromised areas of the brain to areas that are already well-perfused.
3. The prescription of formulations of vitamins and minerals (for example iron) as 'tonics' in the absence of any evidence of vitamin or mineral deficiency. These formulations act only as placebos in such circumstances, and should be recognized as such by the prescriber.

The main consideration in answering the question of whether drug therapy is necessary is the question of the size of the benefit: risk ratio. However, even if the benefit risk ratio is high, it may be worth waiting before starting therapy if-the disease is likely to be self-limiting (as in the case of acute diarrhoeas). Since that eliminates risk altogether.

Which drug?

If drug therapy is indicated, one has to go through the process of deciding which particular drug to use. This involves further detailed questions, relating to the choice from among the classes of drugs available, the appropriate group of drugs within a class, and the particular drug within that group.

Which therapeutic class of drug?

This is sometimes immediately obvious, for example an antibiotic for an infection, an antidepressant for depression, or a bronchodilator for an acute attack of asthma. However, in other cases, the decision can be more complicated, for example in the treatment of congestive heart failure the choice lies among diuretics, positive inotropic drugs, angiotensin-converting enzyme (ACE) inhibitors, and vasodilators, and in the treatment of hypertension the initial choice lies among diuretics, angiotensin-converting enzyme (ACE) inhibitors, beta-adrenoceptor antagonists and calcium channel blockers.

Which group of drugs within the class?

After confirmation of the diagnosis and while planning the treatment the clinician may decide on a particular class of drugs to be prescribed, e.g. in case of treatment of an infection. The therapeutic class is the antibiotics, but within that class there is a choice among several different groups of drug, for example, penicillins, cephalosporins, tetracyclines, aminoglycosides, macrolides, quinolones etc. The choice will depend on the sensitivities of the infecting organism, the site of infection, and particular features of the patient that may constitute contra-indications.

Which particular drug in the group?

Finally, the name of an individual drug has to be written on the prescription. To continue with the example of antibiotics if one decides to prescribe a tetracycline, one can choose from among tetracycline, i.e. oxytetracycline, minocycline, doxcyline, and several others. Again the choice will depends on many different factors.

How to make a rational choice?

The factors that dictate the choice are numerous and are as follows:

(i) Pharmacokinetic considerations:

1. *Absorption.* One might choose bumetanide rather than furosemide for a patient with congestive cardiac failure, in which furosemide is erratically absorbed and bumetanide better absorbed. Of course, as an alternative, one could give furosemide intravenously, thereby circumventing the problem of absorption.

2. *Distribution.* If an antibiotic is well distributed to a particular tissue, that antibiotic may be the antibiotic of choice when that tissue is infected. For example, tetracyclines are concentrated in the bile, and lincomycin and clindamycin in bones.

3. *Metabolism:* Drugs that are extensively metabolized may be less useful in patients with severe liver disease. For example, one would generally avoid using opiate analgesics in patients with hepatic cirrhosis and there are also pharmacodynamic reasons for doing so.

4. *Excretion:* Similar considerations apply in renal insufficiency. One might for example, avoid the aminoglycoside antibiotics in patients with renal impairment if an alternative group of antibiotics is suitable. If a tetracycline is indicated in a patient with insufficiency, doxycycline would be the drug of choice, it does not accumulate in renal failure, as other tetracyclines do.

(ii) Pharmacodynamic considerations:

Sometimes the pharmacological effect of a drug or group of drugs is appreciably greater than that of another. For example, the sulfonylureas are more potent hypoglycemic drugs than the biguanides, and are usually used as first-line drug treatment. In patients with an acute myocardial infarction, the positive inotropic effects of beta-adrenoceptor agonists, such as dobutamine, are greater than those of the cardiac glycosides, such as which may in addition promote arrhythmias.

(iii) Therapeutic considerations:

1. *Features of the disease:* If one knows, or has a good reason to suspect, the identity of an infective organism, then one would choose an antibiotic appropriately. For example, one might choose ampicillin for a patient with a community-acquired bronchopneumonia, since the likeliest infecting organisms will be the pneumococcal *(Streptococcus pneumonia)* or *Haemophilus influenza*, both of which are likely to be sensitive to it is a quinolone or cephalospcrin would be an alternative in penicillin hypersensitivity. Sputum culture, with identification of true organism and of its sensitivity to different antibiotics, will help in making the choice. Other factors can determine the choice; for example, avoid quinolones in pregnant women.

   The severity of the disease can also influence the choice of a drug. For example, mild pain will generally respond to aspirin or paracetamol, while more severe pain requires more potent analgesics, such as codeine or even morphine. Moderate hypertension often responds to a single drug, such as a thiazide diuretic or beta adrenoceptor antagonist, while

severe hypertension often requires treatment with a combination of antihypertensive drugs.

2. *Co-existing diseases:* In the treatment of moderate hypertension one might choose a diuretic, such as bendroflumethiazide, a beta-adrenoceptor antagonist, such as atenolol, an ACE inhibitor, such as lisinopril, or a calcium channel blocker, such as nifedipine. In a patient with left ventricular failure, a diuretic combined with an ACE inhibitor would be the logical choice; in a patient with co-existing angina pectoris without heart failure, a beta-adrenoceptor antagonist would be preferred.

3. *Avoidance of adverse effects:* One would avoid beta-adrenoceptor antagonists in a patient with asthma. In patients with penicillin hypersensitivity, an alternative antibiotic should be used.

4. *Avoidance of adverse drug interactions.* In patients taking warfarin, one often needs to be careful while choosing other drugs. For example, aspirin and some other non-steroidal anti-inflammatory drugs, which can cause gastrointestinal bleeding, should be avoided, barbiturates and chloral derivatives should be avoided since they induce the metabolism of warfarin. Drugs like tetracyclines, sulfonamides, chloramphenicol are avoided in treatment of infections since they inhibit the metabolism of warfarin.

(iv) Patient compliance:

Sometimes a drug is chosen simply because it can be taken once a day, in the hope that minimizing the frequency of drug administration will improve patient compliance. Thus, one might choose once-daily atenolol in preference to twice-daily propranolol. Modified-release formulations are also available for this reason.

Which route of administration?

The route of administration may be dictated by the drug chosen, for example, dopamine can only be given intravenously. However, sometimes the prescriber chooses a particular route of administration because it confers a particular therapeutic benefit e.g. glyceryl trinitrate, is usually given sublingually, since it is absorbed rapidly through the oral mucosa straight into the systemic circulation, thus avoiding its first-pass metabolism in the liver, and rapidly relieving angina pectoris during an acute attack. However, it can also be applied as a patch to the skin, through which it is absorbed slowly. In this way, it has been used to prevent attacks of angina pectoris.

The rectal route can be used for a direct effect on the large bowel (for example prednisolone in the treatment of ulcerative colitis), or because another route is not available (for example diazepam in a patient in whom a seizure makes intravenous access difficult to obtain). The intramuscular route is sometimes used to ensure compliance, for example in the single-dose treatment of gonorrhea with intramuscular penicillin. The subcutaneous route is sometimes used because it allows easy administration of a drug by the patient or a relative. The subcutaneous route may provide a more prolonged effect by slow release of the drug, from the site of injection (for example the different formulations of insulin).

Which formulation?

There are many different drug formulations for different circumstances. For example, oral formulations include tablets, capsules, granules, elixirs, and suspensions. Drugs for injection come as lyophilized powders for reconstitution before injection, or as solutions ready for injection; solutions come in single-dose ampoules, single-dose or multiple-dose vials, and half-litre or litre bottles for infusion.

Where oral administration is concerned, drugs often come in more than one type of formulation, as the following examples show:

- Lithium salts and theophylline come in several different ordinary and modified-release formulations, each with different absorption characteristics a formulation that produces adequate plasma lithium or theophylline concentrations in one patient may not be suitable for another, and it is sometimes worth changing the formulation if plasma concentrations are suboptimal.
- Iron salts are available as ordinary tablets for twice or thrice daily administration or as modified-release formulations for once-daily administration one would often choose the latter in the hope of improving patient compliance and reducing the adverse effects that the ordinary formulations have on the stomach, however, the iron in modified-release formulations is absorbed more erratically, and one might choose the ordinary tablets in a patient whose iron deficiency was not being corrected by a modified-release formulation.

What dosage regimen?

A dosage regimen has three aspects: the dose of the drug, the frequency of its administration, and the timing of its administration. Usually these can be considered together, although in some cases they require separate consideration.

Certain principles govern dosage regimens of drugs, and these principles show how dosage regimens should be altered, depending on the pharmacokinetic and pharmacodynamic characteristics of the prescribed drug, certain characteristics of the patient and the characteristics of the symptoms or disease being treated.

(a) Pharmacokinetic variability:

Variation in absorption, distribution, and elimination of drugs from patient to patient means that one must be flexible in approach to dosages. If there is poor absorption, one may have to increase the dose or choose another route of drug administration, or indeed another drug. Dosages may have to be reduced if elimination is required (for example in hepatic or renal disease). For drugs that are subject to first-pass metabolism in the liver, one may have to use completely different dosage regimens. If the pharmacokinetics of the drugs are altered by another drug, then the dosage regimen may have to be altered.

(b) Pharmacodynamic variability: the dose-response curve:

Dose-response curve shows how the effect of drug varies with dose, and that this is as true in the whole patient; as it is in an experimental tissue in vitro. Because the nature of the dose-response curve varies from patient to patient, flexibility in prescribing is necessary, and if a therapeutic effect does not occur with the initial dosage chosen, an effect may be produced by making small dosage increments within a stated therapeutic dosage range. At the same-

time, increasing the dosage will increase the risk of dose-related adverse effects, and part of the art of drug therapy lies in finding the regimen that produces, a beneficial effect while avoiding adverse effects.

(c) Characteristic of the patient:

Dosage regimens may be different in old people from those in young people. Dosages should sometimes be calculated on the basis of body weight, giving heavier patients higher dosages than lighter patients so better to mention the weight on prescription. Conversely, if a drug is poorly distributed into body fat, a muscular patient may need a higher dosage than a fat patient of the same weight. This applies to digoxin, doses of which should be based on estimated lean body weight.

(d) Characteristics of the disease:

Sometimes dosage regimens are different for the same drug in different diseases, because of the nature of the effect required or because, of some other aspect of dose-responsiveness. For example, the dosage of bromocriptine required for suppression of lactation is considerably lower than that needed for the relief symptoms in Parkinson’s disease.

(e) Choosing a dosage regimen for the individual patient. Dosage regimens in clinical practice cannot always be as precise as in theory, it is nevertheless possible to approach the problem of tailoring a regimen for an individual patient in a systematic manner.

1. The dosage regimens recommended should be from a reliable source of information and according to careful study and clinical experience.

2. Consider the dose-related toxicity of the drug, i.e. does it have a low toxic therapeutic ratio, the toxic dose being little more than the therapeutic dose? If so (for example digoxin, phenytoin, warfarin, gentamicin and lithium), be particularly careful to give too much.

3. Decide on the initial dosage. In general, it is best to start with a dose that is at the lower end of the recommended range and to increase it gradually if a therapeutic effect or the optimal effect does not occur. For some drugs, this gradual increase in dosage from a small initial dosage is an important strategy in avoiding adverse effects (for example the Angiotensin Converting Enzyme inhibitors and L-dopa), while for others increasing dosages may be necessary because of tolerance (for example opiate analgesics).

4. Consider possible pharmacokinetic factors that alter dosage requirements (for example renal insufficiency or drug interactions).

5. Consider the dose-response curve for the patient and whether there are any factors that alter the Pharmacodynamics of the drug. For example, insulin requirements are greater in patients with ketoacidosis and dosages of narcoleptic drugs are lower in previously untreated patients. Drug interactions can alter the pharmacodynamic effects of drugs.

6. Consider other patient characteristics that influence dosages (for example age and weight).

Even when a dosage regimen has been instituted, there may still be room for improvement, and the patient's progress should he monitored carefully for evidence that the regimen is satisfactory (i.e. effective and safe).

(f) Frequency of drug administration:

The frequency of drug administration is usually fixed for a given formulae not a given, drug if so, there is no need to make a separate decision about that. However, one needs to alter the frequency of drugs administration without necessarily altering the total daily dose.

- If furosemide produces a satisfactory diuresis, the kidney is refractory to its effects for another six or so hours and the dose should be withheld for at least that length, of time, however, if a first dose has not proved effective, then another dose can be given soon after the first.
- Although the duration of action of spironolactone is sufficiently long for once-daily administration, some patients complain of gastrointestinal symptoms and benefit from splitting the dose into two parts, one to be taken in the morning and one in the evening.
- For symptomatic treatment, the frequency of symptoms regulates the frequency of dosage. For example, patients will take a tablet of glycleryl trinitrate as often as they suffer attacks of angina pectoris.
- The use of corticosteroids is a special case in which adverse effects can be reduced in some diseases by giving twice the usual daily dose but only on alternate days.
- The use of modified-release formulations to improve compliance and achieve prolonged action (for example modified-release theophylline).

(g) Timing of drug administration:

The study of the ways in which the pharmacokinetics and pharmacodynamics of drugs vary with time (for example diurnally or seasonally) is called chronopharmacology. Chronopharmacological studies have revealed many such variations, a few of which are relevant to the timing of drug therapy. Furthermore, variations with time in the presentation of diseases can affect the timing of drug administration. In most cases the timing of drug administration is fixed for a given formulation of a given drug and, if so, there is no need to make a separate decision about that. However, in some cases, timing may be important, as seen in the following examples:

- *Minimizing adverse effects:*

  For some drugs, adverse effects can be minimized by taking them last thing in the night. For example, sleep can mask some of the adverse effects of the tricyclic antidepressants (dry mouth and drowsiness) and of cytotoxic drugs (nausea and vomiting). On the other hand, potent diuretics, such as bumetanide and furosemide, are generally taken in the morning to avoid the inconvenience of diuresis later in the day.

  If corticosteroids are being used as replacement therapy (for example in Addison's disease), they should be taken in two divided doses during the day, two-thirds in the morning and one-third at night, in order to mimic roughly the normal pattern of endogenous corticosteroid secretion. However, if corticosteroids are to be used for other purposes, they are best given as a single dose in the morning, in order to minimize their

inhibitory effects on adrenocorticotrophin hormone (ACTH) secretion by the pituitary gland and glucocorticoid secretion by the adrenal glands, which are normally at an ebb overnight.

- *The timing of symptoms:*

  The occurrence of symptoms often dictates the timing of therapy, as in the treatment of attacks of angina pectoris or in the use of antacids. It is sometimes best to take non-steroidal anti inflammatory drugs last thing at night, in order to minimize their adverse effects on the stomach and to mitigate early morning stiffness in rheumatoid arthritis, but the occurrence of symptoms at other times will dictate different timing.

- *Timing in relation to meals:*

  Some drugs are best taken before food (for example most penicilins, whose absorption is delayed by food and tetracyclines, whose absorption is impaired by calcium and other salts). Others are better taken with food (for example aspirin, in order to reduce gastrointestinal adverse effects, and griseofulvin, whose absorption is improved by food).

For how long should treatment last?

The duration of treatment depends on the nature of the disease or symptoms and to a great extent on collective experience, e.g. at one end of the scale, a single dose of aspirin relieves a headache. At the other end of the scale, chronic therapy for the individual’s lifetimes is usually required for the treatment of diabetes mellitus,

essential hypertension, hypothyroidism, pernicious anemia, and several other diseases.

Difficulties and controversy often arise in relation to treatments of intermediate duration. For example, it is still not clear for how long treatment with warfarin should be continued in the treatment of deep venous thrombosis and pulmonary embolism. Currently anticoagulant treatments for a deep venous thrombosis is usually continued for 3 months, but there are those who advocate shorter periods (for example 6 weeks) in some cases.

The duration of treatment of infections with antibiotics varies from infection to infection, and depends on the infecting organism, the site of infection, the response to treatment, and in a few cases the dosage of antibiotic. For example, streptococcal tonsillitis and pneumococcal pneumonia might require treatment with penicillin for 7-10 days, non-gonococcal urethritis tetracycline for 10-21 days, and infective endocarditic due to ‘viridians’ streptococci intravenous penicillin for up to 6 weeks. However, in the last case, it is not clear what the minimum duration of treatment should be, and treatment should be, and treatment for 6 weeks may be unnecessarily long. In contrast gentamicin, given in conjunction with penicillin in this infection, is usually continued only for the firs 10-14 days. If amoxicillin is used in the treatment of a urinary tract infection, two large doses 12 hr apart may be sufficient to effect a cure, while treatment for several days is necessary if conventional doses are used.

Tuberculosis is an example of a disease for which the duration of treatment is complex. Quadruple drug therapy (for example rifampicin, isoniazid, pyrazinamide and ethambutol) is usually given in the initial phase for 8 weeks, or until the organism’s sensitivities are known, when a change of drugs may be necessary. This

regimen is used because it takes several weeks to culture the infecting organism, and the risk of resistance to therapy is reduced by using several different drugs. Treatment is then continued with three drugs (say rifampicin, isoniazid, and pyrazinamide) for 6 months in pulmonary infections or longer in extrapulmonary infections. However, there are many different types of antituberculous regimens in use around the world, taking into account the resistance of *Mycobacteria* to antitubercular drugs, drug costs, patient compliance, and the problems of the delivery of medical care to the population.

However, the principles underlying drug prescribing has been emphasized, it is not always easy in drug therapy to achieve optimal efficacy while keeping the risks of adverse effects to a minimum. However, thoughtful prescribing along these lines will help clinician to achieve good drug prescribing. Thus, prescribing is difficult. It requires a thorough knowledge and understanding of the pathophysiology of disease, the pharmacological properties of the relevant drugs. No single intervention can be relied upon to improve prescribing, and a combination of interventions may be required[90]. The main aims for teaching undergraduate medical students, health care providers and doctors to improve their prescribing should include**:**

- Education, to be taken as often as possible (learning should be lifelong, updating oneself through authentic workshops).
- Special study modules, to be taken as required.
- Proper assessment in the final examination, to be taken once or twice.
- A national prescription form for hospitals, to be applied uniformly.
- Guidelines and computerized prescribing systems, to be taken as indicated.

The bottom line is that, if we do not increase the amount of time we spend teaching future prescribers, i.e. the undergraduate students, doctors, dentists, nurses, pharmacists, and others, we may soon be saying ‘See one, prescribe one, harm one’.

2.3 Prescription Errors:

2.3.1 Prescription Errors - a Component of Medications Errors:

Medication errors are failures in any aspect of the treatment process (including the manufacturing or compounding, prescribing, transcribing (when relevant), dispensing and administration of a medicinal product, and the subsequent monitoring of its effects, failures that cause, or have the potential to cause harm to the patient.

Medication errors are basically of two types: intercepted errors and actual errors, on the basis whether they reach the patient or not[74].

Both the types of errors are further divided into four categories:

- Prescription error
- Administration error
- Transcription error
- Dispensing errors.

Prescription errors:

1. No route specified.
2. As-needed order without an indication.
3. Drug is indicated but the dose is inappropriate.
4. As-needed order without a time interval.

5. Dose change ordered without discontinuation of previous order.
6. Order is illegible.
7. Order is incomplete in specifying doses or frequency.

Transcription errors:

1. Order is not transcribed at all.
2. Order is transcribed incorrectly.
3. Allergy is not documented on the medication administration record.
4. Allergy is not documented on the order sheet.

Administration errors:

1. Scheduled dose is not documented as administered.
2. Drug is administered without a physician order.
3. Dose missed because of late transcription.
4. Order is incorrectly entered in the pharmacy computer.

Dispensing errors:

1. Wrong drug or dilution dispensed.
2. Wrong preparation dispensed.

The intercepted errors (the error which has not reached the patient) are documented by preserving a copy of the indent. The actual errors or an “error of omission”, which does reach the patient in spite of auditing, are reported on a proper format called as quality variance report. Except administration error, rest all types of errors could be rectified by prescription auditing. The administration error could only be rectified by hospital rounds, which are also essential for adverse drug reaction

monitoring. Prescription errors, which are corrected and prevented by prescription auditing team, are called as intercepted error.

What is a Medication Error Index?[75,76]

This is required for categorizing medication errors as shown below:

No Error.

Category A: Circumstances or events that have the capacity to cause error.

Error, No harm.

Category B: An error occurred but the error did not reach the patient.

Category C: An error occurred that reached the patient but did not cause patient harm.

Category D: An error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm.

Error, Harm.

Category E: An error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention.

Category F: An error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalisation.

Category G: An error occurred that may have contributed to or resulted in permanent patient harm.

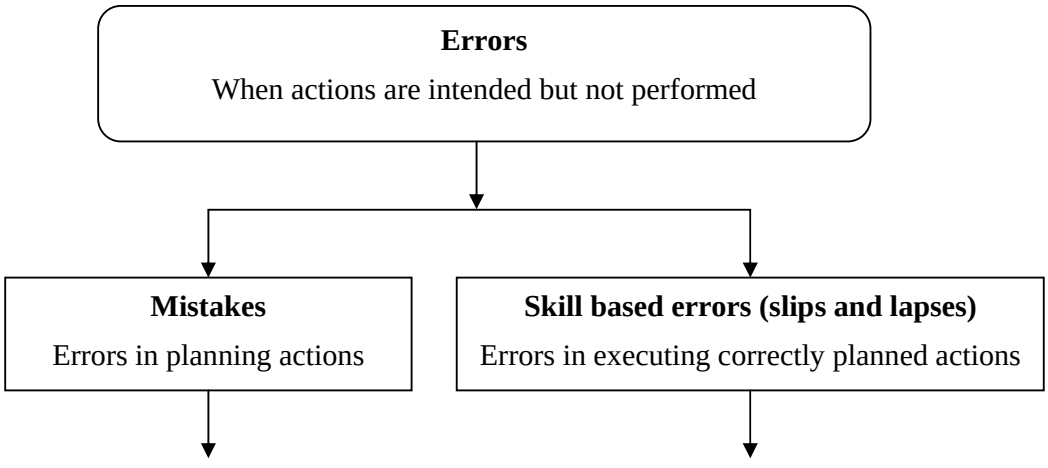
Category H: An error occurred that required intervention necessary to sustain life.

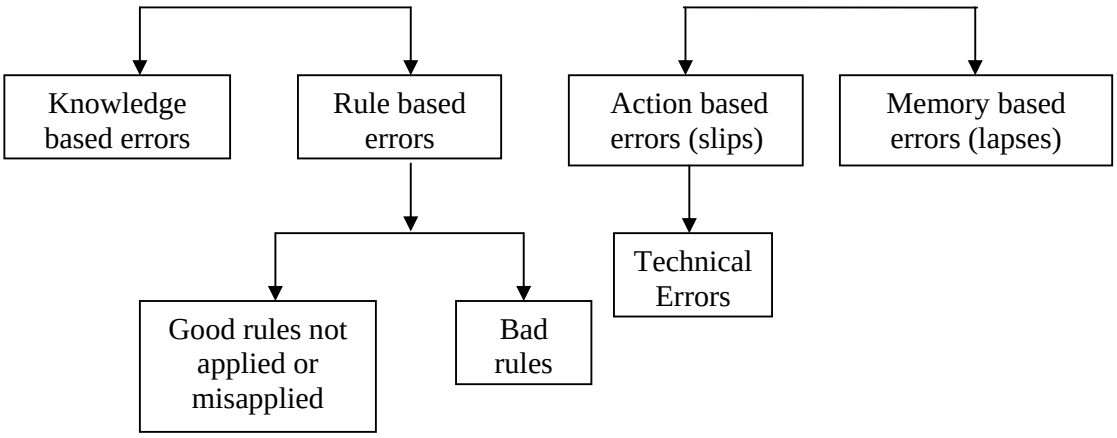
Error, Death.

Category I: An error occurred that may have contributed to or resulted in the patient death.

Classification of medication errors based on psychological theory:

The best way to understand how medication errors happen and how to prevent them is to consider their classification, which can be contextual, modal, or psychological. Contextual classification deals with the specific time, place, medicines, and people involved. Modal classification examines the ways in which errors occur, e.g. by omission, repetition or by substitution. However, classification based on psychological theory[77] is to be preferred, as it explains events rather than merely describing them. Its disadvantage is that it concentrates on human rather than systems sources of errors. This approach yields four broad types of medication errors as shown in the figure below. Mistakes can be divided into (i) knowledge based errors and (ii) rule based errors while failures of skill can be divided into (iii) action based errors (slips, including technical errors) and (iv) memory-based errors (lapses).





Knowledge based errors can be related to any type of knowledge general, specific, or expert. It is a general knowledge that penicillin's can cause allergy to penicillin, a patient is allergic to penicillin is specific knowledge and knowing that cephalosporins can cause a cross-sensitivity reaction is an expert knowledge. Ignorance of any of these facts could lead to a knowledge-based error.

Rule based errors can further be categorized as (a) the misapplication of a good rule or the failure to apply a good rule and (b) the application of a bad rule.

An action-based error is defined as the performance of an action that was not what was intended[78,79]. A slip of the pen, when a doctor intends to write ditiazem but writes diazepam, is an example. Technical errors from a subset of action based errors. They have been defined as occurring when an outcome fails to occur or the wrong outcome is produced because the execution of an action was imperfect[80]. An example is the addition to an infusion bottle of the wrong amount of drug[81].

Memory based errors occur when something is forgotten; for example, giving penicillin, knowing the patient to be allergic, but forgetting.

This classification can help understand how errors can be prevented and strategies that help to reduce their occurrence. Knowledge based errors can obviously be prevented by improving knowledge, e.g. by ensuring that students are taught the basic principles of therapeutics[82,83] and tested on their practical application[84] and that prescribes are kept up to date. Computerized decision support systems can also train prescribers to make fewer errors[85,86].

Mistakes that result from applying bad rules, or misapplying or failing to apply good rules (rule based errors.), can be prevented by importing rules. Memory based errors are the most difficult to prevent. They are best tackled by putting in place system that detect such errors and allow remedial actions. Check lists and computerized systems can help.

2.3.2 Predictors of Medication Errors and Prescription Errors:

Error i.e. something incorrectly done through ignorance or inadvertence is a fact of human condition[87]. People tend to dial wrong numbers, take wrong turnings, and make slips of tongue. Psychologists have pointed out the inevitability of error in human actions[88]. Knowledge and error flow from the same mental sources, only success can tell the one from the other[89]. A conscious human action can be performed correctly and reach its intended goal. Errors arise when an action is intended but not performed .The human factors approach is now widely adopted in understanding medical errors and in seeking ways to reduce harm from errors [90,91].

Forms of errors:

An error is a disorder of an intentional act. The act can be considered in two parts: formulating the plan for action and executing it.

An error in formulating the plan is a mistake. Mistakes occur when people undertake non-routine tasks that require conscious (supervisory) attention, i.e. they require problem-solving, judgement, diagnosis, or theoretical knowledge[92]. Even if a task is routine, cognitive error is still possible, if it is ambiguous or poorly understood or if, for example, the staff are not adequately trained, so that they have to think out explicit solutions to the problems posed by the task. Mistakes can arise from a lack of knowledge, resulting in a poor plan, or from good plans applied in the wrong circumstances. An example of the former would be to begin warfarin treatment by giving three doses of 10 mg on successive days (10-10-10) before monitoring coagulation. Such a plan inevitably leads to over-treatment of many patients[93]. A mistake of the second type occurs when cardiopulmonary resuscitation is instituted on a patient whose cardiac monitor shows a flat-line trace, not because the patient has had a cardiac arrest, but because the leads have fallen off.

An action is initiated with the intention of reaching a specific outcome. When all goes well, there is no error, and the intended outcome is achieved. Sometimes the plan will be wrong, or the information used in formulating the action is wrong, so that it is impossible to reach the intended outcome. Errors of this sort are labeled mistakes. If the plan is correct, and based on correct information, but there is distraction on the route from intention to outcome, then a slip or lapse results. Slips are errors of commission, whereas lapses are errors of omission.

An error in executing a plan can occur either because one or more step in the plan is executed incorrectly - a slip or because one or more steps is omitted - a lapse. Picking penicillamine from a computer list of drug names when intending to prescribe penicillin V is a slip. Intending to write a prescription for penicillin V, but

forgetting to do so, constitutes a lapse. Actions do not take place in isolation, but as part of a system, a group of interacting entities of which the person performing the action is one. Hospital medication systems are very complex, and the entities involved include, at the very least, a medicine, a patient, one or several healthcare professionals, pharmacy and pharmacy staff, and ultimately the manufacturers and suppliers of the medicines[94].

Thus a medication error is taken to be a failure in the frequent process that leads to, or has the potential to lead to harm to the patient' [95]. The treatment process includes the prescribing, transcribing, manufacturing or compounding, dispensing, and administration of a drug - a monitoring therapy. Each of these separate activities h many components. For example, a single prescription on our hospital drugs chart requires the prescriber to include 21 separate pieces of information, such as the patient date of birth and the time of administration of the prescribed drug. Each entails an action with the potential for error.

The process of administration of intravenous injection which is particularly likely to result in harm to the patient has been examined in some detail[96,97]. At least a dozen of separate steps, and many sub-steps, are required to perform this task, some are trivial but others have the potential for serious error. The probability of undertaking multistep task without error is the product of the probabilities of carrying out each step without error. The corollary of this is that a small risk at each step leads to a high probability of error overall. For example, if there are 2 steps, each of which is preformed without error 99% of the time, the overall process will be correct only 80% of the time. Health-care professionals are more likely to make errors when they are inexperienced, inattentive, rushed, distracted, tired or depressed.

Factors that alter the risk of errors are dependent on:

- *The person performing action.*
- *Training of health care professionals.*
- *Site (Hospital, ward, intensive care unit).*
- *Time (late after noon etc.).*
- *Working conditions.*
- *The patient.*
- *The medicine.*

Why to keep a check on prescription errors:

A zero medication error is an impossible thing to achieve because we are humans and not machine. So, the only way to get rid of medication errors is a thorough scrutiny of all the steps involved in medication process and prescription auditing is done at a very important step, i.e. before the medication are dispensed. ADR Monitoring should be a part of auditing e.g. **t**he adverse drug reaction is monitored by searching for the tracer drugs like Avil injection and Effcorlin injection and checking the indications for which they were prescribed, during the hospital rounds. If any adverse drug reaction occurs it is reported on an ADR reporting form. All the details regarding the drug e.g. brand and generic name, doses, route of administration should be documented. The ADR should be described according to the signs and categorized according to the severity. The type of reaction should also be noted down (whether Type I, II, III or IV). All such activities, should be implemented in all the hospitals in India, where the patient load is too high, to be properly handled.

2.3.3 What are Prescribing Faults, Prescribing Errors and Balanced Prescribing?

The two terms 'prescribing' and 'prescription' must be distinguished. 'Prescribing' is (i) the process of deciding what to prescribe and naming it (e.g. 'prescribe rest and relaxation') and (ii) the act of writing the prescription. Because of this ambiguity, it is best to use 'prescribing' to mean the decision-making process and 'prescription' to mean the act of writing the prescription[3].

Various types of faults can occur in the decision-making process: irrational prescribing, inappropriate prescribing, underprescribing, overprescribing and ineffective prescribing. These form a class of errors, but are different in type from the class of errors that can be made in the act of writing a prescription i.e. prescription errors. Adapting the definition of a medication error, a prescribing fault can be defined as 'a failure in the prescribing process that leads to, or has the potential to lead to, harm to the patient's previous definition, which resulted from a Delphi process (a form of committee), stated that a clinically meaningful prescribing error occurs when, as a result of a prescribing decision or prescription writing process, there is an unintentional significant (i) reduction in the probability of treatment being timely and effective or (ii) increase in the risk of harm when compared with generally accepted practice. This definition was developed by the researchers Dean B *et al.*[12] in collaboration with a panel of 30 experts who were surveyed in the United Kingdom. This report grouped prescription errors into “errors in decision making” and “errors in prescription writing”. The first group was further subdivided into “inappropriate prescriptions” and “pharmaceutical issues” and the second group was further subdivided into errors due to “failure to communicate essential information” and “transcription errors” respectively.

I. Errors in decision-making:

A. Prescription inappropriate for patient:

1. Drug prescribed is contraindicated due to a co-existing clinical condition.
2. Patient has clinically significant allergy to drug prescribed.
3. Potential drug-to-drug interaction.
4. Drug dose inappropriate for patient's renal function.
5. Drug dose below or above that recommended for patient's clinical condition.
6. Drug dose giving serum levels significantly above or below therapeutic range.
7. Not altering dose when serum levels are outside therapeutic range.
8. Continuing a drug after adverse drug reaction.
9. Prescribing two drugs instead of one for same condition.
10. Drug not indicated for patient.

B. Pharmaceutical issues:

1. A drug for intravenous infusion in an incompatible diluent.
2. A drug in a greater concentration than recommended for peripheral administration.

