

Clinical Physiology and Pharmacology

The Essentials

Farideh Javid

*Division of Pharmacy and Pharmaceutical Sciences,
School of Applied Sciences, University of Huddersfield, UK*

and

Janice McCurrie

School of Pharmacy, University of Bradford, UK



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Preface

Introduction

Physiology plays a major role in the scientific foundation of medicine and other subjects related to human health and physical performance. Pharmacology is the science which deals with the effects of drugs on living systems and their use in the treatment of disease. This book is designed to enhance students' understanding of physiology and pharmacology via a series of case studies involving human disease and its treatment.

Traditional university teaching methods focus on informing students in terms of physiological and pharmacological theory. This approach, although often extremely efficient and effective, may leave students in a position of remembering the facts and understanding the mechanisms but not necessarily being able to apply their knowledge to real-life situations. The latter ability is a skill which requires time and experience to develop and its acquisition is a key goal in vocational programmes, such as those associated with the training of doctors, pharmacists and other health care professionals. In our own teaching we have found that one very effective means of acquiring this all-important skill is via the use of clinical case studies. The case studies bring basic physiology and pharmacology to life, allowing students to examine ways in which the disruption of homeostatic mechanisms results in patients presenting with specific signs and symptoms. Case studies also enable students to understand how these signs and symptoms can facilitate diagnosis, and this is augmented as the students gain understanding of ways in which pharmacological intervention can be used to treat disruptions in homeostasis.

This book consists of a series of chapters containing case studies organized by major organ system; the book also contains answers to all the questions. There are very few texts available that use clinically relevant case studies to facilitate a student-centred learning approach. This book is designed to fill that niche. This type of student-centred learning not only brings theoretical subjects to life but also promotes deep learning, reflection and enhances analytical skills. We hope you enjoy working through these cases and would be happy to receive your comments on this book to inform future editions.

Aims of the Book

The case studies and the questions which follow will aid your understanding of many types of biological and clinical factors. They are intended to help you prepare for problems associated with clinical physiology and pharmacology that you may meet both in formal examinations and in future professional practice. The case studies presented cover a wide range of psychological, neurological, endocrine, cardiovascular, respiratory, renal, gastrointestinal and reproductive disorders, their symptoms, complications and usual treatment along with the actions, dosage and uses of some widely used drugs. The key points for each case study, which can be found in the Answers section will aid your revision of the major factors associated with each disease or condition.

These case studies provide a practical illustration of common disease states, together with their treatment; the explanations given will help you to relate these conditions to knowledge gained from your lecture courses.

Learning Outcomes

After successfully completing each case, you should be able to:

- understand and describe the signs and symptoms of the disorder in question and its underlying pathophysiology;
- understand and describe the pharmacology of agents currently used in the treatment of the disorder studied;
- appreciate some of the key issues in determining appropriate medication;
- continue to develop your problem-solving skills.

Using This Book

Clinical Physiology and Pharmacology is written primarily for undergraduate students studying modules in physiology and pharmacology as part of a degree in science, pharmacy, preclinical medicine or other health-related courses.

One of the challenges in studying physiology and pharmacology is the very large number of facts and ideas that must be remembered; this factual load can seem daunting. To understand how drugs produce their therapeutic effect, it is essential to have knowledge and understanding of both the physiological mechanisms which underpin pharmacology and the mechanisms of action of drugs currently being used. In addition the innovations of the pharmaceutical industry ensure that the extensive list of therapeutic drugs to be considered continues to increase each year.

Isolated facts, physiological mechanisms, drug names and actions can sometimes be remembered for only a comparatively short time. However, this process of memorizing and understanding facts represents only the first step in your learning.

The next vital stage is to develop your ability to interpret, analyse and use this information in order to solve problems and formulate solutions. Using what you have remembered from your physiology and pharmacology studies to interpret the cases presented in this book will help to move factual knowledge from your superficial memory into deep-memory stores, illustrate the clinical application of this basic knowledge, assist you in revising many important topics and improve both your skills and confidence in problem-solving. Since the information is placed in a realistic setting, your recall of key facts and concepts in physiology and pharmacology will be enhanced.

We hope that using this book will also prove to be a useful step towards applying these skills during your future professional life.

The Case Studies

The case studies are presented as short scenarios with interlinked questions that will both challenge your understanding and lead you through the major learning outcomes of the case as it unfolds.

The *learning outcomes* to be achieved are clearly stated at the beginning of each case study and will focus your attention on the most important facts, topics, mechanisms and concepts to be addressed as you work through it.

