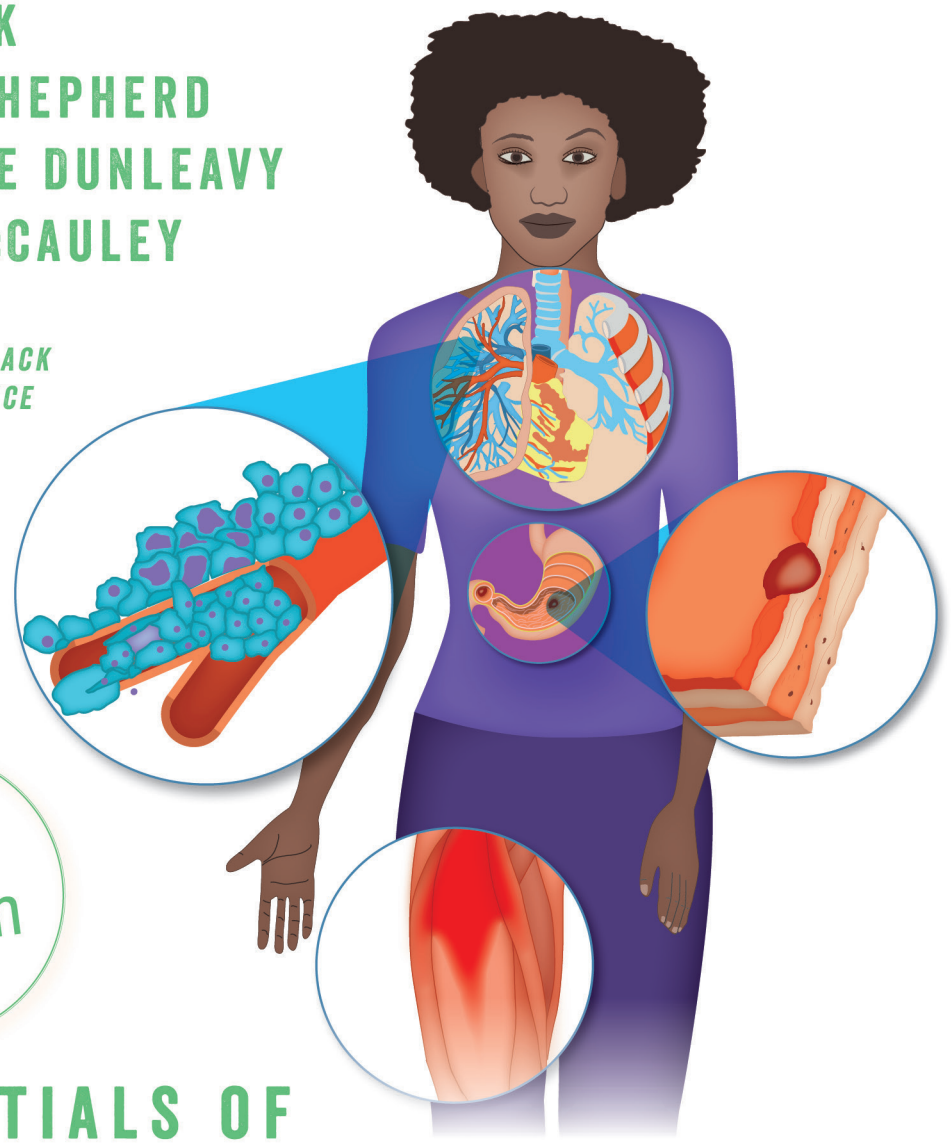
NEAL COOK
ANDREA SHEPHERD
STEPHANIE DUNLEAVY
CLAIRE McCAULEY

FOREWORD BY
BRENDAN McCORMACK
AND TANYA McCANCE



2nd Edition

ESSENTIALS OF PATHOPHYSIOLOGY FOR NURSING PRACTICE

SAGE

Los Angeles | London | New Delhi
Singapore | Washington DC | Melbourne

Los Angeles | London | New Delhi
Singapore | Washington DC | Melbourne

SAGE Publications Ltd
1 Oliver's Yard
55 City Road
London EC1Y 1SP

SAGE Publications Inc.
2455 Teller Road
Thousand Oaks, California 91320

SAGE Publications India Pvt Ltd
B 1/I 1 Mohan Cooperative Industrial Area
Mathura Road
New Delhi 110 044

SAGE Publications Asia-Pacific Pte Ltd
3 Church Street
#10-04 Samsung Hub
Singapore 049483

Editor: Alex Clabburn
Assistant editor: Ruth Lilly
Assistant editor, digital: Mandy Gao
Production editor: Rachel Burrows
Copyeditor: Sarah Bury
Proofreader: William Baginsky
Marketing manager: Ruslana Khatagova
Cover design: Shaun Mercier
Typeset by: C&M Digitals (P) Ltd, Chennai, India
Printed in the UK

Library of Congress Control Number available: 2022932790

British Library Cataloguing in Publication data

A catalogue record for this book is available from the British Library

ISBN 978-1-5297-7596-9
ISBN 978-1-5297-7595-2 (pbk)

CONTENTS

3
PRINCIPLES OF PHARMACOLOGY

Understand

Chapter videos

Watch the following videos to ease you into this chapter.

The videos can be accessed by **scanning the QR code** with your smartphone camera or via **https://study.sagepub.com/essentialpatho2e**.

PHARMACOKINETICS (5:49)

PROCESSING MEDICINE (4:12)

PHARMACODYNAMICS (4:03)

Learning outcomes

When you have finished studying this chapter you will be able to:

1. Explain the four processes of pharmacokinetics, i.e. what the body does to drugs, how drugs are absorbed into and distributed throughout the body, metabolised and excreted.
2. Explain the concept of pharmacodynamics, i.e. what drugs do to the body through their interaction with receptors and the alteration of cell function.
3. Identify factors which influence the action of drugs.
4. Recognise adverse drug reactions and understand approaches to prevention.
5. Identify the key issues for safety in relation to drug administration and polypharmacy, and in drug use with older people or children.
6. Recognise the legal and professional parameters for drug prescribing and the role of the independent nurse prescriber.

INTRODUCTION

This chapter considers the principles of drug therapy. As a registered nurse, you will have considerable involvement in administering, and perhaps prescribing, drugs in a way that will ensure their effective action. The administration of medications (also known as drugs) is the most common treatment of disorders. The use of particular drugs in the treatment of various conditions will be considered in the relevant chapters throughout the book.

Drugs have been defined as:

> A chemical substance of known structure, other than a nutrient or an essential dietary ingredient, which, when administered to a living organism, produces a biological effect. (Rang et al., 2018: 1)

However, some dietary constituents, such as vitamins or iron, are also given as medications. Therefore, you need an understanding of how **pharmacology** influences drug action. In this chapter, you will learn about the key principles of pharmacology and how side-effects, drug interactions and adverse drug reactions may occur. The understanding acquired will provide a necessary foundation to inform your clinical decision making when providing safe person-centred care.

SECTION 1: PHARMACOLOGY

This chapter is written for those preparing for initial registration as a nurse but will also assist those revising the key concepts of pharmacology. Therefore, to begin, the key terms you will require are presented in Table 3.1.

Table 3.1 Pharmacology key terms

Pharmacology	The study of the effects of drugs and how they are used to treat medical conditions
Pharmacokinetics	What the body does to the drug
Pharmacodynamics	What the drug does to the body
First-pass metabolism	Metabolism of a drug into inactive compounds by the liver, immediately after absorption and before it reaches the systemic circulation
Bioavailability	The proportion of a drug administered which reaches the systemic circulation and can have an active effect
Half life	The time taken for the plasma concentration of a drug to decrease by 50%
Therapeutic window	The range of doses that produce a therapeutic response without causing any significant adverse effect

There are two major principles of pharmacology to be considered:

1. **Pharmacokinetics**: what the body does to drugs
2. **Pharmacodynamics**: what drugs do to the body.

While each will be discussed in turn, it is imperative that as a nurse you understand that these pharmacological processes do not happen separately but that there is a dynamic clinical interplay between them with every drug an individual takes (Figure 3.1).

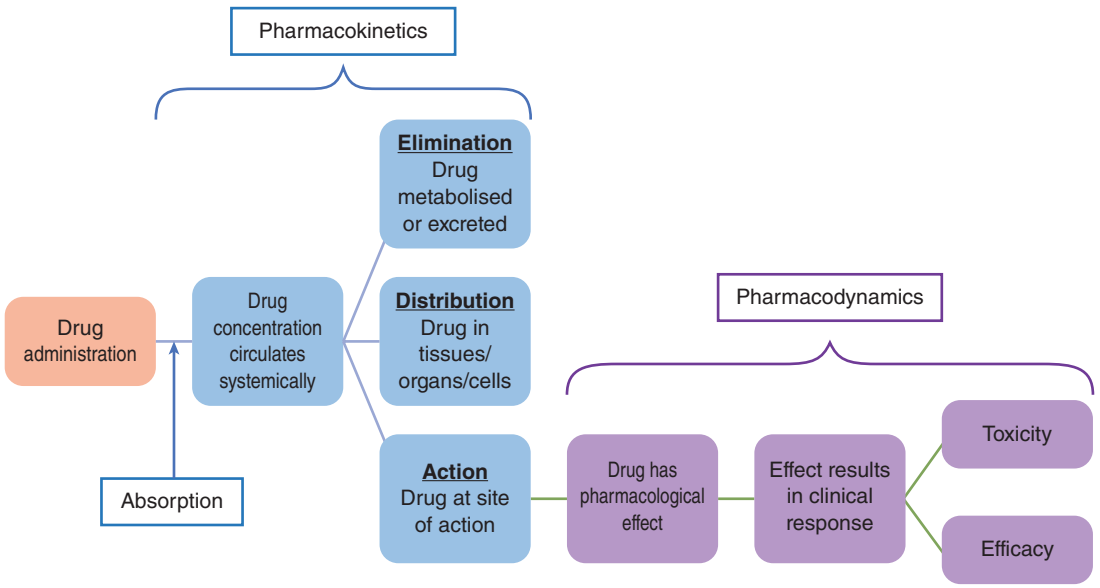


Figure 3.1 Pharmacokinetics and pharmacodynamics

Pharmacokinetics

The degree of drug action is dependent on the level of unbound drug in the general bloodstream and thus available to interact with the appropriate cell receptors (see **Distribution** below).

