# Pharmacology for the Health Care Professions

**Christine M. Thorp**
*University of Salford, UK*

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This book is dedicated to
the memory of my mother

# Contents

# Foreword

Students of pharmacology are well served by a number of academic textbooks on their subject but the majority are written from a traditional academic viewpoint. This new book is different in that it is written specifically for the audience of the Health Care Professions and the author Dr Christine Thorp is particularly well qualified in this respect.

Dr Thorp graduated from the School of Pharmacy and Pharmacology at the University of Bath, first with a BSc in 1975 and then with a PhD in 1979 providing her with a traditional academic view of pharmacology and experience of research. Since then she has undertaken a number of roles, most recently in the Faculty of Health and Social Care at the University of Salford, with responsibility for teaching pharmacology to students in a variety of Health Care Profession disciplines.

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July 2008

# Preface

The need for a book such as this one has arisen as a result of recent changes in legislation and expansion in the numbers of health care professionals involved in administration and/or prescription of medicines.

The book is an introduction to pharmacology for health care professionals. Although anyone involved in the care of patients is a health care professional, this book has been specifically written for physiotherapists, podiatrists and radiographers (otherwise known as *allied health professionals*). However, the book may be of interest to other health care professionals.

The book aims to provide the knowledge of pharmacology necessary for undergraduates of all three professions and practitioners on post graduate programmes for accreditation of supplementary prescribing or access and supply of prescription-only medicines. It may also be of more general use to any health care professional involved in patient care, especially those who administer medicines under patient group directions.

The book is arranged into three parts. In the first part, Principles of Pharmacology, two chapters cover administration, absorption, distribution, metabolism and excretion of drugs (Chapter 2) and adverse drug reactions, drug–drug interactions, individual response to drugs and targets for drug action (Chapter 3).

The second part is Systemic Pharmacology, which covers common disorders of the major body systems and their treatment. The cardiovascular, respiratory, endocrine, musculoskeletal, skin and central nervous systems are considered. An outline of normal physiology of the systems is included where appropriate and relevant diseases described briefly. This is not intended to be a physiology book or a pathophysiology book. Should the reader need to consult such books, suggestions are given in the bibliography. Major groups of drugs are discussed, with emphasis on areas of relevance to the three professions for whom the book is intended.

In addition to drugs used to treat diseases of the major systems, the treatment of infections and parasites, the use of cancer chemotherapy, the use of anaesthetics and analgesics and the use of contrast agents and adjuncts to radiotherapy are included in Part 2.

The final part has two chapters. The first of the two (Chapter 14) is about legislation around the use of medicines with discussion of salient points from the Medicines Act 1968 and the Misuse of Drugs Act 1971. Specific exemptions for podiatrists, the use of patient group directions, supplementary prescribing and independent prescribing and a brief history of non-medical prescribing are considered.

The final chapter (Chapter 15) ‘Prescribing in Practice’ consists of contributions from podiatry, radiography and physiotherapy colleagues. They have described the use of

various forms of access, supply, administration and prescription of medicines in their professions today and considered future developments in the light of the recent legislation allowing pharmacists and nurses to train as independent prescribers. Hopefully this will give the reader a realistic view of what is currently happening and what might happen in non-medical prescribing.

Useful web sites are listed at the end of each chapter, to encourage the reader to use the Internet for sources of reliable and respectable up-to-date information about disease, medicines and therapeutics. Although all websites were accessible at the time of writing, their existence cannot be guaranteed in the future.

Each chapter is followed by one or more case studies to illustrate the clinical use of drugs and problems that may arise from drug–drug interactions and adverse reactions. The situations are not based on any particular individuals; rather information has been gathered from many sources including my colleagues in physiotherapy and podiatry and used to construct the cases.

Finally, the chapters are finished off with review questions to test the reader's understanding of key concepts.

In the appendices, a list of drug names with their main therapeutic uses and a glossary of key terms used in the text are provided.

Drugs in current use are not all covered in this text; neither is this work intended as a recommendation for any drug use. Professionals should always consult the latest edition of the *British National Formulary* for definitive information about medicines.

# Acknowledgements

I would like to thank friends and colleagues who encouraged and supported me in the writing of this book from its early inception through to final completion. I especially want to thank Leah Greene for her technical expertise and unfailing assistance with computer applications. I am grateful to Alison Barlow and Peter Bowden for their helpful ideas with matters relating to podiatry and Louise Stuart, MBE (Consultant Podiatrist) for an insight into supplementary prescribing; to Jan Dodgeon for help with topics relevant to radiography and Chris Frames and Chris O'Neal for their help with devising physiotherapy case studies.