Although each case study presents a unique scenario, some important physiological mechanisms and pharmacological agents are involved in more than one of the scenarios. This will give you the opportunity to rehearse knowledge already gained from a previous case study to answer a question directly and enable you to revise any aspects that were not previously clear. The overlap between cases will also help to emphasize that some signs and symptoms are common to several different conditions and that care must be taken to consider all the factors presented before formulating your answers or coming to a conclusion about the case study.

Key points are provided for each case and are intended both as a short summary of the essential points and as a focus for revision. They can be used to preview or review the case content. Important points should then be easier to remember in the future, especially when, by association, you can recall them in an appropriate clinical context.

The *glossary* collects simple definitions of the most important terms into a single location for easy reference.

The *index* lists the number of the case in which the key terms, conditions and drugs are discussed.

The drug doses stated in this book were checked at the time of writing but may now have changed due to revision or updating of treatment regimes. Current dosage recommendations are available in the up-to-date British National Formulary or any other Formulary.

Farideh Javid
Janice McCurrie

CASE STUDIES

1

Psychological disorders

CASE STUDY 1 A mother's loss

Learning outcomes

On completion of the following case study, you will be able to:

- describe the signs and symptoms associated with this disorder;
- describe the underlying pathophysiology of the disorder presented;
- outline pharmacological approaches to the management of the symptoms;
- explain how drugs may cause their clinical benefits and side effects;
- outline the mechanism of action of amitriptyline hydrochloride;
- explain the advantages of using SSRIs (selective serotonin re-uptake inhibitors) compared to tricyclic antidepressants and MOIs (monoamine oxidase inhibitors).

Part 1

It has been nearly five months since 45-year-old Mrs Ford lost her only son. He was 12 years old and was killed in a car accident while playing with his friends. She has been feeling very down since it happened and has an overall feeling of utter hopelessness. She is unable to feel happiness, has difficulty sleeping and her appetite is greatly reduced. Mrs Ford used to enjoy socializing with her friends; however, now she has lost interest. She had been planning to redecorate the house, but since the loss of her son she cannot be bothered. She does not want to cook and when hungry does not feel like eating. She feels that life has no meaning without her son and wishes to join him very soon. Fortunately, Mrs Ford's sister visited her recently and was so worried about her condition that she convinced her to see a doctor. After visiting her family doctor, Mrs Ford was prescribed amitriptyline hydrochloride. The doctor advised her to take this medication at night.

- Q1** What is the likely diagnosis of Mrs Ford's symptoms?
- Q2** List the symptoms of depression.
- Q3** Which of Mrs Ford's symptoms are consistent with the profile of depression?
- Q4** Comment on the pathophysiology of this condition.
- Q5** What treatments are available for depression?
- Q6** Name three categories of drug currently used to treat patients with depression and comment on their mechanisms of action.
- Q7** To which category of drug does amitriptyline hydrochloride belong?
- Q8** What is the recommended adult dose for amitriptyline hydrochloride? Why was Mrs Ford advised to take the medication at night?
- Q9** What are the possible side effects associated with the use of amitriptyline hydrochloride?

Part 2

A week later Mrs Ford made another appointment with the doctor, complaining that the prescribed medication was not effective.

- Q10** Can you suggest an explanation for the amitriptyline hydrochloride being ineffective? Does Mrs Ford need a different medication?

Part 3

Three weeks later Mrs Ford visited her doctor again. She reported that her mood had improved and that she felt better than before; however, she complained about having a dry mouth and blurred vision. An alternative drug was prescribed, which proved to be more suitable for Mrs Ford.

- Q11** Suggest an alternative drug which is likely to be more suitable for Mrs Ford.
- Q12** Outline the advantages of using SSRIs compared to tricyclic antidepressants. Your answer should include an example of an SSRI and its recommended daily dose.
- Q13** Name the main side effects associated with the use of SSRIs.
- Q14** This patient was not prescribed an MOI. Comment on the disadvantages of using MOIs in the treatment of depression.

CASE STUDY 2 A dangerous father?

Learning outcomes

On completion of the following case study, you will be able to:

- present an overview of mania, its aetiology and associated symptoms;
- outline a possible connection between the use of antidepressants and the development of mania;
- explain therapeutic approaches to managing the symptoms;
- explain the limitations associated with the use of lithium.