The level at which the drug is effective is the therapeutic level, while the toxic (i.e. poisonous) level is the concentration at which toxicity occurs. The difference between these levels is the therapeutic index. A small therapeutic index means that there is little difference between the therapeutic and the toxic levels and side-effects can occur easily. Digoxin, which is used to strengthen the heartbeat in people with heart failure, is an example of a drug with a small therapeutic index. Dose-related adverse drug reactions are therefore common, as an incorrect dose or an age-related change in pharmacokinetics of a person taking such medication can significantly alter its effects (Neal, 2016). It is important to note that lifestyle choices can also have an impact on the therapeutic index of a medication. For example, smoking can increase the metabolism of Clozapine, a drug used in treatment-resistant schizophrenia. Therefore, therapeutic dose adjustments would need to be continually made in those who continue to smoke or those who stop smoking during treatment (Mayerova et al., 2018).

The concentration of the drug in the tissue fluids, and thus their level of activity, is determined by the balance between the four pharmacokinetic processes of absorption, distribution, metabolism and excretion (Figure 3.2).

Figure 3.3 illustrates how these processes act on a single drug dose to achieve and then descend from the therapeutic range. The shaded area shows the therapeutic concentration and duration of action of the drug.

To maintain the concentration within the therapeutic range, repeated doses are administered to ensure that the concentration rises and remains within this zone as the trajectories of successive doses overlap (Figure 3.4). The timing of doses is determined by the half life of the drug, i.e. the time taken for the plasma concentration of the drug to fall by half as it is distributed through the body and is then metabolised and excreted from the body.

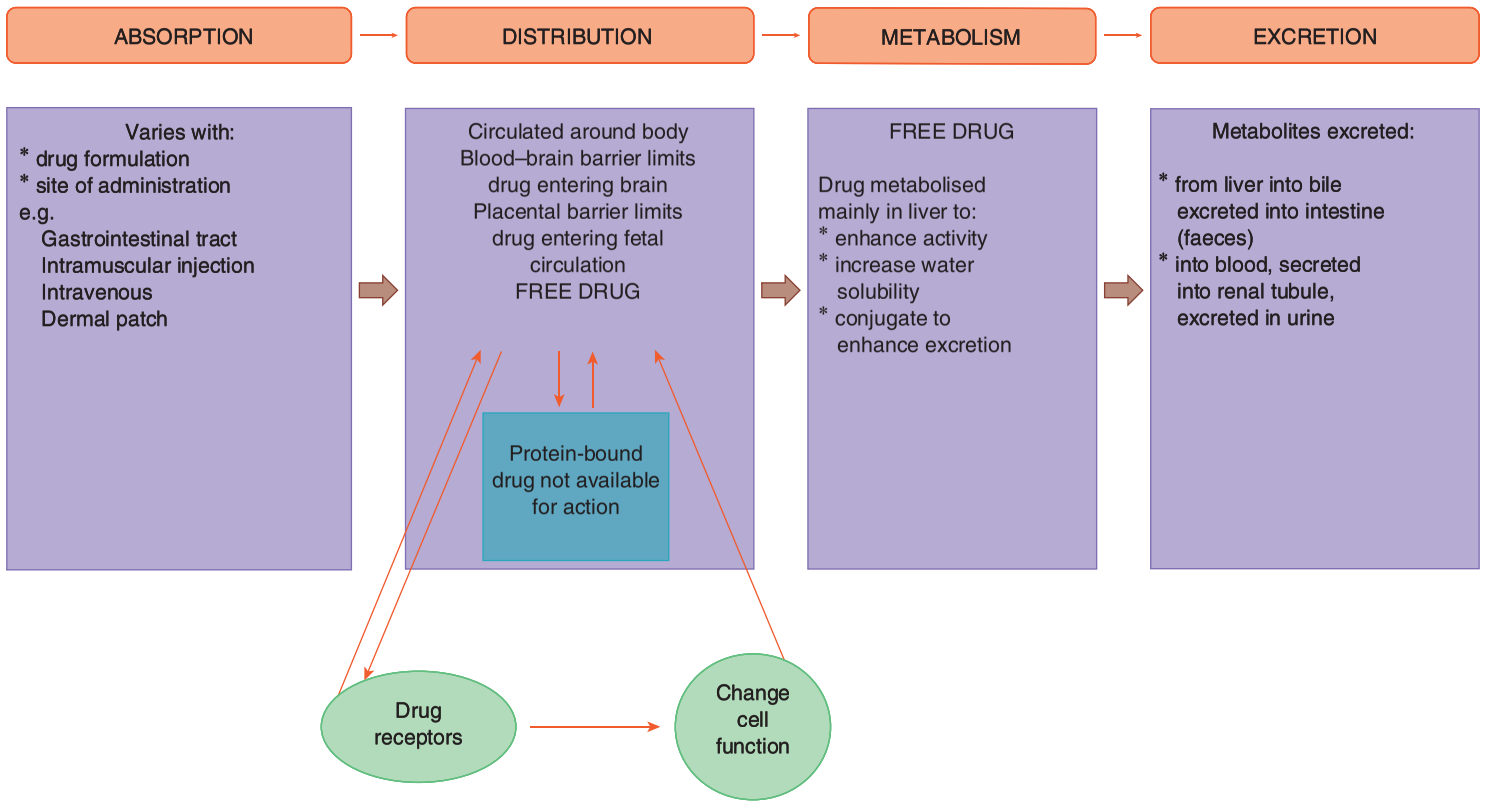


Figure 3.2 Pharmacokinetic mechanisms determining drug concentration

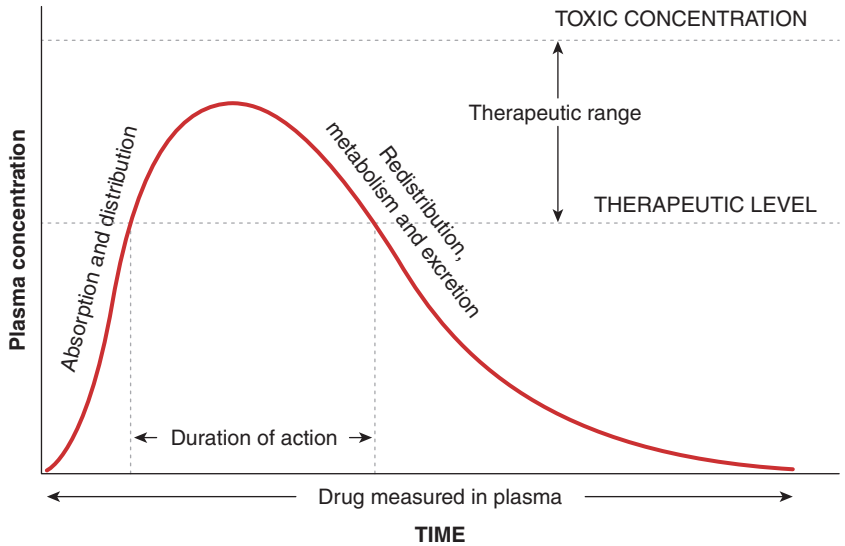


Figure 3.3 Plasma concentration of drug following a single dose

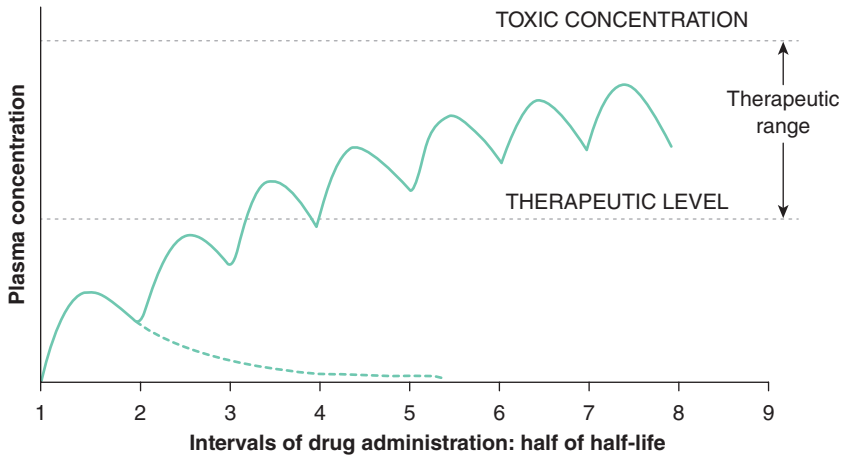


Figure 3.4 Achieving steady state drug concentration

Absorption

Absorption is the first of the pharmacokinetic processes in which drugs move from the site of administration into the bloodstream. The speed and effectiveness of absorption, and thus **bioavailability** (i.e. the proportion of a dose that reaches the systemic circulation and is available to act on the target organs (McGavock, 2016)), varies with the structure of the drug itself and the route of administration. The routes of drug administration are considered in three groups: **enteral**, **parenteral** and **topical** (Lilley et al., 2017) and are discussed below.