II. Errors in prescription writing:

A. Failure to communicate essential information:

1. Wrong drug, dose, or route.
2. Illegible writing.
3. Using drug abbreviations or non-standard terminology.

4. Ambiguous order.
5. Omission of route of administration.
6. Not specifying duration of intermittent intravenous infusion.
7. Omission of prescriber's signature.

B. Transcription errors:

1. Upon admission to hospital failure to prescribe a drug the patient was already on.
2. Upon admission to hospital continuing a general practitioner's prescribing error.
3. Incorrect transcribing when rewriting a patient's drug chart.
4. Ordering "milligrams" while intending "micrograms".
5. Upon admission to hospital unintentionally changing a pre-admission prescription.
6. At discharge writing a prescription unintentionally different from inpatient chart.

A prescription is 'a written order, which includes detailed instructions of what medicine should be given and to whom, in what formulation and dose, by what route, when, how frequently, and for how long'. *Thus, a prescription error can be defined as 'a failure in the prescription writing process that results in a wrong instruction about one or more of the normal features of a prescription. The 'normal features' include the identity of the recipient, the identity of the drug, the formulation and dose, the route, timing, frequency and duration of administration while a balanced prescribing defined as 'the use of a medicine that is appropriate to the patient's condition and, within the limits created by*

the uncertainty that attends therapeutic decisions, in a dosage regimen that optimizes the balance of benefit to harm.

The prescription order is the most frequent outcome of the outpatient physician visit. An estimated 61% of patient visits for a new medical problem will result in the patient receiving at least one prescription. Prescription containing errors communicate incompletely or inadequately to the pharmacist and may have serious detrimental consequences. Some errors will require the pharmacist simply to use additional professional judgment in the interpretation and execution of the prescription. Omissions may require further communication between pharmacist and the physician or at worst may prevent the patient from receiving medications at all.

The types of errors associated with prescriptions may be those associated with incomplete details (omission) or those associated with incorrect details (commission), e.g.:

Errors of omission	Errors of commission
Absence of legal requirements	Incorrect drug or indication for use
Absence of dosage form	Incorrect drug
Absence of strengths	Incorrect indication for use
Absence of dose	Incorrect dose/dosage regimen
Dosage regimen	Quantity duration of Rx
Quantity/duration of treatment	Duplicate therapy drug interactions contraindication or inappropriate therapy

Procedures or professional guidelines are typically available for dealing with omissions from prescription. Such omissions may however present the pharmacist with a legal or an ethical dilemma. On the other hand errors of commission represent a far greater threat to the safety of the patient if not identified and corrected, but are less easy to identify than omissions.

In reality, since pharmacist is not usually privy to diagnosis, ascertaining the appropriateness of a prescribed item might be difficult in some circumstances, e.g. whether or not the prescribed dose or dosage regimen lies within the usual range for the patient, however, where appropriate the condition being treated can be checked and information sought from appropriate texts or references for particular situations e.g. drug interactions, contraindications, incompatibilities and adverse effect. It is important to recognize that the role of computer systems is to support or supplement the pharmacist input, not to supplant.

2.3.4 Prescription Errors and Prescribing Faults:

The process of prescription generation and dispensing is governed by regulatory systems, the purpose of which is to maximize the safety and efficacy of the product supplied. Community pharmacists have an important role in checking prescriptions to ensure that they are appropriate to dispense. Several studies have shown that incorrect prescribing, inadequate information, given by the prescriber or the pharmacist and incorrect use of medications by the patients can cause suffering to the patients and expense to both the patient and the community[98].

Various studies[99] have looked into the issues of poor control of safety in the prescribing system. The system can become unstable and vulnerable if management and clinical controls are not well defined. The magnitude of problem may not be defined until a major adverse event happens. Therefore it is important to monitor the performance of systems by paying attention to problems that may arise.

Prescribing faults and prescription errors are major problems among medication errors. They occur both in general practice and in hospital, and although they are

rarely fatal they can affect patients' safety and quality of healthcare. Prescription errors encompass those related to the act of writing a prescription, whereas prescribing faults encompass irrational prescribing, inappropriate prescribing, under prescribing, overprescribing, and ineffective prescribing, arising from erroneous medical judgement or decisions concerning treatment or treatment monitoring. Appropriate prescribing results when errors are minimized and when the prescriber actively endeavors to achieve better prescribing: both actions are required.

Prevalence:

The prevalence of prescribing faults and prescription errors has been quantified in prospective and restorative cohort studies. Internal or external reviews of prescriptions, performed mostly by experienced pharmacist direct interviews or voluntary reports from prescribers have been used as sources of information. Prescription errors account 70% of medication errors that could potentially result in adverse effects. A mean value of prescribing errors with potential for adverse effects in patients of about 4 in 1000 prescriptions was recorded in a teaching hospital[100]. Such errors are also frequent in ambulatory settings. However, given the inconsistency of the criteria used to identify errors and the various definitions used, it is not surprising that a recent meta-analysis showed that range of errors attributable to junior doctors, who are responsible for most prescriptions in the hospitals, can vary from 2 to 514 per 1000 prescriptions and from 4.2 to 82% of patients or charts reviewed.

Sources:

All procedures related to prescribing are error-generating steps. A prescribing fault can arise from the choice of the wrong drug, the wrong dose, the wrong route of administration, and the wrong frequency or duration of treatment but also from inappropriate or erroneous prescribing in relation to the characteristic of the individual patient or co existing treatments, it may also depend on inadequate evaluation of potential harm deriving from a given treatment. Errors in dose selection occur most commonly, and represent >50% of all prescribing faults.

Inaccuracy in writing and poor legibility of handwriting, the use of abbreviations or incomplete writing of a prescription, for example by omitting the total volume of solvent and duration of a drug infusion, can lead to misinterpretation by healthcare personnel. This can result in errors in drug dispensing and administration. Unintended omissions - or failure to withdraw a drug - are also frequent. A critical point is the transcription of previous treatments at the time of admission to hospital, so called ‘medication reconciliation’. Unintended omission or changes in the dosing regimen are frequent, and account for 15-59% of medication errors[101.] Inaccurate medication history taking can cause omission of treatment, resulting in potential harm in more than one third of patients taking more than four drugs[102] transfer of a patient’s care within the same institution or between a hospital and a general practitioner also favors prescribing faults due to omission[103]. According to the theories of human error, errors in prescribing, as in any other complex and high risk procedure, are occasioned by and depend on failure of individuals, but are generated, or at least facilitated, by failures in systems[104] it might therefore be expected that the larger the number of prescriptions, and the more steps in the prescribing procedure, the higher the risk of error.

Inappropriate prescribing most often derives from a wrong medical decision, because of lack of knowledge or inadequate training. Junior doctors often work in stressful circumstances that are perceived as routine by experienced doctors. Errors are more frequently made by junior members of staff and inadequate knowledge or training often underlie inappropriate prescribing and other faults. Inadequate staffing, lack of skills and knowledge of relevant rules, tasks outside the routine, or taking care of another doctor's patient have also been identified as conditions associated with prescribing faults.

Adverse outcomes can be related to lack of knowledge or skill. Even the apparently simple act of transcribing previous medications and collecting information as a part of the medication history requires a knowledge of pharmacotherapy as well as adequate information about the patient's clinical condition. Equally, the choice of dose requires information about the patient's clinical status and immediate verification of the appropriateness of treatment.

Factors related to patient can also result in errors, leading to adverse effects, since these are associated in most cases with identifiable clinical conditions, such as reduced renal and hepatic function or a history of allergy requiring atypical or unusual dosage and frequency. Polypharmacy and management of elderly patients or children are associated with inappropriate or potentially inappropriate prescribing and errors[105]. Monitoring of drug action is necessarily part of the prescribing process to allow optimization or adjustments of doses or treatments. In ambulatory care, prescribing faults are mostly related to the use of inappropriate doses and inadequate monitoring[106].

Prevention:

Acquisition of information through error reporting system is a prerequisite for preventing prescribing faults and prescription errors, as is the adoption of shred criteria for the appropriateness of procedures. Error reporting systems, but internal and external to healthcare institutions, have been widely used[107]. Reporting is usually voluntary and confidential, but must be timely and evaluated by experts, in order to identify critical conditions and allow systems analysis. Prescribers should be informed and become aware of errors that have been made in their environment and of the conclusions of the analysis.

Spontaneous reporting is about 10 times less effective in directing errors and potential adverse effects than active interventions, such as chart review and patient monitoring[108]. Active systems oriented interventions aimed at importing processes, rather than individual performance should, therefore, be advocated[109], three major intervention strategies can be adopted:

- Reduction of complexity in the act of prescribing by the introduction of automation.
- Improved prescribers knowledge by education and the use of on line aids.
- Feedback control systems and monitoring of the effects of intervention[110].

The use of automated prescribing systems is recommended as an effective tool to reduce medication errors. They can reduce the risk of harm that arises from prescribing faults and improve the quality of medical care by reducing errors in drug dispensing and administration. Computerized advice can give significant benefits by guiding the prescription of optimal dosages. This should translate into reduced time to therapeutic stabilization, reduced risks of adverse effects, and eventually reduced lengths of hospital stay[111]. Nevertheless, electronic systems are not yet widely

available, are expensive, and require training. Comprehensive interventions aimed at improving patient safety using a systematic approach are progressing in different institutions, with the use of uniform medication charts, on which all the relevant clinical information is shown along with the prescriptions, so that transcription is abolished. This approach has been validated as relatively simple alternative to electronic drug prescribing and dispensing systems to a single uniform medication chart forces staff to develop interdisciplinary collaboration and procedures that allow immediate feedback control both among prescribers and between prescribers and other staff (e.g. non prescribing nurses). The input of a hospital pharmacist has been regarded as a major contribution to the identification and reduction of error and is therefore recommended dif it can be afforded.

Education and system approaches:

Education of medical students and junior doctors is highly advisable. Training and feedback control of prescribing by tutors and senior doctors should be associated with availability of online references for immediate identification and verification of potential prescribing faults. The choice of treatment should generally be in line with approved guidelines, although flexibility may be necessary in individual cases.

Constraints can minimize omissions, for example the introduction of check lists or strict rules in writing prescription, and the use of well structured medication charts, as mentioned above. Handwritten prescription should not contain ambiguous abbreviations or symbols. Frequent and immediate review of prescriptions as well as monitoring of potential harms deriving form treatment should be encouraged. Polypharmacy requires special attention. Potentially inappropriate medication should be avoided if possible and carefully monitored when used.

Careful evaluation of drug-drug interactions and all types of adverse reactions is necessarily part of programme aimed at improving patient safety and may require monitoring of plasma drug concentrations and evaluation of biomarkers of beneficial or adverse effects. Audit can contribute to appropriate prescribing and error reduction[112]. Interventions aimed at improving prescribing and reducing errors are a vital component in improving patient safety. As depicted in Dean's definition of a prescribing error[12], following points have to be kept in mind:

- Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, that drug is contraindicated.
- Prescription of a drug to which the patient has a documented clinically significant allergy.
- Not taking into account a potentially significant drug interaction.
- Prescribing a drug in a dose that is inappropriate for the patient's renal function.
- Prescription of a drug in doses below that recommended for the patient's clinical condition.
- Prescribing a drug with a narrow therapeutic index, in a dose predicted to give serum levels significantly above the desired therapeutic range.
- Writing a prescription for a drug with a narrow therapeutic range in dose predicted to give serum levels significantly below the desired therapeutic range.
- Not altering the dose following steady stage serum levels significantly outside the therapeutic range.
- Continuing a drug in the event of a clinically significant adverse drug reaction.

- Prescribing two drugs for the same indication when only one of the drugs is necessary.
- Prescribing a drug to be given by intravenous infusion in a dilutent that is incompatible with the drug prescribed.
- Prescribing a drug to be infused via an intravenous peripheral line, in a concentration greater that that recommended for peripheral administration.
- Failure to communicate essential information prescribing a drug, dose or route that is not that intended.
- Writing illegibly.
- Writing a drug's name using abbreviations or other nonstandard nomenclature.
- Writing an ambiguous medication order prescribing 'one tablet' of a drug that is available in more than one strength of tablet.
- Omission of the route of administration for a drug that can be given by more than one route.
- Prescribing a drug to be given by intermittent intravenous infusion, without specifying the duration over which it is to be infused.
- Omission of the prescriber's signature.
- On admission to hospital, unintentionally not prescribing a drug that the patient was taking prior to their admission.
- Continuing a general practitioner's prescribing error when writing a patient's drug chart on admission to hospital.
- Transcribing a medication order incorrectly writing 'milligrams' when 'micrograms' was intended.
- Writing a prescription for discharge medication that unintentionally deviates from the medication prescribed on the inpatient drug chart.

- On admission to hospital, writing a medication order that unintentionally deviates from the patient's pre-admission prescription.
- Prescribing a drug in a dose above the maximum dose recommended.
- Mis-spelling a drug name.
- Prescribing a drug in a dose that cannot readily be administered using the dosage forms available.
- Prescribing a dose regime (dose/frequency) that is not that recommended for the formulation prescribed.
- Continuing a prescription for a longer duration than necessary.
- Prescribing a drug that should be given at specific times in relation to meals without specifying this information on the prescription.
- Unintentionally not prescribing a drug for a clinical condition for which medication is indicated.

2.4 Detection and Prevention of Medication Errors and Prescription Errors:

In order to build safer systems we must be able to learn from previous errors, and detection is the first crucial 'step'. Scientific societies and surveillance agencies, views, original studies, and case reports may warn us to be on the alert and promote knowledge of risks and improved performance. For this purpose, reports, alerts and recommendations are available on the web, issued by national and federal healthcare systems, regulatory agencies, and non-profit-making organizations - the Food and Drug Administration (FDA), European Medicines Agency (EMEA), United States Pharmacopeia (USP-MEDMARX), UK - National Health Service (NHS), Veterans

Health Administration (VHA), Australian Patient Safety Foundation (APSF), Joint Commission on the Accreditation of Healthcare Organizations (JCAHO).

Prescription auditing to identify and detect prescription errors is processed by bringing information on patterns of existing practice together with information on appropriate practice is an essential component of efforts to improve healthcare. This is possible only when each and every prescription in the hospital is audited by a prescription auditing team. The process of prescription auditing in its broad sense include prescription monitoring, drug utilisation studies, prescription pattern studies, study of prescription habits of doctors, adverse drug reaction monitoring, drug interaction monitoring, criteria based prescription auditing and many other activities.

But the grass-root activities include checking the prescription for drug name (brand name or generic), strength, formulation, dose, routes of administration, frequency, duration of treatment and drug allergies. According to studies cited in the Institute of Medicine report, To Err Is Human: Building a Safer Health System, 44,000 to 98,000 Americans die each year as a result of medical errors[113].

In Indian scenario, a proper reporting of medication errors in the hospital is not available, but out of all visits to the medical emergency department - six per cent are drug-related.

The approaches used to detect errors are likely to be different in research and routine care[114]. In order to prevent medication errors and reduce the risks of harm, organizations need tools to detect them[115]. Any system must then be able to analyze errors and identify opportunities for quality improvement and system changes. The major methods for detecting adverse events are chart review, computerized

monitoring, incident reporting, and searching claims data. Medication errors are mainly detected by means of direct observation and voluntary reporting by doctors, pharmacists, nurses, patients, and others.

Medication errors pose a major threat to patient safety. In England and Wales, over 50000 medication incidents in National Health Service hospitals are reported annually to the UK National Patient Safety Agency[116]. Multiple factors are involved in these events, including faulty supply and labelling and errors of administration, but poor prescribing is probably the most common cause of avoidable events, accounting for over half of all preventable hospital medication errors. Most courses and serious hospital medication errors concern dose, and around 90% involve junior doctors who have recently graduated from medical school making them an important potential target of intervention to improve patient safety. Thus, prescribing is a complex and challenging task that requires diagnostic skills, knowledge of medicines, communication skills, an understanding of the principles of clinical pharmacology, appreciation of risk and uncertainty, and, ideally, experience. It is an anomaly that the hospital doctors who have least experience an expected to prescribe most often. It is also apparent the demands on new prescribers are increasing progressively, owing to several important trends, including (i) the availability of an increasing number of licensed medicine with complex actions, (ii) an increasing number of indications for drug treatment, (iii) greater complexity of treatment regimens, leading to inappropriate polypharmacy, and (iv) more elderly and vulnerable patients. Although errors are inevitable in these circumstances, the important challenge for a health service is to minimize risk. This will require a number of approaches, including changes to system practices (e.g. labelling, team work, checking). The potential influence of education and training as a means of

improving knowledge and skills to prevent medication errors should be the main aims.

Undergraduate medical education has undergone considerable transformation in the last two decades. These changes have come in response to concerns that students were overburdened with scientific facts and were being taught in rigid traditional discipline-based courses, with little regard to social sciences, notably communication skills. This heralded a major change in direction, promoting a reduction in factual burden integration of the curriculum 'both vertically and horizontally', and learning based on body systems. These changes had an adverse effect on the teaching of clinical pharmacology and therapeutics (CPT), a traditional discipline that is factually rich and not organ-based. Identifiable courses and assessments in pharmacology and clinical pharmacology and therapeutics disappeared in many schools, along with the teachers and departments who had delivered them[117]. As a result, many medical students now have little exposure to clinical pharmacologists or indeed any CPT or teaching about practical prescribing. This lack of specialists in a discipline dedicated to fostering safe and rational use of medicines has even led some schools to call on pharmaceutical company support for teaching[118]. The current standards set out for training nurse prescribers in the UK a minimum of 26 days, with an additional 12 days of supervised learning practice[119] would be the envy of many medical students[120]. Although there has been a growing perception, highlighted by clinical pharmacologists and others, that medical school education may have been lacking[121] this view has been challenged[122,123]. A number of health service hospitals have now indicated their own concerns about prepared-ness of new doctors to prescribe and have developed their own assessments, sometimes with important consequences[124].

Medical students themselves have expressed concerns about their training at individual medical schools[125,126]. Weaknesses were identified both in the pharmacological knowledge underpinning prescribing, and the practical elements of calculating dosage, writing up scripts, drug sheets, etc. Prescribing was also the main area of practice in which errors were reported by respondents, indicating a significant potential risk. Risks were reduced, but not removed, by support from colleagues, with newly qualified doctors speaking particularly highly about the help received from pharmacists[127]. According to one of the studies conducted by Heaton there are views of 2413 medical students regarding undergraduate preparation for prescribing[128]. The questions raised about undergraduate training are of obvious relevance to a discussion on medication errors, given that recent graduates undertake a substantial proportion of hospital prescribing and make many of the recorded errors. Review of these events suggests that failures in education and training are a factor. In a prospective study, 88 potentially serious prescribing errors made in a London teaching hospital were identified, 41 prescribers who had been involved were then interviewed, and the findings were analyzed using human error theory. Multiple contributory factors were identified, but 24 doctors (59%) cited their lack of 'skills and knowledge' as important. In another prospective study, 334 medication errors were identified among admissions to 11 medical and surgical units in two tertiary-care hospitals in the USA over a 6-month period, those involved were interviewed[129]. The authors concluded that failure in the 'dissemination of drug knowledge particularly among doctors, accounted for 29% of the errors. Both reports show that error is usually multifactorial, but that knowledge of medicines and prior training are important.

Do educational interventions reduce medication errors?

Is there any evidence that educational interventions alone can reduce prescribing errors? Some defend the status quo on the basis of the paucity of research linking variations in early education experience to subsequent errors. There are obvious difficulties in delivering such evidence because of the large numbers of students required, the long and detailed follow-up, difficulty detecting medication-related events and measuring the quality of prescribing practice, achieving random allocation of learning experience, constant change in curricula, and overcoming the confounding effects of other relevant factors such as working environment and postgraduate education. However, several studies have shown that educational interventions can improve prescribing performance, although most have relied on assessments early after intervention and under controlled conditions rather than on hospital wards. Ross and Loke recently reviewed the literature for trials of educational interventions aimed at improving medical student or junior doctor prescribing[130]. After screening 3189 records they found only 11 controlled trials and four 'before and after' trials that met relevant quality criteria. All but one small study of prescribing errors amongst paediatric residents demonstrated evidence of improved prescribing[131].

This careful review suggests, first, that the available evidence supports efforts to support more intensive educational interventions, and second, that further and better studies are needed.

When is the ideal time to provide education? We are among many commentators who believe that the undergraduate stage is a critical period, because courses are of prolonged duration (5-6 years full time), are undertaken when long-term attitudes and skills can best be developed, and are the only preparation available before the

assumption of legal responsibility for prescribing. In contrast, postgraduate interventions are significantly limited by time constraints imposed by clinical schedules, are more difficult to supervise effectively, and compete with other training requirements (e.g. resuscitation skills). However, postgraduate education does have the potential advantage that it would be delivered when prescribing skills are frequently being practiced in a clinical setting. Prescribing and therapeutics is one of the most rapidly changing aspects of any doctor's clinical practice, and keeping up to date throughout a career that may last several decades presents a major challenge. All will require the necessary time to be set aside for continuing professional development of relevant knowledge and skills and should ideally receive other support in the form of bulletins, audits, and feedback on prescribing activity. The central importance of prescribing as an influence on the quality of medical care should make it a focus within any appraisal and revalidation processes.

Which methods of education might be most effective? The rise of problem-based learning has been a major educational trend, and prescribing education lends itself extremely well to this format, although in one recent study there was no benefit over more traditional didactic methods[132]. An alternative and increasingly popular approach is the development of e-learning packages to support rational prescribing[133,134], allowing learning opportunities to be taken up flexibly at times that best suit learners, a major potential advantage for postgraduates. However, evidence of efficacy is still awaited.

Recommendations for improved training in prescribing:

Irrefutable evidence that more prescribing training will reduce the harm patients suffer from medication errors has yet to emerge. However, the combination of

widely voiced concerns about existing education, growing challenges faced by prescribers, and the relative ease with which errors are identified has led many to advocate precautionary change[135]. Guidance should be directed to recognize the differing ethos of medical curricula adopted in medical schools around the world. These range from a more traditional style, with preclinical phases consisting of traditional sciences taught as disciplines, often by lecture, through to those that are based entirely on problem-based learning in small groups.

All new medical graduates should be able to:

- Establish an accurate drug history.
- Plan appropriate therapy for common indications.
- Write a safe and legal prescription.
- Appraise critically the prescribing of others.
- Calculate appropriate doses.
- Provide patients with appropriate information about their medicines.
- Access reliable information about medicines.
- Detect and report adverse drug reactions.

Recommendations for improving the prescribing education for medical students and junior doctors:

1. Prescribing and therapeutics should be identified as an important vertical theme that is visible throughout the medical curriculum, integrating with and identifiable within relevant horizontal modules.

2. Students' core learning objectives should be clearly identified, including knowledge and understanding about drugs, skills related to the prescribing of drugs, and attitudes towards drug therapy.

3. The factual burden imposed by the large numbers of medicines that are encountered should be eased by prioritizing learning around a core list of about 100 commonly used drugs (a student formulary).

4. There should be an identifiable and robust assessment that tests whether the knowledge and skills outcomes identified above have been achieved, although this might form part of an integrated assessment, it should never be possible to compensate for a poor performance in prescribing by a good performance in other items.

5. Each medical school should identify an individual teacher to oversee this area of the curriculum, who will champion the importance of prescribing as a clinical skill and will ensure that the relevant opportunities are available to allow the relevant learning outcomes to be met.

6. Prescribers should have time to update and reflect on their prescribing practices, dedicated training events should be provided at least once a year.

7. Prescribers should get feedback in the form of quality markers of prescribing relevant to their area of clinical practice.

8. Prescribers should, in the first year after graduation, receive genuine supervision that allows them to discuss problems and seek advice in a non-judgemental way.

9. Prescribers should not be pressurized into prescribing medicines of which they have little experience or understanding.

10. Whenever possible, errors that are identified should be drawn to the attention of the individuals concerned to afford a blame-free learning opportunity, all clinical units, including junior and senior doctors, should review and discuss prescribing incidents at regular intervals.

11. E-learning resources should be made available to support continuing professional development for prescribers at all levels.

12. Prescribing champions should be present in all large healthcare organizations to oversee the processes outlined above.

2.5 Recommendations for Prevention of Medication Errors and Prescription Errors:

1. Provision of sufficient undergraduate learning opportunities to make medical students safe prescribers.
2. Provision of opportunities for students to practice skills that help to reduce errors.
3. Education of students about common types of medication errors and how to avoid them.
4. Education of prescribers in taking accurate drug histories.
5. Assessment in medical schools of prescribing knowledge and skills and demonstration that newly qualified doctors are safe prescribers.
6. European harmonization of prescribing and safety recommendations and regulatory measures, with regular feedback about rational drug use.
7. Comprehensive assessment of elderly patients for declining function.

8. Exploration of low-dose regimens for elderly patients and preparation of special formulations as required.
9. Training for all health-care professionals in drug use, adverse effects, and medication errors in elderly people.
10. More involvement of pharmacists in clinical practice.
11. Introduction of integrated prescription forms and national implementation in individual countries.
12. Development of better monitoring systems for detecting medication errors based on classification and analysis of spontaneous reports of previous reactions, and for investigating the possible role of medication errors when patients die.
13. Use of information technology systems, when available, to provide methods of avoiding medication errors; standardization, proper evaluation, and certification of clinical information systems.
14. Nonjudgmental communication with patients about their concerns and elicitation of symptoms that they perceive to be adverse drug reactions.
15. Avoidance of defensive reactions if patients mention symptoms resulting from medication errors.

Recommendation 1: Provision of sufficient undergraduate learning opportunities to make medical students safe prescribers.

There is evidence that changes in the style of modern medical school curricula may have reduced the visibility of traditional scientific disciplines that underpin safe prescribing, such as pharmacology and clinical pharmacology. There is also evidence that poor knowledge and preparation underlie a promotion of errors made by junior doctors and that focused education in prescribing can improve

performance[136]. It is also a perception among medical students that of all the clinical skills that they will be expected to practise after graduation, the one for which they are least well prepared is prescribing. It is clear that high-quality learning can flourish in different styles of curriculum. However, whatever the setting, learning should be based on enthusiastic leadership, ample sessions that focus on safe prescribing practices, and provision of online learning resources.

Recommendation 2: Provision of opportunities for students to practice skills that help to reduce errors.

Much of the medical school curriculum is devoted to the acquisition of knowledge, and sometimes its application to the skills required in the clinical environment is forgotten. Students should be encouraged to practice relevant clinical skills as soon as possible. These might include taking medication histories, writing new prescriptions and reviewing lists of established prescription medicines in relation to the patient's clinical history, calculating drug doses, preparing and administering medicines under supervision.

Recommendation 3: Education of students about common types of medication errors and how to avoid them.

Medical students are often unaware of the potential hazards posed by medicines when they are prescribed in error, or of the frequency with which this occurs. They should be taught about drugs that are used commonly and pose particular challenges (e.g. anticoagulants, insulin, diuretics) how to monitor the effects of drugs so that potential dangers can be avoided, and the important contribution to error reduction made by good communication and record keeping.

Recommendation 4: Education of prescribers in taking accurate drug histories e.g. taking an accurate medication history.

An accurate medication history is an important element in patient safety. Inaccurate histories, particularly on admission to hospital, can lead to prescribing errors, such as duplication of drugs or unintended discontinuation of medications, with consequent unwanted interactions, failure to detect drug-related pathology, and loss of efficacy of established therapy. In all, 67% of medication histories have at least one prescription error, 22% of which have the potential to harm the patient significantly[137]. Specific drugs are associated with increased risks of errors in the drug history; these include commonly prescribed agents such as anticoagulants and analgesics.

A medication history should elicit specific information from the patient. This should include the details of all prescription medications, over-the-counter drugs, and herbal and other alternative remedies. Drug allergies and previous intolerances should be accurately documented, the dose of the drug, the reaction suffered, and its temporal relation to the drug should be described and susceptibility factors should be sought. The history should be supplemented by examination of the patient, looking for the effects of drugs, and, when appropriate, by relevant laboratory investigations[138]. In addition, one should attempt to ascertain adherence to treatment, from the patient, general practitioner, or family, recognizing that accurate information may be difficult to obtain. Pharmacists obtain better medication histories than physicians and reduce the rate and severity of medication errors during acute admissions. Furthermore, pharmacists attending medical or surgical post-take (admission) ward rounds improve drug history documentation, reduce prescribing costs, and prevent adverse drug reactions.

.**Recommendation 5:** Assessment in medical schools of prescribing knowledge and skills and demonstration that newly qualified doctors are safe prescribers.

Prescribing is probably the practical skill that is most commonly required of all new doctors, but of all the skills that newly qualified doctors are expected to have mastered, they are least confident about prescribing. Medical schools should have effective assessments in place that discriminate between students who have sufficient knowledge and skills for safe medication practices and those who do not. The required standard will differ to some extent, depending on the level of supervision available after graduation. Postgraduate assessment should also be encouraged, as part of appraisal.

Recommendation 6: European harmonization of prescribing and safety recommendations and regulatory measures, with regular feedback about rational drug use e.g. identifying hazardous systems.

Hazards abound in clinical practice. They include:

- Hazardous drugs: These need not be new drugs, even well-established drugs are often subject to medication errors.

- Hazardous patients: Patients present several risk factors for medication errors, there is limited knowledge about how to estimate individual patient risk, although elderly patients constitute a readily identifiable group[139].

- Hazardous professionals: There is a lack of specialists (clinical pharmacologists and clinical pharmacists) trained in the specific problems of medication safety. Consequently, many prescribers are not adequately trained in practical prescribing.

Some settings are more susceptible to involvement in medication errors, such as nursing homes, geriatric home care, surgical departments, intensive care units, and ambulatory care.

Hazardous drugs: Several studies have confirmed persistent problems in prescribing well-established medications[140]. Although there is often a huge amount of knowledge about such medications, less attention is paid to the major safety problems. In some cases safer alternatives to some older risky medications (e.g. warfarrin, amiodarone) are not available. .

Recommendation 7: Comprehensive assessment of elderly patients for declining function[141].

Old patients: Many problems that lead to medication errors particularly affect elderly patients, in whom cognitive impairment, renal insufficiency, dependence on care takers, and polypharmacy are the major predictors of drug-related hospital admissions. Instruments for determining individual patient risk, particularly in patients with multiple comorbidities and several susceptibility factors, are not available for clinical use. There is a lack of professionals specifically trained in geriatrics, geriatric pharmacology, and pharmacoepidemiology. Clinicians do not routinely apply even basic safety recommendations and insufficient attention is paid to well-known risks. There have been few studies on the long-term efficacy in elderly patients of safer low-dose regimens for frequently used medications. In practice, most substances are usually prescribed in too high doses or in low-dose regimens with no evidence of primary or secondary long-term benefit in elderly patients. Drug formulations that contain low doses are less often available.

Recommendation 8: Exploration of low-dose regimens for elderly patients and preparation of special formulations as required.

Recommendation 9: Training for all health-care professionals in drug use, adverse effects, and medication errors in elderly people.

Recommendation 10: More involvement of pharmacists in clinical practice.

Hospital care takes place in a complex and hierarchical organization encompassing different disciplines, which converge at the bedside. Many findings, decisions, and actions take place simultaneously and often acutely. In hospitals, medication and other errors can have many different causes and explanations and often occur at the bedside, where the different disciplines interact. Incidental distraction of attention is likely, and in the case of a specialized activity, such as checking and administering medicines, can lead to suboptimal performance. These types of errors typically occur in the absence of the pharmacist.

In the past few decades, the profession of clinical pharmacy has developed the specialism of pharmaceutical care, which aims at ensuring optimal individual pharmacotherapy and appropriate and errorless drug handling. Involvement of clinical pharmacists in almost the entire medication process, from dispensing to administration to the patient, can reduce medication errors[142]. This can be achieved through special medication ward rounds[143], the use of computer-assisted and barcode-controlled bedside dispensing, and an extra check whenever a pharmaceutical formulation is modified before administration (e.g. crushing a capsule for a patient with an nasogastric tube[144,145], entered via an unusual route, or injected into an intravenous line.

Recommmendation 11: Introduction of integrated prescription forms and national implementation in individual countries, e.g. using uniform prescription forms.

Although electronic prescription systems improve prescribing quality, they are expensive and can generate new types of errors. Integrated prescription forms have also been developed for use in hospitals, with the aim of reducing errors in prescribing and drug dispensing. The prescription is handwritten by the doctor and countersigned by the nurse after administration. The potential advantages are that a single sheet of paper contains all the necessary information about the patient's care, transcription is avoided, communication between physicians and nurses is simplified, and feedback control is facilitated. Although training is required, it is not time- consuming. In addition, uniform prescription charts can be easily implemented at low cost. To improve communication between medical staff and nurses, cooperation should be encouraged, verbal prescription should not be allowed, and only a limited number of abbreviations should be permitted. Feedback control must include immediate notification of errors by medical staff and pharmacists (potential harm deriving from prescription) as well as nurses (incorrect writing), while the prescriber can monitor actual drug administration. Frequent (e.g. daily) review of prescriptions allows identification of potential harm from drug - drug interactions and adverse drug reactions. Audits should be performed periodically to evaluate the appropriateness of the procedures and encourage implementation of the prescription form. Most errors made by junior hospital doctors occur shortly after they come to a new hospital, national prescription forms would help to mitigate this effect.