Special thanks are due to those who contributed to Chapter 15, namely Professor Peter Hogg (Nuclear Medicine) and his co-authors, and Anthony Waddington (Podiatric Surgeon). Without their experience in practice this book would have had far less relevance to the health care professionals for whom it was written.

I have to thank students past and present for their inspiration, comments and suggestions over the years and I hope future students and practitioners will benefit from this.

Thanks to staff at Wiley (in particular Rachael Ballard, Fiona Woods and Jon Peacock), to Neil Manley for creating the index, and to Wendy Mould, who copyedited the book.

Finally, thanks to Alex for his understanding and patience.

# 1
# Introduction

Pharmacology is the science of drugs and their effects on biological systems. A drug can be defined as a chemical that can cause a change in a biological system; the important biological system to be considered in this book is the human body. A drug is the active ingredient in a medicine; a medicine is the formulation of a drug into a tablet, capsule or other delivery system. The Medicines Act 1968 refers to drugs as medicinal products.

Drugs can be naturally occurring substances, for example hormones; everyday substances, for example caffeine and alcohol; synthetic chemicals marketed for therapeutic activity, for example aspirin; or substances used for recreation.

Pharmacology as a science encompasses the following:

- the action of natural chemicals in the body;
- the origins and sources of drugs;
- their chemical structure and physical characteristics;
- their mechanisms of action;
- their metabolism and excretion;
- studies of their action on whole animals, isolated organs, tissues and cells, enzymes, DNA and other components of cells;
- ultimately studies of their actions in humans and their therapeutic uses.

Pharmacology is also the study of the toxic effects of drugs and chemicals in the environment. All drugs are capable of being toxic and all drugs can produce unwanted effects at high doses, or if used incorrectly. The difference between a medicine and a poison is often merely a matter of concentration. In therapeutics, the treatment of disease is intended to have a beneficial effect with adverse effects kept to an acceptable minimum. The science of modern pharmacology is a relatively recent development. Prior to the 1930s, there were very few medicines available, and those that were available came from natural sources. Examples of drugs originally from natural sources and still in use today are quinine (from the bark of the cinchona tree and used to treat malaria), digitalis (from the foxglove and used for heart failure) and aspirin (extracted from the bark of willow tree and originally used to treat fever).

Development of new drugs can happen in many ways. Drugs have been developed following observation of side effects when being used for other purposes. It is now known

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that the site of action of many drugs is a cellular receptor. As knowledge of receptor structures has developed, this has allowed drugs to be designed to fit with receptors. The human genome project and mapping of genes has led to work on the development of drugs to alter genes.

## 1.1 Pharmacology and health care professionals

The importance of pharmacology to health care professionals cannot be overestimated. Members of the three professions, physiotherapy, podiatry and radiography, encounter patients on a daily basis, many of whom will be on drug therapy. Patients are increasingly likely to be receiving at least one drug; many older patients are likely to be on more than one drug, and prescription of eight or nine drugs at the same time is not uncommon. This is known as *polypharmacy* and it increases the chance of patients experiencing adverse effects or the effects of drug–drug interactions.

Depending on the nature of their work, health care professionals may spend some considerable time with individual patients who might have questions about their drug therapy. Some health care professionals may be treating mainly older patients, or younger patients or high-risk patients, and will become experienced and familiar with drugs in their areas of expertise.

Health care professionals can be ideally placed to spot adverse drug reactions and to play an important role in the long-term monitoring of commonly prescribed drugs. As professionals, they should be able to advise patients or know when to refer them to other experts in the health care team. Drug therapy of disease is ever expanding; new drugs exist for effective treatment or cure of more diseases than ever before. Correct use of drugs is paramount. It is therefore important for health care professionals to have an understanding of therapeutic uses of medicines, normal doses, adverse effects, interactions with other drugs, precautions and contraindications. It is equally important to be able to judge whether a change in a patient's condition is caused by drug therapy, or a change in the disease process. Medication can lead to symptoms such as dizziness, fatigue, dry mouth, constipation and patients may or may not associate new symptoms with drug use.

Health care professionals are increasingly involved in the administration of drugs to patients, either as an exemption to the Medicines Act 1968, under patient group directions, or as supplementary prescribers. The Medicines Act 1968, and additional secondary legislation since then, provides a legal framework for the manufacture, licensing, prescription, dispensing and administration of medicines. An exemption to the Medicines Act allows certain professionals, including podiatrists, access to specified prescription-only medicines, providing they are appropriately registered with the Health Professions Council. The use of patient group directions allows many health care professionals to administer prescription-only medicines to specific groups of patients without a normal prescription. Podiatrists, radiographers and physiotherapists are now included in the list of health care professionals who can train to prescribe medicines alongside doctors (and dentists) as supplementary prescribers.