Enteral route (gastrointestinal tract)

The gastrointestinal tract (GIT) is a major route for administration of medications, although various drugs are administered for absorption at different points of the GIT. This route enables absorption through the mouth, stomach or intestine. The majority of orally administered drugs are absorbed in the stomach or intestine into the bloodstream. The acidity of the stomach, which can vary with age, time of day, presence of food and liquid, and presence of medications, can alter the dissolving and absorption of the drug. Some drugs must be taken with water or on an empty stomach, others with food. Some drugs are produced with an enteric coating to prevent dissolving of the coating in the stomach, thus protecting the stomach lining from the active drug which will only be released in the intestine.

First-pass metabolism

Following absorption in the stomach, small intestine or part of the large intestine, the drugs enter the portal circulation which carries the drug molecules to the liver. Here some of the drug is converted into inactive molecules through **first-pass metabolism**, resulting in a smaller proportion of the active drug passing into the general circulation. For drugs that are metabolised in this way, they need to be absorbed where they will bypass the liver and directly enter the general circulation; otherwise they will be destroyed by liver enzymes and not reach their site of action.

Sublingual (i.e. under the tongue) and buccal (between the cheek and the gum) sites for absorption have rich blood supplies and drugs (e.g. glyceryl trinitrate, used in the treatment of acute angina) enter the general blood circulation directly, thus bypassing the liver and rapidly reaching the site of action.

Rectal administration of drugs is also sometimes used, although it is not the preferred route for a lot of patients. This approach (along with parenteral routes – see below) bypasses some of the first-pass metabolism (Lilley et al., 2017).

Table 3.2 Injection routes

Route		Description
Common routes used in nursing practice	Intravenous	Directly into the venous circulation with rapid onset of action
	Intramuscular	Into muscle tissue from which it is absorbed more slowly and randomly
	Subcutaneous	Into subcutaneous tissue (i.e. under the skin), e.g. **insulin** administration
	Intradermal	Very small volumes into the dermis of the skin, mainly diagnostic testing
Routes used by those with specialist training (e.g. doctors, specialist nurses, advanced clinical practitioners)	Intraarterial	Into arteries supplying specific organs
	Intrathecal	Into the **cerebrospinal fluid** (CSF) at 3rd–4th lumbar vertebral space, or intraventricularly, bypassing blood–brain barrier
	Epidural	Same level as intrathecal injection but not into CSF, e.g. local **anaesthesia**
	Intrapleural	Into the pleural space
	Intraarticular	Into a joint cavity, e.g. treating inflammation of joint

Parenteral routes

These include a variety of routes outside the GIT where drugs are administered usually by injection, as in Table 3.2. The routes indicated within the Nursing and Midwifery Council core competencies are: intramuscular, subcutaneous, intradermal and intravenous.

Topical routes

Topical administration involves the application of a medication to a body surface. The drugs may be in different forms (e.g. liquid, cream, powder), but these routes usually deliver a specific amount of drug over a longer period than enteral and parenteral routes, and most also bypass first-pass metabolism. They also minimise systemic side-effects as they often have a localised effect. Topical routes are set out in Table 3.3.

Table 3.3 Topical routes of administration

Skin (transdermal)	Adhesive patches enable a drug to pass through the skin into the systemic circulation at a steady rate
Intravaginal	Drugs administered may have a local effect or a systemic action
Eyes, ears, nose	Drops are usually administered for a local effect; nasal sprays may have a systemic action
Lungs	Inhalation of very small drug particles delivers drugs to alveoli of the lungs where they are rapidly absorbed in the treatment of pulmonary disorders

Absorption processes

The dosage and way the drug is formulated determines the rate of dissolution and absorption of the drug. Drugs in liquid form in solution or suspension are absorbed more rapidly than solid drugs in tablets, capsules, etc. The particle size also influences the rate of dissolution and absorption, with small particles being absorbed more rapidly than larger ones. Table 3.4 indicates how the speed of absorption varies with the formulation of medications.

Table 3.4 Speed of absorption of different enteral drug formulations

Speed	Dissolution	Site of absorption	Type of formulation
Fastest	Mouth	Mouth:	Oral disintegration:
↓		avoids first-pass metabolism	Sublingual tablets
			Buccal tablets
			Oral soluble wafers
	Stomach	Some drugs, particularly liquids, are absorbed. Solid formulations begin absorption in stomach	Liquids, elixirs, syrups
			Suspensions
			Powders, capsules, tablets
Slowest	Intestine	Absorption continues in the intestine. Coated and enteric coated tablets absorbed here	Coated tablets
			Enteric coated tablets

(Continued)

Table 3.4 (Continued)

Speed			
Dissolution (location)	Mouth	Stomach	Intestine
Site of absorption	• Mouth (avoids first-pass metabolism)	• Some drugs, particularly liquids, are absorbed • Solid formulations begin absorption in stomach	• Absorption continues in the intestine • Coated and enteric coated tablets absorbed here
Type of formulation	• Oral disintegration: • Sublingual tablets • Buccal tablets • Oral soluble wafers	• Liquids, elixirs, syrups, suspensions, powders, capsules, tablets	• Coated tablets • Enteric coated tablets

Distribution

This second stage in pharmacokinetics involves the transport of drugs through the circulation to distribute them to their active site. Drugs are distributed first to organs with the biggest blood supply but then to almost all parts of the body. A proportion of the drug molecules in the bloodstream combines with plasma proteins – mainly albumin – and some of the drug remains 'free' or unbound. Malnutrition can result in low albumin levels, and thus reduces the amount of bound drug and increases the free drug molecules. The two forms, bound and free, are in equilibrium. It is only the free drug which is small enough to pass through the capillary walls to enter the extracellular fluid and pass from there to the cells of the body where they react with the drug receptors (see Pharmacodynamics below) (Figure 3.2).

Drug molecules cannot readily enter parts of the body with restricted blood supply or have specific barriers. For example, bones have a limited blood supply while the blood–brain barrier restricts the passage of drugs into the brain (Lilley et al., 2017).

The blood–brain barrier is a semipermeable membrane barrier that separates blood in the general circulation from circulation of blood and extracellular fluid in the brain. The 'tight junctions' between the cells of the brain **epithelium** prevent most substances in the blood from reaching the brain cells. The effectiveness of this barrier is reduced in a number of conditions, including **stroke** (cerebrovascular accident) and neuroinflammatory disorders such as HIV-induced dementia, **multiple sclerosis** and **Alzheimer's disease** (Ballabh et al., 2004).

Metabolism

This stage of pharmacokinetics involves biochemically altering the drug molecule into a different form, which may be an inactive, a more or less active metabolite, or a more soluble substance which can be excreted readily. The liver is the organ with the greatest contribution to drug metabolism, but other tissues also contribute, including kidneys, skeletal muscle, lungs, plasma, and intestinal mucosa.

Lipid-soluble drugs are difficult to excrete from the body, so it is essential that they are converted into a water-soluble substance that is readily excreted. There are two main types of conversion:

1. *Chemical changes (oxidation, reduction or hydrolysis*): carried out by hepatic enzymes known as Cytochrome P450 or microsomal enzymes, which make molecules more water-soluble and less active

2. *Conjugation or combination with an additional molecule (e.g. sulphate, glucuronic acid, glycine, etc)*: form less toxic, less active substances which are more readily excreted.

Both types of conversion are dependent on healthy liver function. It is also worth noting that some drugs can be 'inducers' or 'inhibitors' of the hepatic enzymes necessary for effective metabolism. This can lead to significant drug interactions which could cause toxicity or sub-therapeutic dosing if not carefully monitored.

Excretion

The main organs of **excretion** are the kidneys, although the liver and gut also have a role.

Many drugs are metabolised in the liver before release into the general circulation and transport to the kidney, but others will have bypassed hepatic metabolism and retain their original structure. In the kidney they pass through the processes of filtration, some tubular reabsorption, and active secretion into the renal tubules before excretion in the urine.

Some other drugs are excreted into the biliary system of the liver and pass into the small intestine in the bile, the free drug can then be reabsorbed and the cycle can be repeated. This process is known as enterohepatic circulation and can result in a 'reservoir' of recirculated drug subsequently prolonging drug action until it is eventually passed out in faeces (Rang et al., 2018).

Factors influencing pharmacokinetics

Disturbances in the function of the GIT will disrupt drug absorption. For example, **vomiting** will prevent gastric dissolution and absorption as the drugs are eliminated from the stomach. Surgery which has shortened the small intestine or reduced the size of the stomach will increase the speed with which gut contents, including the administered drug, pass through to the rectum and are eliminated, thereby reducing the time for the drug to be absorbed into the circulation. **Diarrhoea** has a similar effect.