Recommendation 12: Development of better monitoring systems for detecting medication errors, based on classification and analysis of spontaneous reports of

previous reactions, and for investigating the possible role of medication errors when patients die, e.g. bar-coded medication administration.

Before the administration of a medication in hospitals and other institutionalized care settings, the 'five rights' must be verified: the right patient, drug, dose, route, and time. Traditionally, the nurse does this by visually checking the medicine and the patient. However, there is evidence to suggest that this traditional method does not adequately protect the patient from medication-related harm. About 35% of all medication errors occur at the administration stage, and these errors are more likely to affect the patient.

In bar-coded medication administration a nurse typically scans a bar code on the employee identification bandage', the patient's wristband, and the medication to be administered. The portable computer at the bedside sends information to a server, which checks the prescription, System can generate warnings or approvals, provide administration, instructions and information about the drug or deliver reminders for further actions. After administration, the system documents the activity in the patient's medication record for future use.

Case studies and anecdotal reports suggest that barcoded medication administration can produce significant reductions of at least 50% in the number and types of medication administration errors[146]. Besides patient safety, secondary reasons for implementing bar coded medication administration include improved workflow, documentation, billing, and public relations.

Recommendation 13: Use of information technology systems, when available, to provide methods of avoiding medication errors, standardization, proper evaluation, and certification of clinical information systems.

However, digital communication is not only fast, convenient, and inexpensive, but can also provide a high degree of security, through the use of encryption algorithms. The secure e-mail provider (Z mail) is a fine example of a service that offers an economical and secure means to send medical information over the internet. In addition, most broadband telephony providers are also integrating encryption options into their services, making them more attractive for use in medical communication (such as telemedicine and long-distance telephony). Finally, as the options for digital communication become increasingly available, reliable, and secure, they will also be increasingly used for sending medical information.

Published research strongly suggests that modern information systems have a substantial role in preventing medication errors at each step of the medication process. Computerized order entry and decision support systems reduce errors at the prescription stage by producing legible orders, by ensuring the correct dose and route, and by providing point-of-care alerts about potential drug allergies or drug-drug interactions. In a closed-loop system, the electronic orders are automatically transmitted to the pharmacy, altogether eliminating errors of transcription. Automated dispensing devices and robots ensure that the medication being dispensed is matched accurately against the physician's order.

The usefulness of information systems derives from their ability to organize and link multiple pieces of information with consistency and reliability. A good informatics-enabled medication process will spare the clinicians repetitive boring tasks, so that

they can focus on complex clinical decision-making and communicating with each other and their patients.

Recommendation 14: Nonjudgmental communication with patients about their concerns and elicitation of symptoms that they perceive to be adverse drug reactions, i.e. communicating with patients.

Patients' attitudes to medicines influence the ways in which they use them. Some carry out their own evaluations of prescribed medicines, using their own criteria Up to 50% are non-adherent, in the sense that they do not take the medicine 'as prescribed and few solutions to this longstanding problem have been identified. Blind adherence to medication can lead to harm if patients are insufficiently informed about the dangers of prescribed medicines. All of this suggests that it is better to engage with patients' own evaluations and aim for shared goals rather than ignoring or condemning 'non-adherence. Such an approach requires further research and development.

Recommendation 15: Avoidance of defensive reactions if patients mention symptoms resulting from medication errors.

CHAPTER – III

MATERIAL AND METHODS

CHAPTER - III
MATERIAL AND METHODS

A prospective study of out patient prescriptions was conducted in Anand district from January 2008 to May 2010**.** Prescriptions were collected from pharmacy stores catering to clinicians from multiple specialities. Clinicians near the pharmacy stores were informed about the aims of our study and their informed consent (Annexure-I) was taken. The collection of prescriptions was started a month after the consent to minimize bias in prescription writing.

Prescriptions were collected as Xeroxes/Scans of the original document which the patients presented at the pharmacy and in some cases as duplicate printouts of the prescriptions when they were computer generated printouts.

From rural areas in Anand district the approach was similar except that in the majority of the cases the pharmacy stores were within the clinician's hospital premise.

Inclusion criteria:

Allopathic private practitioners/consultants in Anand district prescribing medicines to patients.

Exclusion criteria:

Institutional prescriptions

Non-availability of clinician's consent

In all, 979 prescriptions were collected from the urban–rural practices. i.e. 749 urban (549 manual + 200 computer generated) and 230 rural (191 manual + 39 computer generated).

Analysis:

The prescription copies so obtained were analysed as per WHO guidelines for "Prescription Writing Errors". An error-scoring sheet (checklist) was prepared and each prescription was analysed on various parameters as per the checklist given below:

(A) Patient details: Name, age, sex, weight, address and date of prescription.

(B) Clinician details: Qualification, address, registration number and signature.

(C) Drug details: Mention of generic or brand name, dosage form, route, dose, unit, frequency, duration of treatment, quantity, signa.

(D) Other information: Mention of allergy status, specific drug communication, mention of abnormality in liver/kidney/cardiac condition, refill mentioned or not, dispense as written, follow up, history of intake of other medicines and legibility status of the prescription.

The data obtained was entered in MS office Excel 2003 and further analysis was done using 'SPSS Data' (Statistical Package for the Social Sciences). Comparative analysis was done between urban/rural prescriptions to study the error rates and types of errors in prescription writing.

Analysis was done in the following way:

Overall prescription writing error rates were found for urban and rural prescriptions in Anand district separately for various parameters.

Prescription writing errors in urban and rural prescriptions were compared with each other.

Computerized prescriptions were analysed and compared with manual prescriptions.

The clinicians not using computers were then interviewed to find out their views on using computers for prescription writing and the problems they faced if they had used them in the past.

In pursuance of our aim to find ways and means to reduce prescription errors, we introduced a prescription writing format to aid the prescription writing to some of the clinicians already participating in our study in the urban setup. They were provided their respective letter-heads with a format printed for prescribing (structured format prescriptions - Annexure-II).

We collected xerox or scanned copies of 206 such prescriptions from pharmacy/stores catering to them. Thus as already mentioned above, the previous data (from analysis of manual prescriptions) was compared to the prescription writing error rates in the structured formatted prescriptions. Data was compared using the chi square test.

CHAPTER – IV

RESULTS

CHAPTER - IV

RESULTS

Table-1: Break-up of overall prescriptions (n = 979)

Urban vs Rural

Prescriptions	Urban		Rural		Total
Manual	549	73.29%	191	83.04%	740
Computerized	200	26.70%	39	16.95%	239
Total	749	76.50%	230	23.49%	979

The table above depicts the break-up of overall prescriptions. Total number of prescriptions collected were 979.

Out of these 979 prescriptions, 749 prescriptions were collected from the urban areas. Of these, 549 were handwritten (manual-urban = 73.29%) and 200 were computer generated (26.70%).

Out of the 230 prescriptions collected from the rural areas, 191 were handwritten (manual-rural = 83.04%) and 39 were computer generated (16.95%) thus showing a higher usage of computers in the urban practice.

Table-2: Speciality-wise distribution of prescriptions (n = 979)

Urban vs Rural

	Urban		Rural	
Physicians	177	18.07%	31	3.16%
Surgeons	29	2.96%	50	5.10%
Gynaecologists	53	5.41%	48	4.90%
Paediatricians	253	25.84%	0	0.00%
Otolaryngologists	28	2.86%	0	0.00%
Ophthalmologists	28	2.86%	25	2.55%
Orthopaedics	6	0.61%	10	1.02%
Chest physicians	28	2.86%	0	0.00%
Dermatologists	27	2.75%	0	0.00%
Psychiatrists	34	3.47%	0	0.00%
Gen. practitioners	86	8.78%	66	6.74%
Total	749	76.50%	230	23.50%

The table above depicts the speciality wise distribution of prescriptions out of total random collection of 979 from both the urban and rural settings.

In all, 18.07% of the prescriptions were from the urban physicians while 3.16 % were from rural physicians. 2.96 % of the prescriptions were from urban surgeons, while 5.10 % prescriptions from rural surgeons. Similarly, 5.41% prescriptions were from the urban gynaecologists as compared to 4.90 % from the rural gynaecologists. There were 25.84% of the prescriptions from urban pediatrician while none from the rural areas. There were 2.86% prescriptions from the urban otorhinolaryngologists while none from rural category. There were 2.86% prescriptions from the urban ophthalmologists as compared to 2.55% prescriptions from the rural areas. 0.61% prescriptions were from the urban orthopaedic surgeons as compared to 1.02 % in the rural setting. There were prescriptions from the urban chest physicians 2.86%, from the urban dermatologists 2.75%, urban psychiatrist 3.47% while none from the rural facilities. However there were 8.78% prescriptions from the urban general practitioners as compared to 6.74% from rural general practitioners.

Thus out of a total of 979 prescriptions, 749 (76.50%) prescriptions were collected from urban private practitioners of the above mentioned categories whereas 230 (23.50%) prescriptions were from rural setting.

Table-3: Speciality-wise distribution: Manual versus computer generated (n = 979)

	Manual		**Computerised**	
Physicians (n = 208)	179	86.05%	29	13.94%
Surgeons (n = 79)	40	50.63%	39	49.36%
Gynaecologists (n = 101)	101	100%	0	0%
Paediatricians (n = 253)	115	45.45%	138	54.54%
Otorhinolaryngologists (n = 28)	28	100%	0	0%
Ophthalmology (n = 53)	53	100%	0	0%
Orthopaedics (n = 16)	16	100%	0	0%
Chest physicians (n = 28)	28	100%	0	0%
Dermatologist (n = 27)	27	100%	0	0%
Psychiatrist (n = 34)	1	2.94%	33	97.05%
Gen practitioners (n = 152)	152	100%	0	0%
Total (n = 979)	740	75.58%	239	24.41%

As seen in the table, out of the total 208 prescriptions from the physicians, 86.05% were manual while only 13.94% were computer generated. Out of 79 prescriptions from the surgeons, 50.63% were manual while 49.36% were using computer generated. Out of a total of 253 prescriptions from pediatricians 45.45% were manual while 54.54% were computer generated. The gynaecologists, otorhinolaryngologists, opthalmologists, orthopaedic surgeons, chest physicians, dermatologists and the general practitioners were not using any computer software for prescription writing. Out of 34 prescriptions of psychiatrists, 97.05% were computer generated. Thus out of 979 prescriptions 75.58% of the prescriptions were written manually while 24.41% of the prescriptions in the study were computer generated respectively.

Table-4(A): Analysis of overall prescription writing errors (n = 979)

Clinician details	Mentioned	%	Not mentioned	%
Name	979	100%	0	0.0%
Qualification	955	97.54%	24	2.45%
Contact number	766	78.24%	213	21.75%
Address	979	100%	0	0.00%
Regn. number	361	36.87%	618	63.12%
Esoteric symbol	783	79.97%	196	20.02%
Signature	656	67.00%	323	32.99%

Prescribing doctor's name was mentioned in all the 979 prescriptions and qualifications in 97.54 % instances. 78.24% prescription mentioned the doctors contact numbers, while 21.75 % prescriptions provided no contact numbers for the patient to contact the clinician (only 9.29% prescriptions had the doctor's personal mobile number mentioned). All prescriptions had the doctor's hospital/clinic address. 36.87% had the registration number mentioned. Esoteric symbol was written in 79.97% of the overall prescriptions while doctor's signature was there in only 67.00% prescriptions.

Table-4(B): Analysis of overall prescription writing errors (n = 979)

Patient Details	Mentioned	%	Not Mentioned	%
O.P.D. number	284	29.00%	695	71.00%
Name	907	92.64%	72	7.36%
Age	456	46.57%	523	53.43%
Sex	351	35.85%	628	64.15%
Weight	233	23.79%	746	76.21%
Address	117	11.95%	862	88.05%
Contact number	0	0.00%	979	100%
Date of prescription	925	94.48%	54	5.52%

From the table above it is evident that O.P.D. number was mentioned in only 29.0% prescriptions, while 71.00% bore no O.P.D. number and therefore would be difficult to sequence or recall for future reference. Although 92.64% prescriptions bore the name of the patient, only 34.01% prescriptions had mentioned the full name, while partial name was written in 58.6%. Age was mentioned in almost half the prescriptions i.e. 46.57% but sex and weight were mentioned in only 35.85% and 23.79% prescriptions respectively. Patient's contact address details were present in just 12% of the prescriptions while none bore the contact number of the patient. A vast majority (94.48%) had the date of prescribing mentioned.

Table-4(C-i): Analysis of overall prescribed items (n = 3069)

Prescriptions (n = 979)	Drug items (n = 3069)	
	Manual	Computerized
Urban	1854	595
Rural	420	200

The table above depicts total number of items prescribed by clinicians in the Anand District using manual and computerised modes of prescribing. In our study, a total of 3069 items were prescribed.

Table-4(C-ii): Analysis of overall prescription writing errors in drug items (n = 3069)

	Mentioned	%	Not Mentioned	%
Generic name	62	2.02%	3007	97.97%
Brand name	3007	97.97%	62	2.02%
Route	2140	74.59%	729	25.41%
Dosage form	2490	81.13%	579	18.86%
Dose	1567	51.05%	1502	48.94%
Unit (mg, g, ml etc)	708	23.70%	2279	76.30%
Frequency of administration	2456	80.02%	613	19.97%
Duration of treatment	967	31.50 %	2102	68.49%
Quantity to be dispensed	2638	85.95%	431	14.04%
Signa	1959	63.83 %	1110	36.17%

Total 3069 items were prescribed in the 979 prescriptions included in the study.

Generic names were mentioned in just 2.02% of the prescriptions as compared to 97.97% brand names.

Route of drug administration was mentioned in 74.59% of overall prescriptions.

The dosage form was mentioned in 81.13% but unfortunately the dose in only 51.05 %. Unit was mentioned in only 23.70% of the collected prescriptions. The frequency was mentioned in 80.02% of the prescriptions, the quantity in 85.95 %, duration of medication in only 31.50 % while signa was mentioned in 63.83 % of the prescriptions respectively.

Table-4(D): Others - Analysis of overall prescription writing errors (n = 979)

	Mentioned	%	Not mentioned	%
Allergy	0	0.005	979	100%
Status: RS/ CVS/Liver /Kidney	0	0.00%	979	100%
Refill	0	0.00%	979	100%
Follow Up	186	19.00%	793	81.00%
Dispense as written	0	0.00%	979	100%
Specific drug communication	6	0.61%	973	99.30%
History of intake of other medicine	0	0.00%	979	100%

In the given table allergy was not mentioned in overall prescriptions. Status of respiratory/ cardiac/liver/kidney functioning as well as history of intake of other medicines was not mentioned in any of the prescriptions. Refill was not mentioned in any of the prescriptions, follow up was mentioned in 19.0%, while 'dispense as written' was not mentioned in any prescriptions. Specific drug communication or drug information was mentioned in only 6 out of 979 prescriptions while history of intake of other medicines was not mentioned at all. In the given table 72.97% prescriptions were legible, while 27.02% were poorly legible.

Table-5(A): Clinician details - Comparative analysis of Prescription writing errors between Urban manual n = 549 and Rural manual Prescriptions (n = 191)

Clinician Details	Error rate - manual prescription (No =740)					
	Mentioned			Not mentioned		
	Overall (740)	Urban (549)	Rural (191)	Overall (740)	Urban (549)	Rural (191)
Name p value NA	740 (100%)	549 (100%)	191 (100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Qualification p value 0.000*	716 (97%)	525 (95.60%)	191 (100%)	24 (3%)	24 (4.4%)	0 (0%)
Address p value 0.186	735 (99%)	544 (99.1%)	191 (100%)	5 (1%)	5 (0.9%)	0 (0%)
Registration No. p value 0.337	121 (16%)	94 (17.1%)	27 (14.10%)	619 (84%)	455 (82.9%)	164 (85.9%)
Esoteric symbol p value 0.000*	544 (74%)	423 (77.00%)	121 (63%)	196 (27%)	126 (23.0%)	70 (37%)
Signature P value 0.000*	453 (61.22)	361 (65.76)	92 (48.17)	287 (38.78%)	188 (34.24%)	99 (51.83%)

* *Highly significant (p value less than 0.000).*

There was mention of doctor's name in all the prescriptions i.e. 100%. Doctor's qualification was mentioned in 95.60 % of urban manual prescription while in all 100% of the rural prescription. Doctor's contact address was mentioned in 99.1% of the urban manual prescriptions while in all the rural prescriptions i.e. 100% it was mentioned.

Doctor's registration number was mentioned in only 17.1% of the prescriptions in the urban manual prescriptions, while it was mentioned only in 14.1% of rural prescriptions.

The esoteric symbol was mentioned in 77.00% of the urban manual prescriptions and in only 63.00% of rural prescriptions.

While 87.8% urban practitioners mentioned their contact numbers on the prescriptions only 62.8% rural prescriptions mentioned the contact numbers of the clinicians. Doctors signature was mentioned in 65.76% of the urban manual practioners.

Table-5(B): Comparative analysis of prescription writing errors between urban manual (n =549) and rural manual prescriptions (n= 191)

Variables	Manual Prescriptions (No =740)					
	Mentioned			Not mentioned		
	Overall (740)	Urban (549)	Rural (191)	Overall (740)	Urban (549)	Rural (191)
OPD Number p value 0.829	45 (6%)	34 (6.2%)	11 (5.8%)	695 (94%)	515 (93.8%)	180 (94.2%)
Name p value 0.000*	668 (90%)	477 (86.9%)	191 (100%)	72 (10.0%)	72 (13.1%)	0 (0%)
Age p value 0.000*	217 (29%)	140 (25.5%)	77 (40.3%)	523 (71%)	409 (74.5%)	114 (59.7%)
Sex p value 0.005**	112 (15%)	95 (17.3%)	17 (8.9%)	628 (85%)	454 (82.7%)	174 (91.1%)
Weight p value 0.000*	62 (8%)	62 (11.3%)	0 (0%)	678 (92%)	487 (88.7%)	191 (100%)
Address p value 0.000*	117 (16%)	51 (9.3%)	66 (34.6%)	623 (84%)	498 (90.7%)	125 (65.4%)
Contact no. p value NA	0 (0.00%)	0 (0.00%)	0 (0.00%)	740 (100%)	549 (100%)	191 (100%)
Date of prescription p value 0.000*	686 (93%)	495 (90.2%)	191 (100%)	54 (7%)	54 (9.8%)	0 (0.00%)

* *Highly significant (p value less than 0.000).*
*** Significant (p value less than 0.005).*

Here patient's o.p.d number was mentioned in only 6.2% of the urban prescriptions, and in only 5.8% in the rural manual prescriptions**.**

Patient name was mentioned in 86.9% of urban prescriptions, while in all 100% rural prescriptions it was mentioned. Age was mentioned in 25.5% of urban manual prescriptions and in 40.3% of rural manual prescriptions.

Patient sex was mentioned in 17.3% and 8.9% prescriptions only in urban manual and rural manual prescriptions respectively. Weight was mentioned in 11.3% of the prescriptions in urban setting while none of the rural prescriptions mentioned the patient weight.

Patient address was mentioned in only 9.3% of the urban prescriptions while in 34.5% prescriptions in the rural setting. The contact number of the patient was not mentioned in any of the prescriptions.

Date of prescription order writing was mentioned in 90.2%, of urban manual prescriptions while it was mentioned in all the prescriptions collected from the rural practitioners**.**

Table-5 C(i): Analysis of prescription writing errors of urban manual prescriptions - drug details (urban) - total drug items (n = 1854)

	Urban (Items prescribed = 1854)			
	Mentioned		**Not mentioned**	
Generic	55	2.97%	1799	97.03%
Brand	1799	97.03%	55	2.97%
Dosage form	1434	77.35%	420	22.65%
Route	1449	78.16%	405	21.84%
Dose	876	47.25%	978	52.75%
Unit	258	13.92%	1596	86.08%
Frequency of administration	1438	77.56%	416	22.44%
Duration of treatment	1352	72.92%	502	27.08%
Quantity to be dispensed	1335	72.00%	519	28.00%
Signa	1156	62.35%	698	37.65%

In the given table very few prescribed items in the urban prescriptions had the mention of the generic names i.e. only 2.97% while brand names were preferred overwhelmingly i.e. (97.03%). Dosage form and route were mentioned in only about 77.35% and 78.16 % items respectively. Less than half the items had dose mentioned (47.25%). Units were mentioned in less than 14.00% items. While the frequency of taking the prescribed drug item was mentioned in 77.56%, both the quantity and duration of treatment were written in around 72.00% of the prescriptions. Signa was mentioned in 62.35% of the prescribed items in the urban prescriptions.

Table-5 C(ii): Analysis of prescription writing errors of rural manual prescriptions - drug details (rural) - total drug items (n = 420)

	Rural (Items prescribed = 420)			
	Mentioned		**Not mentioned**	
Generic	1	0.24%	419	99.76%
Brand	419	99.76%	1	0.24%
Dosage form	293	69.76%	127	30.24%
Route	256	60.95%	164	39.05%
Dose mention	118	28.09%	302	71.90%
Unit	12	2.86%	408	97.14%
Frequency of administration	309	73.57%	111	26.43%
Duration of treatment	325	77.38%	95	22.62%
Quantity to be dispensed	300	71.42%	120	28.57%
Signa	208	49.52%	212	50.48%

As in the previous table for urban prescriptions, there was a very minimal use of generic names for drug items in rural category also i.e. only in 0.24% of the prescribed items. Brand names were overwhelmingly used in 99.76% in rural manual prescriptions. Dosage form was mentioned in 69.76% of prescribed items, route in 60.95%, while dose mentioned in only 28.09% of the prescriptions. Unit was mentioned in 2.86% of prescribed items only.

Frequency and duration of treatment were mentioned in 73.57% and 77.38% of the prescribed items respectively. Signa was mentioned in only 49.52% of prescribed items.

Table-5C(iii): Comparative analysis of urban and rural drug items (n=1854 + 420 drug items)

	Urban items prescribed = 1854				Rural items prescribed = 420			
	Mentioned		Not mentioned		Mentioned		Not mentioned	
Generic p value 0.000*	55	2.97%	1799	97.03%	1	0.24%	419	99.76%
Brand p value 0.000*	1799	97.03%	55	2.97%	419	99.76%	1	0.24%
Dosage form p value 0.000*	1434	77.35%	420	22.65%	293	69.76%	127	30.24%
Route p value 0.000*	1449	78.16%	405	21.84%	256	60.95%	164	39.05%
Dose p value 0.000*	876	47.25%	978	52.75%	118	28.09%	302	71.90%
Unit p value 0.000*	258	13.92%	1596	86.08%	12	2.86%	408	97.14%
Frequency of administration p value 0.000*	1438	77.56%	416	22.44%	309	73.57%	111	26.43%
Duration of treatment p value 0.000*	1352	72.92%	502	27.08%	325	77.38%	95	22.62%
Quantity to be dispensed p value 0.000*	1335	72.00%	519	28.00%	300	71.42%	120	28.57%
Signa p value 0.000*	1156	62.35%	698	37.65%	208	49.52%	212	50.48%

* *Highly significant (p value less than 0.000).*

In the table above the total number of drug items prescribed were 2274 i.e. 1854 in the urban manual and 420 in the rural manual prescriptions. Only 2.97 % prescriptions in urban manual prescriptions mentioned the drugs by generic names while only 0.24% prescriptions in the rural setting mentioned the drug items by the generic names.

Dosage form of the prescribed items was mentioned in 77.35% of the urban manual prescriptions almost similar to 69.76% in rural manual prescriptions.

Dose of the prescribed drug items was mentioned in 47.25% of the urban prescriptions while in rural setting it was mentioned in 28.09% prescriptions only.

Unit e.g. mg, gm, ml, was mentioned only for 13.92% prescribed items in urban manual prescribed items whereas in still lesser prescriptions of prescribed items in rural manual prescriptions (2.86%).

However, frequency was mentioned in 77.56% of the prescribed items in urban prescriptions while it was mentioned in 73.57% of the prescribed items in rural manual prescriptions.

Duration of treatment was mentioned in 72.92% of urban manual prescribed items while it was comparable at 77.38% of the prescribed items in rural prescriptions.

An important component of prescription writing i.e. signa was mentioned in 62.35% of the prescribed items for urban manual prescriptions while in just about half of the prescriptions in the rural setting.

Quantity of the prescribed items to be bought by the patients was mentioned in 72.00% of the drugs in the urban manual prescriptions, while in 71.42% items in the rural manual prescriptions.

Table-5 D(i): Comparative prescription writing errors between urban manual n= 549 and rural manual prescriptions n=191 - others - allergy/sensitivity (Y/N)

Allergy/ Sensitivity	Overall		Urban		Rural	
	Count	%	Count	%	Count	%
Mentioned	0	0.00%	0	0.00%	0	0.00%
Not mentioned	740	100.00%	549	100.00%	191	100.00%
Total	740		549		191	

There was no mention of allergy or sensitivity status in either urban or rural prescriptions i.e. it was 0% in both the categories.

Table-5 D(ii): Specific drug communication

	Overall		**Urban**		**Rural**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Mentioned	0	0%	0	0%	0	0%
Not mentioned	740	100%	549	100%	191	100%
Total	**740**		**549**		**191**	

There was no mention of specific communication of drugs or any drug information in either urban or rural prescriptions i.e. it was 0% in both the categories.

Table-5 D(iii): Drug : Status: CVS /RS/L/K

	Overall		**Urban**		**Rural**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Mentioned	0	0%	0	0%	0	0%
Not mentioned	740	100%	549	100%	191	100%
Total	740		549		191	

There was no mention of respiratory /cardiac/liver/ kidney condition of patient in either urban or rural prescriptions i.e. it was 0% in both the categories.

Table-5 D(iv): Dispense as written

	Overall		**Urban**		**Rural**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Mentioned	0	0%	0	0%	0	0%
Not mentioned	740	100%	549	100%	191	100%
Total	740		549		191	

There was no mention of dispense as written in either urban or rural prescriptions i.e. it was 0% in both the categories.

Table- 5 D(v): Follow-up

	Overall		Urban		Rural	
	Count	**%**	**Count**	**%**	**Count**	**%**
Mentioned	42	5.67%	42	7.65%	0	0%
Not mentioned	698	94.32%	507	92.34%	191	100%
Total	740		549		191	

There was mention of Follow up particulars in 7.65% urban and no mention in rural prescriptions respectively.

Table-5 D(vi): History of intake of other medicine

	Overall		Urban		Rural	
	Count	**%**	**Count**	**%**	**Count**	**%**
Mentioned	0	0%	0	0%	0	0%
Not mentioned	740	100%	549	100%	191	100%
Total	740		549		191	

There was no mention of any history of intake of other medicines in either urban or rural prescriptions i.e. it was 0% in both the categories.

Table-5D(vii): Legible/poorly legible

	Overall		Urban		Rural	
	Count	**%**	**Count**	**%**	**Count**	**%**
Legible	540	72.97%	415	75.59%	125	65.45%
Poorly legible	200	27.02%	134	24.41%	66	34.55%
Total	740		549		191	

P Value : 0.000*

* *Highly significant (p value less than 0.000).*

In about 72.97% of the prescriptions there was good legibility while poor legibility in 27.02% of the overall prescriptions. In urban category legibility was in 75.59%, while in rural it was 65.45% and there was poor legibility in 24.14% of prescriptions in the urban set up while 34.55% of the rural prescriptions in rural were having poor legibility.

Table-5 D(viii): Refill mentioned (Y/N)

	Overall		**Urban**		**Rural**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Mentioned	0	0%	0	0%	0	0.00%
Not mentioned	740	100.0%	549	100.0%	191	100.00 %
Total	**740**		**549**		**191**	

As seen in the table overall refill was not mentioned in any prescriptions.

Table-6 A: Analysis of prescription writing errors in urban computer generated prescriptions n=200

Clinician details	**Mentioned**	**%**	**Not mentioned**	**%**
Name	200	100%	0	0.00%
Qualification	200	100%	0	0.00%
Contact no.	164	82%	36	18%
Address	200	100%	0	0.00%
Reg. No.	200	100%	0	0.00%
Esoteric symbol	200	100%	0	0.00%
Signature	164	82.00%	36	18%

The given table depicts that doctors details like full name, qualification, address for correspondence, registration number, esoteric symbol, date of issue of prescription were mentioned in all the computer generated prescriptions i.e. 100%. Doctors contact number as well as doctors signature was there in 82.00% of the prescriptions.

Table-6 B: Analysis of prescription writing errors in urban computer generated prescriptions n = 200

Patient details	Mentioned		Not mentioned	
O.P.D. No.	200	100%	0	0.00%
Name	200	100%	0	0.00%
Age	200	100%	0	0.00%
Sex	200	100%	0	0.00%
Weight	171	85.50%	29	14.50%
Address	0	0.00%	200	100.00%
Contact no.	0	0.00%	200	100.00%
Prescription date	200	100%	0	0.00%

The patient particulars, like the O.P.D. numbers, patient's full name, age, sex were mentioned in all the computer generated prescriptions, i.e. 100%. While weight was mentioned in 85.50% of the computer-generated prescriptions, patients address, patient contact number was not mentioned. Date of issue of prescription was mentioned in all the prescriptions.

Table-6 C: Analysis of prescription writing errors of prescribed items of computer generated prescriptions n = 200 (595 prescribed items)

Drug details	Urban items prescribed = 595			
	Mentioned		Not mentioned	
Generic	3	0.50%	592	99.49%
Brand	592	99.49%	3	0.50%
Dosage form	435	73.10%	160	26.89%
Route	435	73.10%	160	26.89%
Dose	519	87.22%	76	12.77%
Unit	434	72.94%	161	27.05%
Frequency of administration	567	95.29%	28	4.70%
Duration of treatment	567	95.29%	28	4.70%
Quantity to be dispensed	569	95.63%	26	4.36%
Signa	567	95.29%	28	4.70%

There were a total of 595 prescribed drug items in the computer generated prescriptions category. Almost all drug items were prescribed by brand names (99.49%). Dosage form was mentioned for 73.10% of the prescribed items, route was mentioned in 73.10% of the prescribed item. In 87.22% prescribed items dose was mentioned. Units were mentioned in 72.94% of the prescribed items. There was mention of frequency in 95.29% of the prescribed items, while in 95.29% duration of treatment was mentioned. In 95.63% quantity of prescribed items was mentioned, signa was mentioned in 95.29% for the prescribed items. The computer generated prescriptions were 95% free of errors in the mention of quantity, frequency, duration of treatment and signa.

Table-6D: Analysis of prescription writing errors in computerised prescriptions (n = 200) – Others

Drug : Allergy/sensitivity	Mentioned	0	0.00%
	Not mentioned	200	100%
Specific communication of drugs	Mentioned	6	3.00%
	Not mentioned	194	97.00%
Drug : Status: RS/CVS/L/K	Mentioned	0	0.00%
	Not mentioned	200	100%
Refill	Mentioned	0	0.00%
	Not mentioned	200	100%
Follow up	Mentioned	186	93.00%
	Not mentioned	14	7.00%
Dispense as written	Mentioned	33	16.50%
	Not mentioned	167	83.50%
History of intake of other medicine	Mentioned	0	0.00%
	Not mentioned	200	100%

All the prescriptions were in the typed format so there was no question of illegibility or poor legibility. Therefore all 200 prescription were legible. Date of issue of prescription was mentioned in all the prescriptions (100%). However, there was no mention of respiratory /cardiac/ liver / kidney status of the patient or allergic status of the patient, history of intake of other medicines or refill in any of the computerized prescriptions. There was mention of the specific communication of the drugs or drug information in only 3% of the prescriptions, follow up was mentioned in 93.0% of the prescriptions collected, while dispense as written was a mention in 16.50% of the prescriptions.

Table-7A: Comparative analysis of difference between prescription writing errors in urban manual prescriptions (n = 549) and structured format prescriptions (n = 206)

Doctor details		**Prescription Type**			
		Manual		**Format**	
		Count	**N %**	**Count**	**N %**
Name	Mentioned	549	100.00%	206	100.00%
	Not mentioned	0	0%	0	0%
Qualification p value 0.002*	Mentioned	525	95.63%	206	100.00%
	Not mentioned	24	4.37%	0	0.00%
Address p value 0.169	Mentioned	544	99.09%	206	100.00%
	Not mentioned	5	0.91%	0	0%
Reg. No p value 0.000*	Mentioned	94	17.12%	120	58.25%
	Not mentioned	455	82.88%	86	48.75%
Esoteric symbol p value 0.000*	Mentioned	423	77.05%	206	100%
	Not mentioned	126	22.95%	0	0.00%
Signature p value 0.000*	Mentioned	361	65.76%	206	100.00%
	Not mentioned	188	34.24%	0	0%

* *Highly significant (p value less than 0.000)*

In the given table name of the doctor was mentioned in all the urban manual prescriptions as well as in the prescriptions of the structured format.