Prior to 1994, only doctors, dentists and veterinary practitioners were allowed to prescribe medicinal products in the United Kingdom. That year the law was changed to enable district nurses, midwives and health visitors to prescribe from a limited formulary of dressings, appliances and some medicines. This formulary of medicines was extended in 2002.

A review of prescribing, supply and administration of medicines for the Department of Health (1999) (Crown Report 2) recommended two types of prescriber: independent and supplementary.

Over the next few years, supplementary prescribing by nurses and pharmacists was introduced and legislation to allow this was changed in April 2003.

A similar process occurred with podiatry, physiotherapy and radiography and led to extension of supplementary prescribing to these professions in April 2005. In a further development in 2006, nurses and pharmacists became eligible to train as independent prescribers.

Non-medical prescribing is now the term applied to prescribing by members of the health care professions who are not 'medically' qualified.

Prescribing can be described in the following three ways:

1. to order in writing the supply of prescription-only medicine for a named patient;
2. to authorize by means of an NHS (National Health Service) prescription the supply of any medicine (prescription-only, pharmacy or general sales list item) at public expense;
3. to advise a patient on suitable care or medication, including over-the-counter drugs, and therefore with no written prescription.

All health care professionals who are involved in prescribing, and/or administration of medicines have to abide by standards set out by their respective professional bodies. For podiatrists, radiographers and physiotherapists, this is the Health Professions Council. Health care professionals have a responsibility to consult documentation produced by the professional bodies and be accountable for prescribing and administering drugs. All members of health care professions have a responsibility to reduce the risk of errors in prescribing, must assess and appraise their own practice and show a commitment to continuing professional development. This is essential not least because information about drugs and associated legislation is constantly changing. New drugs come on the market, and others are withdrawn or reclassified. Reliable sources of information are the *British National Formulary* (*BNF*), the *Monthly Index of Medical Specialities* (*MIMS*), the *British Pharmacopoeia* (*BP*), patient information leaflets (PILs) and summaries of product characteristics (SPCs) supplied by medicines manufacturers. Official bodies concerned with the use, quality and safety of medicines are the Commission on Human Medicines (CHS, formerly the Committee on the Safety of Medicines), the Medicines and Healthcare Products Regulatory Agency (MHRA) and the National Institute for Health and Clinical Excellence (NICE).

## 1.2 Patient compliance

Patient compliance is important for successful drug therapy. Compliance in this context is defined as the extent to which the patient follows the clinical prescription. Non-compliance and reasons why patients do not always take drugs as prescribed should be appreciated. Some common reasons for non-compliance are that the patient has doubts about a drug's effectiveness, they believe they are cured, they misunderstand instructions, dosage regimes are too complicated, or they experience unacceptable side effects.

Health care professionals play an important role in improving compliance. This is particularly important if a drug is for serious conditions like epilepsy, glaucoma or hypertension, or is for infection because of the problem of drug resistance.

Well-informed patients are more likely to be compliant.

It is worth spending time explaining what the medication is, how it is taken and why, how long it is to be used for, what adverse effects to look out for and any alternatives if appropriate. The importance of the drug therapy can be explained and what might happen if the patient did not comply. Aids to help compliance can be suggested, for example packaging of daily doses can be arranged with pharmacists, special containers can be obtained, the help of relatives can be sought, suitable time of day for administration can be chosen and provision of written information can all help. Patient information leaflets must be included in packaging of medicines.

## 1.3 Drug names

All drugs have at least three names: the chemical name, the generic name and the proprietary name. Chemical names can be complicated and difficult to remember and are not used in this book. A generic name is a drug's official name and the majority of drugs in this book are referred to by their generic names. The proprietary name is the name given to a drug by the manufacturing company. As the same drug can be manufactured by several different companies, a drug can have multiple proprietary names and this can be confusing. Hence, proprietary names have been avoided in this book except where the proprietary name is in common usage. In the United Kingdom, the generic name is known as the *British approved name* (*BAN*). Following European Directive 92/27/EEC, European Law requires the use of the recommended International Non-proprietary Name (rINN). This ensures that all countries, in Europe at least, recognize the same drug. In most cases, the BAN and the rINN were the same, but some British names have been changed. For example, amphetamine is now spelt amfetamine and lignocaine is now lidocaine. Where this has happened, both names are listed in the BNF. Wherever possible, drugs should be prescribed by their generic name; this allows any suitable product to be dispensed and in many cases, it saves the health service money. The only exception to this rule is when a patient must always receive the same brand of a drug because different preparations can result in different blood levels of the drug. No details of dosages are given in this book (except in some of the case studies), because these are subject to change and often have to be varied to suit individual patients. In practice, the *BNF* or *MIMS* should be used as a guide to dosages.