Disorders of the circulation may disrupt the distribution of drugs around the body and to the individual organs or tissues on which they should be working. Disorders of the liver will reduce drug metabolism, thus causing a higher level of drug in the body and increased action on the body. Kidney disorders may also reduce excretion.

In addition to changes in body function influencing drug action, interaction between drugs can also influence their activity (see below).

Drug therapy through the life span

The person's stage in life is important in considering the dosage of drug being prescribed and administered. In development of drugs, most clinical testing does not include pregnant women, babies and children, the elderly, those taking other drugs, heavy drinkers and smokers, and those abusing drugs (McGavock, 2016). Thus, drug therapy in these groups must be managed with considerable care.

The four processes in pharmacokinetics function differently in children and older adults (Table 3.5). These changes mean that drug dosages at the two extremes of life need to be different from those administered to adults in general. The dosage guidelines for many drugs do not include details for the young and old, and specialist guidance is required. One of the considerations in drug therapy with older people is polypharmacy as many of these individuals may have a number of chronic diseases needing treatment.

Apply

Chronic conditions in the Bodie family

Maud is an example of an older person with a number of chronic conditions and, as a result, has been prescribed several different medications. Careful clinical consideration of the potential for interactions or adverse effects is required. As already mentioned, she is taking digoxin to increase the force of myocardial contraction and warfarin to reduce the risk of blood clotting. As aspirin could cause bleeding from the stomach and she is already taking warfarin, she is warned against taking aspirin (or any medication containing aspirin) for pain relief. What other approaches could be used to treat Maud's pain? Digoxin has a narrow therapeutic index. Why is this an important consideration when treating Maud?

Table 3.5 Pharmacokinetics in young and old

Stage	Babies and children vs adults	Older adults
Absorption	Peristalsis reduced Slower gastric emptying First-pass metabolism reduced Intramuscular absorption faster	Reduced absorption due to: Gastric pH increases, emptying slowed Movement through GI tract slowed and blood flow reduced Villi flattening reduces absorption
Distribution	Total body water greater Fat content lower Protein-binding reduced More drugs enter brain	Total body water reduced Combining with plasma proteins lessened Decreased body mass→increased fat
Metabolism	Immature liver → low ability to metabolise drugs Older children with increased liver enzymes need higher doses Genetic factors, liver enzyme production, prenatal influences on mother alter metabolism	Ageing liver decreases in size and produces lower levels of microsomal enzymes Blood flow through liver reduces over time → reduced liver metabolism
Excretion	Kidney function reduced due to immaturity Kidney perfusion may be decreased → reduced urine concentration and drug excretion	Decreased blood flow → lower glomerular filtration Reduction in numbers of functioning nephrons Reduced kidney mass

Source: Adapted from Lilley et al., 2017

Pharmacodynamics

Drugs are designed to act on molecular targets within the body, of which there are many types. Some drugs exert their effect by inhibiting certain transport systems within the body (Verapamil is a calcium channel blocker) or from binding and inhibiting certain enzymes which are essential to the normal bodily function (aspirin is an inhibitor of cyclo-oxygenase) (Neal, 2016). However, most drugs act by

interacting with specific molecules in the body known as receptors (see below) which regulate the activity of the target cells (Barber and Robertson, 2015). Drugs can be of different types, including (Katzung and Trevor, 2015):

- *Agonists*: (activators), which through binding, activate the receptor and alter the cell activity in some way, such as enhancing the action of an enzyme which alters a specific mechanism within the cell.
- *Antagonists*: (inhibitors) do not activate a receptor and, by so doing, prevent other molecules binding with that receptor and activating the particular mechanism. For example, atropine is an antagonist which blocks the acetylcholine agonist site and reduces acetylcholine function.

They can also be described as:

- chemicals normally synthesised within the body, e.g. hormones
- substances not created within the body, called xenobiotics
- poisons: substances that are almost always harmful; however, almost any substance can be harmful in large enough dosages
- toxins: poisons created by biological organisms; some toxins can be used for beneficial results (e.g. botulinum toxin for hyperspasticity).

Drug receptors

Most receptors are in the cell membrane and usually interact with molecules, such as neurotransmitters or hormones, which are formed within the body to regulate cell function. However, drugs also interact with them. The drug molecule must be the specific size and shape to interact (like a lock and key) with the precise receptor it is to affect. How well a drug binds with its designated receptor is

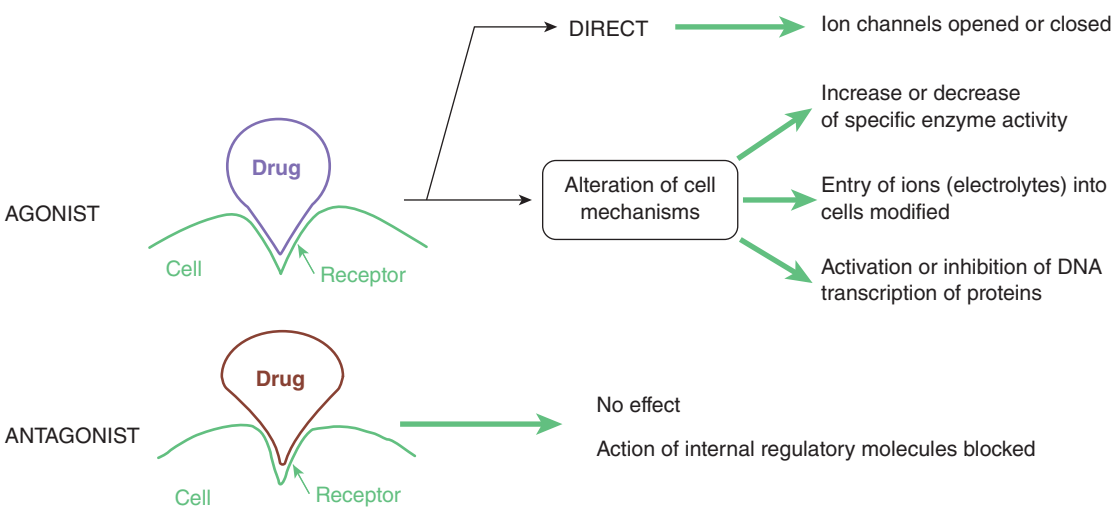


Figure 3.5 Drug–receptor interaction and activity

known as affinity; the tighter the bind the greater the effect (Barber and Roberston, 2015). Drugs can vary considerably in size, complexity and duration of action but are designed to work by modifying a particular aspect of cell function (Figure 3.5).

In addition, fewer than 10% of receptors are within the cell cytoplasm and interact with a range of molecules, mostly hydrophobic, with a major role in the regulation of endocrine function, but also involvement in sensing lipids. A considerable number of drugs, with a structure enabling entry to the cell, combine with such receptors (nuclear receptors) and the drug–receptor combination enters the nucleus of the cell and influences the transcription of DNA (Rang et al., 2018).

Activity 3.1: Understand

Drug receptors

Watch this video to help better understand drug receptors.

The video can be accessed by **scanning the QR code** with your smartphone camera or via **https://study.sagepub.com/essentialpatho2e**.

DRUG RECEPTORS (6:54)

Altered drug activity

This section is dealt with in four parts:

- Side-effects
- Drug interactions
- Types of adverse drug reaction
- Preventing adverse events.

Side-effects

Every drug has the potential to cause side-effects. These can include a more pronounced effect than intended or a predictable response to a drug taken in excess. For example, an excessive dose of paracetamol results in liver damage (hepatotoxicity). The extent or the seriousness of the side-effect depends on a number of factors, including age, patient comorbidities or genetic variability among the population. However, an understanding of the principles of pharmacodynamics can explain why some side-effects occur which may be unrelated to the therapeutic action of the drug and can

range from mild to very severe. It has been previously discussed that many drugs bind to proteins such as receptors or enzymes to exert their therapeutic effect. There are sub-classes of these receptors and different tissues may have different sub-classes, yet most drugs do not bind to a specific receptor only. Therefore, side-effects can be caused by the lack of specificity of a drug to a receptor. In other words, fewer side-effects will be experienced if the drug is designed to be more specific to its intended receptor (McFadden, 2019).

Apply

The pharmacodynamics of side-effects

Salbutamol is a drug known as a bronchodilator and is used in the treatment of asthma. Salbutamol is also known as a beta-2 (β_2) adrenergic receptor agonist, and will therefore bind most to β_2 adrenergic receptors to exert its bronchodilating effect. However, there are minimal differences in β_2 and beta-1 (β_1) receptors, so Salbutamol will also bind with β_1 receptors, the effect of which is to increase the heart rate. Therefore, from this we can predict that when a patient is using Salbutamol in the treatment of an acute asthmatic attack, it is likely they will experience the side-effect of tachycardia.

Drug interactions

Drugs are potentially hazardous in a number of different ways. Interactions can occur between drugs, between drugs and herbs (many drugs come from plant sources), between drugs and foods, and can alter drug activity at each stage of pharmacokinetics (i.e. absorption, distribution, metabolism, excretion). They can also compete for binding sites on receptors which may or may not lead to the activation of that receptor (pharmacodynamics) (Rang et al., 2018). When people are prescribed additional drugs, the potential for interactions must be considered and checked, and the individual warned about the particular risks associated with their own drug regime. The risk of interactions is of particular concern in older people who may be receiving drugs for the treatment of several chronic conditions. As previously outlined, both pharmacokinetics and pharmacodynamics change with age, and therefore an understanding of the clinical interplay between these processes is essential to choose the right treatment, at the correct dose for the appropriate duration.