Fifty-six-year-old Mr Watson was taken to his doctor by his daughter, who described her dad's condition as being critical and possibly dangerous. She explained that her dad was extremely overexcitable, irritable and angry most of the time; he had developed the delusion that he was in possession of special powers and was showing inappropriate elation. She also mentioned that he had been taking antidepressants for a while, following her mother's death one year earlier.

The doctor made a diagnosis and prescribed lithium, advising Mr Watson to stop taking his antidepressant medication and also not to take non-steroidal anti-inflammatory drugs in combination with his new medication.

- Q1** What is your diagnosis of Mr Watson's condition?
- Q2** What are the symptoms of mania?
- Q3** Outline the underlying pathophysiology of mania.
- Q4** Is there a relationship between the development of mania and the use of antidepressants?
- Q5** When lithium therapy is initiated, what is the recommended daily dose?
- Q6** Describe the mechanism of action of lithium.
- Q7** Comment on the side effects associated with the use of lithium.

- Q8** Why was Mr Watson advised not to take non-steroidal anti-inflammatory drugs in combination with lithium? Are any other medications contraindicated for patients taking lithium?
- Q9** Identify alternative drugs which can be used for patients with mania.

CASE STUDY 3 Continual concerns for Mr Watson

Learning outcomes

On completion of the following case study, you will be able to:

- present an overview of manic depressive disorder (bipolar affective disorder) and the associated symptoms;
- describe its pathophysiology and pharmacological approaches to managing the symptoms of manic depressive disorder;
- explain the clinical benefits and side effects of the drugs used.

Mr Watson has now been on medication to treat his mania for the past year. Recently, his daughter consulted their doctor again, expressing concerns about her father's condition. She explained that her father is now experiencing two opposing mood states: these range from depression to periods when he becomes agitated, extremely talkative and does not want to go to sleep. His mood then appears elevated and euphoric and these irritable moods can last for weeks. On further questioning by the doctor, it became clear that her paternal grandfather had also suffered similar mood swings.

- Q1** What is the likely diagnosis for Mr Watson?
- Q2** Comment on the pathophysiology of mood swings in manic depressive disorder.
- Q3** What is the recommended medication for patients with manic depressive disorder?
- Q4** What is the recommended dose of lithium for long-term therapy? Are any special precautions necessary when patients are treated with this agent?
- Q5** Name an alternative medication (including the daily dose) suitable to treat manic depressive illness.
- Q6** Is the fact that Mr Watson's father also suffered from mood swings significant?
- Q7** What advice should be given to patients with manic depressive illness?

CASE STUDY 4 A scary presentation

Learning outcomes

On completion of the following case study, you will be able to:

- describe anxiety and the associated neurotransmitters;
- describe symptoms of anxiety, including somatic and psychological symptoms;
- describe its pathophysiology;
- outline the mechanisms of action of common anxiolytic agents;
- explain the mechanism of action of benzodiazepines;
- explain the connection between anxiety, phobia and panic disorder.

Jo had been asked to give a seminar as part of her final-year project. She was anxious to perform well and spent one month preparing for the presentation. During the preparation period, she was irritable, restless and had difficulty in concentrating; she also complained of diarrhoea. Jo asked some of her friends if they would listen to her practise, prior to the final presentation. But as the day of the practise presentation approached, Jo became very tense, pale and sweaty. She felt increasingly apprehensive and uncomfortable, was unable to talk properly as her mouth was dry and she was very aware that her heart was beating rapidly (tachycardia). She visited her doctor to ask for help as she felt unable to carry on with her normal duties in life.

- Q1** What is the likely diagnosis of Jo's symptoms?
- Q2** List the symptoms of anxiety.
- Q3** Outline the somatic and psychological symptoms evident in this case.
- Q4** Which neurotransmitters are mainly associated with anxiety?
- Q5** What is the explanation for Jo's tachycardia (increase in the heart rate)?
- Q6** Which other conditions could be confused with anxiety?

- Q7** What could the doctor prescribe for Jo?
- Q8** What are anxiolytics? Your answer should cover the major subdivisions of this class of drug.
- Q9** By giving an example of a benzodiazepine, explain the mechanism of action of the named agent in anxiety.
- Q10** What are the main concerns associated with the use of benzodiazepines?
- Q11** Explain the mechanism of action and usual daily dosage of an anxiolytic agent which does not belong to the benzodiazepine class.
- Q12** Can anxiety develop into a phobic state and/or a panic disorder?

CASE STUDY 5 Fussy Jane

Learning outcomes

On completion of the following case study, you will be able to:

- present an overview of obsessive–compulsive disorder and the associated symptoms;
- describe its pathophysiology;
- explain the pharmacological approaches to managing the symptoms of this condition.