Qualification of the doctors was mentioned in 95.63% of the urban manual prescriptions while it was mentioned in 100% prescriptions of structured format.

Address of the doctor was mentioned in 99.09% of the urban manual prescriptions while it was mentioned in all 100% structured format.

There was a mention of the registration number in only 17.12 % prescriptions in the urban manual category while 58.25% doctors mentioned their registration number in the structured format. The esoteric symbol was printed in 77.05% of prescriptions in the urban manual prescriptions but it was mentioned in all structured format prescriptions. prescriber's signature was there in 65.76% of the urban manual prescriptions while it was there in 100% of the structured format.

Table-7B: Comparative analysis of prescription writing errors in urban manual prescriptions (n= 549) and structured format prescriptions (n= 206)

Patient details		**Prescription type**			
		Manual		**Format**	
		Count	**%**	**Count**	**%**
OPD No. p value 0.00*	Mentioned	34	6.19%	34	16.50%
	Not mentioned	515	93.81%	172	83.50%
Name p value 0.00*	Mentioned	477	86.89%	206	100.00%
	Not mentioned	72	13.11%	0	0%
Age p value 0.00*	Mentioned	140	25.50%	154	74.76%
	Not mentioned	409	74.50%	52	25.24%
Sex p value 0.00*	Mentioned	95	17.30%	153	74.27%
	Not mentioned	454	82.70%	53	25.73%
Weight p value 0.00*	Mentioned	62	11.29%	62	30.10%
	Not mentioned	487	88.71%	144	69.90%

Patient details		Prescription type			
		Manual		Format	
		Count	%	Count	%
Address p value 0.00*	Mentioned	51	9.29%	167	81.07%
	Not mentioned	498	90.71%	39	18.937%
Contact No. p value 0.00*	Mentioned	0	0%	25	12.14%
	Not mentioned	549	100%	181	87.86%
Date of prescription p value 0.00*	Mentioned	495	90.16%	204	99.03%
	Not mentioned	54	9.84%	2	0.97%

* *Highly significant (p value less than 0.00).*

Here in the table above o.p.d number was mentioned in 6.19% of prescriptions in the urban manual prescriptions while after introduction of structured format, it was mentioned in 16.50%.

Patient name was mentioned in 86.89% of urban manual prescriptions while it was mentioned in all 100% of the structured formats.

Age was mentioned in only 25.50% of the urban manual prescriptions whereas it showed improvement to 74.76% of the prescriptions in structured format.

Gender details were mentioned in only 17.30% of the prescriptions in the urban manual category while they were mentioned in 74.27% of the prescriptions in the structured format.

Weight of the patients was mentioned in only 11.29% of the urban handwritten prescriptions while it was mentioned in 30.10% of the prescriptions in structured format.

Address was mentioned in only 9.29% of the manual prescriptions while in structured format there was a marked improvement to 81.07%. Contact number as such was not mentioned in urban manual prescriptions but was mentioned in 12.14% of the prescriptions in structured format.

Date of issue of the prescriptions on the urban manual prescriptions was mentioned in 90.16% while it was mentioned in 99.03% of the structured format prescriptions.

Table-7C: Comparative analysis of between prescription writing errors in urban manual prescriptions (n = 1854 prescribed items) and structured format prescriptions (n = 672 prescribed items)

Drug details	No. = 1854 Mentioned /Not mentioned				No. = 672 Mentioned /Not mentioned			
Generic P value 0.000	55	2.96%	1799	97.03%	7	1.04%	665	98.95%
Brand P value 0.000	1799	97.03%	55	2.96%	665	98.95%	7	1.04%
Dosage form P value 0.000	1434	77.34%	420	20.65%	545	81.10%	127	18.89%
Route P value 0.000	1449	78.15/%	405	21.84%	650	96.72%	22	3.27%
Dose mention P value 0.000	876	47.24%	978	52.75%	329	48.95%	343	51.04%
Unit P value0.000	258	13.92%	1596	86.08%	117	17.41%	555	82.58%
Frequency of administration P value 0.000	1438	77.56%	416	22.24%	620	92.26%	52	7.73%
Duration of treatment P value 0.000	1352	72.92%	502	27.08%	605	90.02%	67	9.97%
Quantity to be dispensed P value 0.000	1335	72.00%	519	28.00%	552	82.14%	120	17.85%
Signa P value 0.0000	1156	62.35%	698	37.65%	672	100%	0	0%

The table above depicts that compared to the urban manual prescriptions, structured format prescriptions showed a marked improvement in the various parameters.

Dosage form from 77.34% to 81.10%, route of the prescribed items from 78.15% to 96.72%, dose from 47.24% to 48.95% of the prescribed items, frequency from 77.56% to 92.26% in structured format prescriptions, duration of treatment from 72.92% to 90.02%, quantity of the prescribed items to be bought by the patients was mentioned in 72.00% of the drugs in the urban manual prescriptions, while in 82.14% prescriptions in the structured format prescriptions.

Signa was mentioned in only 62.35% of the prescribed items for urban manual prescriptions while table shows improvement to 100% of the prescribed items in the structured format.

However in certain areas, structured format prescriptions faired poorly e.g. in case of unit (mg, gm, ml) from 13.92% in manual prescribed items to 17.41% only in the structured format prescriptions. In 2.96% prescriptions in urban manual prescriptions the drugs were mentioned by generic names while in only 1.04% prescriptions in the structured format mentioned the drug items by the generic names.

Table-7D: Comparative analysis between prescription writing errors in urban manual prescriptions (n = 549) and structured format prescriptions (n= 206)

Others		**Prescription type**			
		Manual		**Format**	
		Count	%	Count	%
Allergy/Sensitivity p value 0.00*	Mentioned	0	0%	106	51.46%
	Not mentioned	549	100%	100	48.54%
Legibility p value 0.00*	Legible	415	75.59%	206	100%
	Poorly legible	134	24.5%	0	0%
Specific drug Communication p value 0.00*	Mentioned	0	0.00%	17	8.25%
	Not mentioned	549	100%	189	91.75%

Others		Prescription type			
		Manual		Format	
		Count	%	Count	%
Status: RS/CVS/L/K p value 0.00*	Mentioned	0	0.00%	106	51.46%
	Not mentioned	549	100.00%	100	48.54%
Refill p value 0.00*	Mentioned	0	0.00%	15	7.28%
	Not mentioned	549	100.0%	191	92.72%
Follow up p value 0.00*	Mentioned	42	7.65%	0	0.00%
	Not mentioned	507	92.34%	206	100%
Dispense as written p value 0.00*	Mentioned	0	0.00%	15	7.28%
	Not mentioned	549	100%	191	92.72%
History of other medicine p value 0.00*	Mentioned	0	0.00%	51	24.75%
	Not mentioned	549	100.00%	155	75.24%

* *Highly significant (p value less than 0.00).*

As depicted in the table with the introduction of the structured format in the urban practitioners there was improvement in mentioning the following parameters in the structured format category. Mention of the allergy or sensitivity status of patient from 0% to 51.46 %, mention of specific drug communication from 0% to 8.25%, mention of status of Respiratory/cardiac/liver/kidney from 0% to 51.46%, dispense as written from 0% to 7.28%, history of intake of other medicines from 0% to 24.39% of the prescriptions under structure format category. However, there was poor improvement in mention of refill as well as follow up being mentioned in only 7.28% and 0.00% respectively.

Table-8A: Combined table of prescription writing errors in urban manual (n = 549), urban structured format (n = 206), urban computer generated prescriptions (n = 200)

Doctors details		Prescription Type					
		Manual		Format		Computerized	
		Count	%	Count	%	Count	%
Name	Mentioned	549	100.00%	206	100.00%	200	100%
	Not mentioned	0	0%	0	0%	0	0%
Qualifi-cation	Mentioned	525	95.63%	206	100.00%	200	100%
	Not mentioned	24	4.37%	0	0.00%	0	0%
Address	Mentioned	544	99.09%	206	100.00%	200	100%
	Not mentioned	5	0.91%	0	0%	0	0%
Reg. No	Mentioned	94	17.12%	120	58.25%	200	100%
	Not mentioned	455	82.88%	86	48.75%	0	0%
Esoteric symbol	Mentioned	423	77.05%	206	100%	200	100%
	Not mentioned	126	22.95%	0	0.00%	0	0%
Signature	Mentioned	361	65.76%	206	100%	164	82%
	Not mentioned	188	34.24%	0	0.00%	36	18%

In the given table in each category i.e. urban manual, urban structured format and urban computer generated prescriptions, doctor's details like name and qualification were mentioned 100% in the urban manual, structured format and computer generated prescriptions. Address of the doctor being mentioned 100% in both structured format and computerized prescriptions while in urban manual it was mentioned in 99.09%. Registration number was mentioned in all computerized prescriptions whereas it was mentioned in just over half of the structured format prescriptions but barely in 17.12% of the urban manual category. Esoteric symbol was mentioned in all the structured format and computerized prescriptions while in three quarters of the prescriptions in the urban manual category.

Doctor's signature was there in 100% of the structured format prescriptions while in the computerized category had it in 82.00% of the prescriptions but the urban manual prescriptions fared badly even here at 65.76%.

Table-8B: Combined table of prescription writing errors in urban manual (n=549),urban structured format (n=206), urban computer generated prescriptions (n=200)

Patient details		Prescription Type				Computerized	
		Manual		Format			
		Count	%	Count	%		
OPD No.	Mentioned	34	6.19%	34	16.50%	200	100.00%
	Not mentioned	515	93.81%	172	83.50%	0	0.00%
Name	Mentioned	477	86.89%	206	100.00%	200	100.00%
	Not mentioned	72	13.11%	0	0%	0	0.00%
Age	Mentioned	140	25.50%	154	74.76%	200	100.00%
	Not mentioned	409	74.50%	52	25.24%	0	0.00%
Sex	Mentioned	95	17.30%	153	74.27%	200	100.00%
	Not mentioned	454	82.70%	53	25.73%	0	0.00%
Weight	Mentioned	62	11.29%	62	30.10%	171	85.50%
	Not mentioned	487	88.71%	144	69.90%	29	14.50%
Address	Mentioned	51	9.29%	167	81.07%	0	0.00%
	Not mentioned	498	90.71%	39	18.94%	200	100.00%
Contact No	Mentioned	0	0%	25	12.14%	0	0.00%
	Not mentioned	549	100%	181	87.86%	200	100.00%
Prescription date	Mentioned	495	90.16%	204	99.03%	200	100.00%
	Not mentioned	54	9.84%	2	0.97%	0	0.00%

The above table depicts that O.P.D. number mentioned in 6.19% of prescriptions in the urban prescriptions and in computerized category it was 100% while after introduction of structured format, there was improvement in 16.50%.

Patients name was mentioned in 86.89% of urban manual prescriptions while it was mentioned in 100% of the structured format in computerized prescriptions respectively.

Age of the patient was mentioned in only 25.50% of the urban manual prescriptions whereas it shows improvement in mention of age in 74.76% of the prescriptions in structured format. In computerize prescriptions it was mention in all 100% of cases.

Gender was mentioned in only 17.30% of the prescriptions in the urban manual category while it was mentioned in 74.27% of the prescriptions in the structured format. In computerize prescriptions it was mentioned in 100% prescriptions.

Weight of the patients was mentioned in only 11.29% of the urban manual prescriptions while it was mentioned in 30.10% of the prescriptions in structured format and in the computerize prescriptions it was mentioned in 85.50% prescriptions.

Address of the patient was mentioned in only 9.29% of the manual prescriptions while in structured format there was a positive response of mention of present address in about 81.07% of the structured format prescription cases. In computerize prescriptions there is no mention of the address of the patients. Contact number was mentioned in only 12.14% of the structured format while in both the urban manual category and in the computerize category it was not mentioned.

Particulars on mention of date of issue of the prescription on the urban manual prescriptions by the doctors were mentioned in 90.16% while it was mentioned in 99.03% of the structured format prescriptions and 100% in computerized prescriptions.

Table-8C: Comparison of prescription writing errors in urban manual drug items (n = 1854), urban structured format drug items (n = 672), urban computerised prescriptions drug items (n = 595)

Drug items	N = 1854 (Urban manual)				N = 672 (Urban structured format)				N = 595 (Urban computerised)			
	Mentioned		Not mentioned		Mentioned		Not mentioned		Mentioned		Not mentioned	
Generic	55	2.96%	1799	97.03%	7	1.04%	0	98.95%	3	0.50%	592	99.49%
p Value 0.000*												
Brand	1799	97.03%	55	2.96%	665	98.95%	7	1.04%	592	99.49%	3	0.50%
p Value 0.000*												
Dosage form	1434	77.34%	420	20.65%	545	81.10%	127	18.89%	435	73.10%	160	26.89%
p value0.000 *												
Route	1449	78.15%	405	21.84%	650	96.72%	22	3.27%	435	73.10%	160	26.89%
p value 0.000*												
Dose mention	876	47.24%	978	52.75%	329	48.95%	343	51.04%	519	87.22%	76	12.77%
p value0.000 *												
Unit	258	13.92%	1596	86.08%	117	17.41%	555	82.58%	434	72.94%	161	27.05%
p value0.000*												
Frequency of administration	1438	77.56%	416	22.24%	620	92.26%	52	7.73%	567	95.29%	28	4.70%
p value 0.000*												
Duration of treatment	1352	72.92%	502	27.08%	605	90.02%	67	9.97%	567	95.29%	28	4.70%
p value 0.000*												
Quantity to be dispensed	1335	72.0%	519	28.00%	552	82.14%	120	17.85%	569	95.63%	26	4.36%
p value 0.000*												
Signa	1156	62.35%	698	37.65%	672	100%	0	0%	567	95.29%	28	4.70%
p Value0.000 *												

* *Highly significant (p value less than 0.000)*

Here in the table generic names were hardly used in 2.96%, 1.04%, 0.50% prescriptions in the urban manual, urban structured format and urban computerized category respectively.

Dosage form of the drugs was mentioned in 77.34% in urban manual, in 81.10% in structured format, while in 73.10% in computerized prescriptions. So structured format intervention showed a significant improvement in writing the dosage form of the drugs.

Similarly, route was mentioned in 78.15% in urban manual, in 96.72% in structured format, while 73.10% in computerized prescriptions.

Dose was mentioned in 47.24% in urban manual, 48.95% in the structured format category, 87.22% in the computerized category.

Unit was mentioned in barely 13.92% in urban manual, 17.41% in structured format while in 72.94% in the computerized category.

Frequency was mentioned in 77.56% in the urban manual category, 92.26% in the structured format while 95.29% in the computerized category. The introduction of the structured format has shown improvement in writing the frequency.

Duration of treatment was mentioned in 72.92% in the urban manual category, 90.02% in the structure format while 95.29 % in the computerized category.

Quantity was mentioned in 72.00% in the urban manual category, 82.14% in the structure format while 95.63% in the computerized category.

There was a significant improvement in the signa in structured format i.e. 100% as compared to 62.35% in the urban manual category and in 95.29% in the computerized category.

Table-8D: Combined table of prescription writing errors in urban manual (n = 549), urban structured format (n = 206), urban computer generated prescriptions (n = 200)

Others		Prescription type					
		Urban manual		Structure format		Computerized	
		Count	%	Count	%	Count	%
Allergy/ sensitivity	Mentioned	0	0.00%	106	51.46%	0	0.00%
	Not mentioned	549	100.00%	100	48.54%	200	100.00%
Legibility	Legible	415	75.59%	206	100.00%	200	100.00%
	Poor legible	134	24.41%	0	0.00%	0	0.00%
Specific drug communi-cation	Mentioned	0	0.00%	17	8.25%	6	3.00%
	Not mentioned	549	100.00%	189	91.75%	194	97.00%
RS/CVS/H/R	Mentioned	0	0.00%	106	51.46%	0	0.00%
	Not mentioned	549	100.00%	100	48.54%	200	100.00%
Refill	Mentioned	0	0.00%	15	7.28%	0	0.00%
	Not mentioned	549	100%	191	92.72%	200	100.00%
Follow up	Mentioned	42	7.65%	0	0.00%	186	93.00%
	Not mentioned	507	92.35%	206	100.00%	14	7.00%
Dispense as written	Mentioned	0	0.00%	15	7.28%	33	16.50%
	Not mentioned	549	100.00%	191	92.72%	167	83.50%
History of intake of other medicine	Mentioned	0	0.00%	51	24.75%	0	0.00%
	Not mentioned	549	100.00%	155	75.24%	200	100.00%

As depicted in the given table - Allergy or sensitivity was not mentioned in urban manual as well as computerized prescriptions while in 51.46% of the structured format it was mentioned.

Except in 24.41% poor legible of the urban prescriptions others were legible 75.59%, all the prescriptions were in the typed format in the computerized category so there was no

question of illegibility or poor legibility, while in structured format also all prescriptions were 100% legible.

Specific drug communication was mentioned in only 8.25% and 3.00% of the prescriptions in the structure format category and computer generated prescriptions respectively while it was not mentioned at all in urban manual prescriptions i.e. 0%.

Status of respiratory/cardiac/hepatic/renal systems in the prescriptions was only mentioned in structured format intervention in 51.46% of the prescriptions while it was not mentioned in the urban manual and in the computer generated prescription category.

Refill was not mentioned in urban manual as well as in computerized prescriptions, however, in only 7.28% of the structured format it was mentioned.

Follow up was mention in computer generated prescriptions i.e. in 93.00% while in the urban manual it was mentioned in 7.65% only and not mentioned in structured format.

Dispense as written was mentioned in 7.28% and 16.50% prescriptions in structure format and computerized prescriptions while not mentioned in urban manual 0%.

History of intake of other medicines was mentioned in 24.75% 0f structured format as compared to urban manual and computerized wherein it was not at all mentioned.

75.59% prescriptions were legible in the urban manual prescriptions while all prescriptions were legible in the structured format as well as computerised prescriptions.

Table-9A: Comparison of prescription writing error rates in urban manual (n = 549), urban structured format (n = 206) and rural manual (n = 191)

Doctors details		Prescription type					
		Urban manual		Format		Rural manual	
		Count	%	Count	%	Count	%
Name	Mentioned	549	100%	206	100%	191	100%
	Not mentioned	0	0%	0	0%	0	0%
Qualification	Mentioned	525	95.63%	206	100%	191	100%
	Not mentioned	24	4.37%	0	0.00%	0	0%
Address	Mentioned	544	99.09%	206	100%	191	100%
	Not mentioned	5	0.91%	0	0%	0	0%
Reg. No	Mentioned	94	17.12%	120	58.25%	27	14.10%
	Not mentioned	455	82.88%	86	48.75%	164	85.90%
Esoteric symbol	Mentioned	423	77.05%	206	100%	121	63.00%
	Not mentioned	126	22.95%	0	0.00%	70	37.00%
Signature	Mentioned	361	65.76%	206	100%	92	48.17%
	Not mentioned	188	34.24%	0	0.00%	99	51.83%

As depicted in the table above, doctor's details were mentioned in all 100% of the prescriptions in the urban manual, urban format prescriptions and rural manual prescriptions.

Qualification of the doctors was mentioned in 95.63% of the urban manual prescriptions while it was mentioned in 100% prescriptions of structured format as well as in rural manual prescriptions.

Address of the doctor was mentioned in 99.09% of the urban manual prescriptions while it was mentioned in all 100% structured format and the rural manual prescriptions.

There was a mention of the registration number in only 17.12% prescriptions in the urban manual category while 58.25% doctors mentioned their Registration number in the structured format while it was mentioned in 14.10% of prescriptions in rural manual category.

The esoteric symbol was present in 77.05% of prescriptions in the urban manual prescriptions and in 63% of the rural manual but was mentioned in 100% of the structured format prescriptions. Prescriber's sign was present in less than half of the rural manual prescriptions and in 65.76% of the overall prescriptions but improved to 100% in the structured format prescriptions.

Table-9B: Table of comparison of prescription writing error rates in urban manual (n=549), urban format (n=206) and rural manual (n=191) – patient's details

Patient details		**Prescription type**					
		Urban manual		**Format**		**Rural manual**	
		Count	**%**	**Count**	**%**	**Count**	**%**
OPD No.	Mentioned	34	6.19%	34	16.50%	11	5.80%
	Not mentioned	515	93.81%	172	83.50%	180	94.20%
Name	Mentioned	477	86.89%	206	100.00%	191	100.00%
	Not mentioned	72	13.11%	0	0%	0	0.00%
Age	Mentioned	140	25.50%	154	74.76%	77	40.30%
	Not mentioned	409	74.50%	52	25.24%	114	59.70%
Sex	Mentioned	95	17.30%	153	74.27%	17	8.90%
	Not mentioned	454	82.70%	53	25.73%	174	91.10%
Weights	Mentioned	62	11.29%	62	30.10%	0	0.00%
	Not mentioned	487	88.71%	144	69.90%	191	100.00%

Patient details		Prescription type					
		Urban manual		Format		Rural manual	
		Count	%	Count	%	Count	%
Address	Mentioned	51	9.29%	167	81.07%	66	34.60%
	Not mentioned	498	90.71%	39	18.94%	125	65.40%
Contact no.	Mentioned	0	0%	25	12.14%	0	0.00%
	Not mentioned	549	100%	181	87.86%	191	100%
Date of prescription	Mentioned	495	90.16%	204	99.03%	191	100%
	Not mentioned	54	9.84%	2	0.97%	0	0.00%

Herein o.p.d. number was mentioned in 5.80% rural manual prescriptions, 6.19% of the urban manual prescriptions while after introduction of structured format, it was mentioned in 16.50%.

Patient's name was mentioned in 86.89% of urban manual prescriptions while it was mentioned in all of the structured format and rural manual prescriptions.

Age was mentioned in only 25.50% of the urban manual prescriptions whereas it fared better at 40.30% in the rural manual prescriptions. It showed improvement to 74.76% of the prescriptions in structured format.

Gender details were mentioned in only 8.90% prescriptions in rural manual category, 17.30% of the prescriptions in the urban manual category but in 74.27% of the prescriptions in the structured format which clearly was a huge improvement.

While weight of the patients was mentioned in none of the rural manual prescriptions and only 11.29% of the urban handwritten prescriptions, it was mentioned in 30.10% of the prescriptions in structured format.

Address was mentioned in only 9.29% of the urban manual prescriptions while in rural manual prescriptions it was a mention in 34.60% but 81.07% of the structured format prescriptions mentioned it.

The mention of date of prescription threw a pleasant surprise in that while it was mentioned in 90.16% urban manual prescriptions and in 99.03% of the structured format prescriptions, in the rural manual category it was mentioned in all prescriptions.

Contact no. of patients was mentioned in neither urban manual prescriptions nor the rural manual prescriptions and just in 12.14% structured formats.

Date of issue of prescription was mentioned in 90.16% of the prescriptions in the urban manual prescriptions, in 99.03% prescriptions in rural category while in 100% prescriptions in structured format.

Table-9C: Comparison of prescription writing errors in urban manual drug items (n = 1854), urban structured format drug items (n=672), rural manual (n= 420)

Drug items	No. = 1854 (Urban manual)				No. = 672 (Urban structure format)				No. =420 (Rural manual)		
	Mentioned		Not mentioned		Mentioned		Not mentioned		Mentioned		Not mentioned
Generic	55	2.96%	1799	97.03%	7	1.04%	0	98.95%	1	0.24%	419 (99.76%)
p Value 0.000*											
Brand	1799	97.03%	55	2.96%	665	98.95%	7	1.04%	419	99.76%	1 (0.24%)
p Value 0.000*											
Dosage form	1434	77.34%	420	20.65%	545	81.10%	127	18.89%	293	69.76%	127 (30.24%)
p value 0.000 *											
Route	1449	78.15%	405	21.84%	650	96.72	22	3.27%	256	60.95%	164 (39.05%)
p value 0.000*											

Drug items	No. = 1854 (Urban manual)				No. = 672 (Urban structure format)				No. =420 (Rural manual)		
	Mentioned		Not mentioned		Mentioned		Not mentioned		Mentioned		Not mentioned
Dose mention p value 0.000 *	876	47.24%	978	52.75%	329	48.95%	343	51.04%	118	28.09%	302 (71.90%)
Unit p value 0.000 *	258	13.92%	1596	86.08%	117	17.41%	555	82.58%	12	2.86%	408 (97.14%)
Frequency of admini-stration p value 0.000*	1438	77.56%	416	22.24%	620	92.26%	52	7.73%	309	73.57%	111 (26.43%)
Duration of treatment p value 0.000*	1352	72.92%	502	27.08%	605	90.02%	67	9.97%	325	77.38%	95 (22.62%)
Quantity to be dispensed p value 0.000*	1335	72.0%	519	28.00%	552	82.14%	120	17.85%	300	71.42%	120 (28.57%)
Signa p Value 0.000*	1156	62.35%	698	37.65%	672	100%	0	0%	208	49.52%	212 (50.48%)

* *Highly significant (p value less than 0.000).*

The given table depicts that only in 0.24% rural manual prescriptions, 2.96 % of the urban manual and only 1.04% prescriptions in the structured format category, drugs were mentioned by generic names.

Dosage form of the prescribed items was mentioned in 77.34% of the prescriptions of the urban manual category, 81.10% in structured format prescriptions and just 69.76% of the rural prescriptions.

Route of administration was mentioned in 96.72% of the prescribed items in structured format prescriptions in comparison to 78.15% in the urban manual prescriptions and only 60.95% in rural manual prescriptions.

Dose or strength of the prescribed drug items was marginally improved in structured format prescriptions to 48.95% in comparison to 47.24% in the urban manual prescriptions although they were both much better than the 28.09% in rural manual group of prescriptions.

Unit e.g. mg, gm, ml was mentioned only for 13.92% prescribed items in urban manual prescriptions and improved to just 17.41% in structured format prescriptions. Even here rural manual prescriptions fared much worse at 2.86%.

Frequency was mentioned in 77.56% of the prescribed items in urban prescriptions while it was mentioned in 92.26% of the prescribed items in structured format prescriptions and in 73.57% of the rural manual prescriptions.

Duration of treatment was mentioned in 72.92% of urban manual prescribed items and 77.38% of the rural manual prescriptions but improved to 90.02% of the prescribed items in the structured format prescriptions.

Quantity of the prescribed items was comparable at 72.00% of the drugs in the urban manual prescriptions to 71.42% of the rural manual prescriptions, while it improved to 82.14% in the structured format group. Signa was mentioned in more than half of the prescribed items i.e. in 62.35% of urban manual prescriptions while it showed improvement to 100% in the structured format group. In rural category just half of the prescriptions mentioned signa.

Table-9D: Comparison of urban manual (n = 549), urban structured format (n = 206), rural manual (n = 191)

Others		Prescription type					
		Urban manual		Structured format		Rural manual	
		Count	%	Count	%	Count	%
Allergy or sensitivity	Mentioned	0	0.00%	106	51.46%	0	0.00%
	Not mentioned	549	100%	100	48.54%	191	100%
Legibility	Legible	415	75.59%	206	100%	125	65.45%
	Poor legible	134	24.41%	0	0.00%	66	34.55%
Specific drug communication	Mentioned	0	0.00%	17	8.25%	0	0.00%
	Not mentioned	549	100%	189	91.75%	191	100%
Status RS/CVS/ H/R	Mentioned	0	0.00%	106	51.46%	0	0.00%
	Not mentioned	549	100%	100	48.54%	191	100%
Refill	Mentioned	0	0.00%	15	7.28%	0	0.00%
	Not mentioned	549	100%	191	92.72%	191	100%
Follow up	Mentioned	42	7.65%	0	0.00%	0	0.00%
	Not mentioned	507	92.35%	206	100%	191	100%
Dispense as written	Mentioned	0	0.00%	15	7.28%	0	0.00%
	Not mentioned	549	100%	191	92.72%	191	100%
History of intake of other medicine	Mentioned	0	0.00%	51	24.75%	0	0.00%
	Not mentioned	549	100%	155	75.24%	191	100%

As depicted in the table, comparison between the urban manual and structured format prescriptions shows that there was improvement in mention of the following parameters like allergy or sensitivity in patients from 0% to 51.46% of the prescriptions, mention of status of respiratory/cardiac/hepatic/renal from 0% to 51.46%, but a poor improvement in mention of specific drug communication from 0% to 8.25%, refill from 0.00% to only 7.28% and no

improvement in mention of follow up which was mentioned in 7.65% of the urban manual prescriptions while not at all in the formatted prescription form.

While dispense as written improved only marginally from 0% to 7.28%, history of intake of other medicines was improved modestly from 0% to 24.75%. Similarly, if we compare rural manual prescriptions and the structured format, the results appear to be almost the same except that follow up was not mentioned at all in the rural manual prescriptions as compared to a few in urban manual prescriptions. Prescriptions in urban manual category were 75.59% prescriptions legible while 24.41% were poorly legible, while in structured format prescriptions all prescriptions were legible. In rural manual category the ratio of legibility verses poor legibility was 65.45%:34.55%.

CHAPTER – V

DISCUSSION

CHAPTER - V

DISCUSSION

Prescription errors account for 70% of medication errors that could potentially result in adverse effects[3]. In our study a total of 740 handwritten prescriptions were collected from urban as well as from rural sector. They were screened for the essential elements of prescription writing[6]. Our observations showed various types of lacunae in prescription writings as discussed below.

Doctor's details: Name of the doctor was mentioned in all the prescriptions in our study i.e. 100% while their qualifications were mentioned in 97.54%. Our findings are some what similar to findings of study conducted by Sibailly *et al.* [147] which stated that the prescriber's name was mentioned in 99.2% of the prescriptions, and qualifications mentioned in 98.8% of the prescriptions. While in a study conducted by Irshaid *et al.*[2] in hospitals of Saudi Arabia it was found that as many as 17% prescriptions did not bear the name of the prescriber. Similarly Balbaid and Al-Dawood[148] reported that prescriptions from ministry of health hospitals in Jeddah city were deficient in patient's name in 14% of the cases. This is similar to a study carried out by Ansari M[149] wherein prescribers name was mentioned in 85.4% of the prescriptions. Such type of deficiencies can pose a major difficulty for dispensing pharmacist to contact the prescriber in case of any clarification. Apart from this it becomes and illegal document if it does not bear the name of the doctor. In a study conducted by Wilson *et al.*[150] on legal issues in prescription writing in two health institutions in Nigeria stated that for teaching hospital prescribers name was mentioned in 80% of the prescriptions. In the similar study, it was mentioned in 100% prescriptions in health centre in Nigeria, which is similar to the situation in Anand district where all prescriptions carried the prescriber's name.

In our study doctor's contact address was mentioned in 100.00% of the overall prescriptions. Thus all prescriptions had the doctor's hospital address in line with the study done by Sibailly *et al.*[147] where clinician's address was mentioned in 100% of the prescriptions. On the contrary, study conducted by Irshaid *et al.* [2] revealed that only 9.6% of the prescriptions had prescriber's address which is an important element to be included in the prescription.

In all 78.24% prescriptions mentioned the contact numbers either in the form of landline number or mobile numbers on the prescriptions in our study while in contrast the study done by Irshaid *et al.* [2], shows that, none of their prescriptions contained the telephone number of the prescriber. This parameter has a lot of significance as an error of omission or commission if detected by a pharmacist can be avoided or an instruction not clearly understood by the patient can be clarified if the prescriber is just a phone call away. On the other hand clinicians were not very comfortable about giving their personal phone numbers as they find it invading their privacy at times, as discussed with the clinicians in our study.

In our study doctor's registration number was mentioned in only 36.87% of the overall manual prescriptions. On the contrary it was mentioned in 98.8% of the prescriber's prescriptions in study by Sibailly *et al.* [147] and in 99.06% prescriptions in a study done by Ansari *et al.*[149] in Nepal while it was mentioned in 89% of the prescriptions in study conducted by Meyer TA[7]. In one of the study conducted by Kuann Mun Ni et al.[151] hardly 0.5% of the prescribers mentioned their registration number on the prescription letter pads In the same context out of the 397 prescriptions screened in a single day, 96.7% had one or more legal or procedural requirement missing. The medicolegal significance of mentioning registration number of the qualified medical practitioner cannot be overemphasized besides being a legal requirement to be fulfilled by doctors as well as registered medical practitioners by the director General of health. This again indicated a need for pharmacy and medical educators to further emphasize the importance of writing complete

prescriptions and also calls for implementation of educational and monitoring programmes to bring more awareness to all concerned so as to reduce the rate of non compliance in prescription writing and hence minimizing chances of prescription errors. Moreover according to information regarding medical council registration number, doctors are required to quote their registration number on all medical prescriptions, reports and all other documentation and records, whether in paper or electronic format relating to their medical practice thus prescribing doctor should put his rubber stamp bearing his full name, qualification and registration number. This requirement arises from section number 43 (8) of the Medical Practitioner Act 2007 and comes in with the annual certificate of registration by the Medical Council of India[152].