In addition, some drugs that have a narrow margin of safety can have adverse effects when used alone or when taken with another drug, can increase drug levels and the potential for toxicity (Lynch, 2016). St John's Wort is a herb often taken by individuals independently of medical advice, but which can interact in relation to the pharmacokinetics or pharmacodynamics processes of a number of drugs: individuals should be asked about their use of this herb when drugs are prescribed (Rang and Dale, 2018). The British National Formulary (BNF) has a useful section on drug interactions and a recent copy should be consulted. Interactions will be considered using the principles of pharmacokinetics and pharmacodynamics.

Absorption

Some interactions can affect drug absorption. For example, taking antacids may reduce the absorption of a number of drugs, including some used in the control of blood cholesterol, and a number of commonly used antibiotics, digoxin, certain anti-epileptic drugs and others.

A further example is an effect on metabolism that occurs in the gut and normally destroys some toxins (including certain drugs) before absorption. Grapefruit, grapefruit juice and Seville oranges inactivate some of the enzymes involved so that higher levels of the drugs concerned enter the body and may have a toxic effect (FitzGerald, n.d.). Examples of drugs affected include some antimalarial drugs, calcium-channel blockers, some statins regulating blood **cholesterol** level, and others (McGavock, 2016).

Distribution

The distribution of drugs varies according to blood perfusion through the tissues and is often uneven due to a variation in blood perfusion in different tissues. Poorly perfused tissues such as muscle and fat result in the slow distribution of drugs (Le, 2017a). Additionally, a drug may compete for a common binding site on a plasma protein of another medication, and therefore alter its distribution or the level of free 'unbound' drug in the plasma. Such an interaction can lead to toxicity due to an increase in the concentration of free drug, requiring dose adjustments or contraindicating concomitant use (Rang and Dale, 2018).

Metabolism

A number of drugs inhibit or induce (speed up) the activity of the drug-metabolising enzymes in the liver (McGavock, 2016). Medication that inhibits these enzymes could cause an increase in the drug levels in the blood, which could increase the drug's pharmacological activity and duration of action. However, medication that induces drug metabolising enzymes will result in faster metabolism and (normally) levels will fall more rapidly with a reduced duration of action. Some foods can alter drug metabolism, for example, grapefruit juice can inhibit cytochrome P450 involved in drug metabolism in the liver (Koziolek et al., 2019). In addition, some herbs can also influence drug metabolism (Marko, 2016). St John's Wort has been identified as causing the induction of enzymes. Therefore, the risk of drug interaction is increased as the effectiveness of the drug and its duration of action have been altered.

Excretion

Most drugs are excreted through filtration by the kidneys following metabolism in the liver, in which the drug molecules combine with other chemicals which prevent their reabsorption following filtration in the kidneys. In addition to filtration, the elimination of many drugs involves active tubular secretion in the proximal tubule, which is dependent on energy and can be blocked by substances that block this process. The pH of urine varies considerably, altering the degree of excretion of drugs. Excretion through the kidneys decreases with age and by the age of 80 it is about 50% of its previous performance at age 30 (Le, 2017b). Renal disorders will reduce drug excretion. If the renal excretion of a drug has been reduced in the elderly, in those living with renal disorders or through the interaction of another drug, there is a significant risk of toxicity due to high levels of free drug within the plasma and its insufficient elimination from the body (Rang and Dale, 2018).

Drugs may compete for the same binding site on plasma proteins; this may cause the level of free (active) drug in the bloodstream to be raised. This may be of no significance, but if a drug with a narrow therapeutic index (e.g. digoxin) is displaced, it can result in toxicity.

When two drugs compete for binding with the same cell membrane receptor, then an adverse reaction may occur. A molecule that binds to such a molecule is called a ligand and may be an agonist which activates the receptor or an antagonist which blocks receptor activity. If one drug acts as an antagonist, it opposes the other's activity (Farinde, 2016).

Adverse drug reaction

An adverse drug reaction (ADR) is defined as 'an unwanted or harmful reaction which occurs after administration of a drug or drugs and is suspected or known to be due to the drug(s)' (NICE, 2017). There are a number of ADRs, however, that are most frequently categorised as either Type A or Type B (MHRA, 2015).

Type A – Exaggeration of known pharmacological activity

These adverse effects are similar to but stronger than the normal effects of the drug and are related to the dose administered and the individual's susceptibility to the drug (Rang et al., 2018). Accurate administration and careful observation of the effects of the drug are the first essential aspects of management. As these reactions are often dose dependent, such adverse effects are reversible if the dosage is reduced. **Iatrogenic** reactions are caused by medical examination or treatment.

Type B – Unexpected and idiosyncratic reaction

There are several major groups of ADRs unrelated to therapeutic actions which may occur with a normal dose.

Idiosyncratic reactions

Idiosyncratic reactions tend to be serious, unpredictable and uncommon. Unexpected chemical reactions can occur in susceptible people due to individual variation in DNA (nuclear or mitochondrial). They may cause damage to organs, e.g. liver, kidneys.

Immunological reactions

A number of drugs can cause an **allergic reaction** in some individuals. It is important that those affected are aware of the drugs to which they are allergic, compounds within which they may be contained, and understand that they must not take them. These individuals are often recommended to carry an adrenaline pen (an EpiPen) for emergency treatment in, for example, **anaphylactic shock**. They may also be advised to wear a Medic Alert bracelet. In addition, the In Case of Emergency (ICE) function on most smartphones often hosts the information (Rang et al., 2018).

Allergic reactions can be of various types, ranging from life-threatening to relatively minor, and include:

- Anaphylactic shock: this occurs due to the release of histamine and other mediators, causing a rash, tissue swelling, **bronchospasm** and hypotension, and may be lethal (anaphylactoid reactions are similar changes but occur due to nonimmune-mediated release of mediators from **mast cells** and/or **basophils** or by direct complement activation)

- Haematological reactions
- Allergic liver damage
- Other reactions, including skin eruptions which can range from mild rashes to life-threatening skin loss.

Carcinogenesis and fetal abnormalities

Some drugs can cause mutations in DNA, resulting in the initiation of cancers. Other drugs, if given during pregnancy, can result in a range of fetal abnormalities, as can German measles (rubella). The best-known example of a drug causing major abnormalities is the use of thalidomide in the late 1950s and 1960s in the treatment of early morning sickness. Eventually the increased incidence of major abnormalities in newly born infants was linked to this drug. There have been considerable changes in the testing required in the development of new drugs to reduce the risk of occurrence of similar tragedies. The terms used for such abnormalities are:

- *Carcinogenic*: has the potential to cause **cancer**
- *Teratogenic*: the drug can disturb embryonic or fetal development and result in a birth defect.

In more recent years, a commonly used anti-epileptic drug, sodium valproate, has also been associated with fetal abnormalities and has led to a new **syndrome** called fetal valproate syndrome (Dodou and Whiteley, 2014). This has led to a considerable review of how epilepsy is managed in pregnant women and those planning a pregnancy. Within the UK, the yellow card reporting system has been vital in upholding pharmacovigilance, where the adverse effects of drugs are monitored, assessed and evaluated by the Medicines and Healthcare products Regulatory Agency (MHRA) to prevent potential harm (BNF, 2021).

Preventing adverse events

One of the major causes of adverse drug events is an error in administration. Care in complying with all the issues mentioned under 'The essentials of drug administration' (below) is essential. If an inadvertent error does occur, it is crucial that it is reported immediately so that any necessary remedial action can be implemented.

Activity 3.2: Apply

Adverse drug reaction profile

Watch this video and think about the importance of adverse drug reactions and how to recognise them.

The video can be accessed by **scanning the QR code** with your smartphone camera or via **https://study.sagepub.com/essentialpatho2e**.

ADVERSE DRUG REACTION PROFILE (4:10)

SECTION 2: DRUG ADMINISTRATION

Nurses administer medication to those in hospital and other residential settings and play a role in ensuring that those in the community take their medications correctly. It is thus essential that you understand the principles underpinning drug action and administration. As indicated earlier, drugs used in the treatment of **disease** can be harmful if administered incorrectly or inappropriately; every nurse must know about, and must accurately perform, administration to ensure that drugs will function as anticipated. The nurse must also know when it is appropriate to omit a drug from administration. The essentials of drug administration are the necessary aspects of practice to ensure patient safety in relation to drugs and are stated below.

Safe administration

The basic principle is that the prescription is correct for the person/recipient and is administered as prescribed (except when it is not appropriate and should be omitted). Safe administration of medicines requires professional judgement and concentration on the part of the nurse. (See the Apply box below.)

Most health care institutions have specific standards for drug administration. For example, student nurses can usually only administer drugs under the supervision of a registered nurse, and controlled drugs must normally be checked and administered by two registered nurses (a student nurse can sometimes be a third person in this situation).