Finally, after checking the luggage several times, Jane and her husband managed to get out of the house in time to go to the airport for their holiday abroad. On their way to the airport, Jane asked her husband if they could go back and check the front door once more. She was not sure that the door was properly locked. Her husband reminded Jane that she had checked the door twice before they left. However, Jane did not take ‘no’ for an answer and insisted on going back to the house. In the past year, her husband had become increasingly aware of Jane’s odd behaviours and was fed up with her unnecessary checking of everything several times. Even in the kitchen she would re-wash the crockery, clean all the surfaces several times and repeatedly wash her hands. After returning from their holiday, her husband persuaded Jane to visit their doctor.

- Q1** What is the likely diagnosis of Jane’s symptoms?
- Q2** What are the characteristics of obsessive–compulsive disorder?
- Q3** What is the underlying pathophysiology of this condition?
- Q4** (A) Name three drugs that can be prescribed for patients with obsessive – compulsive disorder. (B) Comment on the mechanism of action of the drugs you have mentioned in part A.
- Q5** Are any other treatments suitable for this condition?

CASE STUDY 6 David's withdrawal

Learning outcomes

On completion of the following case study, you will be able to:

- describe schizophrenia and its associated positive and negative symptoms;
- describe the causative factors and associated neurotransmitters;
- explain the pharmacological approaches to managing the symptoms;
- explain how neuroleptic drugs may produce their clinical benefits and side effects;
- outline the benefits of using haloperidol in schizophrenic patients.

Emma made an appointment for her 27-year-old brother, David, to visit his doctor and persuaded him to keep the appointment. She has been very concerned about his recent behaviour and thoughts. David claims to be able to see and talk to his mum, who died 10 years ago. Recently, he has avoided visits to his local football club and he no longer mixes with his friends. Sometimes he talks very slowly and quietly but on some occasions he is very loud and violent in speech. David has not previously been a religious man, but recently he keeps talking about God. He appears to think that God is talking to him, asking him to perform certain tasks. David was initially very reluctant to talk to the doctor but eventually revealed that he thought his sister was trying to poison him, so he had stopped eating at home. His doctor made a diagnosis and prescribed haloperidol.

- Q1** What is the likely diagnosis of David's symptoms?
- Q2** What are the positive symptoms of schizophrenia?
- Q3** What are the negative symptoms of schizophrenia?
- Q4** Can both positive and negative symptoms occur together?
- Q5** Identify the positive and negative symptoms presented in this case.
- Q6** Are all David's symptoms consistent with the profile of schizophrenia?

- Q7** What other conditions could be confused with schizophrenia and should be eliminated before a final diagnosis is made?
- Q8** What is the main neurotransmitter associated with schizophrenia?
- Q9** What are the possible causes of schizophrenia?
- Q10** To what category of drugs does haloperidol belong? Comment on the mechanism of action of haloperidol.
- Q11** Name other neuroleptic drugs you know of and comment on the problems associated with neuroleptic therapy.

CASE STUDY 7 Forgetful mum

Learning outcomes

On completion of the following case study, you will be able to:

- describe Alzheimer's disease and its associated symptoms;
- describe its pathophysiology and associated neurotransmitters;
- outline pharmacological approaches in managing its symptoms;
- describe the benefits in the use of anticholinesterase inhibitors in managing the symptoms and their associated drawbacks.

Robina was very worried about her mum who is in her early sixties. It was the second time that her mum had forgotten to pick up her granddaughter from school. She noticed that her mum was becoming increasingly absent-minded and that, although Robina repeated everything that her mum needed to do on a daily basis, she still forgot to do it. This reminded Robina of her grandmother, as she was also very absent-minded and needed help in managing her daily routine tasks. Her mum had previously revealed that there was some history of being absent-minded in the family and, as her mum's condition was getting worse, Robina made an appointment for her to see their doctor. The doctor made a diagnosis and referred the patient to a local specialist clinic, where donepezil was prescribed.

- Q1** What is the likely diagnosis for Robina's mum?
- Q2** What is Alzheimer's disease?
- Q3** Comment on its pathophysiology.
- Q4** Which neurotransmitter is mainly associated with Alzheimer's disease?
- Q5** To which category of drugs does donepezil belong?
- Q6** Comment on the mechanism of action of cholinesterase inhibitors.
- Q7** What are the adverse effects associated with cholinesterase inhibitors?
- Q8** Are other drugs effective in Alzheimer's disease?