The esoteric symbol was mentioned in 79.97% of the prescriptions in our study, which is somewhat similar to study done by Ansari *et al.* [149] wherein in 66.8% of the prescriptions treatment symbol was missing while in a study conducted by Al Khaja *et al.*[153] showed that 96.1% of the prescriptions bore this symbol. . The esoteric symbol “Rx” separates the superscription from the inscription sections, which means “take thou” or a prayer to the God of healing, Zeus or Jupiter (i.e. the Gods whose protection may have been sought in medical contexts). This perhaps suggests that a vast majority of our clinicians do believe in the age-old adage ‘I treat, He cures’ as they write a prescription beginning with “Rx ”, depicting that he or she is completing the command.

Doctor’s signature was present in 67.00% of the prescriptions in our study as compared to study by Sibailly *et al.*[147] in which 99.8% bore doctor’s signature and 96% prescriptions bore doctors signature in Professor Wilson[150] study. On contrary study by Ansari *et al.*[149] had doctors signature in only 15.7% prescriptions. As in our study 67.00% prescriptions bore doctors signature, which would imply that a large number of prescriptions in our study would be invalid for execution by the pharmacist, but were being honoured nevertheless, thereby raising major legal issues. In another study conducted by Balbaid and

Al-Dawood *et al.*[148] prescriber signatures were deficient in 16.3% of the cases and in a study conducted by Irshaid *et al.*[2], the same was deficient in 18.1% of the cases. Thus the clinicians in our study fared much worse on this front with almost 33% prescriptions being without signatures.

Patients details: Date of issue of prescription was mentioned in 94.48% of the prescriptions in our study which is similar to 94.2% in study conducted by Sibailly *et al.*[147].

The date of issue of prescription to the patient was not mentioned in 5.52% of the prescriptions in our study, which is similar to the study of Balbaid and Al Dawood (8.7%)[148] and Fancois *et al.* (4.5%)[154]. The mention of date signifies the fact that a medical consultation was sought and action was taken by the clinician for the ailment. Since treatment protocols follow set algorithms, the mention of date is essential to show that the treatment followed the dynamics of patient response to treatment instituted. This can have serious implications in medicolegal cases since the prescription is a legal document and not mentioning date can be construed to be negligence even in nonmedico-legal cases.

OPD number was mentioned in only 29.00% prescriptions, clearly illustrating a lack of serial case recording for future easy access to old case records if required. This shows the glaring lacuna in the Indian medical reporting. Despite great medical acumen and skills of Indian doctors acclaimed all over the world, this poor record keeping reduces the credibility of Indian medical research.

Patient's name was not mentioned in 7.36% of overall prescriptions (only 34.01% had the full name, while partial name in 58.63%). In a populous country like ours, there can be numerous persons with the same name so it is imperative to reduce erroneous medication by mentioning the full name. Patient's age was not mentioned in 53.43% prescriptions. This can be an important factor in various prescriptions and can lead to very serious implications, besides being an important factor in identification also. Patient's sex was not mentioned in

64.15%.In comparison with our findings that prescriptions were deficient in mentioning name, age and sex, the study by Irshaid *et al.*[2] had deficiency in the same to the extent of 5.4%, 22.7% and 48.7% of prescriptions, respectively.

Patient's weight was mentioned in just 23.79% of the overall prescriptions which is an important part of prescription order writing (superscription). According to WHO[6] the inclusion of weight is recommended and should be included in the prescription especially at the extremes of ages[6,155] because of its implications on the pharmacokinetics and pharmacodynamics. Lack of information on weight of child in the prescriptions could lead to medication errors during dispensing. Only 54% of the paediatric prescriptions in our study which were computer generated were having information on weight of child but in all fairness it must be pointed out here that a majority had this data mentioned in the accompanying case file and thus it perhaps now needs to be understood that this should be considered an extension of the prescription itself.

The address of patient is among the elements that should be added in the prescription according to WHO guidelines for better prescribing[6]. Patient address was mentioned in only 11.95% of the overall prescriptions while contact number of the patient was not mentioned in any of the prescriptions Also there was lacunae in mention of address in a study conducted by Wilson *et al.*[150] i.e. patients address was mentioned in only 1.8% of prescriptions respectively. This too shows the lack of will to remind patient for follow-ups and at times even to make corrections if errors of omission or commission are noticed by the clinicians before an unwanted event occurs. Omission of patient's address from prescriptions is a serious deficiency as when the problems in prescriptions are discovered and the patient needs to be contacted urgently to correct the problem. Relative lack of information about the patient reported in this study was similar to the one reported by Mallet *et al.*[156].

Drug details: Low generic prescribing ranging from 0.24% - 2.96% of the drugs was one of the most glaring features of prescription writing as seen our data. In our study, generic names were mentioned in just 2.02% prescriptions compared to 97.97% brand names in all. This perhaps shows that clinicians have either more faith in a particular brand or that they do not wish the pharmacist to have the liberty to decide the brand. Besides, a majority of patients on chronic lifestyle disease management, like to remember their drugs by brand names which are much easy to recall as opposed to generic names. Nevertheless, there could be more ulterior motives in over prescribing particular brands, but that is outside the purview of our study and best left under wraps. This finding is similar to study conducted by Kumari *et al.*[157] wherein there is low generic prescribing (1.1%) at the tertiary health care level. As seen in our data various studies done in India i.e. Bapna *et al.*[158], Hazra *et al.*[159] in this regard had similar findings perhaps due to a dominating influence of the pharmaceutical companies and medical representatives. On the contrary generic prescribing may vary in several studies carried out in other countries like the one carried by Blatt *et al.*[160] which reports that 16% of outpatient prescriptions contained brand names in hospital in Cameroon, study by Biswas *et al* [161] done in outpatient reported the percentage of drugs being prescribed by generic names was 35%. One of the study conducted by Thawani *et al.*[162] states that generic prescribing of drugs was prevalent in 69.93% of prescriptions.

In our study the dosage form was mentioned in 75.94% but the doses in only 51.01%. In our practice “dose” i.e. the quantity of drug to be taken, is mentioned as “frequency of tablets to be taken” that is a common practice. Apparently it seems that deciding on the dose to be dispensed to the recipient is left for the pharmacist to decide upon. On the contrary, one of the studies conducted by Bawazir[163] reports that dose of the drug was missing in only 4% of the prescriptions which is a good practice. It is important for the clinicians to bear in the mind that the dose or strength of the medicines prescribed, is particularly needed when the pharmaceutical product exists in more than one strength. In our study unit was mentioned in

only 23.70% of the collected prescriptions. In all fairness to the prescribers, many of the drugs were fixed dose combinations/single dose and therefore do not need to be specified as well it is difficult to memorise each dose. The frequency of administration was mentioned in 80.02% of the prescriptions. The quantity was mentioned in 85.95% prescriptions and duration of medication was mentioned in 31.50% of the prescriptions. This would imply that a very large number of prescriptions would leave it to the discretion of the pharmicist or the patients themselves to decide on their own, a perfect recipe for disaster. However as compared to these findings in our sample, a study conducted by Balbaid and Al Dawood[148] reported that the dose, frequency, and duration of medication were there in 92.4%, 93.1%, 89.8% of the prescriptions.

Signa/direction for drug use was mentioned in 63.83% of the overall prescriptions. Study conducted by Irshaid *et al.*[2] reported that prescriptions were seriously deficient in instructions for patient use and the majority of the (90.7%) prescriptions contained only partial instructions while in only 2.3% of the prescriptions there were full instructions for patient use. Again contrary to this, Bawazir[163] reported that instructions/directions for drug use were missing in only 4% of the prescriptions, a finding that certainly will affect the adequacy of therapy. Numerous studies have demonstrated patients difficulty in recalling or understanding basic directions for taking the medicines. If the medication is to be taken at a specific time of the day, if a particular dosage interval is desired or if there are any additional directions for use, these should be noted on the prescription and precisely explained to the patient in simple terms. The presence of this information is of help to prevent dispensing errors.

Others: Details like allergy, mention of medical condition like status of respiratory/hepatic/ renal/cardiac functioning as well as, history of intake of other medicines was not mentioned in any of the prescriptions but it is worth mentioning here that though the prescription itself did not contain this data, it was mentioned in the accompanying case files in quite a few

cases which is a part of data base prescribing system complex to detect problems to warn the patients[31,35] thereby forcing us to reconsider the case file to be an integral extension of the prescription. By acquiring this complete information one can study the prescribing faults and the rationality status of the prescriptions. Mention of refill was not there in any of the prescriptions. This is an interesting observation and perhaps partially explained by the fact that most clinicians are either uncomfortable with the patient taking medicines for long periods of time without regular follow up checks as doses and drugs may need to be altered with changing patient physiology, prognosis and additional factors or perhaps have financial considerations not to mention refills. Study done by Al Khawaja *et al.*[152] also states that there was no mention of the refill element in the prescriptions. In fact mentioning the number of refills on each original prescription order irrespective of whether it is for controlled substance helps to control the overuse and the abuse of prescription medications, however follow up was mentioned in 5.67% of prescriptions only in our study.

Specific drug communication or drug information was mentioned in barely 0.61% of the prescriptions in our study, as compared to study done by Irshad *et al.* [2] which reported that specific drug information was mentioned in 85% of the out patients. Parameters like 'Dispense as written' or 'do not substitute' was not written. Poor handwriting was noted in 20.42% of the prescriptions in our study while in the study by Irshaid *et al.*[2] poor handwriting was recorded in a large number of prescriptions (65.3%), in another study by Balbaid *et al.*[148] illegible handwriting in 7.2% of the prescriptions was reported. Similar study conducted by Meyer *et al.*[7] found that 15% of the prescriptions had illegible handwriting. Furthermore, Makonnen *et al.* [164] also reports in the study done in tertiary care pharmacy that illegible prescriptions accounted for 15% of the cases. Poor handwriting is a serious problem and is a matter of concern for pharmacist, patient, further referral etc. When the pharmacists are in doubt they may call the doctor otherwise it might lead to pharmacist dispensing wrong medication, to the patient with serious or even fatal results.

On a comparative analysis it was clearly evident in our study, that computer generated prescriptions were much more error free than hand written ones. In fact as seen in our study, half of the pediatricians were using computer-generated prescriptions. Almost all the computer generated prescriptions contained 100% information on clinician details like name, qualification, address, registration number, esoteric symbol and the patient details like OPD number, name, age, sex of the patient. Similarly, in the drug item related prescriptions errors there was a marked reduction in the errors in areas like dose, unit, frequency of drug administration, duration of treatment, quantity, signa and legibility of prescriptions. On similar lines were the findings in a study done by Bates *et al*.[165] which reports reduction in prescription errors in computer generated prescriptions. Also the problem of legibility would not be there as computer generated prescription would be printed. In our study there were some lacunae in computerised prescriptions in a few areas like in the doctors signature 82%, use of generic names barely in 0.50% prescriptions, no mention of refill, and mention of dispense as written in only 16.50% of the prescriptions. Investing in information technology may not always be feasible, at least not in those health care settings with the economic constraints. On discussing with our clinicians, it became evident that not all were very keen about using software for prescription writing. They were of the opinion that the use of computer software for prescription writing was a very tedious job. Most of the practitioners possessed or had purchased the software for the same but did not want to use it. They felt that they needed a separate skilled person for the same since they felt dissociated from the patient while entering data themselves and even the prescription did not bear their personal touch. This conveys the message that although technologies have helped in reducing errors in certain ways but they have their own shortcomings.

In our study modified prescription format significantly reduced the errors in prescription writing as compared to standard handwritten prescriptions with improvement in most of the

parameters such as mention of clinicians details, patient details, drug details as well as in others. Similar to these are findings as documented in study by Gommans J. *et al.*[166]. This study showed an improvement in the quality of prescribing by improvising the alternative interventions like modification of medication charts, which showed progressive improvement in legibility (97%), patient identification (100%), documentation of date (98%), mention of drug dose (99%) and route (97%) but the identification of prescribers still remained suboptimal. Modified prescription forms significantly reduced clinically important prescribing problems as compared to standard forms. Based on the legal requirements of prescription, modified forms do decrease omission errors as compared to standard forms which is also stated in a study done by Kennedy A.G.[167] which reports that after introduction of modified prescription format, problems remained with only 2.3% of the prescriptions.

Limitations:

- In our study we could not study the prescription for "prescribing faults" due to a paucity of details necessary to make this assessment as listed below in the list of prescribing error definition by Dean *et al.*[12]. It is our contention that the patient file should be considered an extension of the prescription so that important data (a lot of this data was found available in the respective files which were issued to patients by the clinicians in our study as shown in Annexure-III) becomes available for a better assessment of prescribing errors. Interventions aimed at improving prescribing and reducing errors are a vital component in improving patient safety. The patient files are containing the full detailed medication history as well as patient particulars in detail, which is a very important aspect for the determination of the prescribing faults (errors of commission). Our study is an effort to highlight one of the aspect of error i.e. prescription errors in the act of writing a prescription rather than prescribing faults which emphasizes mainly on the rationality aspects of

prescriptions like overprescribing, underprescribing, inappropriate prescribing and irrational prescribing for which education regarding clinical pharmacology and therapeutics is needed. Broadly the rational drug therapy means correct use of correct drug/s when indicated. Not only the disease, but the patient, the family and the environment (socioeconomic and educational levels) should also be selected while selecting the drugs. To study this aspect of prescribing errors there should be full medication history, which is missing in OPD prescriptions. Rational therapeutic decisions are based on the criteria like examination of patient for the evidence of drug effects and drug actions, planning appropriate therapy and dosage regimens by calculations based on age, body weight and gender of patient, the clinical condition of the patient. At the same time education on drug therapy to patients is a must to improve compliance. There has been considerable variations in the study designs, methods, and error definitions and error rates of medication errors and its types. Till consistent definitions and methods are used we struggle to understand the types of errors and their occurrence in this part.

Agreement on a standard definition is urgently required, as demonstrated by the wide range of definitions used in the studies we reviewed. Thirty-five separate criteria were noted from studies, which used varying combination of these. A strong contender for the 'ideal' definition is Dean's Delphi derived definition[3,12] which represents the result of an expert consensus (doctors, pharmacists and nurses), this definition has the benefit of describing both elements of prescription writing and of decision making, but where all elements are a possible danger to patients. Two directions for future research are suggested that will provide the information needed. First, future research in prescribing error rates should be well constructed and generalised using standard definitions and methodology. A well-conducted study of prescribing errors by junior doctors is urgently needed. Second, further in depth research into the reasons for errors using human error theory is required, building

on the work done by Dean *et al.*[16] although attention should continue to be focused on systems, factors, individual factors should not be discounted. Future research should concentrate on providing the theoretical foundations prior to developing and validating actual interventions. Listed below is the list of prescribing error as defined by Dean *et al.*[12]

- Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, that drug is contraindicated, prescription of a drug to which the patient has a documented clinically significant allergy, not taking into account a potentially significant drug interaction, prescribing a drug in a dose that, according to National Formulary or data sheet recommendations, is inappropriate for the patient's renal function, prescription of a drug in doses below that recommended for the patient's clinical condition, prescribing a drug with a narrow therapeutic index in a dose that is predicted to give serum levels significantly above the desired therapeutic range, and not altering the dose following steady stage serum levels significantly outside the therapeutic range, continuing a drug in the event of a clinically significant adverse drug reaction, prescribing two drugs for the same indication when only one of the drugs is necessary, prescribing a drug to be given by intravenous infusion in a dilutent that is incompatible with the drug prescribed, prescribing a drug to be infused via an intravenous peripheral line, in a concentration greater than that recommended for peripheral administration, writing illegibly, writing a drug's name using abbreviations or other nonstandard nomenclature, writing an ambiguous medication order prescribing 'one tablet' of a drug that is available in more than one strength of tablet, omission of the route of administration for a drug that can be given by more than one route, prescribing a drug to be given by intermittent intravenous infusion, without specifying the duration over which it is to be infused, omission of the prescriber's signature, on admission to hospital, unintentionally not prescribing a drug that the patient was taking prior to their admission continuing a

general practitioner's prescribing error when writing a patient's drug chart on admission to hospital, transcribing a medication order incorrectly writing 'milligrams' when 'micrograms' was intended, writing a prescription for discharge medication that unintentionally deviates from the medication prescribed on the inpatient drug chart, on admission to hospital, writing a medication order that unintentionally deviates from the patient's pre-admission prescription, prescribing a drug in a dose above the maximum dose recommended in the National Formulary or data sheet, misspelling a drug name, prescribing a drug in a dose that cannot readily be administered using the dosage forms available, prescribing a dose regime (dose/frequency) that is not recommended for the formulation prescribed, continuing a prescription for a longer duration than necessary, prescribing a drug that should be given at specific times in relation to meals without specifying this information on the prescription, unintentionally not prescribing a drug for a clinical condition for which medication is indicated.

CHAPTER – VI

CONCLUSION

CHAPTER - VI

CONCLUSION

In the present study after assessing the prescriptions and then comparing with the predetermined standards of good quality prescribing, it is evident that out patient prescription errors are abundant and often occult. The handwritten prescriptions be it from urban or rural areas, are associated with relatively higher error rates associated with prescription writing in the Anand district in all areas like doctors details, patient details and drug details and even on other aspects like allergies, major illnesses and specific communication about the drug. The computerized prescriptions on the contrary had the lowest frequency of prescription writing errors.

Although there is an increasing awareness regarding the use of computers for the generation of prescription orders in some practice settings. In developing countries handwritten prescriptions will most probably continue to be the main tools for communicating therapeutic intent for a long time. Computer Physician order entry systems have advantages of clear legibility, accurate information on drugs, patient specific information such as warnings on overdoses, drug interactions and alerts on drug allergies, but they are expensive to introduce, measures must also be taken to encourage doctors to write prescriptions legibly. In conclusion this study is an effort to assess the quality of handwritten prescriptions in Anand district and interventions thereof designed to address the identified deficiencies in prescription writing i.e. especially in the area of omission errors. Prescribers could be helped by designing systems to reduce the risk of these errors like that of a compromise between error prone manual method and indifferent (in human) approach of computerised prescription. The approach sorted, could be a prescription form printed with proper layout i.e. a structured format. While the prescriptions continued to be manually

written, the printed spaces in the prescription, became reminders to the clinicians and therefore the error rates in various parameters fell dramatically. Various educational interventions like face to face education and group seminars can also help to bring about modest changes in prescription errors.

REFERENCES

REFERENCES

1. Smith CM. Origin and uses of *Primum non nocere.* J. Clin. Pharmacol. 2005; 45: 371-7.

2. Irshad YM, AI Homrany M, Hamdi AA *et al.* Compliance with good practice in prescription writing at outpatient clinics in Saudi Arabia. East Mediterr Health J. 2005; 11 (5-6): 922-8.

3. Velo G, Minuz P. Medication errors prescribing faults and prescription errors. Br. J. Clin. Pharmacol. 2009; 67: 624-628.

4. Ross S, Bond C, Rothnie H, Thomas S, Macleod MJ. What is the scale of prescribing errors committed by Junior Doctors, a systematic review. Br. J. Clin. Pharmacol. 2009; 67: 629-640.

5. Benet LZ. Principles of prescription order writing and patient compliance instructions. In Appendix-1: Goodman and Gilman's. The Pharmacological Basis of Therapeutics. New York: McGraw-Hill; 1996. 1697-1706.

6. De Vries TPGM, Henning RH, Hogerzeil HV, Fersle DA. Guide to good prescribing: A practical manual. Geneva, World Health Organization. 1994; 51-55 (WHO/DAP/94.11).

7. Meyer TA. Improving the quality of the order writing process for inpatient order and outpatient prescriptions. American Journal of Health system Pharmacy. 2000; 57 (4): 18-22.

8. Ferner RE, Aronson JK. Clarification of Terminology in Medication errors: Definitions and classifications. Drug Saf. 2006; 29: 1011-22.

9. Lesar TS, Briceland L, Stein DS. Factors related to errors in medication prescribing. JAMA. 1997; 277: 312-317.

10. Dean B, Vincent C, Schacter M, Barber N. The incidence of prescribing errors in hospital inpatients, an over view of research methods. Drug Saf. 2005; 28: 891-900.

11. Knudsen P, Herborg H, Mortensen AR, Knudsen M, Hellebek A. Preventing medication errors in community pharmacy: root-cause analysis of transcription errors. Qual saf Health care. 2007; 16: 285-290.

12. Dean B, Barber N, Schachter M. What is a prescribing error? Qual Health Care. 2000; 9: 232-237.

13. Ridley SA, Booth SA, Thompson CM. Prescription errors in UK critical care units: Journal of Association of Anesthetics of Great Britain and Ireland. 2000; 59 (12): 1193-1200.

14. Shah SN, Aslam M, Avery AJ. A survey of prescription errors in general practice. Pharm. J. 2001; 267: 860-862.

15. Barach P, Small SD. Reporting and Preventing medical mishaps: Lessons from non medical near miss reporting systems. BMJ. 2000; 320 (7237): 759-763.

16. Dean B *et al.* Causes of prescribing errors in hospital in patients, a prospective study. The Lancet. 2002; 359: 1373-1379.

17. Aronson JK. A prescription for better prescribing. BMJ. 2006; 333: 459-460.

18. Jaykaran, Bhardwaj P, Chavda N, Yadav P, Panwar A. Prescribing knowledge of the intern doctor in India. The Internet Journal of Epidemiology. 2009; 7 (1): p 1-3.

19. Nolan TW. System changes to improve patient safety. BMJ. 2000; 320: 771-3.

20. Medical Prescription – Wikipedia the free encyclopedia http/en.wikipedia.org. Medical prescription (cited 2006 June 26).

21. Chen XQ, Qian SC. Great achievements in ancient Chinese pharmacy. J. Traditional Med. and Egyptian writing. 1989; 9: 230-232.

22. Karenberg and Leitz. Headache in magical and medical papyri of ancient. Egypt Cephalalgia. 2001; 21: 911-916.

23. Allen LV, Popvich NG, Ansel HC. Introduction to drugs, drug dosage forms and drug delivery systems. In: Ansel's pharmaceutical dosage forms and drugs delivery systems. Wolters Kluwer Publishers; 2007 p. 4-23.

24. Open database: History of Pharmacy, College of Pharmacy taken from "Great moments in Pharmacy By George A, Bender, Paintings by Robert A Thom, Parke, Davis and Company 1968. Available at http://www.pharmacy.wsu.edu.history/ history.

25. Kuperman GJ, Teich JM, Bates DW. Patient safety and computerized medication ordering at Bringham and Womens Hospital. Joint Comm. J. Qual. Improv. 2001; 277: 509- 521.

26. United States Pharmacopeial Convention. Use caution-avoid confusion, USP Quality Review. May 1999 (a) Number 66.

27. Leape LL. Error in medicine. JAMA. 1994; 272: 1851-1857.

28. United States Pharmacopeial Convention. Proposed drug name changes for error prevention, USP Quality Review. October 1999 (b) Number 69.

29. Teichman PG, Caffee AE. Prescription writing to maximize patients safety. Fam. Pract. Manag. 2002; 9: 27-30.

30. Kohn LT. The Institute of Medicine Report on Medical Error: overview and implications for pharmacy practice. Am. J. Health Syst. Pharm. 2001; 58: 63-66.

31. Ramesh KV, Shenoya A, Chowta MN. Accepted abbreviations for writing the prescri-ptions. In: Practical Pharmacology for MBBS. Arya Publishing Company; 2006. p 9.

32. ISMP List of error prone abbreviations, symbols and dose designations. Available from www.usp.org/pdf/EN/patient safety/ismp.

33. Winslow EH, Nestor VA, Davidoff SK, Thompson PG, Borum JC. Legibility and completeness of physicians handwriting medication orders. Heart Lung Journal. 1997; 26: 158-164.

34. Cabral JD. Poor physician penmanship. JAMA. 1997; 278:1116-1117.

35. Berwick DM, Winickoff DE. The Truth About Doctors' Handwriting: A Prospective Study. Br. Med. J. 1995; 313: 1657-1658.

36. Cohen MR, Davis NM. Developing safe and effective preprinted physician order forms. Hosp. Pharm. 1992; 27: 508-528.

37. Lyors R, Payne C, Mc Cabe M, Fielder C. Legibility of Doctors' Handwriting: quantitative comparative study. Br. Med. J. 1998; 317 (7162): 863-864.

38. Cohen MR, Anderson RW, Atilio RM, Green L, Muller RJ. Preventing medication errors in cancer chemotherapy. Am. J. Health System Pharm. 1996; 53: 737-746.

39. Berwick DM, Winickoff DE. The Truth About Doctors' Handwriting: A Prospective Study. Br. Med. J. 1995; 313: 1657-1658.

40. Institute for Safe Medication Practice. A call to Action: Eliminate handwritten prescriptions within 3 years! 2000: A white paper.

41. Aronson JK. X marks the spot. BMJ. 1999; 318: 1543 [PubMed].

42. Muller A, Monnet DL, Talon D, Hénon T, Bertrand X. Discrepancies between prescribed daily doses and WHO defined daily doses of antibacterials at a University hospital. Br. J. Clin. Pharmacol. 2006; 61: 585–91 [PubMed].

43. Kucukarsalan SN, PetersM, MlynarekmM, NafzigerDA.Pharmacists on roundsing teams reduce preventable adverse drug events in hospital general medicine units. Arch Intern Med. 2003; 163: 2014-2018.

44. Dean B, Schachter M, Vincent C, Barber N. Prescribing errors in hospital inpatients: their incidence and clinical significance. Qual Saf Health Care. 2002; 11: 340–4 [PubMed].

45. Fijn R, Van den Bemt PM, Chow M, De Blaey CJ, Brouwers JR. Hospital prescribing errors: epidemiological assessment of predictors. Br. J. Clin. Pharmacol. 2002; 53: 326-331 [PubMed].

46. Aronson JK. Rational prescribing, appropriate prescribing. Br. J. Clin. Pharmacol. 2004; 57: 229–30 [PubMed].

47. General Medical Council. Tomorrow's Doctors. Recommendations on Undergraduate Medical Education. London: General Medical Council. 2002; [30 March, 2006]. http://www.gmc-uk.org/education/undergraduate/tomdoc.pdf.

48. Ellis A. Prescribing rights: are medical students properly prepared for them? BMJ. 2002; 324: 1591.

49. Wells JL, Borrie MJ, Crilly R, Brymer CD, Hurwitz JS. A novel clinical pharmacy experience for third-year medical students. Can. J. Clin. Pharmacol. 2002; 9: 7-16 [PubMed].

50. Grahame-Smith DG, Aronson JK. The Oxford Textbook of Clinical Pharmacology and Drug Therapy. 3. Oxford: Oxford University Press, 2002. The four processes of drug therapy, p. 3-6.

51. Leathard HL. Understanding medicines: extending pharmacology education for dependent and independent prescribing (Part II). Nurse Educ. Today. 2001; 21: 272-277 [PubMed].

52. Lewington G, Marshall K. Access to emergency hormonal contraception from community pharmacies and family planning clinics. Br. J. Clin. Pharmacol. 2006; 61: 605-8 [PubMed].

53. British Thoracic Society, Scottish Intercollegiate Guidelines Network. [30 March, 2006]. British Guideline on the Management of Asthma. A National Clinical Guideline. Revised Edition November 2005. Available at http://www.sign.ac.uk/pdf/sign63s1.pdf.

54. Resuscitation Council (UK) Trading Ltd. [30 March, 2006]. Resuscitation Guidelines 2005. Available at http://www.resus.org.uk/pages/guide.htm.

55. Lim PZ, Tunis SL, Edell WS, Jensik SE, Tohen M. Medication prescribing patterns for patients with bipolar disorder in hospital settings: adherence to published practice guidelines. Bipolar Disord. 2001; 3: 165–73 [PubMed].

56. Kanji S, Corman C, Douen AG. Blood pressure management in acute stroke: comparison of current guidelines with prescribing patterns. Can. J. Neuro. Sci. 2002; 29: 125-131 [PubMed].

57. Gall MJ, Harmer JE, Wanstall HJ. Prescribing of oral nutritional supplements in primary care: can guidelines supported by education improve prescribing practice? Clin. Nutr. 2001; 20: 511-15 [PubMed].

58. Zwar N, Henderson J, Britt H, McGeechan K, Yeo G. Influencing antibiotic prescribing by prescriber feedback and management guidelines: a 5-year follow-up. Fam. Pract. 2002; 19: 12–17 [PubMed].

59. Tamblyn R, Huang A, Perreault R, Jacques A, Roy D, Hanley J, McLeod P, Laprise R. The medical office of the 21st century (MOXXI): effectiveness of computerized decision-making support in reducing inappropriate prescribing in primary care. CMAJ. 2003; 169: 549-56 [PubMed].

60. Teich JM, Merchia PR, Schmiz JL, Kuperman GJ, Spurr CD, Bates DW. Effects of computerized physician order entry on prescribing practices. Arch. Intern. Med. 2000; 160: 2741-7 [PubMed].

61. Kawahara NE, Jordan FM. Influencing prescribing behavior by adapting computerized order-entry pathways. Am. J. Hosp. Pharm. 1989; 46: 1798–801 [PubMed].

62. Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review. Arch. Intern. Med. 2003; 163: 1409-16 [PubMed].

63. Gandhi TK, Weingart SN, Seger AC, Borus J, Burdick E, Poon EG, Leape LL, Bates DW. Outpatient prescribing errors and the impact of computerized prescribing. J. Gen. Intern. Med. 2005; 20: 837-41 [PubMed].

64. Ferner RE. Computer aided prescribing leaves holes in the safety net. BMJ. 2004; 328: 1172-3 [PubMed].

65. Weingart SN, Toth M, Sands DZ, Aronson M, Davis RB, Phillips RS. Physicians' decisions to override computerized drug alerts in primary care. Arch. Intern. Med. 2003; 163: 2625-31 [PubMed].

66. Koepsell TD, Gurtel AL, Diehr PH, Temkin NR, Helfand KH, Gleser MA, Tompkins RK. The Seattle evaluation of computerized drug profiles: effects on prescribing practices and resource use. Am. J. Public Health. 1983; 73: 850-5 [PubMed].

67. Boreham NC, Mawer GE, Foster RW. Medical students' errors in pharmacotherapeutics. Med. Educ. 2000; 34: 188–93 [PubMed].

68. Maxwell S, Walley T. Teaching safe and effective prescribing in UK medical schools: a core curriculum for tomorrow's doctors. Br. J. Clin. Pharmacol. 2003; 55: 496-503. Available at http://www.bps.ac.uk/coreCPTCurricula.pdf. [PubMed]

69. Smith AJ, Tasioulas T. Education on prescribing can be improved. BMJ. 2002; 325: 776 [PubMed].

70. Herzig S, Jakobs KH, Michel MC. Novel teaching techniques in pharmacology. Naunyn Schmiedeberg's Arch. Pharmacol. 2002; 366 (1).

71. Audit Commission. A Spoonful of Sugar – Improving Medicines Management in Hospitals. London: Audit Commission, 2001.

72. Royal College of Physicians of London. [30 March, 2006]. Clinical Pharmacology and Therapeutics in a Changing World. Report of a Working Party. May 1999. Available at http://www.rcplondon.ac.uk/pubs/brochures/pub_print_clinph.htm.

73. US Food and Drug Administration. [30 March, 2006]. Innovation or Stagnation. Challenge and Opportunity on the Critical Path to New Medical Products. US Department of Health and Human Services, March 2004. Available at http://www.fda.gov/ oc/initiatives/criticalpath/whitepaper.html.

74. Aronson JK, Ferner RE. Clarification of terminology in drug safety. Drug saf. 2005; 28: 851-70.

75. Joshi MC. Medication error reporting through prescription auditing. Inside - Express Health Care Management. 2005 June 16. p 1-5. Available at http://www.express health care mgmt.com 20050630/insight 01.shtml.

76. Barker K, Cowley E. Liability for errors in expanded pharmacy practice: issues for technicians and pharmacists. Platform presentations of the American Pharmaceutical Association. Annual Meeting updated 2000 March 10.

77. Reason JT. Human Error. New York: Cambridge University Press, 1990.

78. Ferner RE, Aronson JK. Errors in prescribing, preparing and giving medicines - definition, classification and prevention. In: Side effects of Drugs, Annual 22.