Apply

The essentials of drug administration

Within the UK, the Royal Pharmaceutical Society/Royal College of Nursing (RPS/RCN) *Professional Guidance on the Administration of Medicines in Healthcare Settings (2019–2023)* (2019: section 14, 15) states: 'Before administration, the person administering the medicine must have an overall understanding of the medicine being administered and seeks advice if necessary from a prescriber or a pharmacy professional'.

Correct person: The name and person's details on the prescription chart must correspond with the name on the patient's identification details (e.g. on their armband), including full name, identification number, DOB, age, and with the patient's verbal statement (when possible). Some patients with, for example, dementia may be confused, and a photograph should be included with their prescription. Any issues around consent must be identified and discussed. Any allergies recorded must also be noted and considered.

Appropriate prescription: The drug details on the prescription must be correct. That is, the dosage prescribed must be appropriate for the person, taking account of the normal dose of the drug, the different strengths in which it is dispensed, and the person's condition and age. You should not normally find that you have to administer very large numbers of a tablet to give the prescribed dose. The start and finish date should be adhered to.

Correct drug: The drug name, form and route of administration, strength, dose and time of administration should all be specified. The date of expiry of the prescription (e.g. for antibiotics) must be checked. Any queries must be checked with the prescriber. It is essential to use the BNF and the agreed formulary to check the information about the drug and its use before administering or prescribing a drug. Do not administer a drug without understanding its specific indication for the patient you are caring for.

(Continued)

Administration: The administration of the drug must be correct. The prescription must be checked carefully against the drug container. Some drugs have similar (but not exactly the same) names, but completely different actions: great care is required.

- Check for any side-effects, interactions or contraindications before administration.
- The dosage must match the prescription.
- The route of administration must be as specified.
- The correct time of administration must be adhered to. Some drugs are most effective if administered in the morning, others in the evening, some on an empty stomach, others with food.
- The drug must be administered in person to the appropriate recipient, and consumption witnessed (i.e. not left on the locker).
- Any special considerations or instructions must be adhered to.

Recording: Accurate records of drugs administered must be completed and signed by the responsible person. Any adverse reactions must be reported and recorded.

(Lawson and Hennefer, 2010; Lilley et al., 2017)

Important notes

- You should never administer drugs for another nurse unless you have been fully involved in all processes outlined in these principles; otherwise you cannot be certain about what you are giving and whether it is appropriate.
- There will be occasions when it is not appropriate to give a prescribed drug. For example, you would not administer anti-hypertensive drugs to a person with very low blood pressure as you would lower it further, potentially causing them serious harm.
- If in any doubt, ***always check with the prescriber before administration!!!***

Go deeper

Frequent drug administration errors

It is imperative that drugs are administered to the person exactly as intended and as directed by the prescriber. In order to do this safely, the prescribing directions must be clear and unambiguous, and when they are not, clarity is sought. There are a number of frequent drug administration errors which could be avoided by applying the principles of pharmacokinetics when administering different drug formulations to ensure the dose remains within the therapeutic levels prescribed.

Modified release formulations

Not all medications are released into the bloodstream immediately following administration (immediate release). Some drug formulations (modified release [MR]) have been designed to slow the release of the drug to increase the therapeutic effect of the drug and reduce the potential for side-effects. There are different types of modified release formulations and they usually have the following abbreviations after the drug name to indicate a different rate of drug release: MR, ER XL, SR, CR.

Delayed Release: the drug is released at a delayed point following administration.

Extended Release (ER or XL): this prolongs the release of the drug and can be either sustained (SR) or controlled (CR). SR enables the drug to be released over a sustained period but not at a constant rate, whereas CR maintains drug release at a constant rate over a sustained period (Perrie and Rades, 2012).

An understanding of modified release formulations is essential for safe and effective drug administration as drugs can be available in a number of different formulations. For example, Metformin is a drug used in the treatment of type 2 diabetes mellitus and is available as both Metformin and Metformin SR. The incorrect administration of these could alter its therapeutic action and lead to the ineffective management of this condition.

Altering drug formulations

Drugs are designed to ensure optimum absorption. Some drugs require an enteric coating (E/C) to ensure they remain intact as they move through the stomach and into the small intestine. It is therefore inappropriate and unsafe to alter the drug formulation by crushing or splitting tablets/capsules as the rate of drug absorption will have changed. If the specified drug formulation has become challenging for the person, this must be discussed with a pharmacist so a suitable alternative can be identified (Barber and Robertson, 2015).

Abrupt withdrawal of medication

It is essential that a drug is administered at the correct dose, direction and treatment duration intended by the prescriber. The abrupt withdrawal of medication can have a significant impact on a person, causing a dramatic, and sometimes rapid, deterioration in their condition. Nurses must be observant and actively listen to people in their care to ensure intentional or unintentional withdrawal is avoided. An example of this would be in the use of selective serotonin reuptake inhibitors (SSRIs) in the treatment of depression. By applying the principles of pharmacokinetics, a nurse should understand the need for a careful and monitored reduction in dosage to ensure a balanced withdrawal of medication while not negatively impacting mood or, alternatively, to facilitate the appropriate 'wash out' period to enable a change in antidepressant medication more appropriate for their recovery journey.

(Continued)

Multiple prescribers

Multiple prescribers may be involved in the care of people living with comorbidities. This may be due to the transition of a person from a hospital setting into community-based care or their conditions dictate they are treated by a number of different specialist clinicians within the broader multidisciplinary team. The diversity in approaches can lead to differing clinical priorities within the treatment plan. Nurses must always remember that conditions which affect the physical, mental, emotional and social wellbeing of a person rarely happen in isolation, and therefore the need for collaborative communication and meticulous record keeping is essential.

Polypharmacy

Polypharmacy is defined as the use of multiple concurrent medications by an individual. People are increasingly living with complex conditions and the different medications used to treat them require careful management. Polypharmacy is recognised as having both positive and negative effects. The use of multiple medications is sometimes required to treat various conditions and improve quality of life. However, the use of multiple treatments can be inappropriate, indicating the 'over diagnosis' of a person or the use of one drug to treat the side-effects of another. Specifically, polypharmacy places many ageing people at risk, as older people tend to be prescribed more drugs, which have the potential to interact and also place high demand on the liver and organs involved in elimination (e.g. the kidneys). The use of multiple medications should be informed by careful clinical consideration and regular comprehensive medication review to minimise the potential of drug interactions or adverse reactions.

Person-centred context

The Bodie family

Among a family group of the size and range of ages of the Bodies, you would expect to find a number of them taking drugs for chronic or acute disorders, and indeed this is the case with this family. Indeed, they may also take medications irregularly for symptom management not necessarily related to a disorder (e.g. paracetamol for an occasional headache).

As is fairly common with their age group, the oldest members of the family, George (84) and Maud (77), are both taking drugs to manage chronic conditions. For her **heart failure** Maud is taking digoxin to regulate the cardiac cycle and warfarin to limit the associated risk of blood clotting, and thyroxine for her below normal level of activity of the thyroid gland. George is prescribed statins to lower his raised blood cholesterol levels.

In the next generation, two members of the family, Hannah and Sarah, are going through the menopause, and HRT (hormone replacement therapy) has been used to help minimise the symptoms often associated with this stage of life. Sarah stopped taking these recently after 2+ years, while Hannah is gaining relief from symptoms by using HRT patches.

Edward has chronic low back pain and, when it is particularly problematic, uses OTC (over the counter) pain-relieving drugs and visits an osteopath as necessary. In addition, Matthew is receiving antidepressant medication on a long-term basis.

Among the grandchildren, Derek has mild asthma and Margaret has hay fever. Both manage their conditions themselves under the overall guidance of their GP. They request prescriptions for the necessary inhalers or oral medication to control symptoms as necessary.

Activity 3.3: Apply

Drug interactions and polypharmacy

Spend some time reviewing the Bodie family case notes and identifying the potential drug interactions that have been caused by polypharmacy. Some of these interactions could have been avoided by applying a holistic approach to medication management, in which the whole person is considered within each clinical judgement made. Remember there is a clinical interplay between the pharmacokinetics (what the body does to the drug), pharmacodynamics (what the drug does to the body) and the lived experience of each person a nurse will care for!

SECTION 3: PRESCRIBING MEDICATION

Prescribing within the nursing profession has evolved considerably since its tentative inception in the late 1990s. The benefits of increased access, capacity and improved patient choice, through managing the full delivery of care in various clinical settings, has led to an attitudinal shift in public and interdisciplinary acceptance of independent nurse prescribers (Nuttall and Rutt-Howard 2020). While there is an increasing recognition of the complexities of the role, it provides an invaluable contribution by building on a core knowledge base, skills and person-centred approach to prescribing valued by patients and professional colleagues (Dowden, 2016). The Nursing and Midwifery Council's *Standards of Proficiency for Registered Nurses* (NMC, 2018a) now requires nurses to be equipped to progress to the completion of a prescribing qualification after registration. The drugs that may be prescribed by registered nurses who have an additional prescribing qualification are identified within an agreed formulary. In addition, all nurses must learn to undertake the necessary accurate calculations to prescribe drugs safely (see below).