Examples of individual drugs have been kept to a minimum in the text, with usually just one or two examples given in each section. It would be impractical to try to remember the names of all drugs available. In practice, health care professionals quickly become familiar with drugs commonly used in their area.

Nevertheless, the examples used in this book amount to over 300 drug names, which are listed for easy reference in Appendix I.

# Part I
## Principles of pharmacology

# 2
# Drug disposition

## 2.1 Chapter overview

If a drug is to have a therapeutic effect on the body, it first has to reach its site of action. In order to do this a drug has to be administered in some way. Unless the route of administration is directly into the blood stream, the drug has to be absorbed, usually by diffusion. Once absorbed, distribution of the drug to different parts of the body follows. This necessarily includes passage through the liver. Most drugs are treated as potentially toxic substances and are metabolized by the liver. This detoxifies them and some drugs are almost totally inactivated on first pass through the liver. Eventually a drug will be excreted from the body. This usually occurs via the kidneys, although some drugs can be lost in faeces or exhaled air. This chapter discusses the processes of administration, absorption, distribution, metabolism and excretion of drugs together with factors affecting these processes. Collectively, these processes describe drug disposition, the way in which the body handles drugs. The study of the fate of drugs in the body is known as *pharmacokinetics*.

## 2.2 Administration of drugs

In order to get to their site of action in the body, drugs have to be administered in some way. There are two major routes of drug administration: enteral and parenteral. Enteral means to do with the gastrointestinal tract and includes oral and rectal administration. The parenteral route includes all other means of drug administration. There are many routes of parenteral administration, some of which are intended for a drug to have a systemic effect and others for a local effect. See Figure 2.1.

(In some definitions, parenteral is synonymous with injection (for example in the Medicines Act), but here the term is used to describe all routes of administration that are not enteral.)

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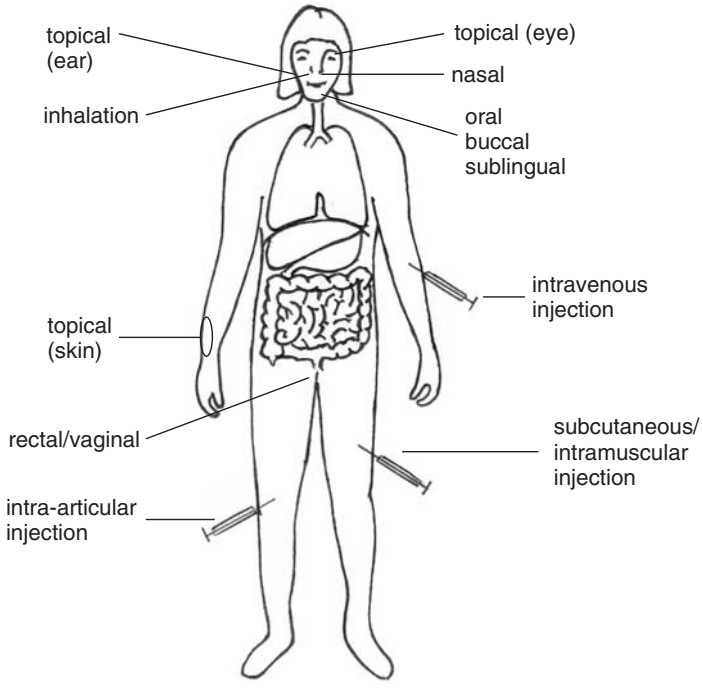


**Figure 2.1** Sites of drug administration

### 2.2.1 Oral administration

The vast majority of drugs are administered by mouth as pills, capsules, tablets or liquids. Following oral administration, absorption of a drug is from the stomach or intestine directly via the hepatic portal system to the liver before reaching the general circulation. The liver is the main site of drug metabolism and inactivation (see page 20). Many factors affect drug absorption from the gastrointestinal tract, including lipid solubility of the drug; its molecular weight; the pH of the local environment; the surface area of the absorbing membrane; gastric emptying time; the rate of removal from the gastrointestinal tract by the blood and the degree of plasma protein binding of the drug once in the blood stream.

Because by mouth is a common route of drug administration, it is considered in more detail in Section 2.3.5.

There are advantages and disadvantages of administering drugs by the oral route. Advantages are that it is a safe and convenient route, generally acceptable to the patient and requires no particular skills. Disadvantages are that many drugs do not taste particularly nice; some can upset the stomach and cause nausea and vomiting or even ulcerate the stomach lining, while others may be destroyed by stomach acid or digestive enzymes or be extensively metabolized in the liver. The oral route requires a co-operative and conscious patient.