79. Norman DA. Categorization of action slips. Psycho Rev. 1981; 88: 1-15.

80. Runciman WB, Sellen A, Webb RK, Williamson JA, Currie M, Morgan C *et al*. The Australian incident monitoring study. Errors, incidents and accident in anaesthetic practice. J. of Anaesth Intensive Care. 1993; 21: 506-19.

81. Ferner RE, Langford NJ, Anton C, Hutchings A, Bateman PA. Random and systematic medication errors in routine clinical practice; a multicentre study of infusions, using acetylcysteine as an example. Br. J. Clin. Pharmacol. 2001; 52: 573-7.

82. Maxwell S, Walley T. Teaching safe and effective prescribing in UK medical schools, a core curriculum for tomorrow's doctors. Br. J. Clin. Pharmacol. 2003; 55: 496-503.

83. Likic R, Maxwell SRJ. Prevention of medication errors; teaching and training. Br. J. Clin. Pharmacol. 2003; 55: 496-503.

84. Langford NJ, Landray M, Martin U, Kendall MJ, Ferner RE. Testing the practical aspects of therapeutics by objective structured clinical examination. J. Clin. Pharmacol. Ther. 2004; 29: 263-6.

85. Frank O, Kidd M. A guide to computer-generated prescriptions. Aust. Fam. Physician. 1996; 25 (9): 1162-1163.

86. Reason JT. Human Error. Cambridge: Cambridge University Press, 1990.

87. Mach E. In: Knowledge and error: sketches on the psychology of enquiry, ed. McGuinness B. Dordrecht: D. Reidel Publishing Company. 1975; 79-91.

88. Vincent C, Ennis M, Audley RJ. Medical Accidents. Oxford: Oxford University Press, 1993.

89. Leape LL. A systems analysis approach to medical error. In: Medication Errors, ed. Cohen MR. Washington, DC: American Pharmaceutical Association. 1999; 2.1-2.14.

90. Kirwan B. Human-error analysis. In: A Guide to Practical Human Reliability Assessment, ed. Kirwan B. London: Taylor and Francis. 1994; 79-182.

91. Fennerty A, Dolben J, Thomas P. Backhouse G, Bentley DP, Campbell IA *et al.* Flexible induction dose regimen for warfarin and predication of maintenance dose. BMJ. 1984; 288: 1268-70.

92. Lewis D. How to define theoretical terms. J. Philos. 1970; 67: 427-46.

93. Shallice T. Specific impairments of planning. Philos. Trans. R. Soc. Lond. B. 1982; 298: 199-209.

94. Faddis MO. Eliminating errors in medication Am. J. Nurs. 1939; 39: 1217-23.

95. Lane R, Stanton, NA, Harrison D. Applying hierarchical task analysis to medication administration errors. Appl. Ergon. 2006; 37: 669-79.

96. Anton C, Nightingale P, Adu D, Lippin G, Ferner RE. Improving prescribing using a rule based prescribing system. Quality health care. 2004; 13: 186-190.

97. Agrawal A. Medication error preventing using information technology system. Br. J. Clin. Pharmacol. 2009; 67: 681-686.

98. Manasse HR. Medication use in imperfect world medicine misadventuring as an issue of public policy part 1. Am. J. Hosp. Pharm. 1989; 46: 929-44.

99. Davidson W, Collet J. Jackson C. An analysis of the quality and cost of repeat prescriptions. Pharm. J. 1998; 260: 458-60.

100. Kuo GM, Phillips RL, Graham D, Hickner JM. Medication errors reported by US family physicians and their office staff. Qual. Saf. Health Care. 2008; 17: 286-90.

101. Cornish PL, Knowles SR, Marchesano R, Tam V, Shadowitz 5, Juurlink DN, Etchells EE. Unintended medication discrepancies at the time of hospital admission. Arch. Intern. Med. 2005; 165: 424-9.

102. Tam VC, Knowles SR, Cornish PL, Fine N, Marchesano R, Etchells EE. Frequency, type and clinical importance of medication history errors at admission to hospital: a systematic review. CMAJ. 2005; 173: 510-5.

103. Herborg H, Mortensen AR, Hellebek A. Preventing medication errors in community pharmacy: root-cause analysis of transcription errors. Qual. Saf. Health Care. 2007; 16: 285-90.

104. Reason JT, Carthey J, Leval MR. Diagnosing 'vulnerable system syndrome': an essential prerequisite to effective risk management. Qual. Health Care. 2001; 10: 21-5.

105. Spinewine A, Schmader KE, Barber N, Hughes C, Lapane KL, Swine C, Hanlon JT. Appropriate prescribing in elderly people: how well can it be measured and optimised? Lancet. 2007; 370: 173-84.

106. Homsen LA, Winterstein AG, Søndergaard B, Haugbølle LS, Melander A. Systematic review of the incidence and characteristics of preventable adverse drug events in ambulatory care. Ann. Pharmacother. 2007; 41: 1411-26.

107. Dean B. Learning from prescribing errors. Qual. Saf. Health Care. 2002; 11: 258-60.

108. Jha AK, Kuperman GJ, Teich JM, Leape L, Shea B *et al*. Identifying adverse drug events: Development of a computer based monitor and comparison with chart review and stimulated voluntary report. J. Am. Med. Inform. Assoc. 1998; 5: 305-14.

109. Pollock M, Bazaldua OV, Dobbie AE. Appropriate prescribing of medications: an eight step approach. Am. Fam. Physician. 2007; 75: 231: 239-40.

110. Glasziou P, Irwig L, Aronson JK. Evidence based Medical Monitoring: From Principles to Practice. Oxford, Wiley Black Well, 2008.

111. Dureiux P, Trinquart L, Colombert I, Niles J, Walton R, Rajeshwaran A *et al*. Computerised advice on drug dosage to improve prescribing practice. Cochrane Database Syst. Review. 2008; (3) CD002894.

112. Thomas AN, Boxwall EM, Laha SK, Day AJ, Grundy G. An educational and audit tool to reduce prescribing errors in intensive care. Qual. Saf. Health Care. 2008; 17: 360-3.

113. Institute of medicine of the National Academics. Preventing medication errors Quality Chasm Series, Washington DC. The National Academics Press 2007.

114. Grol R, G Rinsaw J. From best evidence to best practice: Effective implementation of change in patient care. Lancet. 2003; 362: 1225-30.

115. Morimoto T, Gandhi TK, Seger AC, Hseich TC, Bates DW. Adverse drug events and medication errors: Detection and classification methods. Qual. Safe Health Care. 2004; 13: 306-14.

116. National Patient Safety Agency - Patient safety incident reports in the NHS: National Reporting and Learning System Data Summary, Issue 7. Available at http://wvjw.npS3. nhs.uk/ patientsafety/patient-safety-incident-data/quarterly-data-reports (last accessed 14 February 2009).

117. Maxwell SRM, Webb DJ. Clinical pharmacology - too young to die? Lancet. 2006; 367: 799-800.

118. Coombos R. The pharmaceutical industry is stepping in to fill the therapeutics void. BMJ. 2009; 338: 70-71.

119. Nursing and Midwifery Council. Standards of Proficiency for Nurse and Midwife Prescribers. London: Nursing and Midwifery Council, 2006.

120. Ellis A. Prescribing rights: are medical students prepared for them? BMJ. 2002; 324: 1591.

121. Maxwell S, Walley T, Ferner R. Using drugs safely. BMJ. 2002; 324: 930-931.

122. Rubin P. A prescription for better prescribing. Medical education is a continuum. BMJ. 2006; 333: 601.

123. Kmietowicz Z. General Medical Council to gather data on prescribing errors after criticism. BMJ. 2007; 334: 278-279.

124. South Tees Hospitals NHS Trust. Report from the meeting of the Clinical Governance Committee held on Wednesday 25 October 2006. Available at http://www.southtees.

125. Han WH, Maxwell RJ. Are medical students adequately trained to prescribe at the point of graduation? Views of first year Foundation doctors. Scott. Med. J. 2006; 51: 27-32.

126. Illing JG, Kergon C, Burford B, Spencer J, Peile E, Davies C *et al*. How prepared are medical graduates to begin practice? A comparison of three diverse UK medical schools. Final summary and conclusions for the CMC Education Committee, 15 December 2008. Available at http://www.gmc-uk.org/about/research/research_commissioned.asp.

127. Tobaiqy M, McLay J, Ross S. Foundation year 1 doctors and clinical pharmacology and therapeutics teaching. A retrospective view in light of experience. Br. J. Clin. Pharmacol. 2007; 64: 363-72.

128. Heaton A, Webb DJ, Maxwell SRJ. Undergraduate preparation for prescribing: the views of 2413 UK medical students and recent graduates. Br. J. Clin. Pharmacol. 2008; 66: 128-134.

129. Leape LL, Bates DW, Cullen DJ, Cooper J, Demonaco HJ, Gallivan T *et al*. Systems analysis of adverse drug events. ADE Prevention Study Group. JAMA. 1995; 274: 35-43.

130. Ross, Loke Y. Do educational interventions improve prescribing by medical students and junior doctors? A systematic review. Br. J. Clin. Pharmacol. 2009; 67: 662-670.

131. Kozer E, Scolnik D, Macpherson A, Rauchwerger D, Koren G. The effect of a short tutorial on the incidence of prescribing errors in pediatric emergency care. Can. J. Clin. Pharmacol. 2006; 13: 285-91.

132. Likic R, Vitezic D, Maxwell S, Polasek O, Francetic I. The effects of problem-based learning integration in a course on rational drug use: A comparative study between two Croatian medical schools. Eur. J. Clin. Pharmacol. 2009; 65: 231-6.

133. Maxwell SRJ, McQueen DS, Ellaway R, Drug: A dynamic interactive electronic drug formulary for medical students. Br. J. Clin. Pharmacol. 2006; 62: 73-81.

134. Smith A, Tasioulas T, Cockayne N, Misan G, Walker G, Quick G. Construction and evaluation of a web-based interactive prescribing curriculum for senior medical students. Br. J. Clin. Pharmacol. 2006; 62: 653-659.

135. Franson KL, Dubois EA, de Kam ML, Cohen AF. Measuring learning from the TRC pharmacology e-learning program. Br. J. Clin. Pharmacol. 2008; 66: 135-141.

136. Maxwell SRJ, Wally T. Teaching, prescribing and therapeutics. Br. J. Clin. Pharmacol. 2003; 55: 496-503.

137. Tam Hells EE. Frequency, type and clinical importance of medication history errors at admission to hospital; a systematic review, CMAJ. 2005; 173: 510-515.

138. Grahame-Smith DG, Aronson JK. The drug history and the clinical examination and investigation of drug effects. In: The Oxford Textbook of Clinical Pharmacology and Drug therapy, 3rd edn. Oxford: Oxford University Press, 2002.

139. Fialová D, Topinková E, Gambassi G, Finne-Soveri H, Onsson PV, Carpenter I *et al*. Potentially inappropriate medication use among elderly home care patients in Europe. JAMA. 2005; 293: 1348-1358.

140. De Smet PA, Denneboom W, Kramers C, Grol R. A composite screening tool for medication reviews of outpatients: general issues with specific examples. Drugs Aging. 2007; 24: 113 -60.

141. Morris JN, Fries BE, Steel K, Ikegami N, Bernabei R, Carpenter GI *et al*. Comprehensive clinical assessment in community setting: applicability of the MDS-HC. J. American Geriatrics Society. 1997; 45: 1017-1024.

142. Saseen I, Grady SE, Hansen LB, Hodges BM, Kovacs SI, Martinez LD *et al*. Future clinical pharmacy practitioners should be board-certified specialists. J. of Pharmacotherapy. 2006; 26: 1816-1825.

143. Lenderink BW, Egberts TCG. Closing the loop of the medication process using electronic medication administration registration. Pharm. World Sci. 2004; 26: 185-190.

144. Agrawal A, Khachewatsky I. Evaluation of an electronic medication reconciliation system in inpatient setting in an acute care hospital. Stud Health Technol Inform. 2007; 129:1027-1031.

145. Cornish P. 'Avoid the crush': Hazards of medication administration in patients with dysphagia or a feeding tube. CMAJ. 2005; 172: 871-872.

146. Paoletti RD, Suess TM, Lesko MG, Feroli AA, Kennel JA, Mahler JM *et al.* Using bar-code technology and medication observation methodology for safer medication administration. Am. I. Health Syst. Pharm. 2007; 64: 536-543.

147. Sibailly G, DiPaolo ER, Gehri M, Krahenbur JD, Fanconi S, Pannatier A. Outpatient Prescription writing Quality in a Paediatric General Hospital. European Association of Hospital Pharmacists. Geneva. 22-24 March 2006. Available at http//www.eahp. eu/content.

148. Balbaid OM, Al Dawood KM. Assessment of physicians prescribing practices at Ministry of health hospitals in Jeddah city, Saudi Arabia. Saudi Medical Journal. 1998; 19: 28-35.

149. Ansari M, Neupane D. Study on determination of errors in prescription writing. A Semi-electronic Perspective. Kathmandu University Medical Journal. 2009; 7 (27): 238-241.

150. Wilson O, Erhun A. Adekoya, Mercy OE, Olukemi B. Legal issues in prescription writing: A study of two health institutions in Nigeria. International Journal of Pharmacy Practice. 2003; 17 (3): 189-193.

151. Kuan M, Chua S, Mohmed R. Noncompliance with prescription writing requirements and prescribing errors in an Outpatient Department. Malaysian Journal of Pharmacy. 2002; 1 (2): 45-50.

152. Medical Ethics - Text of Medical council of India regulations [cited 14 July 2009] Available from http//www.medclic.comIndia.

153. AlKhaja KA, Handu SS, James H, Mathur VS, Sequeira RP. Assessing prescription writing skills of pre-clerkship medical students in a problem based learning curriculum. International Journal of Clinical Pharmacology and Therapeutics. 2005; 43: 429-435.

154. Fancois P *et al*. Evaluation of prescription writing quality in a French university hospital. Clinical performance and quality health care. 1997; 5: 111-115.

155. Lofholm PW, Katzung BG, Rational prescribing and prescription writing. In: Katzung BG. Basic and clinical pharmacology. New York McGraw-Hill; 2001. p 1104-1112.

156. Mallet HP, Nijkam A, Scouflaire SM. Evaluation of, prescription practices and of the rational use of medicines in Niger. Sante. 2001; 11: 185-193.

157. Kumari R, Idris MZ, BhushanV, KhannaA, Agarwal M, Singh SK. Assessment of Prescription pattern at public health facilities of Lucknow district. Indian Journal of Pharmacology. 2008; 40: 243-247.

158. Bapna JS, Tekur U, Gitangili B, Shashidharan CH, Pradhan SC, Thulasimani M *et al*. Drug utilization at primary health care level in southern India. Eur. J. Clin. Pharmacol. 1992; 43: 413-415.

159. Hazra A, Tripathi SK, Alam MS. Prescribing and dispensing activities at the health facilities of a non-governmental organization. National Med. J. India. 2000; 13: 177-82.

160. Blatt A, Chambon R, Lemerdeley P. Legal format and cost of prescriptions at the central hospital in Yahounde, Cameroon. Medicine Tropicale. 1997; 57: 37-40.

161. Biswas NR, Jindal S, Siddique MM, Maini R. Patterns of prescription writing and drug use in opthamology in a tertiary hospital in Delhi. British Journal of Clinical Pharmacology. 2001; 51: 267-269.

162. Thawani V, Motghare V, Purwar MB, Pagare A. Drug utilization in indoor patients of Govt. Medical College Hospital, Nagpur. Journal Academy of Hospital Administration. 1991; 9: 49-51.

163. Bawazir S. Prescribing pattern of ambulatory care physicians in Saudi Arabia. Annals of Saudi medicine. 1993;13: 172-177.

164. Makonnen E, Yoseph M, Berhane Y. Quality of prescription at a tertiary care pharmacy in Addis Ababa Ethiopian medical journal. 2002; 40: 233-239.

165. Bates DW, Cohen M, Leape LL, Overhage MJ, Shabot MM, Sheridan T. Reducing the prescription errors by using information technology. J. Am. Med. Inform. Assoc. 2001; 8: 299-308.

166. Gommans J, Mcintosh P, Bees S, Allan W. Improving the quality of written prescriptions in a general hospital: the influence of 10 years of serial audits and targeted interventions. Intern. Med. J. 2008; 38: 243-248.

167. Kennedy AG, Littenberg B. A modified outpatient prescription form to reduce Prescription errors. Joint Commission Journal on quality and patient safety. 2004; 30: 480-487.

ANNEXURES

Annexure-I

INFORMED CONSENT FORM

STUDY TITLE: PRESCRIPTION DRUG ERRORS IN ANAND DISTRICT

DOCTOR'S NAME: _____

I have been explained regarding the research project 'PRESCRIPTION DRUG ERRORS IN ANAND DISTRICT' to be conducted by Dr. Anuradha Joshi. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason.

I understand that my identity will not be revealed in any information released to third parties or published.

I agree to take part in the above study.

Signature of the Doctor:

Date:

Signatory's Name:

Signature of the Investigator:

Date:

Annexure-II

ડૉ. ધ્રુવપાલ સિસોદીયા ઓર્થો એન્ડ આઇ કેર હોસ્પિટલ

EYE CARE HOSPITAL

ડૉ. સોનલ ડી. સિસોદીયા (એમ.એસ., ઓપ્થલ.)

સ્થાનકવાસી જૈન ઉપાશ્રય પાસે, મહાવીર ચોક, વેન્ડોર ચોકડી પાસે,
આણંદ. ફોન (૦૨૬૯૨) (હો.) ૨૫૨૫૯૫ (રહે.) ૨૫૩૫૯૫

Patient's Name : _____ Date : _____

Age : _____ Sex : _____ Weight : _____

Address : _____

_____

Chief Complaints : _____

Diagnosis : Provisional/Final : _____

℞

	સવાર		બપોર			રાત્રે			
	નરણા પહેલા	નરણા પછી	જમવા પહેલા	જમવા પછી	સાંજે	જમતા પહેલા	જમવા પછી	સૂતી વખતે	QTY

Dispense as Written / Substitution permitted

Refills - Permitted : ..... Times

Signature with Registration No.

❖ **Check List :**	**Yes**	**No**	
▪ Allergies/Sensitivities	☐	☐	_____
▪ Hepatic disease	☐	☐	_____
▪ Cardiac disease	☐	☐	_____
▪ Renal Disease	☐	☐	_____

History of intake of any other Medicine : _____

_____

_____

Specific Drug Information / Instruction to Patient : _____

_____

_____

Annexure-III

Tab- Aspisol -75
Tab. Clavix-AS-75
Tab- Atorva-40
Tab- Clavix-75
Tab- Ativan (1 mg)

DAMA from Saadat hospital

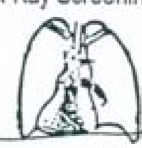
OUT PATIENT RECORD

Chief Complains
– giddiness, while standing – since 4 day
– [illegible] constipation

Investigation
Inj. Panto -40
Inj. Lopusin
Inj. Hydrocortisone
[illegible] Biofan

Past History
H/o chest pain, giddiness, sweating & [illegible] before 4 days –
Δ: [illegible] MI – Rx taken

X-Ray Screening



X-Ray 25/6/14
NAD
→ Acute inferior wall MI

G/E Pallor – Absent
BP = 96/74
P = 64
SpO_2 = 96%
Sclera: muddy yellow
Appetite
Sleep
stool :– constipation
urine : (N)

ECG Addiction: bidi
F/H/O: –
Past H/o: –
Allergic to drugs

CVS
CVS: mitral area – murmur

Echo/Usg
25/6/14

TMT
Hb = 12.2
TC = 15,600
Neutro = 85
Lympho = 10
S.creatinine = 1.0

ECG: (24/6/14)
S/o ST Elevation Inferior MI
RBS → 158

RS
RS: Harsh sound

A/S
P/A: Liver spleen / NP

Other Investigation
Echo Hypokinetic Normal size LV inferobasal LV
normal values
EF 60 Mild TR

CNS Orally (N)
Ener – (N)

Planned Investigation
Coronary. Angiography

Provisional Diagnosis
Inferior wall MI

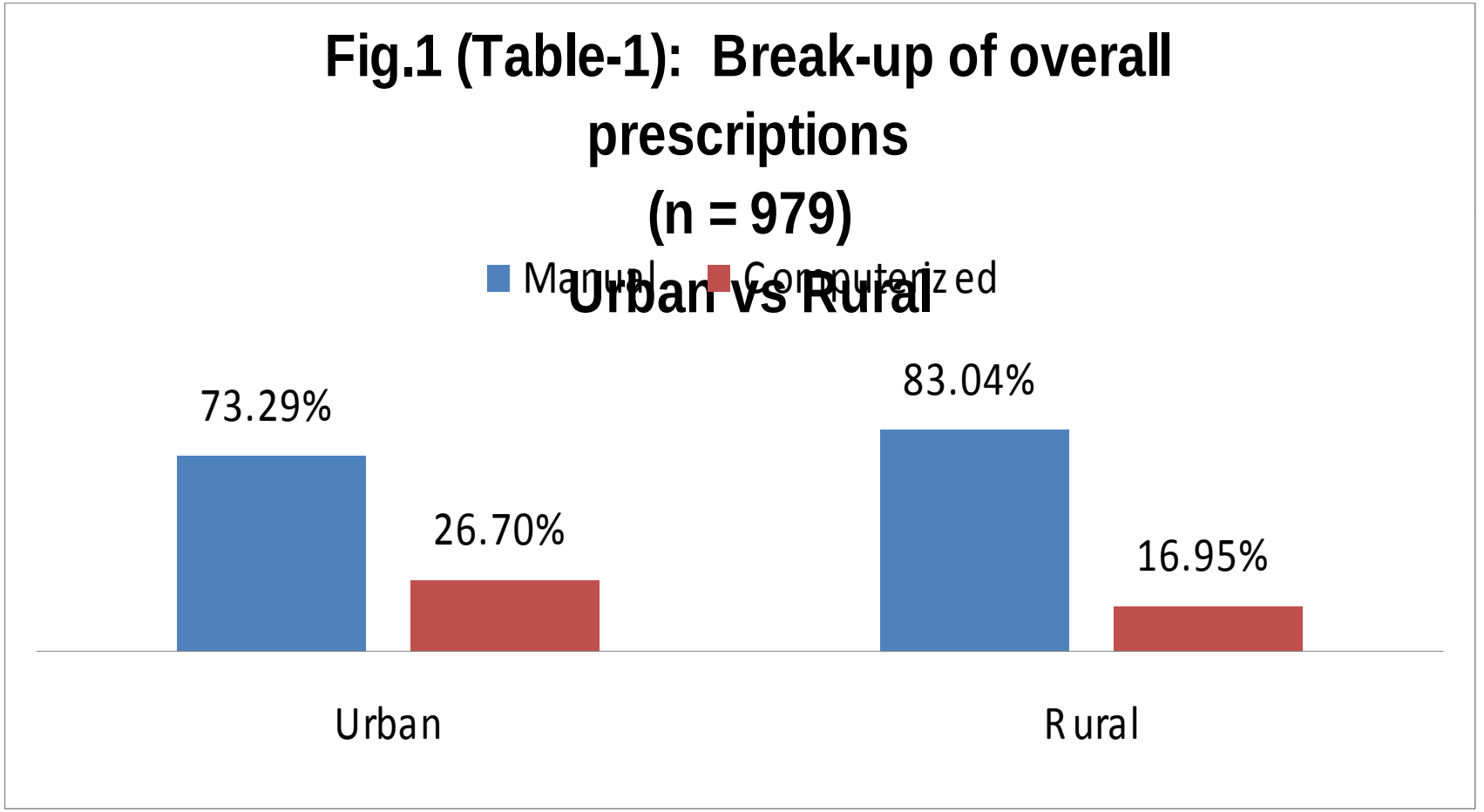
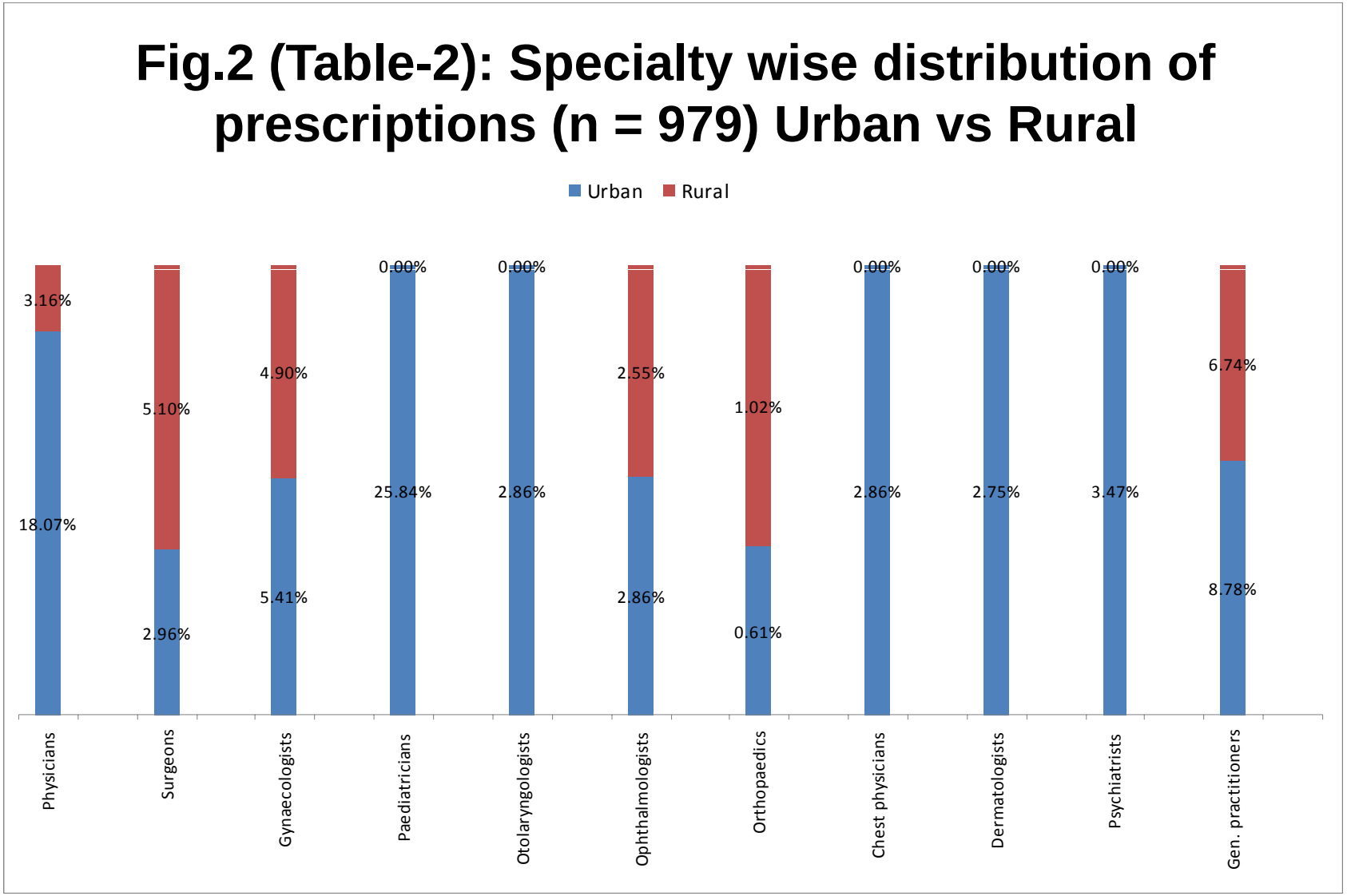


Fig.1 (Table-1): Break-up of overall prescriptions
(n = 979)
Urban vs Rural
Manual
Computerized
73.29%
26.70%
83.04%
16.95%
Urban
Rural

Fig.2 (Table-2): Specialty wise distribution of prescriptions (n = 979) Urban vs Rural



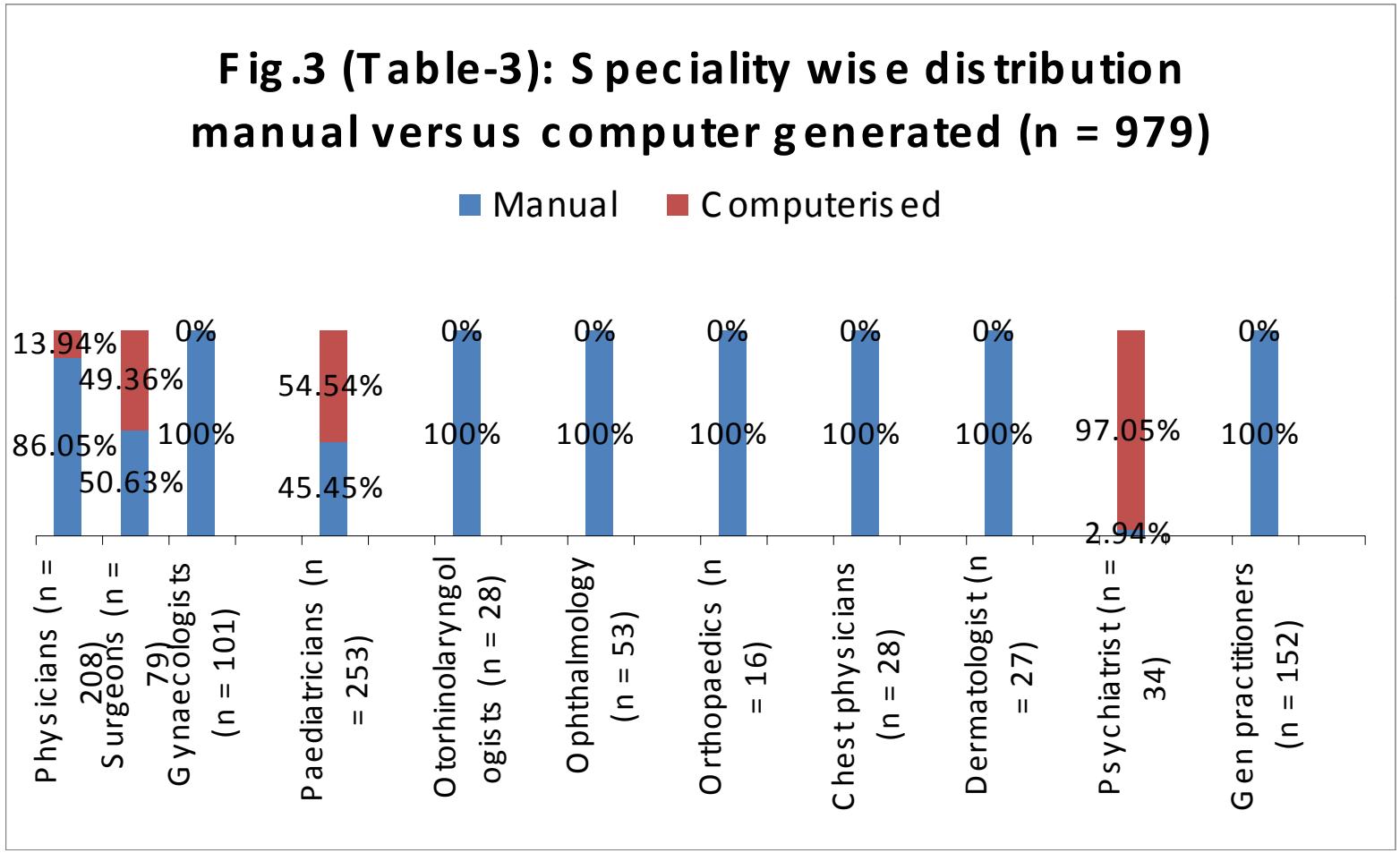


Fig.3 (Table-3): Speciality wise distribution manual versus computer generated (n = 979)
Manual
Computerised
13.94%
86.05%
49.36%
50.63%
0%
100%
54.54%
45.45%
0%
100%
0%
100%
0%
100%
0%
100%
0%
100%
97.05%
2.94%
0%
100%
Physicians (n = 208)
Surgeons (n = 79)
Gynaecologists (n = 101)
Paediatricians (n = 253)
Otorhinolaryngologists (n = 28)
Ophthalmology (n = 53)
Orthopaedics (n = 16)
Chest physicians (n = 28)
Dermatologist (n = 27)
Psychiatrist (n = 34)
Gen practitioners (n = 152)