At present, there are three main groups of prescribers (Dowden, 2016):

1. **Independent prescribers** are able to prescribe medicines on their own initiative from the BNF (within their area of competence) and include doctors, dentists and some non-medical health professionals (including nurses, pharmacists and, more recently, registered chiropodists/podiatrists, physiotherapists, optometrists and registered therapeutic radiographers).
2. **Community practitioner nurse prescribers** can prescribe independently but only from the Nurse Prescribers Formulary for Community Practitioners.
3. **Supplementary prescribers** can only prescribe drugs (from the BNF) agreed as part of the patient's clinical management plan.

Non-medical prescribers

Non-medical health professionals must have completed appropriate education and supervision in preparation for their prescribing role, in addition to their standard professional education. They then have their names entered on the appropriate prescribers register and are permitted to prescribe within their area of expertise. Within the UK, the Royal Pharmaceutical Society (RPS) have developed *A Competency Framework for All Prescribers* (RPS, 2021), which has now standardised the core elements of safe and effective prescribing practice among all prescribers (Figure 3.6). This has been adopted by the Nurse and Midwifery Council (NMC, 2018b).

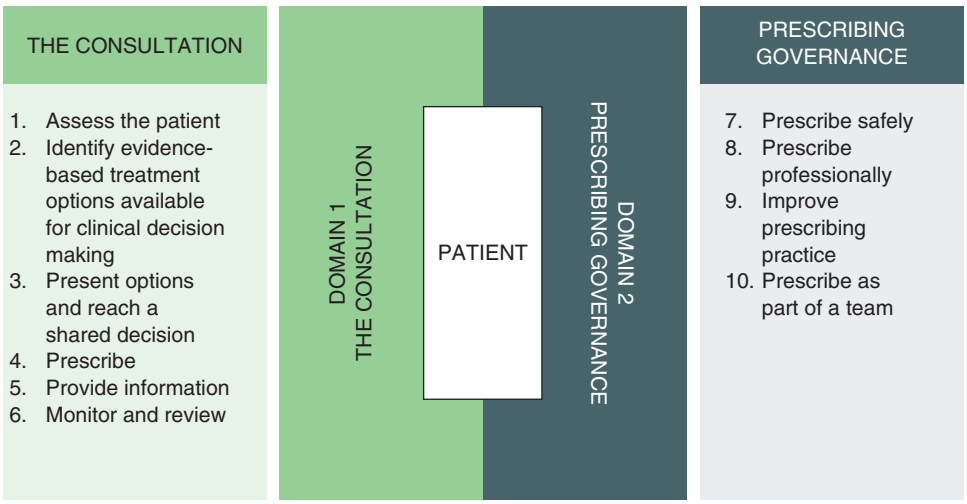


Figure 3.6 A Competency Framework for all Prescribers (RPS, 2021)

Supplementary prescribers

This type of prescribing differs from independent prescribing in that it requires a doctor or dentist to take on the role of the independent prescriber (IP) in partnership with the non-medical prescriber, who is designated the supplementary prescriber (SP). This prescribing dynamic requires the IP to hold the diagnostic responsibility and to set the parameters in which the SP can prescribe (Nuttall and Rutt-Howard, 2020). Supplementary prescribers are permitted to prescribe within the limits of a clinical management plan (CMP) (Table 3.6) agreed for a specific group of people by the supplementary prescriber, doctor (independent prescriber) and recipient.

Pharmaceutical legislation

All jurisdictions have legal standards for the management of drugs. In the UK, The Human Medicines Regulations (2012) replaced and simplified the various Acts and Statutory Instruments dealing with the preparation, storage, prescribing etc. of medicines (Appelbe and Wingfield, 2013). Legal issues related to

Table 3.6 Essential differences between CMP, PGDs and PSDs

Clinical Management Plan (CMP)	A handwritten or electronically generated agreed clinical treatment plan for a specific patient and his/her specific condition before prescribing begins
Patient Group Directive (PGD)	The use of a PGD is not the same as prescribing as it is not generated on an individual basis. It is a written directive on the sale, supply or administration of a medication to a patient group, e.g. immunisations
Patient Specific Directive (PSD)	The use of a PSD is a written directive from an independent prescriber for a medication to be supplied or administered for a specific patient, e.g. a ward round drug chart

Source: Nuttall and Rutt-Howard, 2020

medication and prescribing are briefly considered in this section, which is based on UK law. Almost all countries have regulations related to the management of medications – if applicable to you, undertake the activity below.

Activity 3.4: Apply

Pharmaceutical regulations

Those of you reading this book in countries other than the United Kingdom can undertake this activity. Look up the regulations related to drug prescription and administration which apply in your own country. You should be able to find this on the Web under: pharmaceutical regulations [name of your country].

Drug classifications

There are three groups of medications (Appelbe and Wingfield, 2013):

1. General Sales List (GSL) drugs can be sold without supervision, e.g. in a supermarket or shop.
2. Pharmacy (P) medicines are those which are not included in the GSL or the POM (below) groups and can only be sold over the counter (OTC) in registered premises under the supervision of a pharmacist. They do not need a prescription.
3. Prescription Only Medicines (POM) can only be provided by a pharmacist in registered premises in response to a prescription written by an authorised prescriber. The premises are usually a community pharmacy or hospital pharmacy, although some doctors, usually in rural communities, act as dispensing doctors and are permitted to provide drugs to some people in their care.

In providing person-centred care, it is important to be aware of all the drugs being taken by an individual, including OTC (i.e. both P and GSL) medications, as they may interact with those being prescribed. Drugs which can be prescribed within the UK National Health Service (NHS) are determined by the National Institute for Health and Care Excellence (NICE). Information about these drugs and others which must be self-funded (with a prescription and consultant's agreement), and considerable additional information, is contained within the British National Formulary (BNF, 2022). This is an essential reference for prescribers

and those who administer medications. It is published in print twice a year (March and September), with monthly updates available online.

Unlicenced/Off label drugs

For a drug to become a licenced medication it must hold a marketing authorisation by a recognised regulator – the MHRA in the UK. To prescribe 'off label' means that the drug has been prescribed outside the parameters of its licence for authorised use. An unlicenced medication does not hold a licence or a marketing authorisation for use under any indication (MHRA, 2014). However, independent prescribers can prescribe unlicenced or 'off label' medication only if the prescriber is satisfied that a licenced medication would not meet the specific clinical need of the patient and it is within their competence to do so (RPS, 2021).

Controlled drugs (CDs)

Under UK law, the Misuse of Drugs Act 1971 prohibits certain activities in relation to the manufacture, supply and possession of controlled drugs. The relevant penalties applicable to certain drugs are related to the level of harm attributed to their use, and they have therefore been categorised in three classes (Class A, B and C). Class A are the most harmful (BNF, 2021). Within the Misuse of Drugs Regulations 2001 controlled drugs have been defined in five schedules (1–5), each specifying the requirements for the import, export, production, supply, possession, prescribing and record keeping for controlled drugs (Nuttall and Rutt Howard, 2020). Prescriptions for Schedule 2 and Schedule 3 controlled drugs are subject to strict prescription requirements which must be met before a pharmacist can dispense the prescription (BNF, 2022). As controlled drugs are liable for misuse and abuse within both hospital and community care settings, it is imperative that strict adherence to these requirements is maintained and meticulous prescribing, dispensing and administration records are kept.

Apply

Misuse and abuse: Drug dependency

Matthew Bodie has a history of depression and has previously taken antidepressants (SSRIs, i.e. selective serotonin reuptake inhibitors) and received a short course of cognitive behavioural therapy (CBT). However, following the COVID-19 national lockdown, he is currently unable to work as a self-employed electrician or attend his local DIY group. He has become increasingly isolated as he lives alone and is experiencing ongoing 'pain' in his back, which is generalised and difficult to rate on the pain scale, but he believes happened in his last job before lockdown. He has been buying OTC painkillers to self-treat for several weeks and his pharmacist has contacted his nurse with concerns around the frequency of his intake and Matthew's mood. As a future nurse prescriber, what are the key considerations when reviewing Matthew's case? How can person-centred prescribing inform the compassionate care Matthew needs?

Shared decision making and health literacy

Medicine taking behaviour can be transformed by prescribers when a person's beliefs, motivations and perspectives are explored and incorporated into a shared decision-making process. Different terminology is often used to describe a person's behaviours towards their treatment, such as compliance, concordance and adherence. Compliance implies the extent to which a person follows the clinical advice they have been offered, and thus has been viewed as too paternalistic (Sackett and Haynes, 1976). Adherence follows on from this, implying more patient involvement, as it is defined by how much the person's behaviours are aligned to the agreed recommendations made with their health care provider (WHO, 2003). Concordance is used to describe a more collaborative approach, as treatment decisions are shared by incorporating the beliefs and perspectives of both the person and the health care professional. This can be facilitated through the promotion of health literacy, which is defined as 'the ability of an individual to obtain and translate knowledge and information in order to maintain and improve health in a way that is appropriate to the individual' (Lui et al., 2020). It is imperative that nurse prescribers actively work to improve health literacy among those they care for, through the use of effective communication and structured health education to empower patients to become active agents in the delivery of their own person-centred care (Nutbeam et al., 2018).

CHAPTER SUMMARY

This chapter has considered some of the core principles which underpin the pharmacological treatment of disorders. It aims to enable you to be safe practitioners in relation to drug administration and prescribing through using your knowledge and understanding, professional judgement, concentration and sense of responsibility.