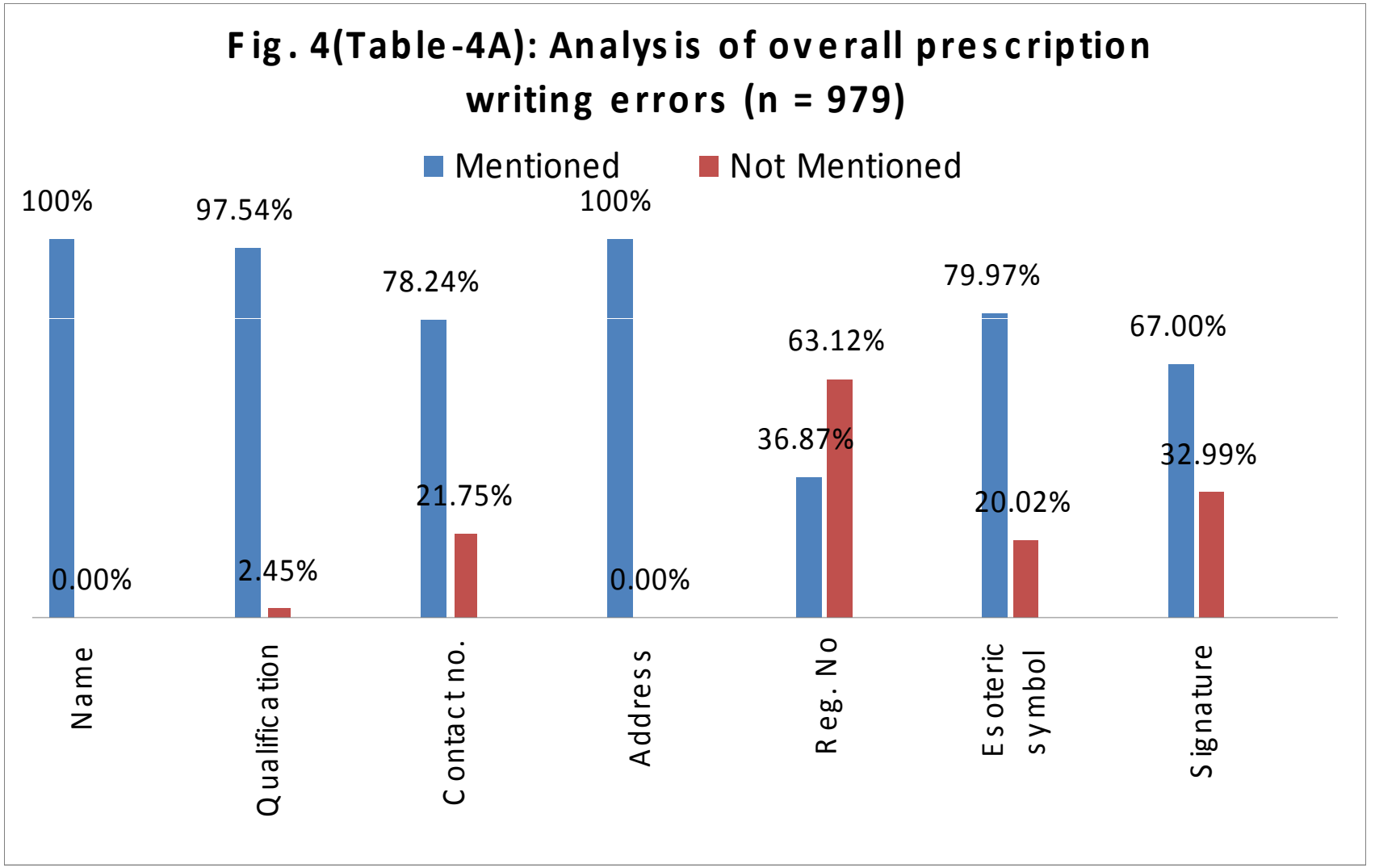


Fig. 4(Table-4A): Analysis of overall prescription writing errors (n = 979)
Mentioned
Not Mentioned
100%
0.00%
97.54%
2.45%
78.24%
21.75%
100%
0.00%
63.12%
36.87%
79.97%
20.02%
67.00%
32.99%
Name
Qualification
Contact no.
Address
Reg. No
Esoteric symbol
Signature

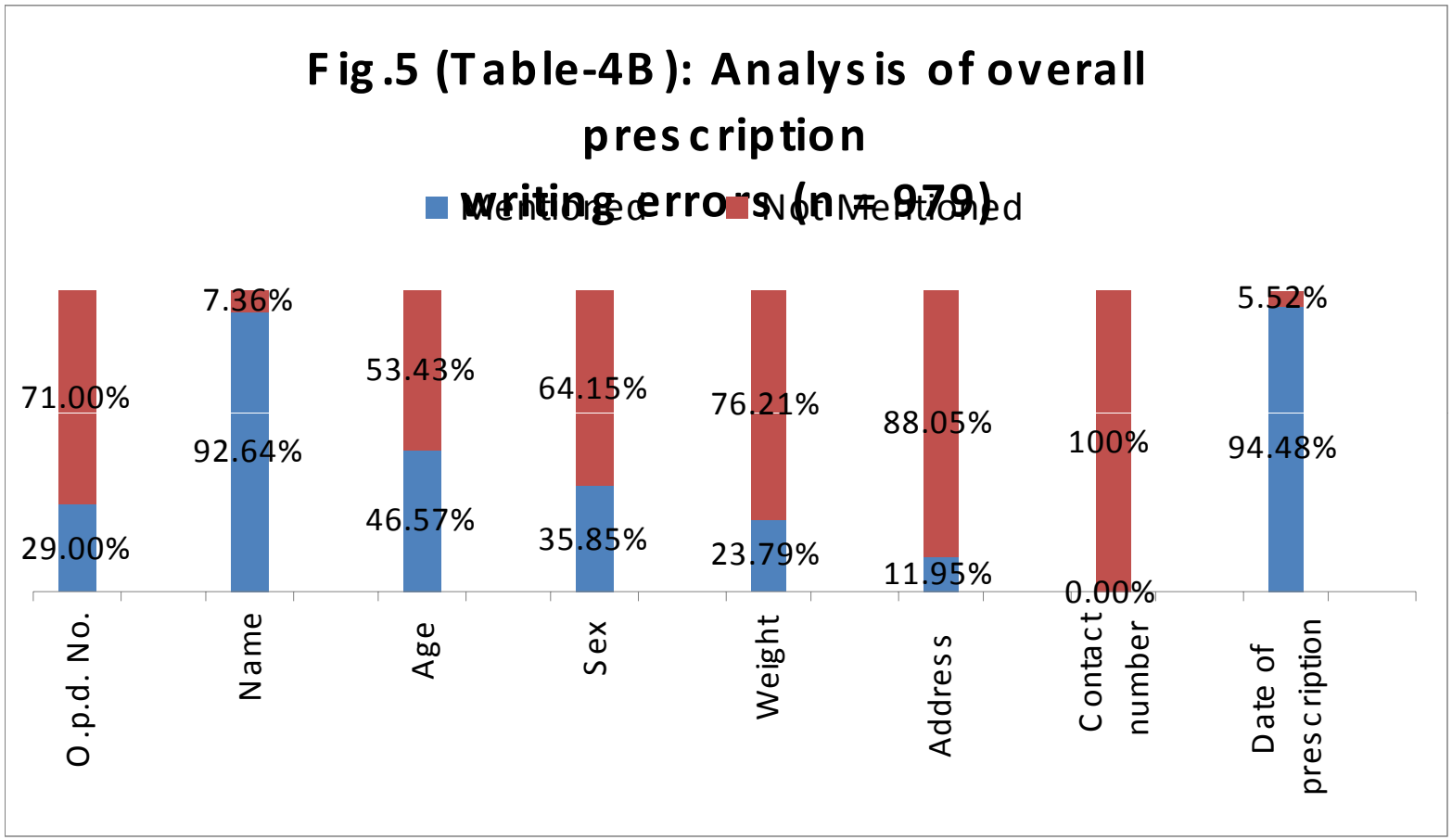
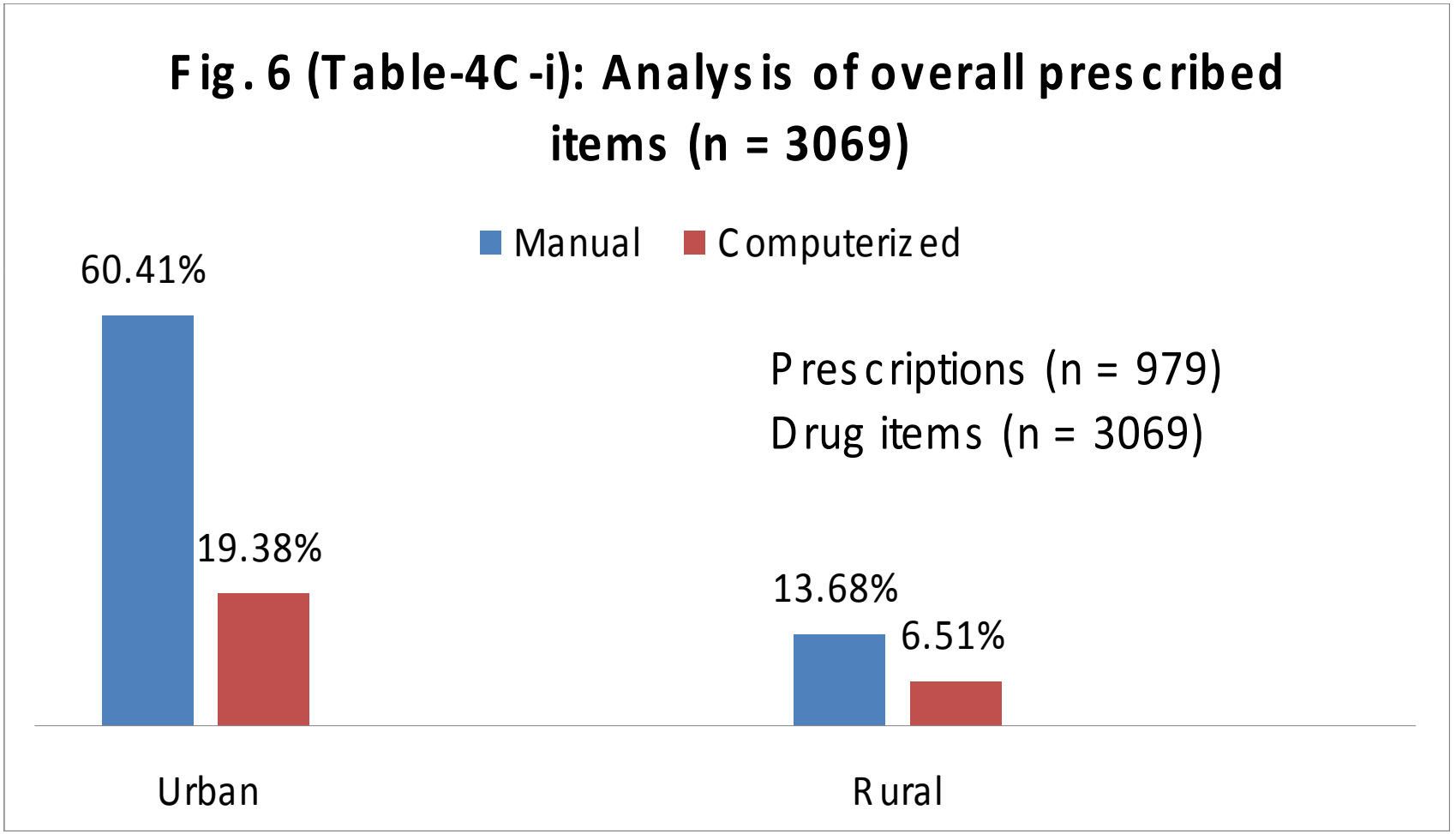


Fig.5 (Table-4B): Analysis of overall prescription writing errors (n = 979)
Mentioned
Not Mentioned
71.00%
29.00%
7.36%
92.64%
53.43%
46.57%
64.15%
35.85%
76.21%
23.79%
88.05%
11.95%
100%
0.00%
5.52%
94.48%
O.p.d. No.
Name
Age
Sex
Weight
Address
Contact number
Date of prescription

Fig. 6 (Table-4C-i): Analysis of overall prescribed items (n = 3069)



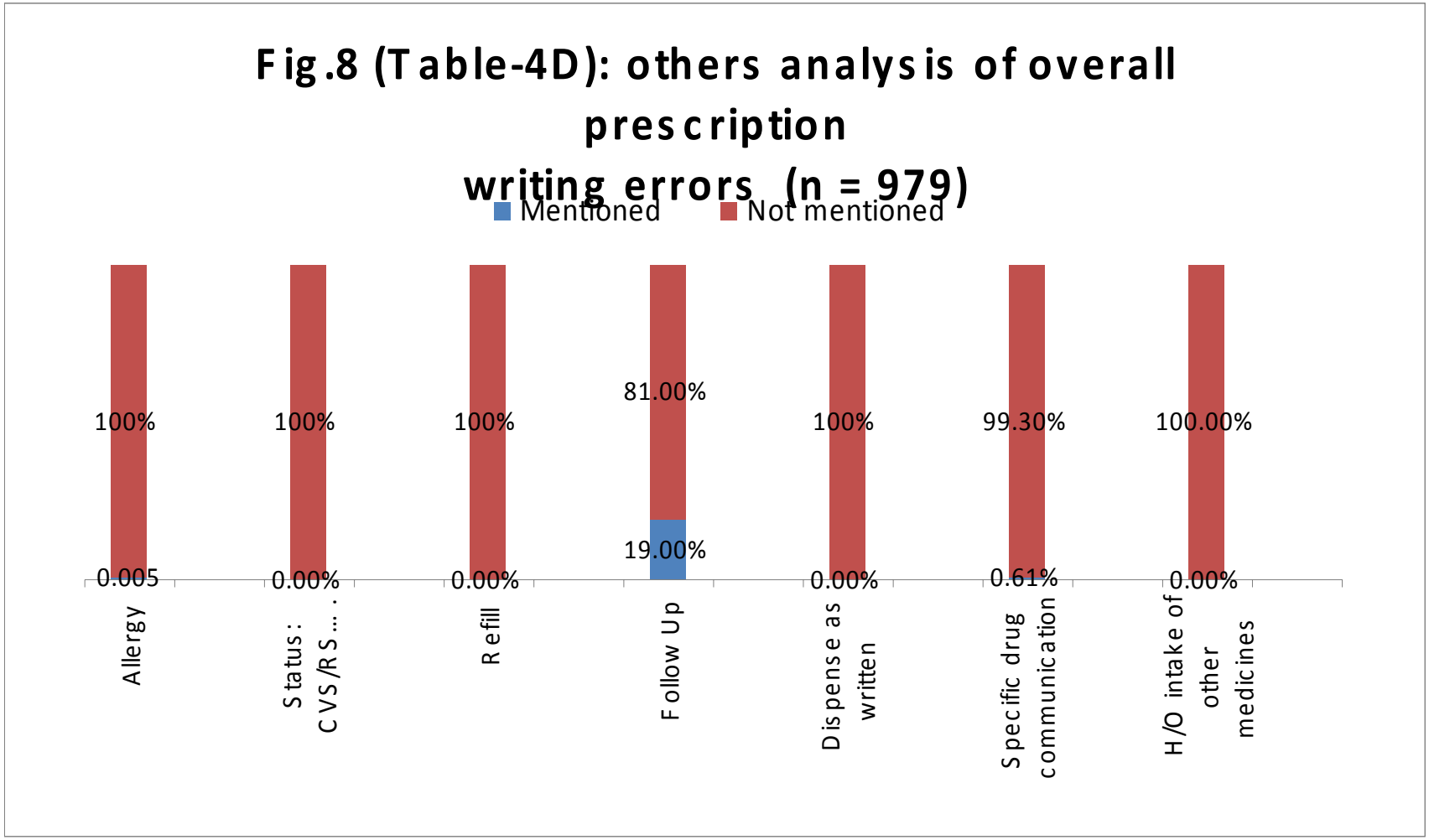


Fig.8 (Table-4D): others analysis of overall prescription writing errors (n = 979)
Mentioned
Not mentioned
100%
100%
100%
81.00%
19.00%
100%
99.30%
100.00%
0.005
0.00%
0.00%
0.00%
0.61%
0.00%
Allergy
Status: CVS/RS....
Refill
Follow Up
Dispense as written
Specific drug communication
H/O intake of other medicines

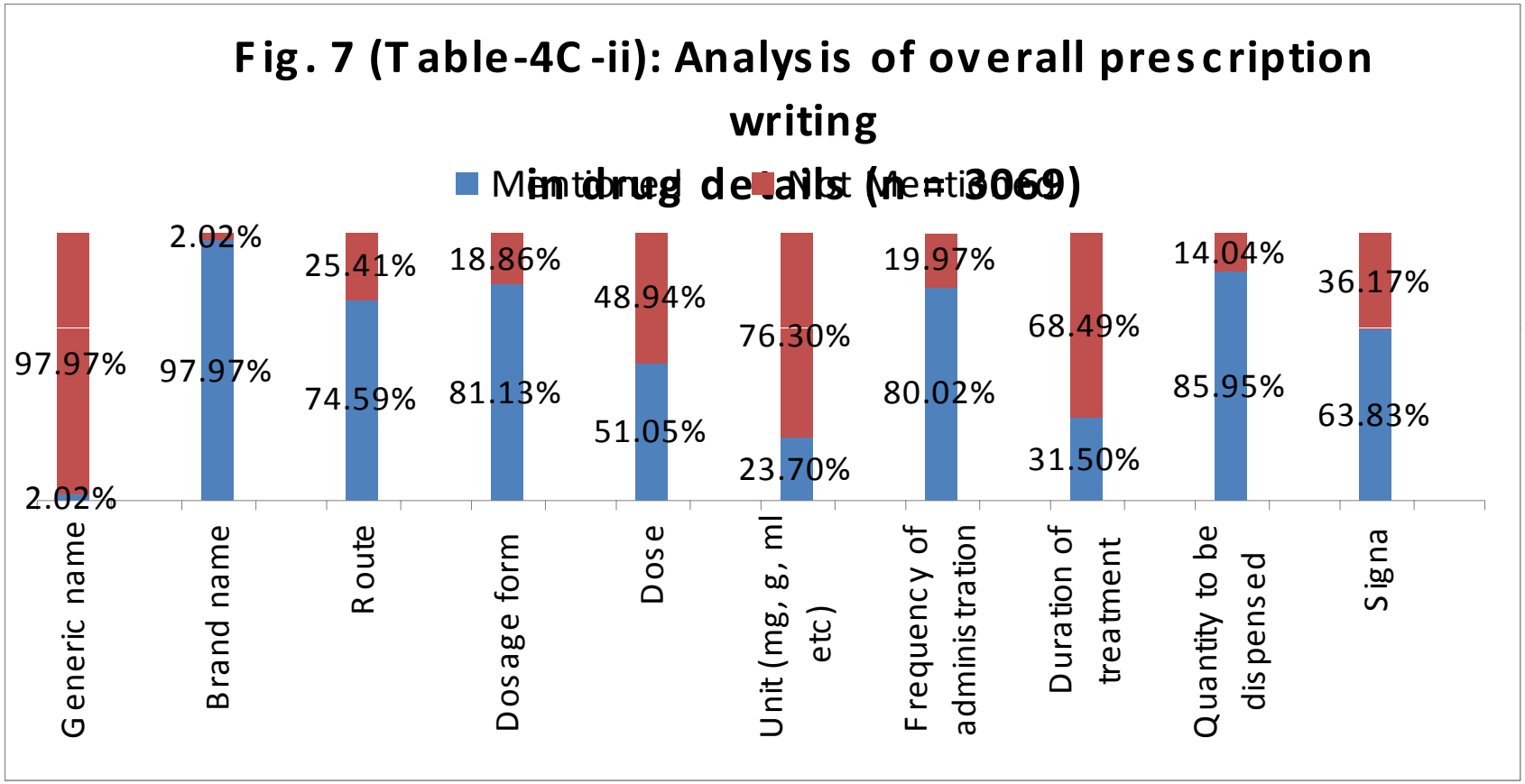
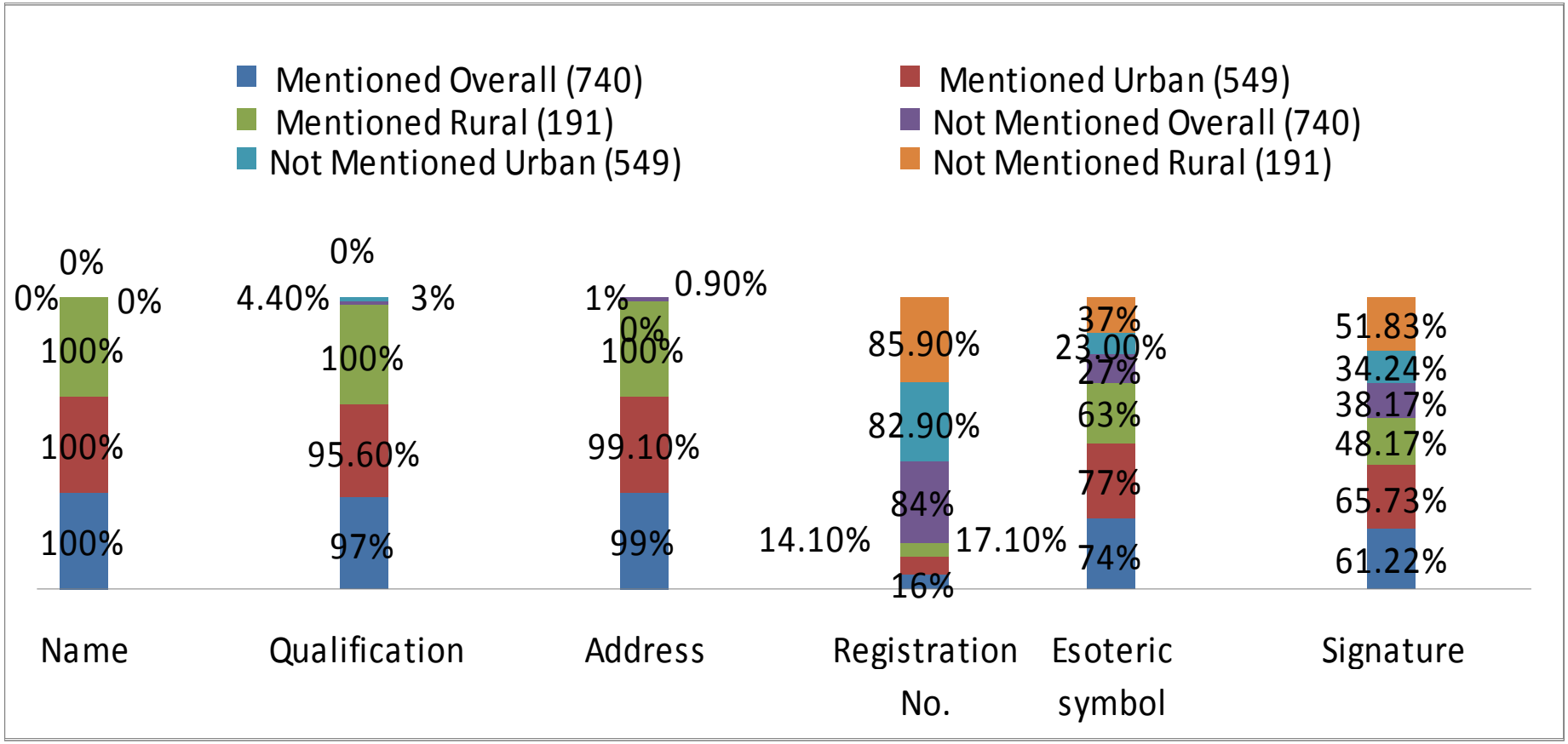


Fig. 7 (Table-4C-ii): Analysis of overall prescription writing in drug details (n = 3069)
Mentioned
Not mentioned
97.97%
2.02%
2.02%
97.97%
25.41%
74.59%
18.86%
81.13%
48.94%
51.05%
76.30%
23.70%
19.97%
80.02%
68.49%
31.50%
14.04%
85.95%
36.17%
63.83%
Generic name
Brand name
Route
Dosage form
Dose
Unit (mg, g, ml etc)
Frequency of administration
Duration of treatment
Quantity to be dispensed
Signa

Fig.9 (Table-5A): Comparative analysis of prescription writing errors between urban manual (n = 549) and rural manual prescriptions (n = 191) Clinician details



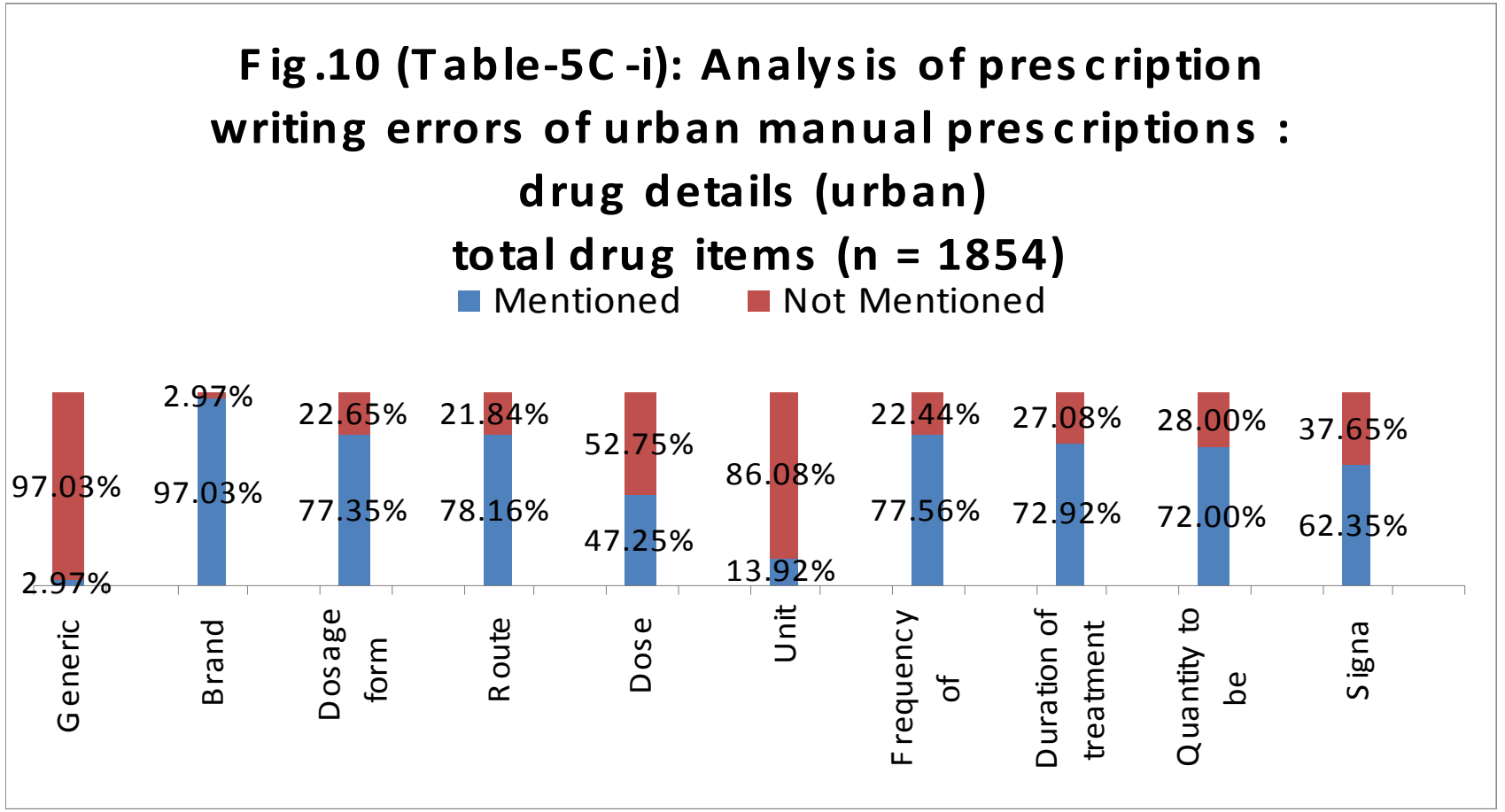


Fig.10 (Table-5C-i): Analysis of prescription writing errors of urban manual prescriptions : drug details (urban)
total drug items (n = 1854)
Mentioned
Not Mentioned
97.03%
2.97%
2.97%
97.03%
22.65%
77.35%
21.84%
78.16%
52.75%
47.25%
86.08%
13.92%
22.44%
77.56%
27.08%
72.92%
28.00%
72.00%
37.65%
62.35%
Generic
Brand
Dosage form
Route
Dose
Unit
Frequency of
Duration of treatment
Quantity to be
Signa

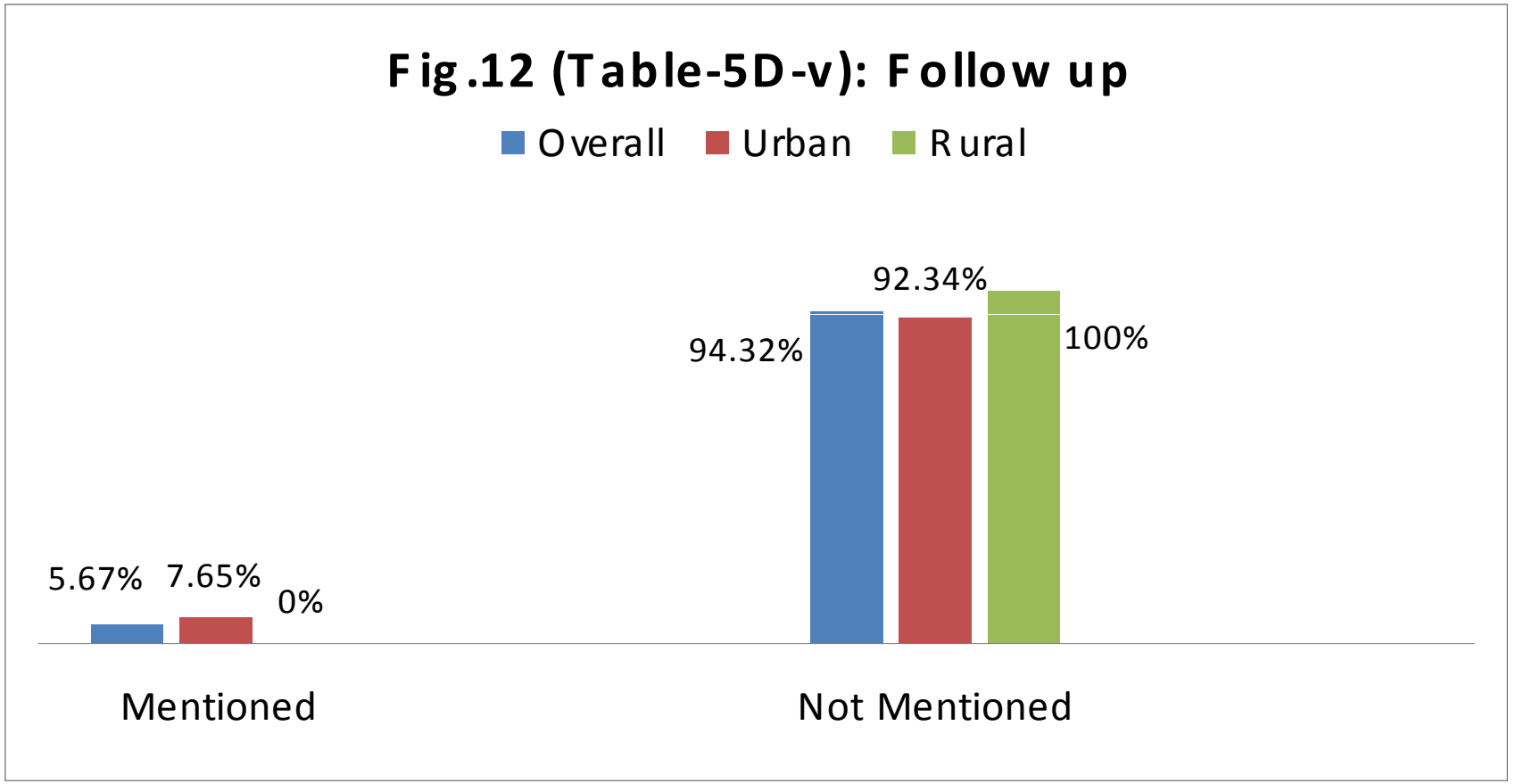
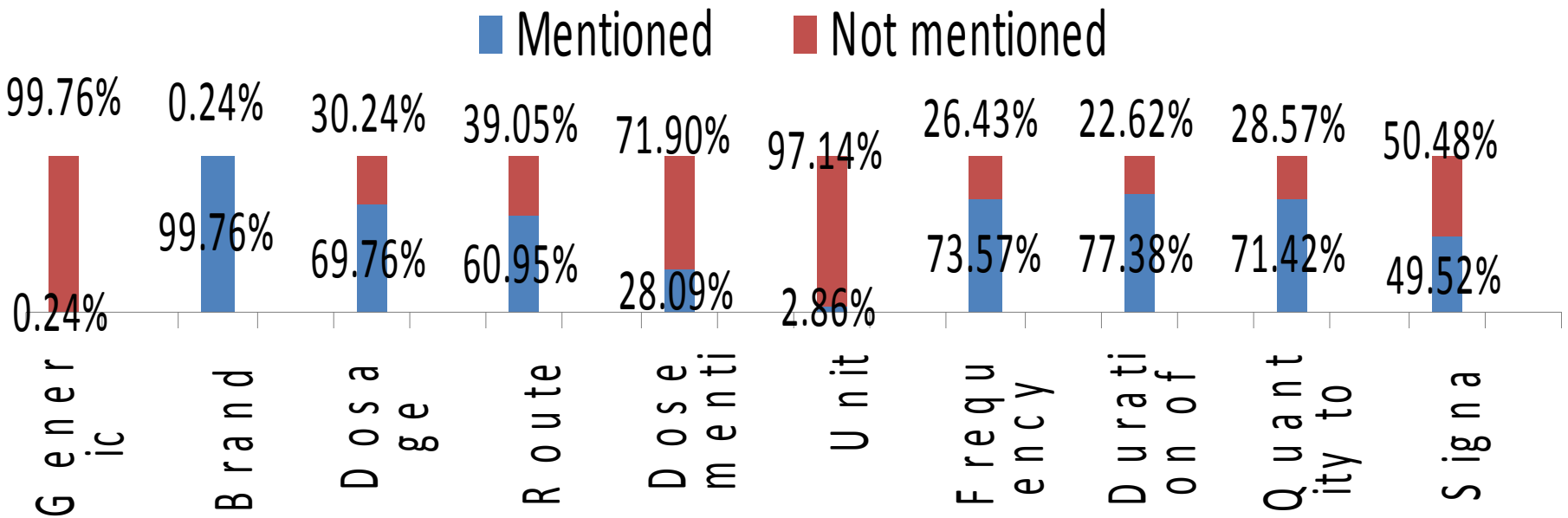