Key points

- Drugs are available in three groups in the UK: General Sales List (GLS), Pharmacy (P) and Prescription Only Medicines (POM). The last group can only be provided if prescribed by an independent prescriber or a supplementary prescriber within a clinical management plan.
- Drugs link with receptors within the cells of the target organs. The drugs may be agonists (activators) or antagonists (inhibitors).
- The level of drug action depends on the concentration of the drug in the bloodstream. This is determined by the pharmacokinetic stages of:
    a. Absorption – by enteral (first-pass metabolism must be taken into account), parenteral or topical routes. The speed of absorption varies with route of administration and formulation of the drug.
    b. Distribution – a proportion of the drug will be carried in combination with plasma proteins. The free drug is available for combining with receptors and modifying cell function.
    c. Metabolism – drug molecules are mainly metabolised in the liver to an inactive or more active substance, or to a more water-soluble form which can be readily excreted.

(Continued)

d. Excretion – the kidneys are the main organ for drug excretion but some drugs are excreted into the bile, thence into the small intestine and pass out in the faeces.

- The basic principle of drug administration is that the correct person receives the correct drugs. Dosages vary in the young and in older adults due to variation in the pharmacokinetics.
- A range of adverse drug events can occur and are particularly common in older adults due to polypharmacy and a reduction in organ function. They can be due to the known effects of the drug, idiosyncratic in nature, or due to immunological reactions or mutagenic changes in the DNA.

Revise

Test your knowledge

The content of this chapter will have helped you to understand the principles of drug therapy. Revise the different sections in turn and then try to answer the questions below.

Answers are available online at **https://study.sagepub.com/essentialpatho2e/answers**.

1. Outline the different classes of drugs and the groups of prescribers.
2. Identify and briefly describe the main terms used to describe types of drugs.
3. Outline how drugs act on the body.
4. Identify and briefly describe the four stages of pharmacokinetics.
5. Specify the main routes for the administration of drugs.
6. What do you understand by first-pass metabolism? How can it be avoided?
7. Outline the essentials of drug administration.
8. Briefly discuss the potential difficulties in drug administration with older people.
9. Outline the types of adverse drug effects that can occur and consider how these can be limited.

Revise

Ace your assessment

For additional revision resources visit **https://study.sagepub.com/essentialpatho2e**.

- Revise key terms relevant to this chapter with interactive flashcards.
- Test yourself with quizzes and multiple-choice questions.
- Access the glossary with audio to hear how complex terms are pronounced.

REFERENCES

Appelbe, G.E. and Wingfield, J. (eds) (2013) *Dale and Appelbe's Pharmacy and Medicines Law*, 10th edition. London: Pharmaceutical Press.

Ballabh, P., Braun, A. and Nedergaard, M. (2004) The blood–brain barrier: an overview – structure, regulation, and clinical implications. *Neurobiology of Disease*, *16* (1): 1–13.

Barber, P. and Robertson, D. (2015). *Essentials of Pharmacology for Nurses*, 3rd edition. Maidenhead: Open University Press.

BNF (2022) *British National Formulary*, 82nd edition. London: BMJ Group and Royal Pharmaceutical Society.

Dodou, K. and Whiteley, P. (2014) Concerns with using sodium valproate to treat epilepsy in pregnant women. *The Pharmaceutical Journal*, *292* (7808): 482.

Dowden, A. (2016) The expanding role of nurse prescribers. *Prescriber*, 20 June. Available at: www.prescriber.co.uk/article/expanding-role-nurse-prescribers/ (accessed 20 August 2018).

Farinde, A. (2016) *Clinical Pharmacology, Drug–Receptor Interactions*. Kenilworth, NJ: MSD Manual, Professional Version. Available at: www.msdmanuals.com/professional/clinical-pharmacology/pharmacodynamics/drug%E2%80%93receptor-interactions (accessed 9 October 2018).

FitzGerald, R. (n.d.) *Important Drug Interactions*. University of Liverpool, Wolfson Centre for Personalised Medicine/MRC Centre for Drug Safety Science. Available at: https://www.rcplondon.ac.uk/file/3974/download (accessed 20 December 2020).

Katzung, B.G. and Trevor, A.J. (2015) *Basic and Clinical Pharmacology*, 13th edition. New York, NY: McGraw-Hill Education.

Koziolek, M., Alcaro, S., Augustijns, P., Basit, A.W., Grimm, M., Hens, B. et al. (2019) The mechanisms of pharmacokinetic food-drug interactions – a perspective from the UNGAP group. *European Journal of Pharmaceutical Sciences*, *134*: 31–59. http://doi.org/10.1016/j.ejps.2019.04.003

Lawson, E. and Hennefer, D.L. (2010) *Medicines Management in Adult Nursing*. Exeter, UK: Learning Matters.

Le, J. (2017a) *Clinical Pharmacology: Drug Distribution to Tissues*. Kenilworth, NJ: MSD Manual, Professional Version. Available at: www.msdmanuals.com/en-gb/professional/clinical-pharmacology/pharmacokinetics/drug-distribution-to-tissues (accessed 9 October 2018).

Le, J. (2017b) *Clinical Pharmacology: Drug Excretion*. Kenilworth, NJ: MSD Manual, Professional Version. Available at: www.msdmanuals.com/en-gb/professional/clinical-pharmacology/ pharmacokinetics/drug-excretion (accessed 9 October 2018).

Lilley, L.L., Collins, S.R. and Snyder, J.S. (2017) *Pharmacology and the Nursing Process*, 8th edition. St Louis, MO: Mosby.

Lui, C., Wang, D., Liu, C., Jiang, J., Wang, X., Chen, H. et al. (2020) What is the meaning of health literacy? A systematic review and qualitative synthesis. *Family Medicine and Community Health*, *8*: e000351. https://doi.org/10.1136/fmch-2020-000351

Lynch, S.S. (2016) *Clinical Pharmacology: Drug Interactions*. Kenilworth, NJ: MSD Manual, Professional Version. Available at: www.msdmanuals.com/en-gb/professional/clinical-pharmacology/factors-affecting-response-to-drugs/drug-interactions (accessed 9 October 2018).

Marko, M.G. (2016) *Special Subjects: Overview of Dietary Supplements*. Kenilworth, NJ: MSD Manual, Professional Version. Available at: www.msdmanuals.com/en-gb/professional/ special-subjects/dietary-supplements/overview-of-dietary-supplements#v1126015 (accessed 9 October 2018).

Mayerova, M., Ustohal, L., Jarkovsky, J., Pivnicka, J., Kasparek, T. and Ceskova, E. (2018) Influence of dose, gender, and cigarette smoking on clozapine plasma concentrations. *Neuropsychiatric Disease and Treatment*, *14*, 1535–43. https://doi.org/10.2147/NDT.S163839

McFadden, R. (2019) *Introducing Pharmacology For Nursing and Healthcare*. Harlow: Pearson.

McGavock, H. (2016) *How Drugs Work: Basic Pharmacology for Health Professionals*, 4th edition. Boca Raton, FL: CRC Press.

MHRA (Medicines and Healthcare products Regulatory Agency) (2014) The Supply of Unlicensed Medicinal Products ('specials'), MHRA Guidance Notes 14. MHRA: London

MHRA (Medicines and Healthcare products Regulatory Agency) (2015) *Guidance on Adverse Drug Reactions*. London: Medicines and Healthcare products Regulatory Agency. Available at: www.mhra.gov.uk

National Institute for Health and Care Excellence (NICE) (2017) Adverse Drug Reactions. Available at https://cks.nice.org.uk/topics/adverse-drug-reactions/ (accessed 21 December 2021).

Neal, M.J. (2016) *Medical Pharmacology at a Glance*, 8th edition. Oxford: John Wiley & Sons.

NMC (Nursing and Midwifery Council) (2018a) *Future Nurse: Standards of Proficiency for Registered Nurses*. London: NMC.

NMC (Nursing and Midwifery Council) (2018b) *Standards for Prescribing Programmes*. London: NMC.

Nutbeam, D., McGill, B. and Premkumar, P. (2018) Improving health literacy in community populations: a review of progress, *Health Promotion International*, *33* (5): 901–11. https://doi.org/10.1093/heapro/dax015

Nuttall, D. and Rutt-Howard, J. (2020) *The Textbook of Non-Medical Prescribing*, 3rd edition. Oxford: Wiley Blackwell.

Perrie, Y. and Rades, T. (2012) *Pharmaceutics-Drug Delivery and Targeting*, 2nd edition. London: Pharmaceutical Press.

Rang, H.P., Ritter, J.M., Flower, R.J. and Henderson, G. (2018) *Rang and Dale's Pharmacology*, 9th edition. London: Churchill Livingstone, Elsevier.

Royal Pharmaceutical Society/Royal College of Nursing (2019) *Professional Guidance on the Administration of Medicines in Healthcare Settings (2019–2023)*. London: RPS/RCN.

RPS (Royal Pharmaceutical Society) (2021) *A Competency Framework for all Prescribers*. London: RPS.

Sackett, D. and Haynes, R.B. (1976) *Compliance with Therapeutic Regimens*. Baltimore, MD: Johns Hopkins University Press.

World Health Organisation (2003) *Adherence to Long-term Therapies: Evidence for Action*. Geneva: WHO. Available at: www.who.int/chp/knowledge/publications/adherence_report/en/ (accessed 11 July 2014).