Fig.12 (Table-5D-v): Follow up
Overall
Urban
Rural
5.67%
7.65%
0%
94.32%
92.34%
100%
Mentioned
Not Mentioned

Fig.11 (Table-5C-ii: Analysis of prescription writing errors of rural manual prescriptions - drug details (rural) total drug items (n = 420)



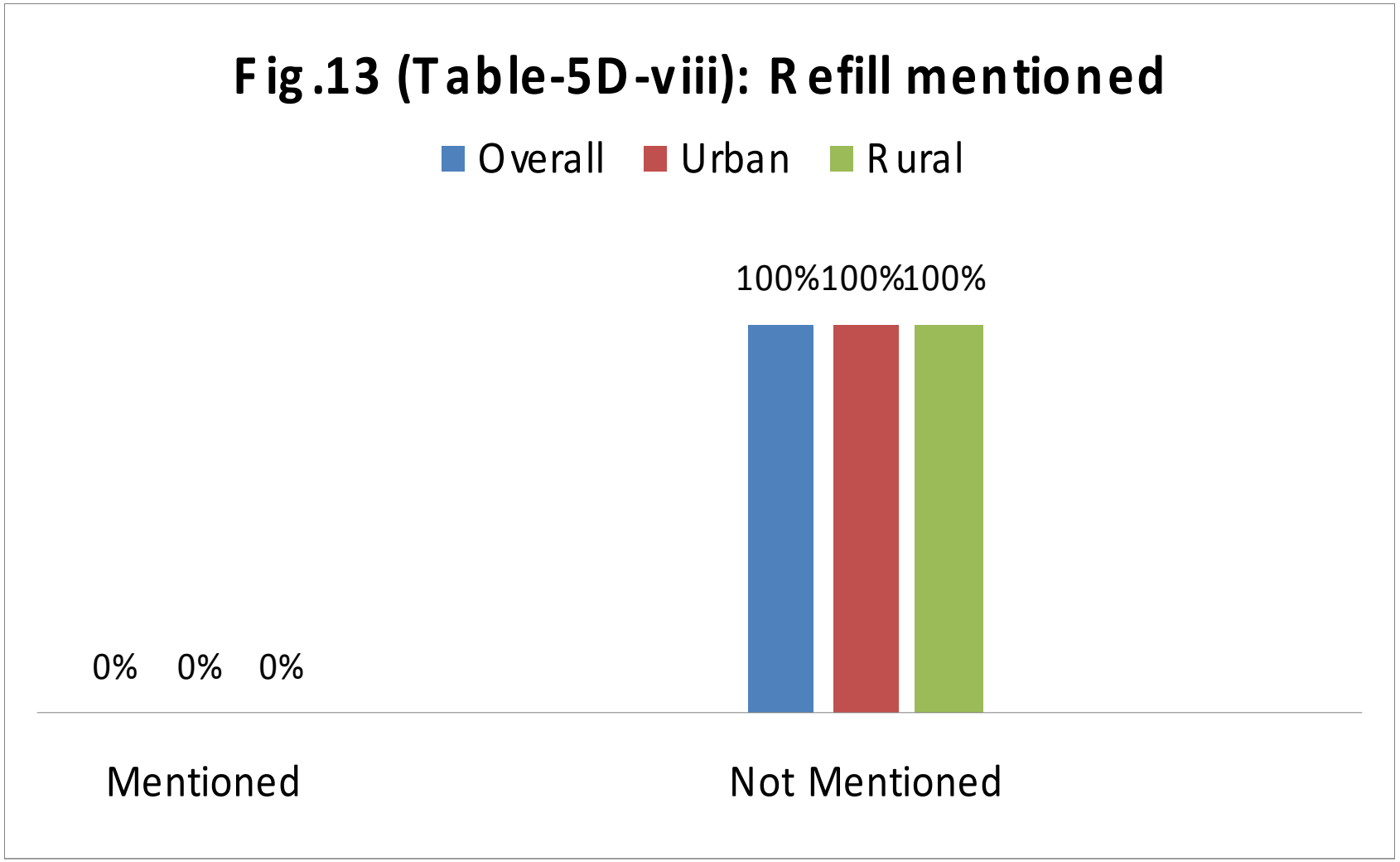
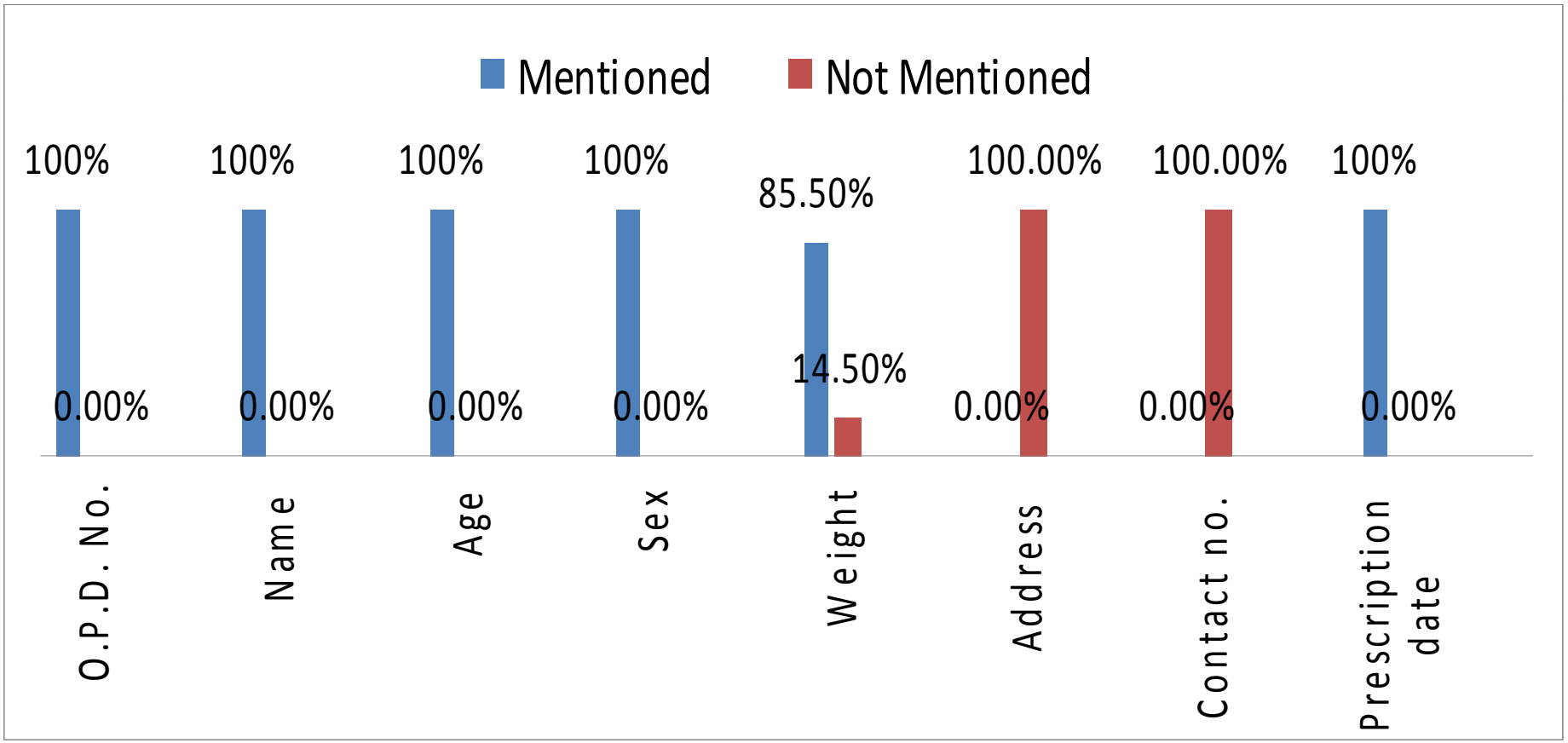


Fig.13 (Table-5D-viii): Refill mentioned
Overall
Urban
Rural
100%100%100%
0% 0% 0%
Mentioned
Not Mentioned

Fig.15 (Table-6B): Analysis of prescription writing errors in urban computer generated prescriptions (n=200)



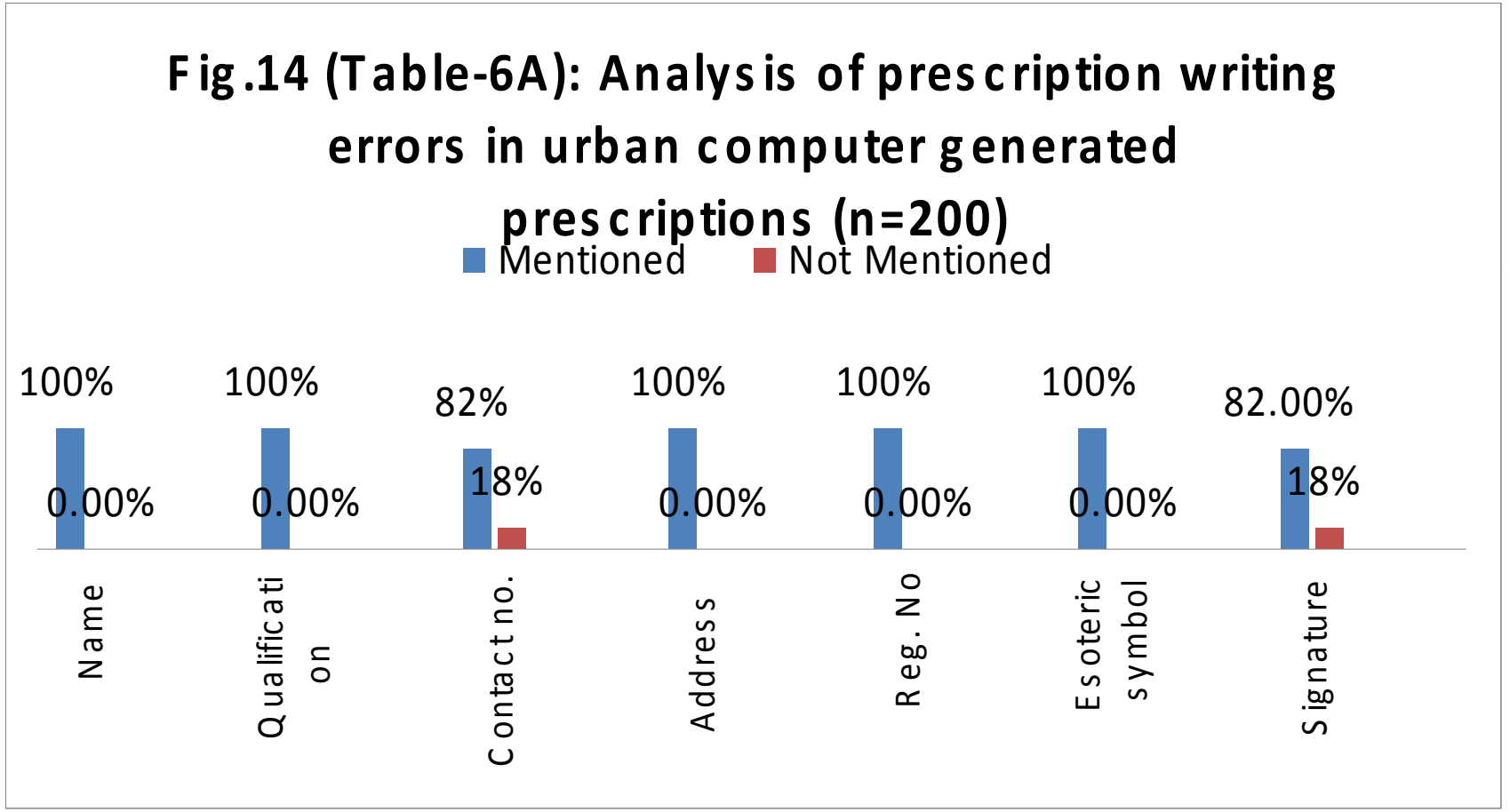


Fig.14 (Table-6A): Analysis of prescription writing errors in urban computer generated prescriptions (n=200)
Mentioned
Not Mentioned
100%
0.00%
100%
0.00%
82%
18%
100%
0.00%
100%
0.00%
100%
0.00%
82.00%
18%
Name
Qualification
Contact no.
Address
Reg. No
Esoteric symbol
Signature

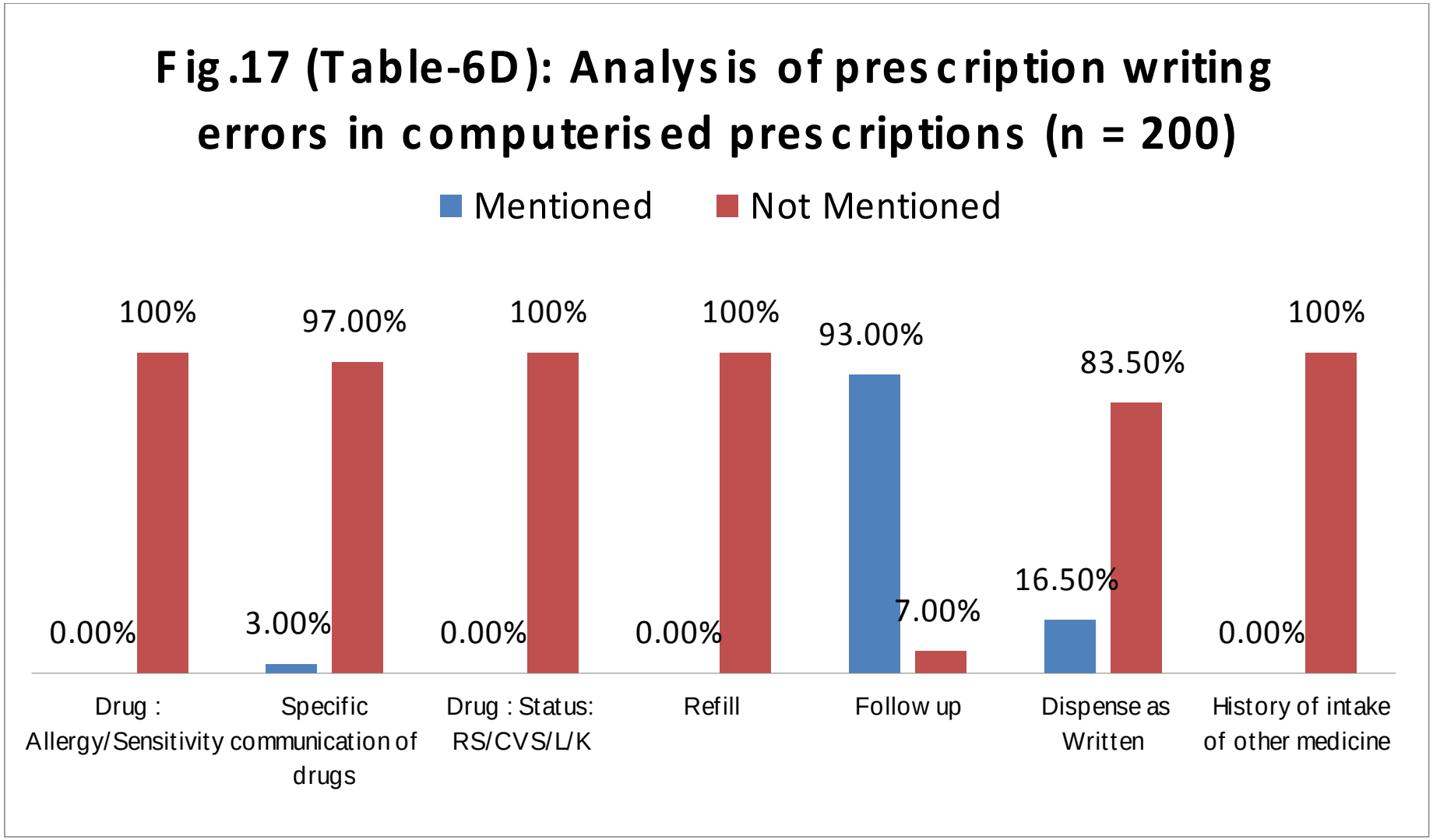


Fig.17 (Table-6D): Analysis of prescription writing errors in computerised prescriptions (n = 200)
Mentioned
Not Mentioned
100%
97.00%
100%
100%
93.00%
83.50%
100%
0.00%
3.00%
0.00%
0.00%
7.00%
16.50%
0.00%
Drug : Allergy/Sensitivity
Specific communication of drugs
Drug : Status: RS/CVS/L/K
Refill
Follow up
Dispense as Written
History of intake of other medicine

Fig.16 (Table-6C): Analysis of prescription writing errors of prescribed items of computer generated prescriptions n=200 (595 prescribed items)

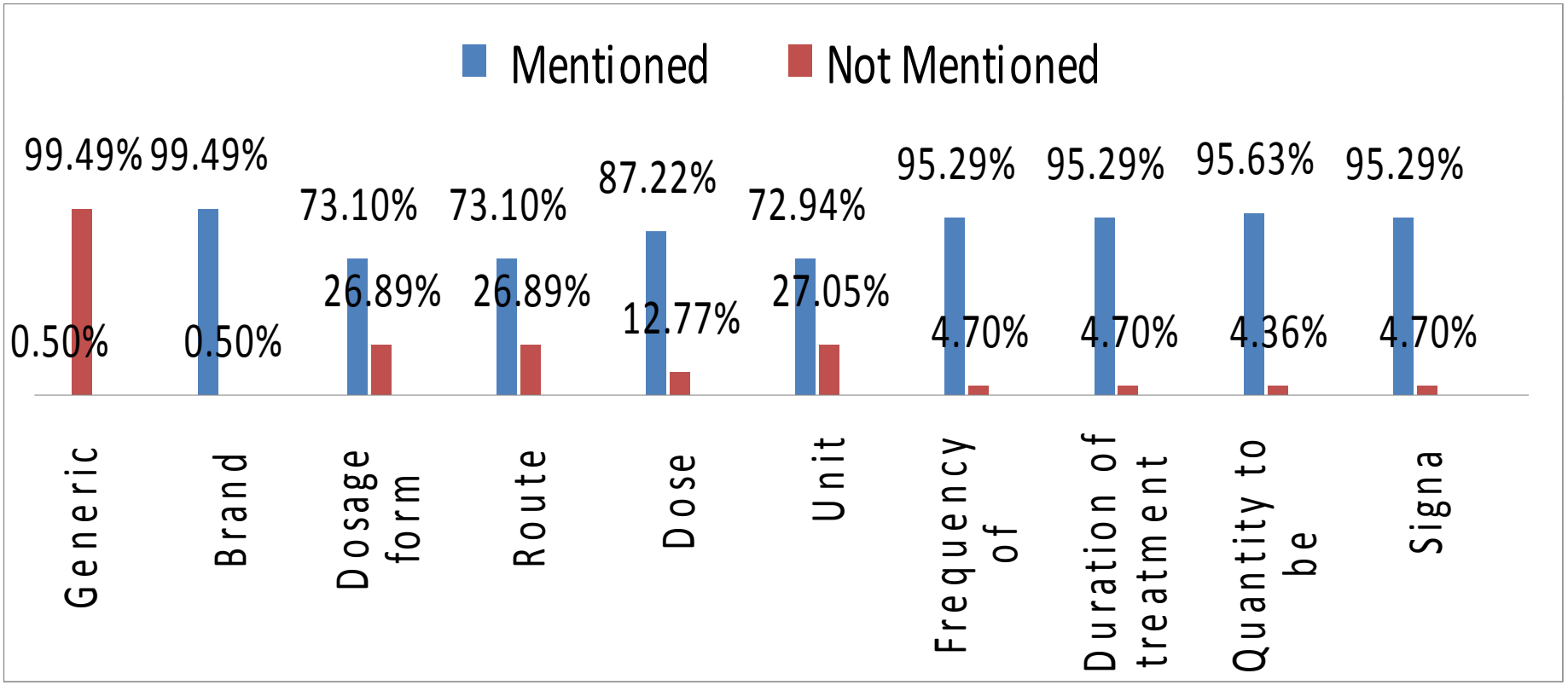


Fig.-18 (Table-7A): Comparative analysis of difference between prescription writing errors in urban manual prescriptions (n = 549) and structured format prescriptions (n = 206)

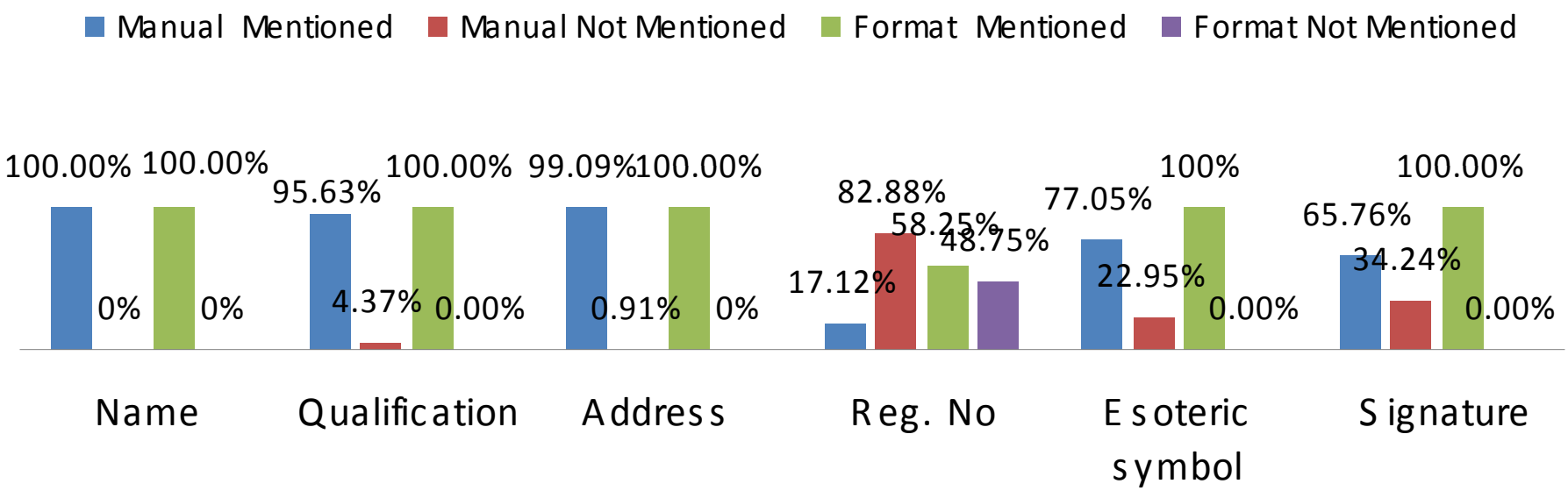
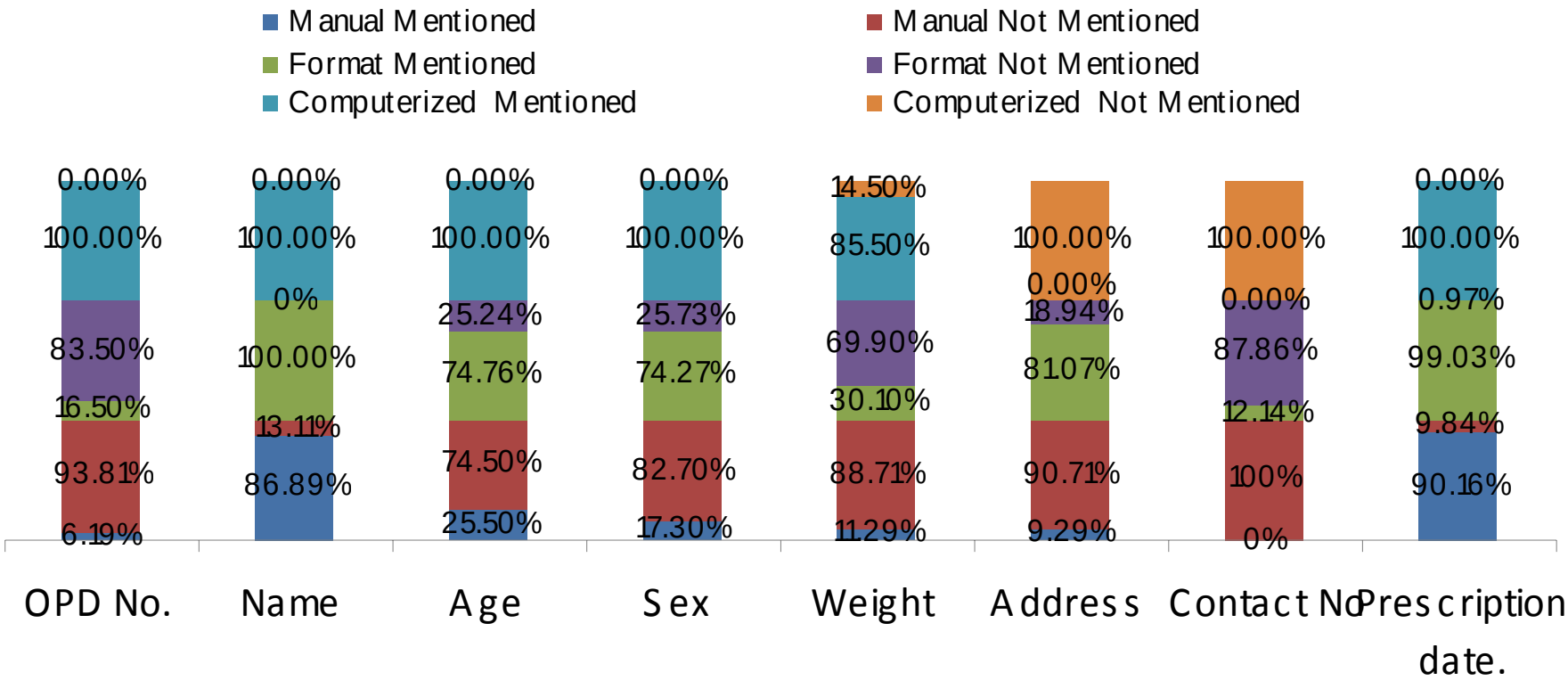


Fig.19 (Table-8B): Combined table of prescription writing errors in urban manual (n = 549), urban structured format (n = 206), urban computer generated prescriptions (n = 200)



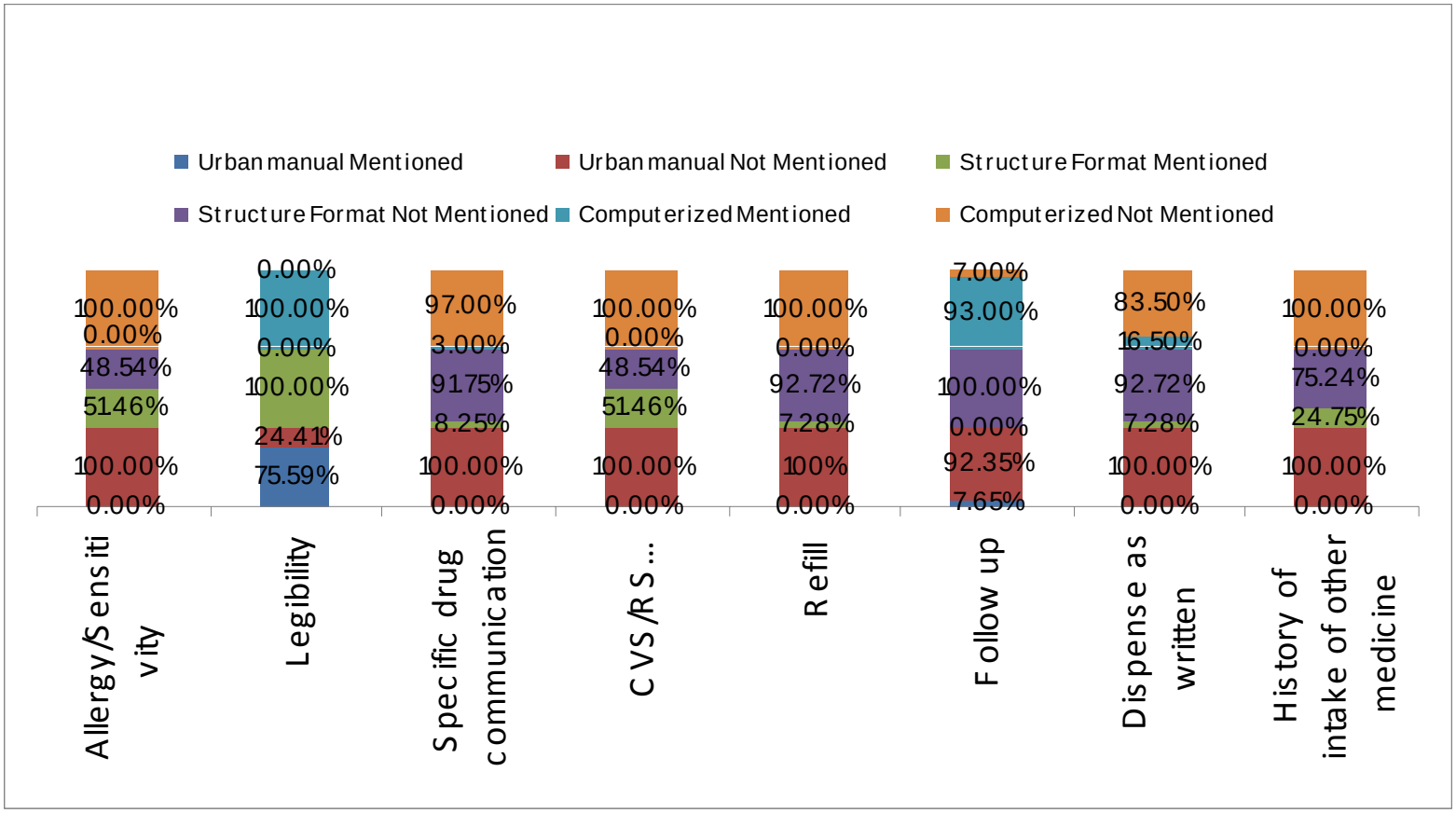

Urban manual Mentioned
Urban manual Not Mentioned
Structure Format Mentioned
Structure Format Not Mentioned
Computerized Mentioned
Computerized Not Mentioned
100.00%
0.00%
48.54%
51.46%
100.00%
0.00%
0.00%
100.00%
0.00%
100.00%
24.41%
75.59%
97.00%
3.00%
91.75%
8.25%
100.00%
0.00%
100.00%
0.00%
48.54%
51.46%
100.00%
0.00%
100.00%
0.00%
92.72%
7.28%
100%
0.00%
7.00%
93.00%
100.00%
0.00%
92.35%
7.65%
83.50%
16.50%
92.72%
7.28%
100.00%
0.00%
100.00%
0.00%
75.24%
24.75%
100.00%
0.00%
Allergy/Sensitivity
Legibility
Specific drug communication
CVS/RS...
Refill
Follow up
Dispense as written
History of intake of other medicine

Fig.20 (Table-8C): Comparison of prescription writing errors in urban manual drug items (n = 1854), urban structured format drug items (n = 672), urban computerized prescriptions drug items (n = 595)